

ESCUELA SUPERIOR POLITÉCNICA DEL LITORAL

**Facultad de Ingeniería en Mecánica y Ciencias de la
Producción**

“Selección de Equipos, Montaje y Puesta en Marcha de una
Planta de Refrigeración de Dos Etapas”

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Es mi deseo expresar mi gratitud a cada una de las personas que de diversas maneras han colaborado para que la realización de este trabajo se materialice, especialmente al Ing. Ignacio Wiesner. Director de Tesis.

DEDICATORIA

A mi esposa, hijos, y con el mayor de los afectos a mis padres.

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RESUMEN

En el presente trabajo muestra los pasos que se siguieron para la selección, montaje y puesta en marcha de nuevos equipos en la planta de refrigeración de una empresa dedicada a la producción de café soluble, aumentando de esta forma la capacidad instalada, como parte del proyecto de incremento de la producción de café liofilizado en un 100%

Para lograr el incremento establecido previamente, se planteo la necesidad de rehabilitar una línea de producción que se encontraba fuera de servicio por mas de 15 años.

En la primera parte se consideró la capacidad instalada, la carga térmica del sistema y se seleccionaron los equipos requeridos para las nuevas necesidades.

El montaje de los equipos y la puesta en marcha se realizó conforme al cronograma ajustado a las circunstancias de parar la producción de acuerdo a los programas normales de mantenimiento, reiniciando el proceso productivo con ambas líneas de liofilización.

Una vez realizado el arranque de la planta se realiza el análisis del funcionamiento de la misma y se analiza el nuevo comportamiento del

sistema de refrigeración, comparando los parámetros de operación de la planta Antes vs. Después.

Después de los cambios realizados se tienen las siguientes mejoras: incremento en el valor del coeficiente de performance del sistema, de 1.53 a 1.82, la elevación de la presión de evaporación en los sistemas de congelamiento y liofilización (2" Hg) y el descenso de la presión de condensación (20 psig).

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ABREVIATURAS

| | |
|-------------|---|
| Lbs | Libras |
| Hr | Hora |
| mm | Milímetros |
| RPM | Revoluciones por minutos |
| Kgs | Kilogramos |
| COP | Coeficiente de Performance |
| PLC | Programmable Logic Control |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society of Testing and Measurement |

SIMBOLOGIA

| | |
|-------------|--|
| % | Porcentaje |
| " | Pulgada |
| ® | Marca Registrada |
| Ø | Diámetro |
| HG | Mercurio |
| Psig | Libras por pulgadas cuadradas manométricas |
| Psia | Libras por pulgadas cuadradas manométricas |
| °C | Grados Centígrados |
| °F | Grados Fahrenheit |
| Btu | British Thermal Unit |
| ∑ | Sumatoria |
| HP | Caballos de Fuerza |
| BHP | Caballos de Fuerza al freno |
| Q | Calor |
| V | Voltios |
| Hz | Hertz |
| Cp | Calor específico |
| M | Masa |
| ΔT | Variación de temperatura |
| Qs | Calor de sublimación |
| L | Calor latente |
| TR | Toneladas de refrigeración |

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INTRODUCCIÓN

En el año 1997, en la planta industrial dedicada a la elaboración de café soluble, donde me desempeñé como Ingeniero de Refrigeración, la gerencia plantea la necesidad de incrementar las ventas de producto debido a la gran demanda internacional, para lograr este objetivo fue necesario la rehabilitación de una línea de producción que se encontraba fuera de funcionamiento por muchos años. Esta línea es de la misma capacidad de la que a la fecha estaba en operación.

Para producir café instantáneo liofilizado, el extracto de café es primeramente congelado; luego el contenido de humedad es sublimado aplicando temperatura moderada en un túnel con ambiente al vacío. Uno de los componentes principales en el proceso es la producción de frío a muy baja temperatura. La planta de refrigeración proporciona la cantidad de frío necesario para el proceso.

Como parte del equipo de trabajo, me correspondió determinar si la capacidad instalada en la planta de refrigeración sería suficiente para abastecer a la segunda línea de producción, lamentablemente ésta no poseía capacidad suficiente para las dos líneas de proceso, Las unidades que se encuentran operativas tienen aproximadamente 20 años de funcionamiento, y su eficiencia se ha visto reducida considerablemente a pesar de haber

contado con planes de mantenimiento oportunos, por tanto se toma la decisión de comprar equipos nuevos cuya capacidad sumada a la de los equipos instalados suplan las necesidades de ambas líneas de producción.

Los componentes originales de la planta de refrigeración son de la marca Vilter® y han probado a través del tiempo su calidad y buen desempeño por lo que se decide mantener esta línea de equipos.

Una vez realizadas las negociaciones y puesta la orden de compra, empieza a correr el tiempo planificado en el cronograma, haciendo coincidir los tiempos de fabricación, importación y montaje de los equipos con el tiempo normal de producción, en tanto que el período de mantenimiento coincide con la interconexión de la planta antigua con la moderna. Como parte de la garantía el fabricante envía a un técnico de servicio para realizar la inspección de la instalación, calibración de equipos y arranque inicial.

El arranque de la planta tuvo lugar desde el 20 al 24 de Julio de 1998. La nueva planta de refrigeración trabajó sólo para una línea de producción. La segunda línea de liofilización inició su producción en el mes de Octubre de 1998. La planta de refrigeración pudo abastecer sin problemas a las dos líneas de producción, lográndose de esta forma el objetivo planteado por la gerencia.

CAPITULO 1

1. IDENTIFICACIÓN DEL PROBLEMA Y SELECCIÓN DE EQUIPOS

1.1 Descripción De La Planta

En la figura 1.1 se muestran los siguientes componentes de la planta:

1. Compresores de primera etapa
2. Intercoolers
3. Compresores de segunda etapa
4. Condensadores evaporativos
5. Recibidores de refrigerante líquido
6. Máquinas de hielo
7. Evaporadores
8. Trampas de succión
9. Liofilizador

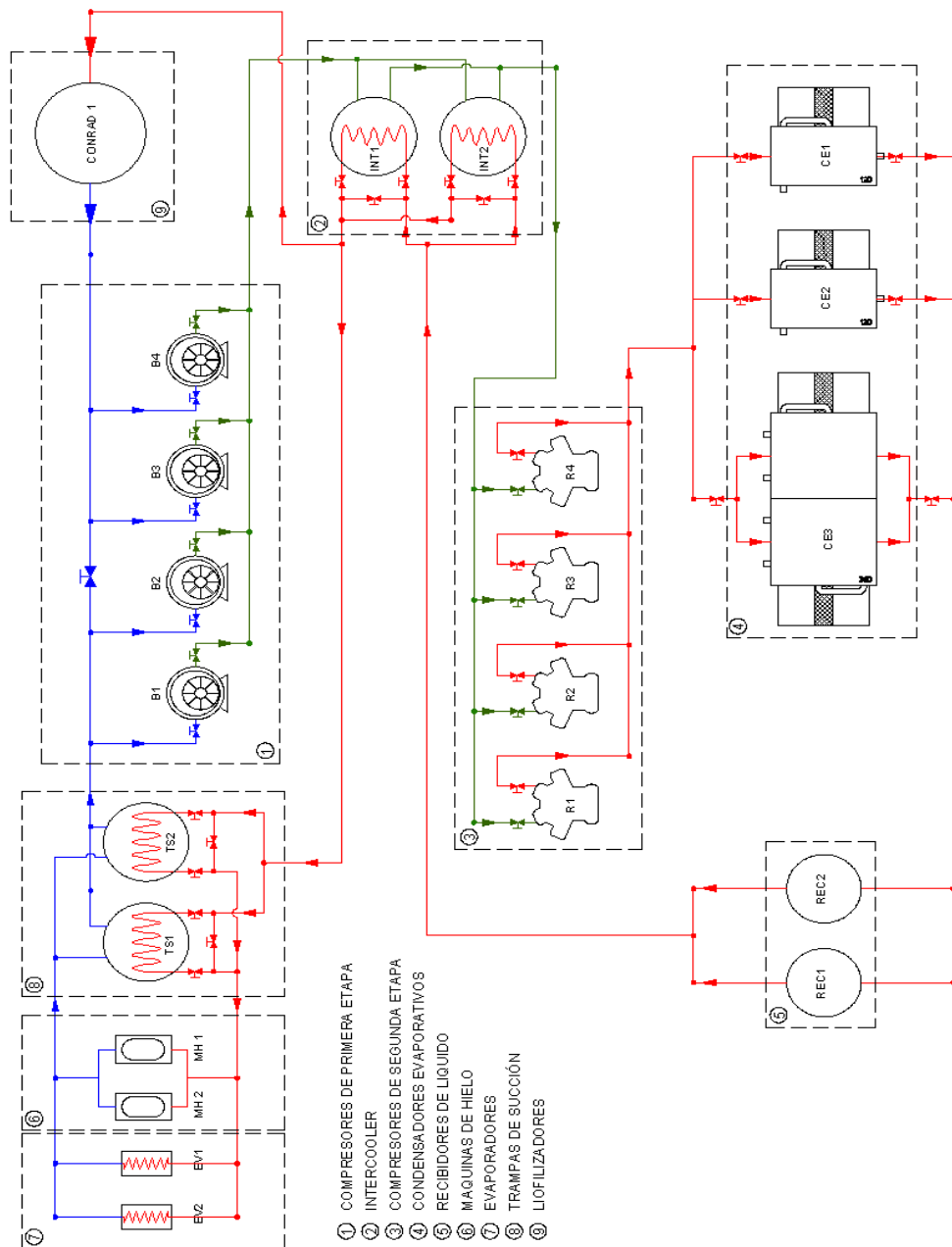


Figura 1.1 Diagrama de la Planta de Refrigeración

En la primera etapa de compresión existen dos niveles diferentes de evaporación. Los compresores conocidos como Booster 1 y 2 (B1 y

B2), son compresores rotativos de paletas que trabajan para la etapa de congelamiento y granulación obteniendo una presión de succión de 20"Hg, con temperatura de evaporación de -60°C .

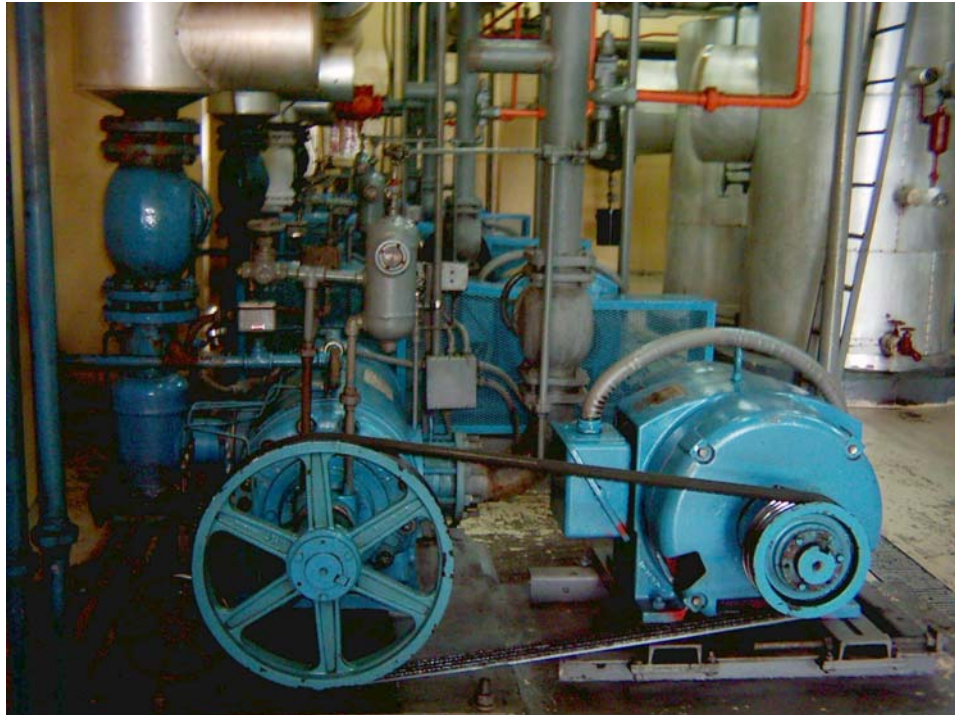


Figura 1.2 Compresor rotativo VRB-11

Los compresores Booster 3 y 4 (B3 y B4) trabajan para la etapa de liofilización logrando una presión de evaporación de 14"Hg, con temperatura de evaporación de -50°C .

Para el congelamiento de producto que se encuentra inicialmente líquido a aproximadamente 16°C se utilizan dos máquinas de hielo (MH1 y MH2), las cuales son tambores inundados con amoníaco a –

60°C. La temperatura de congelamiento del producto es de -45°C . Luego el producto congelado ingresa a una cámara frigorífica enfriada por dos evaporadores (E1 y E2) tipo inundado y mantienen la temperatura de la cámara a -40°C .

Las trampas de succión son tanques acumuladores, los cuales reciben cualquier exceso o rebose de amoníaco líquido proveniente de las maquinas de hielo o de los evaporadores, y evitan que el refrigerante líquido llegue directamente a los compresores.



Figura 1.3 Trampas de Succión

La etapa en la que se somete el producto congelado a un proceso de liofilización, trabaja a una temperatura de evaporación de -40°C , y

utiliza un sistema de recirculación de amoníaco a través de serpentines para captar el vapor de agua producto de un proceso de sublimación.

Los cuatro compresores booster tienen un punto común de descarga de refrigerante a 15 psig. y temperatura de descarga alta. Este valor de presión se lo conoce comúnmente como presión intermedia.

Este gas a presión intermedia debe ingresar a los compresores de la segunda etapa, pero tiene que ser enfriado y este trabajo se lleva a cabo en el enfriador intermedio (intercooler).



Figura 1.4. Intercoolers

El gas en condiciones de temperatura 0°C y 15 psig, es comprimido por los compresores de segunda etapa y llevado a las condiciones de 180 psig y 120°C. En la segunda etapa de compresión se cuenta con 4 compresores de pistones, los cuales prenden y apagan según lo demande el sistema.



Figura 1.5 Compresor recíprocante VMC-448

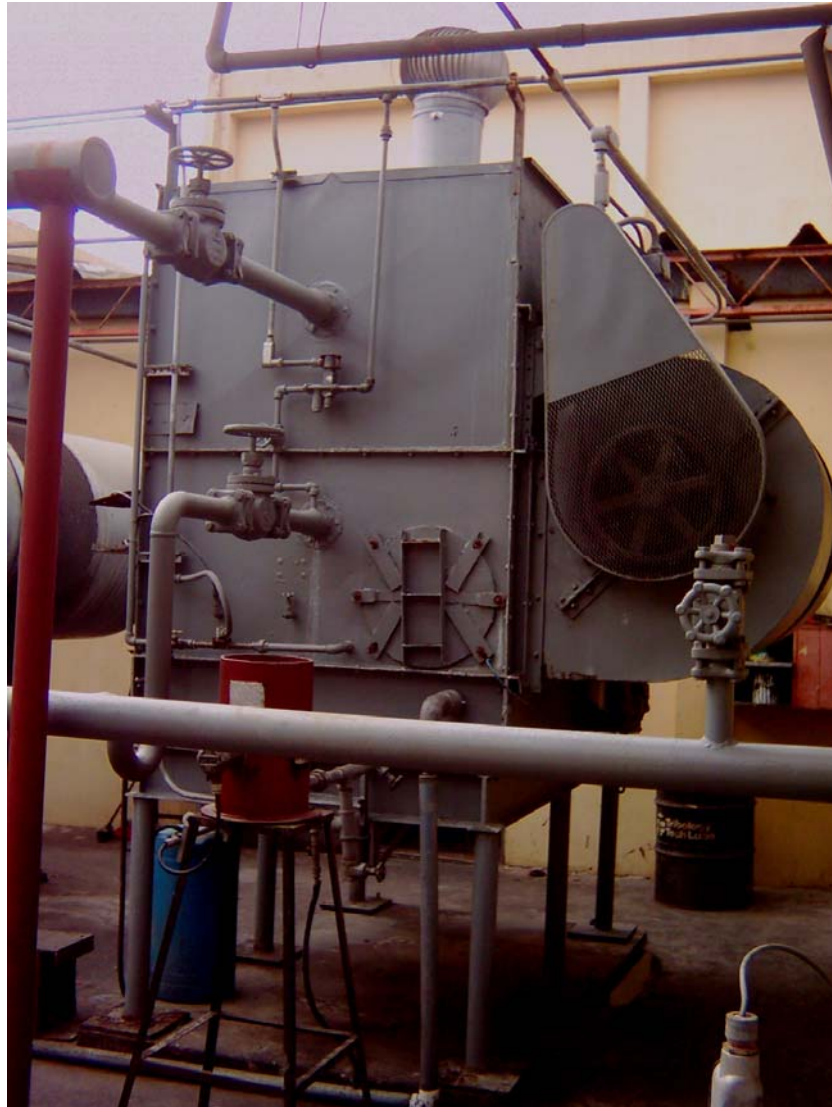


Figura 1.6 Condensador Evaporativo VGC 120

El amoníaco gas es convertido en refrigerante líquido en los condensadores evaporativos y almacenado en los tanques recibidores, desde donde regresará al sistema para continuar el ciclo de refrigeración.



Figura 1.7 Recibidores de refrigerante líquido

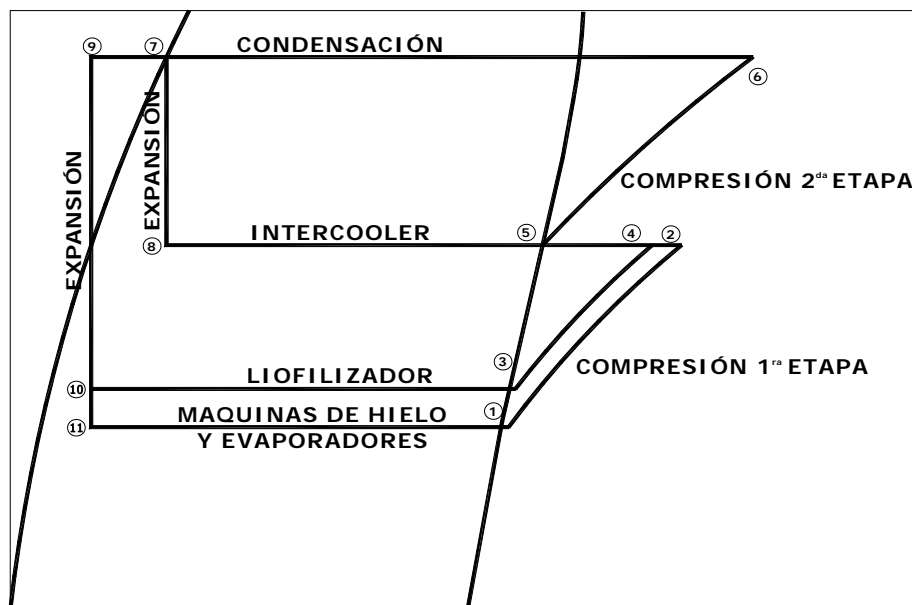


Figura 1.8. Diagrama de Presión Entalpía de la Planta de Refrigeración

Proceso de Liofilización

La liofilización es un método de conservación de los alimentos. Durante este proceso, se dan simultáneamente dos sub-procesos, la congelación del alimento y la remoción del agua del mismo mediante un proceso conocido como sublimación. El alimento congelado es enfriado hasta una temperatura cercana a -40°C , luego de lo cual, es colocado en bandejas dentro de una cámara de refrigeración al vacío, donde se aplicará calor de manera controlada.

Como resultado, el agua del alimento es convertida directamente de su estado sólido a vapor de agua sin haber pasado previamente por el estado líquido.

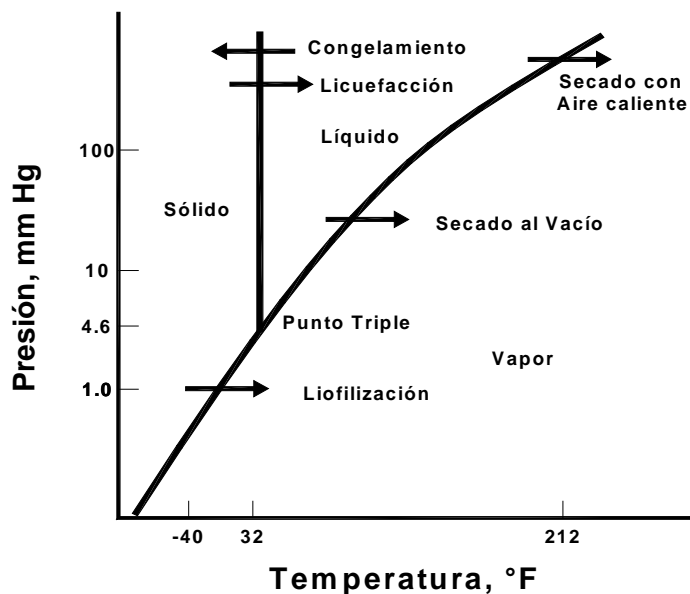


Figura 1.9 Diagrama de Fases del Agua

En la figura 1.9 se presenta el diagrama de fases del agua señalando los diferentes procesos posibles.

En el interior de la cámara al vacío se encuentran intercambiadores de calor por los que circula amoníaco líquido a -40°C . Estos serpentines, conocidos como “trampas de vapor”, captan el vapor de agua sublimado, ya que de lo contrario se perdería el nivel de vacío en el túnel y el producto se dañaría. Esta es la carga real para el sistema de refrigeración.

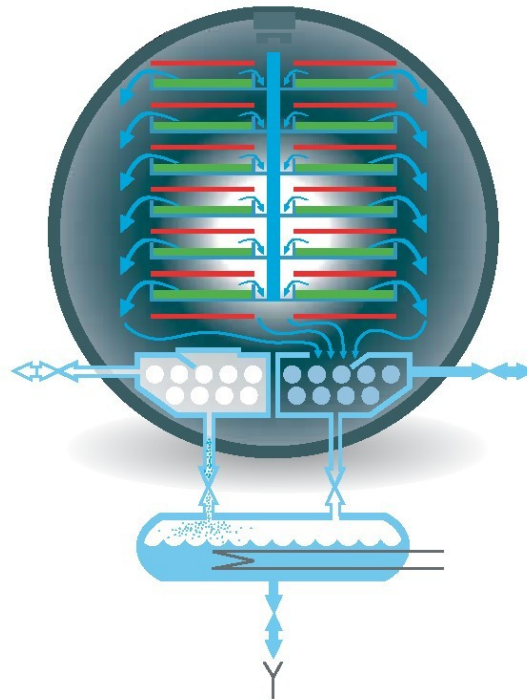


Figura 1.10 Funcionamiento del Liofilizador

La **figura 1.10** muestra el proceso en donde una trampa de vapor (derecha) se encuentra condensando vapor de agua, mientras la trampa de la izquierda se encuentra en descongelamiento.

Este es un sistema de congelamiento y descongelamiento continuo, lo cual permite la producción ininterrumpida. Durante estos cambios de trampa se produce una demanda pico para la planta de refrigeración la cual es esquematizada en la **figura 1.11**. Los compresores boosters no tienen un control de capacidad fino, solamente velocidad baja y alta, y son encendidos según el criterio del operador de turno. La grafica muestra que siempre se encuentran encendidos más compresores de los necesarios, sin importar la demanda del sistema.

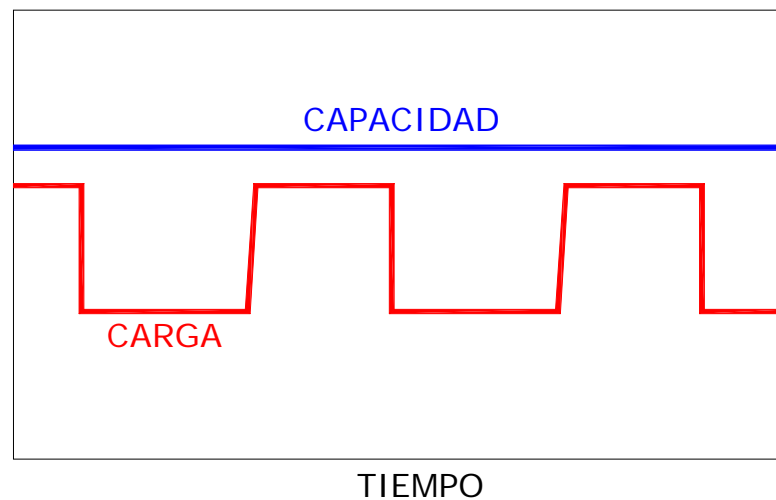


Figura 1.11. Comportamiento de la Carga y la Capacidad

1.2 PARAMETROS INICIALES DE OPERACION

La **figura 1.12** muestra el diagrama Presión vs. Entalpía. (P-h) para un momento de carga máxima. La **tabla 1** indica los valores de presión absoluta, temperatura y entalpía para los diferentes puntos de operación del sistema de refrigeración y es la base para poder realizar el cálculo del coeficiente de performance, COP, que es el indicador del rendimiento del sistema de refrigeración, y se define como la relación entre la cantidad de calor removida y la energía utilizada para operar el ciclo. También se conoce como Efecto Refrigerante / Trabajo del Compresor.

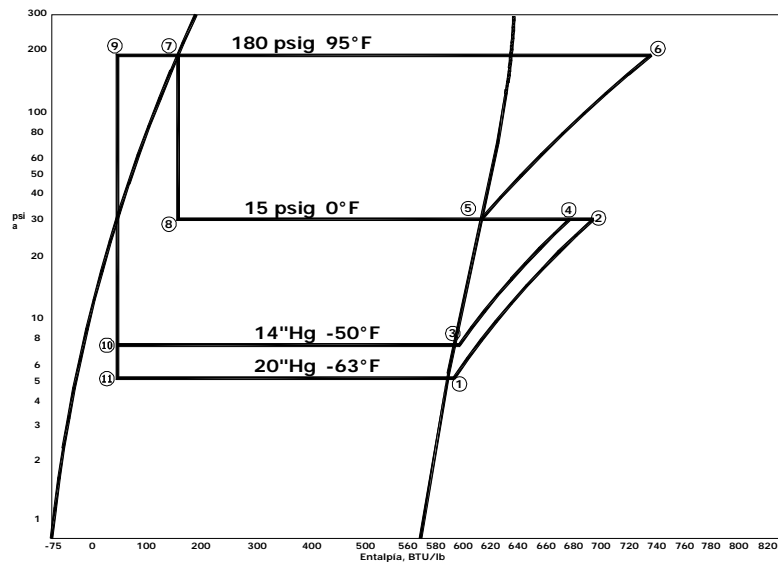


Figura 1.12 Diagrama de Presión Entalpía Inicial de la Planta de Refrigeración

TABLA 1
PARÁMETROS INICIALES DE OPERACIÓN

| | Temp | Presión | Entalpía |
|-------|-------|---------|----------|
| Punto | °F | psia | Btu/lbm |
| 1 | -63,0 | 5,30 | 592,00 |
| 2 | 148,0 | 30,00 | 692,00 |
| 3 | -50,0 | 7,67 | 593,70 |
| 4 | 115,0 | 30,00 | 675,00 |
| 5 | 0,0 | 30,00 | 612,00 |
| 6 | 248,0 | 195,80 | 735,00 |
| 7 | 95,0 | 195,80 | 149,40 |
| 8 | 0,0 | 30,00 | 149,40 |
| 9 | 0,0 | 195,80 | 40,00 |
| 10 | -50,0 | 7,67 | 40,00 |
| 11 | -63,0 | 5,30 | 40,00 |

$$COP = \frac{\sum \text{Efecto Refrigerante}}{\text{Trabajo de Compresor}}$$

$$COP_{inicial} = 1.53$$

Características del amoníaco

Aunque el amoníaco es tóxico, inflamable y explosivo bajo ciertas condiciones, sus excelentes propiedades térmicas lo hacen ser un refrigerante ideal para fábricas de hielo, para grandes almacenes de

enfriamiento, etc., donde se cuenta con los servicios de personal experimentado y donde su naturaleza tóxica es de poca consecuencia.

El amoníaco es el refrigerante que tiene mas alto efecto refrigerante por unidad de peso. El punto de ebullición del amoníaco bajo la presión atmosférica estándar es de 28°F.

En la presencia de la humedad el amoníaco se vuelve corrosivo para los materiales no ferrosos.

El amoníaco no es miscible con el aceite y por lo mismo no se diluye con el aceite del cárter del cigüeñal del compresor. Deberá usarse un separador de aceite en el tubo de descarga de los sistemas de amoníaco.

El amoníaco es fácil de conseguir y es el mas barato de los refrigerantes.

Su estabilidad química, afinidad por el agua y no-miscibilidad con el aceite, hacen al amoníaco un refrigerante ideal para ser usado en sistemas muy grandes.

TABLA 2
PROPIEDADES DEL AMONÍACO

| | |
|------------------------------------|--|
| Fórmula química | NH ₃ |
| Denominación Internacional | R-717 |
| Identificación del cilindro | Negro, con una franja color rojo en el centro |
| Peso molecular | 17 |
| Punto de ebullición | -28°F |
| Punto de solidificación | -108°F |
| Temperatura crítica | 270°F |
| Combustibilidad | En caso que se acerque llama al lugar donde hay filtración. |
| Peligro de explosión | Explota siempre que el amoníaco alcanza, en presencia del aire, una cantidad crítica de alrededor de 13% al 16% y hay chispas o llamas presentes |
| Aspecto visual | Incoloro |
| Olor | Fuertemente irritante |
| Toxicidad | Muy peligroso |

1.3 CAPACIDAD INSTALADA

La capacidad de los equipos instalados en la planta de refrigeración se da en Toneladas de Refrigeración.

TABLA 3
CAPACIDAD DE COMPRESORES VILTER PRIMERA ETAPA DE COMPRESIÓN

| Denominación | Tipo | Modelo | Capacidad TR | Motor HP | Velocidad RPM |
|--------------|----------|--------|--------------|----------|---------------|
| B 1 | Rotativo | VRB 11 | 22 / 34 * | 50 / 75 | 550 / 865 |
| B 2 | Rotativo | VRB 11 | 24 / 36 * | 50 / 75 | 570 / 855 |
| B 3 | Rotativo | VRB 11 | 24 ** | 40 | 394 |
| B 4 | Rotativo | VRB 11 | 35 / 53 ** | 50 / 75 | 564 / 845 |

*-60°F Temperatura de evaporación y 15,7 psig de descarga

**-50°F Temperatura de evaporación y 15,7 psig de descarga

TABLA 4
CAPACIDAD DE COMPRESORES VILTER SEGUNDA ETAPA DE COMPRESIÓN

| Denominación | Tipo | Modelo | Capacidad TR | Motor HP | Velocidad RPM |
|--------------|--------------|---------|--------------|----------|---------------|
| R 1 | Reciprocante | VMC 448 | 52.4 * | 100 | 1200 |
| R 2 | Reciprocante | VMC 448 | 52.4 * | 100 | 1200 |
| R 3 | Reciprocante | VMC 448 | 52.4 * | 100 | 1200 |
| R 4 | Reciprocante | VMC 448 | 52.4 * | 100 | 1200 |

*15,7 psig de succión y 185 psig de descarga

TABLA 5
CAPACIDAD DE CONDENSADORES EVAPORATIVOS VILTER

| | | | Motor HP | | |
|---------------------|---------------|---------------------|----------------------|-------------------|---------------|
| Denominación | Modelo | Capacidad TR | Bomba de Agua | Ventilador | Estado |
| C E 1 | VGC 120 | 85 * | 2 (1) | 15 (2) | Operativo |
| C E 2 | VGC 120 | 85 * | 2 (1) | 15 (2) | Operativo |
| C E 3 | VGC 360 | 256 * | 2 (2) | 20 (4) | Operativo |

* 96,3°F Temp Condensación 20°F Temp Evaporación 78°F Temp Bulbo Húmedo

TABLA 6
CAPACIDAD DE EVAPORADORES

| Denominación | Marca | Modelo | Capacidad TR | Motor Ventilador HP * | Estado |
|---------------------|--------------|------------------|---------------------|------------------------------|---------------|
| E 1 | Vilter | HG-4725-5360 FLA | 18,93 | 1/2 (3) | Operativo |
| E 2 | Vilter | HG-4725-5360 FLA | 18,93 | 1/2 (3) | Operativo |

* Velocidad del ventilador 1800 RPM

TABLA 7
CAPACIDAD DE MAQUINAS DE HIELO

| Denominación | Capacidad lbs / hr | Tiempo de Congelamiento minutos | Estado |
|---------------------|---------------------------|--|---------------|
| M H 1 | 453 - 580 | 1 - 2 | Operativo |
| M H 2 | 453 - 580 | 1 - 2 | Operativo |

Temperatura NH3 -40°F

TABLA 8
CAPACIDAD DE LIOFILIZADOR MARCA ATLAS

| Denominación | Modelo | Capacidad | | | | Estado |
|--------------|--------|--|--------|---|--------|--------------|
| | | Líquidos con 40% materia seca lbs / hr | | Sólidos con 15% materia seca lbs / hr | | |
| | | Entrada | Salida | Entrada | Salida | |
| LIOF 1 | 300 | 758 | 308,56 | 592,33 | 89,54 | Operativo |
| LIOF 2 | 300 | 758 | 308,56 | 592,33 | 89,54 | No operativo |

1.4 Requerimientos de una Línea de Producción

Para poder determinar si la capacidad instalada en la planta de refrigeración es suficiente para poder dar arranque a una segunda línea de liofilización se debe calcular lo siguiente:

- Carga de congelamiento de producto de línea 1.
- Carga en la cámara frigorífica 1.
- Carga en el liofilizador 1.

Cálculo de Carga de congelamiento de producto.

La cantidad máxima de congelamiento de producto se determina a partir de la capacidad máxima del liofilizador: 758 lbs/hr de producto con 40% de sólidos solubles.

| | |
|-----------------------------|--------------|
| Masa de Producto a congelar | 758,00 lb/hr |
| Contenido de agua, 60% | 454,80 lb/hr |
| Contenido de sólido, 40% | 303,20 lb/hr |
| Temperatura inicial | 60°F |
| Temperatura final | -60°F |

Para el congelamiento del agua se deben considerar tres etapas:

1 -2 Enfriamiento desde 60°F a 32°F

2 -3 Cambio de fase a 32°F

3 -4 Subenfriamiento desde 32°F a -60°F

| | |
|--------------------------|--|
| Carga de enfriamiento | $Q_{12} = m \times c_p \times \Delta T_{12}$ |
| Carga de congelamiento | $Q_{23} = m \times L$ |
| Carga de subenfriamiento | $Q_{34} = m \times c_p \times \Delta T_{34}$ |

$$Q_{12} = 12.721,67 \text{ Btu/hr}$$

$$Q_{23} = 65.491,20 \text{ Btu/hr}$$

$$Q_{34} = 19.456,34 \text{ Btu/hr}$$

$$Q_{\text{total agua}} = 97.669,21 \text{ Btu/hr}$$

Para el congelamiento del sólido se considera enfriamiento desde 60°F a -60°F de una sustancia con calor específico 0,4 BTU/lb°F por debajo de 32°F.

$$Q_{\text{sólido}} = 14.553,60 \text{ Btu/hr}$$

Energía necesaria para congelar la mezcla

$$Q_{\text{total agua}} + Q_{\text{sólido}} = 112.222,81 \text{ Btu/hr}$$

$$Q_{\text{total}} = 9,35 \text{ TR}$$

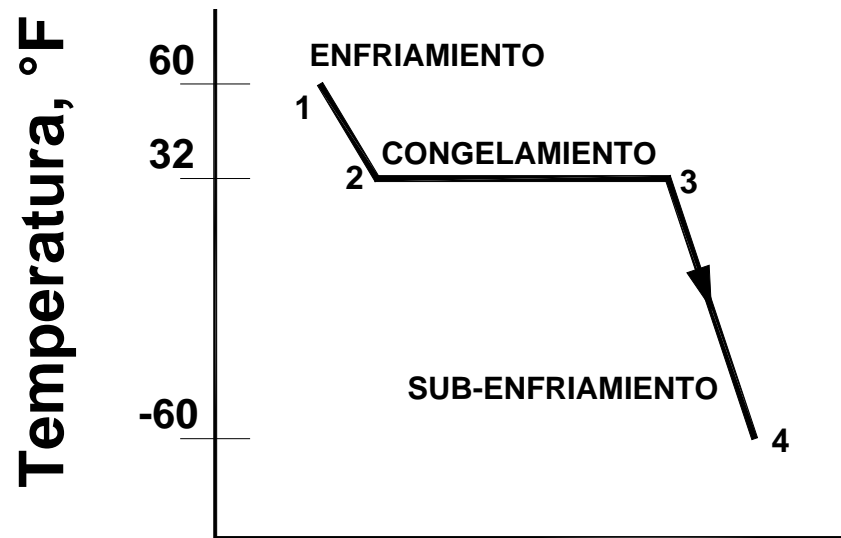


Figura 1.13 CONGELAMIENTO DE AGUA

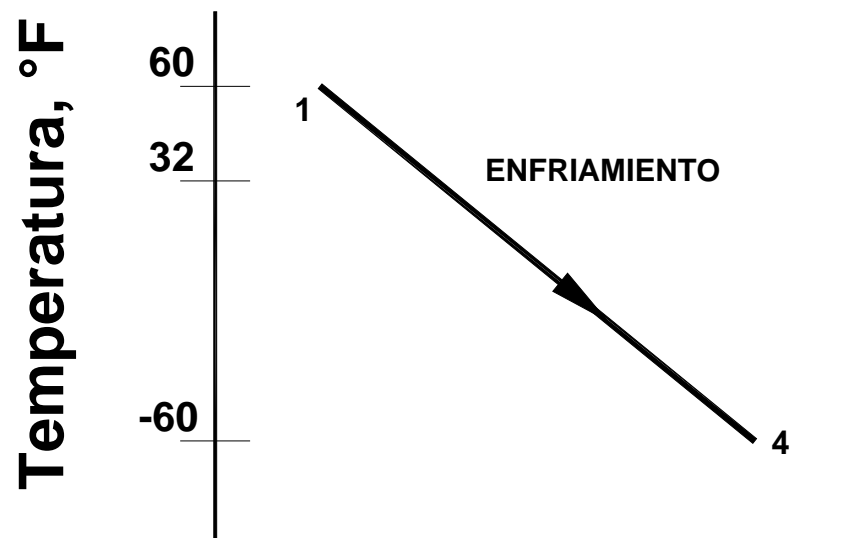


Figura 1.14. CONGELAMIENTO DEL SÓLIDO SOLUBLE

Cálculo de Carga de la cámara frigorífica

Condiciones externas de diseño

| | |
|--|--------|
| Altitud | 0 pies |
| Temperatura exterior de bulbo seco | 61°F |
| Temperatura exterior de bulbo húmedo | 57°F |
| Temperatura de bulbo seco de aire infiltrado | 61°F |
| Temperatura de bulbo húmedo de aire infiltrado | 57°F |

Condiciones internas de diseño

| | |
|------------------------------------|-------|
| Temperatura interior de bulbo seco | -40°F |
| Humedad relativa del cuarto | 30 % |

**TABLA 9
DESCRIPCIÓN DE CARGAS**

| | | Horas de Trabajo | Carga Btu/hora | % Carga Total |
|--------------|-----------------------|------------------|------------------|---------------|
| Pared sur | 594 pies ² | 24 | 959,9 | 0,43% |
| Pared norte | 594 pies ² | 24 | 959,9 | 0,43% |
| Pared este | 360 pies ² | 24 | 581,8 | 0,26% |
| Pared oeste | 360 pies ² | 24 | 581,8 | 0,26% |
| Techo | 660 pies ² | 24 | 2.178,0 | 0,97% |
| Piso | 660 pies ² | 24 | 1.372,8 | 0,61% |
| Personas | 1 | 20 | 1.208,0 | 0,54% |
| Motores | 32 hp | 24 | 81.280,0 | 36,10% |
| Luces | 240 watts | 24 | 819,0 | 0,36% |
| Agua | 11 lbs | 24 | 2.235,0 | 0,99% |
| Bandejas | 966 | 24 | 23.426,0 | 10,40% |
| Infiltración | 845 cfm | 24 | 109.568,0 | 48,66% |
| | | | 225.170,2 | 100,0% |

Capacidad requerida por hora

225.170,2 Btu/hr
18,8 TR

Cálculo de Carga en el liofilizador

$$\text{Carga de sublimación} \quad Q = m \times L$$

El liofilizador tiene una capacidad para sublimar 449 libras de agua por hora.

$$Q_s = 809.883,75 \text{ Btu/hr}$$

$$Q_s = 67,49 \text{ TR}$$

TABLA 10

REQUERIMIENTOS DE UNA LÍNEA DE PRODUCCION

| | Instalada | Necesaria | Diferencia |
|---------------------|-----------|-----------|------------|
| 1ra eta comp. -60°F | 46 | 30,97 | 15,03 |
| 1ra eta comp. -50°F | 77 | 74,24 | 2,76 |
| 2da eta comp.* | 209.6 | 164,13 | 43,87 |
| Condensación | 282 | 164,13 | 117,87 |

Capacidad en Toneladas de Refrigeración

* Ver **Apendice H** High Stage Multipliers for two stage systems

TABLA 11
REQUERIMIENTOS DE DOS LÍNEAS DE PRODUCCION

| | Instalada | Necesaria | Diferencia |
|---------------------|-----------|-----------|----------------|
| 1ra eta comp. -60°F | 46 | 61,94 | -15,94 |
| 1ra eta comp. -50°F | 77 | 148,48 | -71,48 |
| 2da eta comp.* | 209.6 | 328,26 | -120,26 |
| Condensación | 282 | 328,26 | -46,26 |

* Ver **Apndice H** High Stage Multipliers for two stage systems

De esta tabla se deduce que es necesaria la instalación de equipos en las diferentes etapas del sistema de refrigeración, cuya selección se determinará a continuación.

1.5 Selección de equipos

Para la selección de equipos se tomarán los siguientes lineamientos:

- a) Se seleccionarán equipos marca Vilter.
- b) Debido a que la eficiencia de los compresores rotativos ha disminuido por desgaste y fugas internas, se tomará en cuenta solamente su capacidad a baja velocidad y darán servicio para los túneles de liofilización.
- c) En la segunda etapa, se seleccionará un compresor que tenga la misma capacidad que los 4 compresores reciprocantes.

- d) Debido a que la eficiencia de los condensadores evaporativos ha disminuido por problemas de incrustación y corrosión, no se toma en cuenta su capacidad nominal al 100%.

Del **Apendice H** *Booster Compressor ratings*. se selecciona para cada línea de congelamiento de producto y cuarto de frío un compresor de tornillo modelo VSS-751, 43.3 TR y 71.5 BHP, trabajando a -60°F temperatura de evaporación, 18.7" Hg presión de evaporación y 0°F temperatura de descarga, 15.6 psig presión de descarga.

Se selecciona para la línea de liofilización un compresor de tornillo modelo VSS-1051, 85.2 TR y 102.8 BHP, trabajando a -50°F temperatura de evaporación, 14.4" Hg presión de evaporación y 0°F temperatura de descarga, 15.6 psig presión de descarga.

Para seleccionar un compresor de segunda etapa se debe considerar la capacidad máxima de puede manejar cada compresor de primera etapa.

| | |
|---------------|----------|
| VSS 751 | 43.3 TR |
| VSS 751 | 43.3 TR |
| VSS 1051 | 85.2 TR |
| BOOSTERS 4, 5 | 77.0 TR |
| | 248,8 TR |

| | |
|-------------------------------------|-----------|
| Multiplicador de 2da etapa | 1.56 |
| Carga para Compresores de 2da etapa | |
| etapa | 388.12 TR |
| Instalada | 208,00 TR |
| Faltante | 180,12 TR |

Se selecciona para la segunda etapa de compresión un compresor de tornillo modelo VSS-901, 210.9 TR y 319.8 BHP, trabajando a 0°F temperatura de evaporación, 15.6 psig presión de evaporación y 95°F temperatura de condensación, 180.6 psig presión de descarga. Ver

Apéndice H.



Figura 1.15. Compresor de Tornillo

Selección de Condensador

| | |
|---------------------------|-----------|
| Carga para condensadores: | 388.12 TR |
| Capacidad Disponible: | 282.00 TR |
| Faltante | 106.12TR |

Se selecciona Condensador Evaporativo VGC 360 con capacidad para 169.2 TR a las siguientes condiciones:

| | |
|--------------------------|-------|
| Temperatura bulbo húmedo | 82 °F |
| Temperatura bulbo seco | 95 °F |
| Factor de Capacidad | 0,5 |
| Factor de Corrección | 0,94 |

Ver **Apéndice G** Condensadores Evaporativos.

CAPITULO 2

2. MONTAJE MECÁNICO

2.1 Cronograma de trabajo

El cronograma de trabajo se inicia en el mes de Septiembre de 1997 con el estudio de factibilidad del proyecto, existiendo tareas como las de fabricación de equipos cuyo desarrollo coincidirá con el avance de la obra civil, montaje de tuberías y otras tareas que no interfieren con el funcionamiento de la planta.

La parada por el mantenimiento general de la fábrica se hace coincidir con la llegada y puesta en sitio de los equipos, para poder realizar un alto total en la planta de refrigeración, teniendo inclusive que retirar el refrigerante del sistema.

Para esta labor se tuvieron que realizar los trámites correspondientes ante el CONSEP, ya que el uso del amoníaco es una sustancia controlada por esta institución.

El cronograma finaliza con la puesta en marcha de los equipos para la producción primero con una línea de liofilización y más adelante con dos líneas de liofilización.

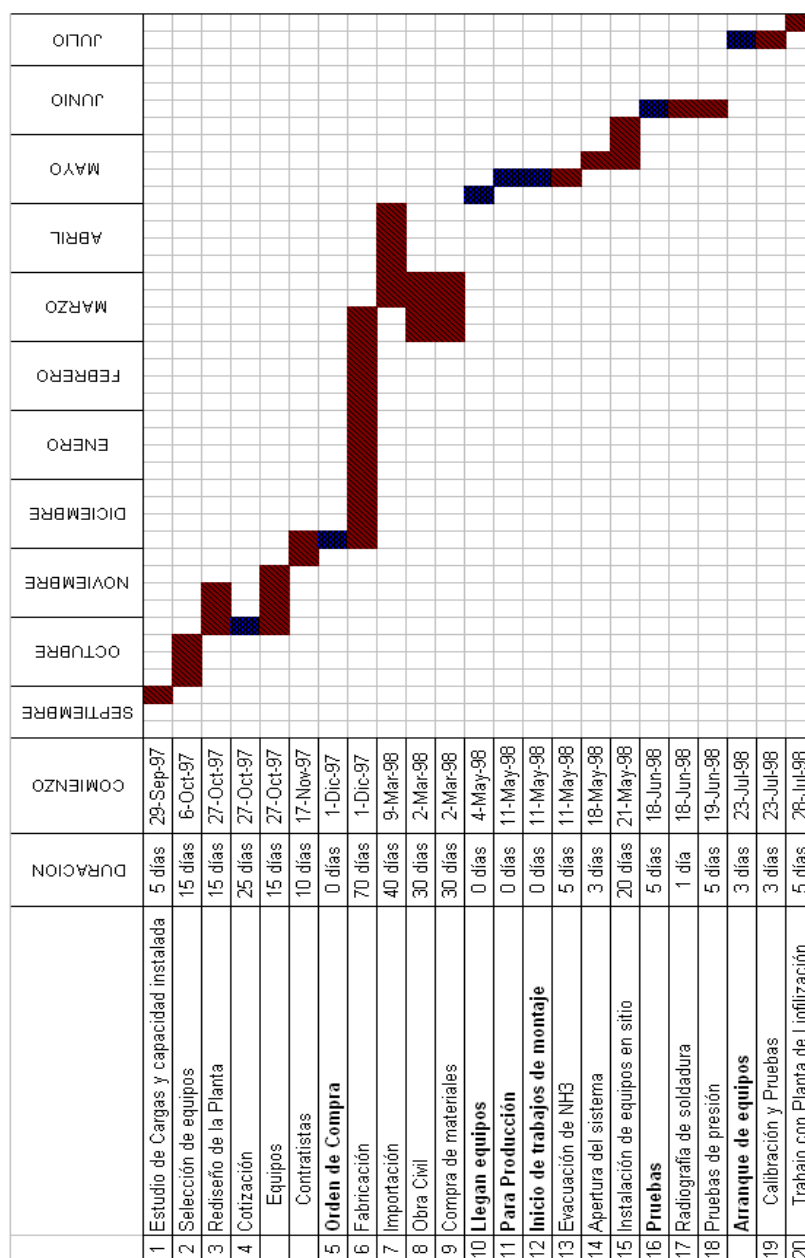


Figura 2.1 Cronograma de Trabajo

2.2 Montaje de Equipos

Los equipos a instalar son:

2 Compresores de Tornillo VSS 751

1 Compresor de Tornillo VSS 901

1 Compresor de Tornillo VSS 1051

1 Condensador Evaporativo VGC 360

Los compresores a instalar son:

Compresor del tipo tornillo Vilter[®], modelo VSS-751-VVR-A-B-NEC-LI, 43.3 TR, de capacidad, operando a -60°F succión, 15.7 psig descarga, utilizando 71.5 BHP, con motor de 75 HP.

Compresor del tipo tornillo Vilter[®], modelo VSS-1051-VVR-A-B-NEC-LI, 85.2 TR, de capacidad, operando a -50°F succión, 15.7 psig descarga, utilizando 102.8 BHP, con motor de 125 HP.

Compresor del tipo tornillo Vilter[®], modelo VSS-901-VVR-A-B-NEC-LI, 210.9 TR, de capacidad, operando a 0°F succión, 180.6 psig descarga, utilizando 345 BHP, con motor de 350 HP.



Figura 2.2 Compresor de Tornillo VSS 1051

Los compresores de tornillo VSS son básicamente máquinas libres de vibración. Por consiguiente ninguna base especial es necesaria.

El suelo o fundación en que la unidad se pondrá debe ser diseñado para soportar el peso de funcionamiento entero de la unidad.

La figura 2.3 muestra las recomendaciones del fabricante para la preparación de la base.

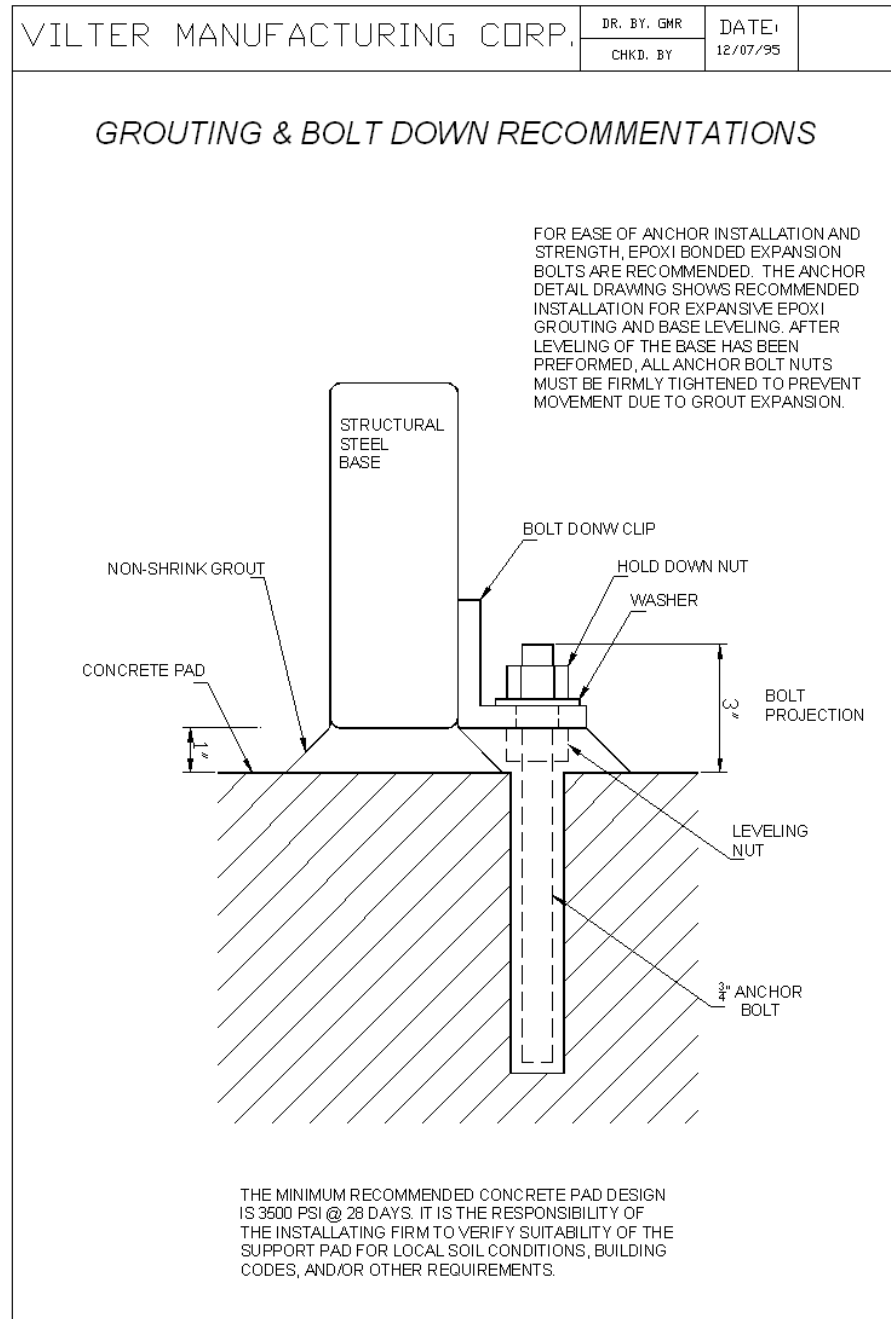


Figura 2.3 Diagrama típico de anclaje de compresores.

Estos tres modelos tienen las siguientes características:

- Válvula deslizante de reducción de capacidad infinita desde 10% a 100% accionadas por servo motor.
- Válvula deslizante de reducción de volumen.
- Bomba de recirculación del aceite de lubricación remota.
- Válvula reguladora de presión de aceite de lubricación.
- Acople motor-compresor con su protector.
- Válvula de retención a ser instalada en la descarga después del separador de aceite.
- Filtro tipo de malla en la succión.
- Separador de aceite de múltiples etapas incluye: dos visores de nivel, válvula de drenaje de seguridad dual y calefactor.
- Enfriamiento del aceite por medio de inyección de refrigerante líquido.
- Filtro de aceite intercambiable de alta capacidad micrónica.
- Panel de control con microprocesador incorporado para operar a 115V. Incluye lo siguiente:
- Lectura continua de presiones, temperaturas, valores de retardo, límites de control y seguridad, tiempo de operación, amperaje de consumo en el motor, porcentaje de capacidad y posición de las válvulas deslizantes.

- Controles de seguridad, alarma e interrupción de operación incluyendo: alta presión de descarga, baja presión de succión, baja temperatura de succión, baja presión de lubricación, alta y baja temperatura de aceite, alto diferencial de presión a través del filtro de aceite y alto consumo de amperios a través del motor.
- Controles de operación incluyendo: Control de máximo consumo de amperios en el motor, control manual o automático de reducción de capacidad, control manual o automático de volumen, límite de arranques del motor por hora, control de reducción de capacidad, contactos de arranque y parada.
- Panel con todos los transductores necesarios.
- Arrancador de estado sólido (Soft Start), para operar a 460V/3PH/60Hz, control 110V, incluye circuit breaker.

Procedimiento de alineación del acople Motor-Compresor

El equipo a utilizar es el sistema OPTALIGN de alineación Láser.

- Examen del motor y compresor, revisión de manuales para determinar tolerancia de alineamiento.
- Instalación del medidor láser.

- Medición inicial, determinación de la posición del motor eléctrico respecto al compresor.
- Realizar corrección de patas cojas.
- Movimiento(s) del motor eléctrico hasta alcanzar el valor de tolerancia establecido.
- Ajuste de los pernos de sujeción.
- Medición final de alineamiento. La tolerancia debe estar dentro de 0.004"(4/1000") o 0.010cm (10/1000cm) al verificar la alineación en caliente.
- Después de que la rotación del motor se ha verificado (en el sentido de las agujas del reloj al mirar el eje del motor) se puede instalar el espaciador en la sección intermedia del matrimonio.

Condensador Evaporativo

Las características del condensador evaporativo Vilter[®] son: modelo VGC 360, 219.9 TR operando a una temperatura de 0°F de succión, 96.3°F temperatura de condensación y 80°F temperatura de bulbo húmedo. Incluye válvulas de servicio en la entrada y la salida de refrigerante.

El condensador evaporativo se ubicará en un edificio aledaño al edificio original, a la misma altura que los condensadores existentes, y asegurando la circulación de aire. Se instalan trampas de líquido a la salida de los serpentines.

También, se instala una línea de ecualización para mantener una presión estable en el recibidor para asegurar el drenaje libre desde los condensadores.

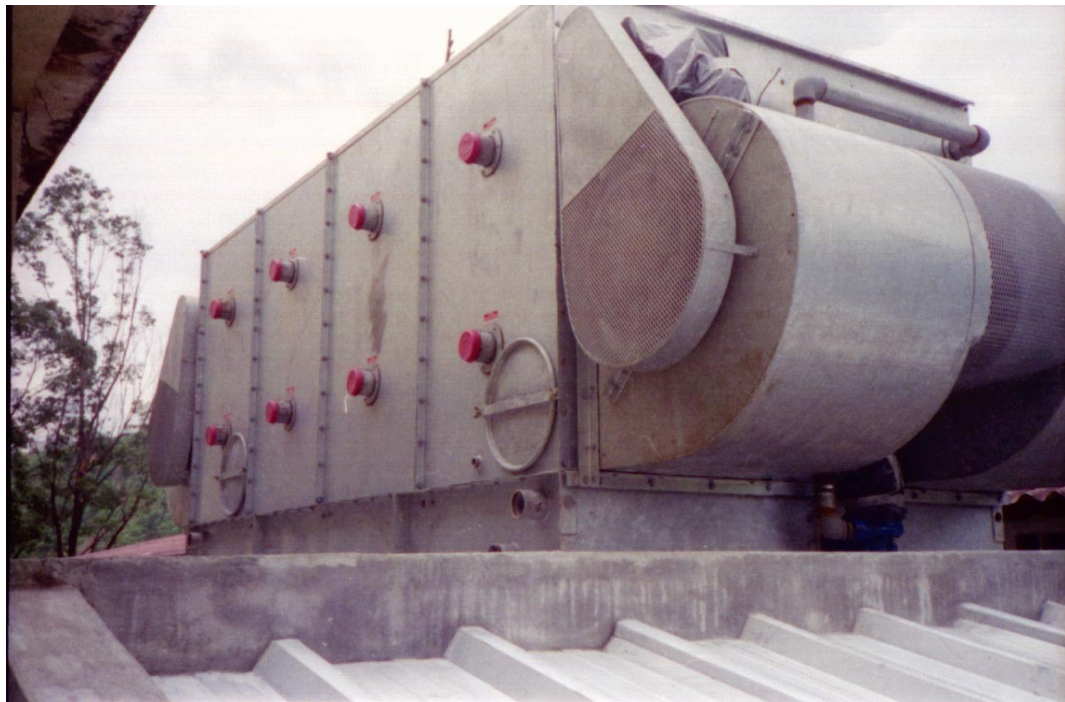


Figura 2.4. Condensador Evaporativo VILTER VGC 360



Figura 2.5. Fundición de losa para Condensador Evaporativo

2.3 Trabajos de soldadura y aplicación de normas

Los trabajos de soldadura que se realizan son los siguientes:

Nueva línea principal de succión Ø8". Primera etapa

Succión de compresores VSS de Primera etapa

Nueva línea principal de descarga Ø8". Primera etapa

Descarga de compresores VSS de Primera etapa

Tubería de succión de compresores de segunda etapa Ø8"

Tubería de succión de compresores recíprocos Ø5"

Tubería de succión de compresor de tornillo VSS-901

Tubería de descarga de boosters VSS

Tubería de inyección de líquido Ø2" (L~45m)

Tuberías de líquido y gas de Condensador Evaporativo Ø4"

Línea de Equalización Ø1 ½"

Materiales de Tuberías y Accesorios

La tubería de amoníaco debe estar conforme a ANSI/ASME, B31.5 Código para tubería bajo presión, y ANSI/IIAR 2-1992, Equipment Design and Installation of Ammonia Mechanical Refrigeration Systems que declara:

1. Líneas de líquido de $\varnothing 1\frac{1}{2}$ " y menores deben ser de tubo de acero al carbono de cédula 80.
2. Líneas de líquido desde $\varnothing 2$ " hasta $\varnothing 6$ " deben ser de tubo de acero al carbono de cédula 40.
3. Líneas de vapor de $\varnothing 6$ " y menores deben ser de tubo de acero al carbono de cédula 40.
4. Líneas de vapor desde $\varnothing 8$ " hasta $\varnothing 12$ " deben ser de tubo de acero al carbono de cédula 20.
5. La tubería de acero al carbono debe ser ASTM A-53, tipo E (soldado con resistencia eléctrica) o tipo S (sin costura), grado A o B; o A-106 (sin costura), grado A o B.
6. A-53 grado F no se permite para tubería de amoníaco.



Figura 2.6 Instalación de Tuberías

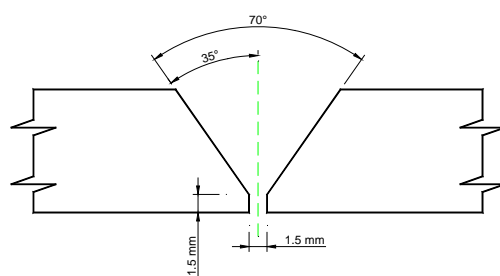
En la instalación se utilizarán tuberías de acero sin costura ASTM A53-GR B para la conducción de fluidos.

La preparación más usual en la soldadura de tubería es la de bordes en V. La figura 2.6 muestra la preparación con bordes en V, en función del espesor de pared del tubo.

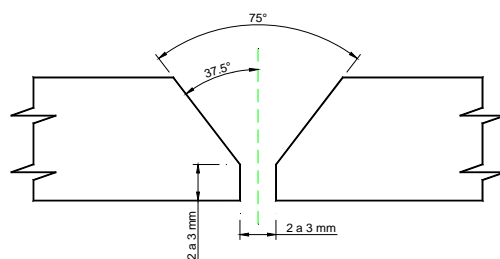
Normalmente, y con independencia del diámetro, se consideran paredes finas las de espesor comprendido entre 3 y 8 mm; y paredes gruesas, las de más de 8 mm de espesor.



Figura 2.7 Válvulas a instalar



TUBO DE PARED FINA



TUBO DE PARED GRUESA

Figura 2.8 Preparación de bisel para soldar tuberías a tope

Especificaciones de Soldadura

Para sistemas de refrigeración a baja temperatura se utiliza soldadura E6010 o E6011 para el pase de raíz y E7018, E8018 o E8018-G para los pases de relleno.

Los palillos de soldadura deben mantenerse en un ambiente libre de humedad, debido a que esta puede hacer aumentar el peligro de porosidad en el cordón de soldadura.

Las uniones, codos y tees para tubería roscada son para un mínimo presión de diseño de 3000 psi y contruidos de acero forjado. Los accesorios para la tubería soldada deben ser del mismo tipo de tubería usado; es decir, accesorios de cedula 40 para tubería de cédula 40 y accesorios de cedula 80 para tubería de cédula 80.

2.4 Ensayo No Destructivo y Pruebas de estanqueidad

La compañía SENDRE realiza la inspección de los puntos de soldadura.

A continuación se indica la información general del procedimiento de inspección:

- Fuente de radiación: Iridio 192
- Técnica: Doble Pared/Simple Imagen
Doble Pared/Doble Imagen
- Exposición: Varias
- Penetrómetro: ASTM - 1 -A

- Distancia fuente-película: Varias
- Pantallas de plomo: 0.127 mm/0.127 mm
- Película: AGFAD7
- Densidad observada: 2.0-3.0
- Revelado: Manual
- Norma aplicada: ASME SEC.V,ART.2 y ANSI B31.3



| | | | | | |
|--|-------------------------|---|---|--|--|
|  | | SERVICIOS EN ENSAYOS NO DESTRUCTIVOS Y REPRESENTACIONES. | | SENDRE Cía. Ltda. | |
|  | | <ul style="list-style-type: none"> • RADIOGRAFÍA INDUSTRIAL • ULTRASONIDO • PARTÍCULAS MAGNÉTICAS • LÍQUIDOS PENETRANTES • CORRIENTES INDUCIDAS • ANÁLISIS DE MATERIALES • ASESORÍA EN SOLDADURA Y CORROSIÓN | | PADRE SOLANO 1311 Y GARCÍA MORENO 3er. PISO OF N° 1 TELFS.: 691175 - 280231 - 289649 FAX: 289649 Guayaquil - Ecuador | |
| CLIENTE: | | | PROYECTO: | | |
| | | | TUBERÍA DE 2, 3, 6 y 8 PLG. DE DIÁMETRO PARA AMONIACO. | | |
| INFORME | PROCEDIMIENTO N° | FECHA | N° DE PAGS. | | |
| SENDRE N° 071/98 | RX 01/98 | Abril 20/98 | 04 | | |
| INFORME DE INSPECCION POR RADIOGRAFIA | | | | | |
| INFORMACION GENERAL: | | | | | |
| <ul style="list-style-type: none"> • Fuente de radiación: Iridio 192 • Exposición: Varias • Distancia fuente-película: Varias • Película: AGFA D7 • Revelado: Manual • Norma aplicada: ASME SEC. V, ART. 2 y ANSI B31.3 | | <ul style="list-style-type: none"> • Técnica: Doble Pared/Simple Imagen Doble Pared/Doble Imagen • Penetrómetro: ASTM - 1-A • Pantallas de plomo: 0.127 mm/0.127 mm • Densidad observada: 2.0 - 3.0 | | | |
| ELEMENTOS INSPECCIONADOS: <u>SOLDADURAS EN TUBERÍA DE 2, 3, 6 y 8 PLG. DE DIÁMETRO</u> | | | | | |
| <ul style="list-style-type: none"> • Material: Acero | | Espesor: 6.0 - 8.0 mm | | Sobremona: - - - - - | |
| <ul style="list-style-type: none"> - Las soldaduras inspeccionadas fueron numeradas y marcadas en la tubería - Número de soldaduras y placas radiográficas por soldadura: <ul style="list-style-type: none"> - Tubería de 2 plg.: una soldadura (S10), 2 placas: PA y PB - Tubería de 3 plg.: dos soldaduras (S6, S8), 2 placas: PA y PB - Tubería de 6 plg.: dos soldaduras (S7, S9), 3 placas: (0 - 18 cm), (18 - 36 cm), (36 - 0 cm) - Tubería de 8 plg.: una soldadura (S5), 3 placas: (0 - 24 cm), (24 - 48 cm), (48 - 0 cm) | | | | | |
| TOTAL PLACAS RADIOGRAFICAS: 15 | | | | | |
| Se adjunta hojas de resultados. | | | | | |
| REP. SERV. ENS. NO DESTRUCTIVOS SENDRE CIA. LTDA. | | | | | |

Figura 2.9 Informe de Inspección por Radiografía

Pruebas de estanqueidad

Uno de los pasos más importantes al poner un sistema de refrigeración en funcionamiento, es la prueba de fugas. Esto debe hacerse para asegurar un sistema hermético que operará sin cualquier pérdida apreciable de refrigerante.

En la prueba de presión se utilizó nitrógeno seco para elevar la presión. En el lado de baja presión se probó inicialmente con 50 psig y para detectar si existen fugas grandes en bridas y accesorios, se pasó agua jabonosa observando si se formaban burbujas en los puntos probados. Además se probaron los cordones de soldadura.

Al reparar fugas pequeñas se procedió a elevar la presión del sistema hasta 100 psig y esta condición se mantuvo por 24 horas. Una caída de presión permisible es de 5 psig cada 24 horas. Al término de este plazo no se observó caída de presión en el sistema. A continuación se procedió a probar el sistema de alta presión siguiendo los mismos pasos que en la prueba del sistema de baja presión, con la diferencia que se incrementará la presión hasta 200 psig.

Una vez superada la prueba el nitrógeno fue drenado a un tanque con agua, ya que el gas se había contaminado con rastros de amoníaco

remanentes en el sistema. Para estas pruebas se utilizaron 4 termos de nitrógeno de 120 Kgs. cada uno.

Como complemento de la prueba se cargó una pequeña cantidad de amoníaco y se elevó la presión hasta 100 psig y se realizó la prueba con palillos de azufre. Cuando existen trazas de amoníaco este reacciona con el azufre produciendo humo y de esta forma se localizan los puntos de fuga. Esta última prueba resultó exitosa, pudiéndose asegurar que el sistema estaba hermético y seguro.

Evacuación de gases no condensables

Después de las pruebas de fugas es necesario la evacuación de los gases no condensables, el aire y los gases no-condensables tenderán a alojarse en el condensador, disminuyendo de esta forma el espacio para el líquido condensado y causando que las presiones de descarga se eleven.

Para lograr la evacuación de los gases no condensables se conectó una bomba de vacío de gran capacidad para lograr un vacío de 28"Hg. Este proceso duró aproximadamente 16 horas. Para realizar un buen vacío se deben mantener cerradas las válvulas que conectan al ambiente y abrir todas las válvulas de equipos. Los gases que no

lograron ser evacuados por la bomba de vacío serán retirados del sistema por el purgador de gases no condensables.



Figura 2.10 Purgador de Gases no Condensables

Aislamiento de tuberías.

El aislamiento de las tuberías de $\varnothing 10''$, $\varnothing 8''$, $\varnothing 6''$ y $\varnothing 5''$ se lo realizará con poliuretano en 4" de espesor y forrado con planchas de aluminio de 0.7mm de espesor. Las tuberías de $\varnothing 2''$, $\varnothing 3/4''$ y $\varnothing 1/2''$ se aislarán

con poliuretano con espesor de 3" y forradas con planchas de aluminio de 0.5mm de espesor.

Las tuberías a aislar son las siguientes:

Nueva línea principal de succión Ø8". Primera etapa (T= -45°C)

Tubería de succión de compresores VSS de Primera etapa (T= -45°C)

Tubería de succión de compresores de segunda etapa Ø8" (T= -20°C)

Tubería de succión de compresores recíprocos Ø5" (T= -20°C)

Tubería de succión de compresor de tornillo VSS-901 (T= -20°C)

Tubería de inyección de líquido a compresores de tornillo Ø2" (T= +35°C).

Se ha tomado como referencia el apéndice J en el que se muestran los espesores de aislamiento recomendados según el diámetro de la tubería y la temperatura de trabajo.



Figura 2.11 Aislamiento de Tuberías y Tanques

2.5 Puesta en marcha

Revisión antes del arranque

- La unidad debe estar nivelada y anclada a la base
- Las válvulas de succión y descarga deben estar apoyadas independientemente del equipo.
- Las válvulas de succión y descarga deben estar abiertas.
- Las válvulas de seguridad estar instaladas en el separador de aceite
- El nivel de aceite en el separador debe estar entre los dos visores
- Se debe revisar la alineación del motor
- Realizar una prueba de presión en el equipo
- El nivel de amoníaco en los recibidores debe ser suficientes par el enfriamiento de los compresores.
- Comprobar la alimentación eléctrica al microprocesador y a los motores.
- Comprobar el sentido de giro del motor y de la bomba de aceite
- Comprobar los sensores de presión y temperatura.
- Calibrar los motores de control de capacidad y control de volumen
- Calentar el aceite del separador antes del arranque.

Condiciones para arrancar un compresor

Antes de que el compresor de tornillo pueda arrancar, se deben cumplir las siguientes condiciones:

- Todos los valores de seguridad, tanto de presión como de temperatura, deben estar en condición normal.
- La presión de succión debe estar por encima del setpoint mínimo establecido, para asegurar que hay carga.
- La válvula de control de capacidad debe estar por debajo de 10%
- La válvula de control de volumen debe estar por debajo de 10%
- Cuando el switch prendido/apagado es presionado, la bomba de aceite arrancará. Cuando la presión de aceite se ha incrementado lo suficiente, el compresor arrancará.
- Las válvulas de control de capacidad y volumen se moverán en respuesta a las demandas del sistema.

CAPITULO 3

3. EVALUACIÓN TÉCNICA

3.1 Parámetros Finales de Operación

En la **tabla 12** se enlistan los parámetros de operación una vez puestos en marcha los compresores de tornillo, y en la **figura 3.1** se presenta el gráfico Presión vs. entalpía que muestra el nuevo comportamiento de la planta.

Se realiza el cálculo del COP actual y su valor es 1.82.

TABLA 12

PARÁMETROS FINALES DE OPERACIÓN

| | Temp | Presion | Entalpía |
|-------|-------|---------|----------|
| Punto | °F | psia | Btu/lbm |
| 1 | -60,0 | 5,55 | 589,60 |
| 2 | 138,0 | 30,00 | 674,00 |
| 3 | -46,0 | 8,68 | 595,20 |
| 4 | 94,0 | 30,00 | 663,00 |
| 5 | 0,0 | 30,00 | 612,00 |
| 6 | 225,0 | 175,00 | 722,00 |
| 7 | 88,0 | 175,00 | 138,00 |
| 8 | 0,0 | 30,00 | 138,00 |
| 9 | 0,0 | 175,00 | 40,00 |
| 10 | -46,0 | 8,68 | 40,00 |
| 11 | -60,0 | 5,55 | 40,00 |

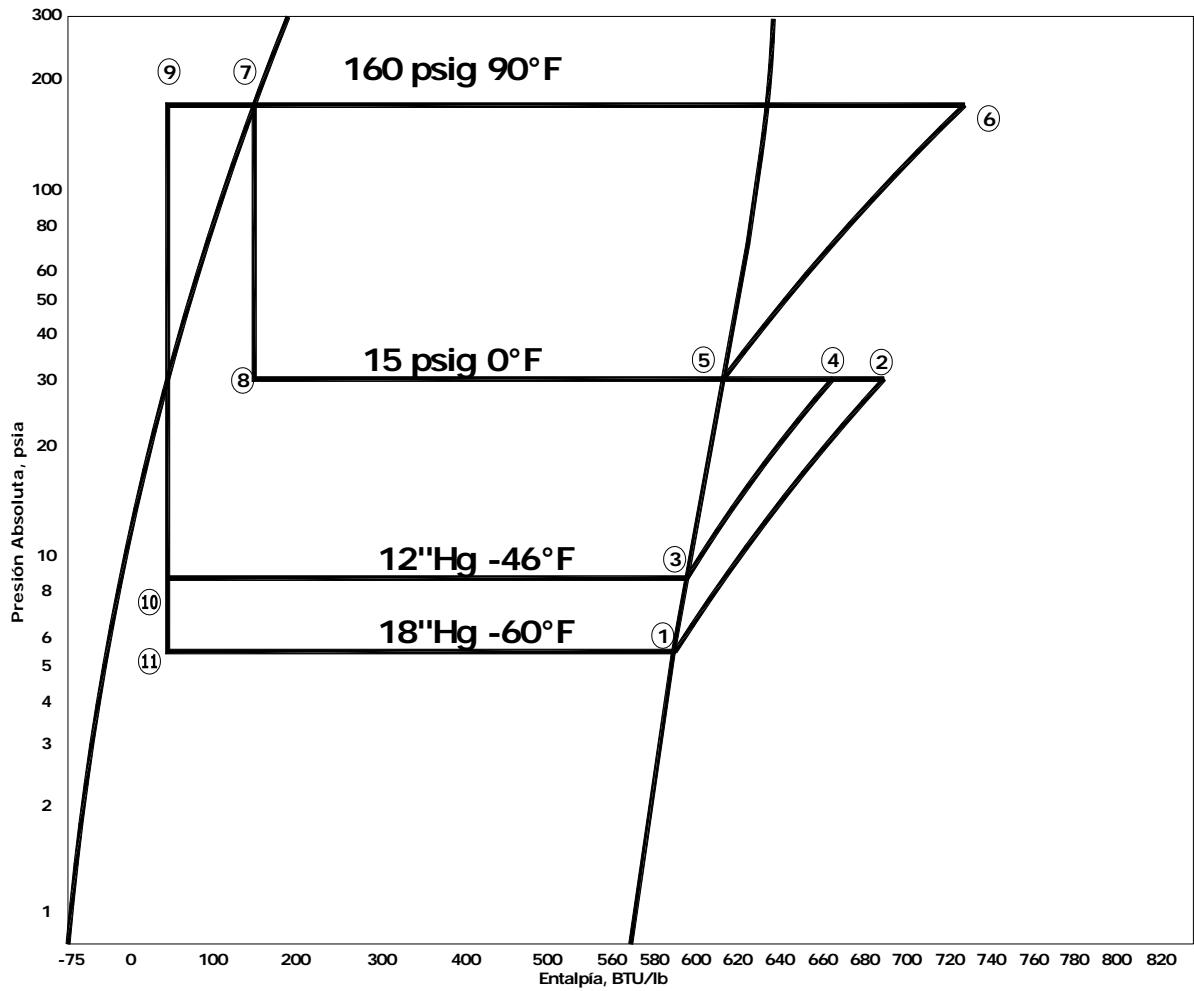


Figura 3.1 Diagrama de Presión Entalpía Final de la Planta de Refrigeración

La figura 3.2 Muestra la disposición de los equipos añadidos al sistema.

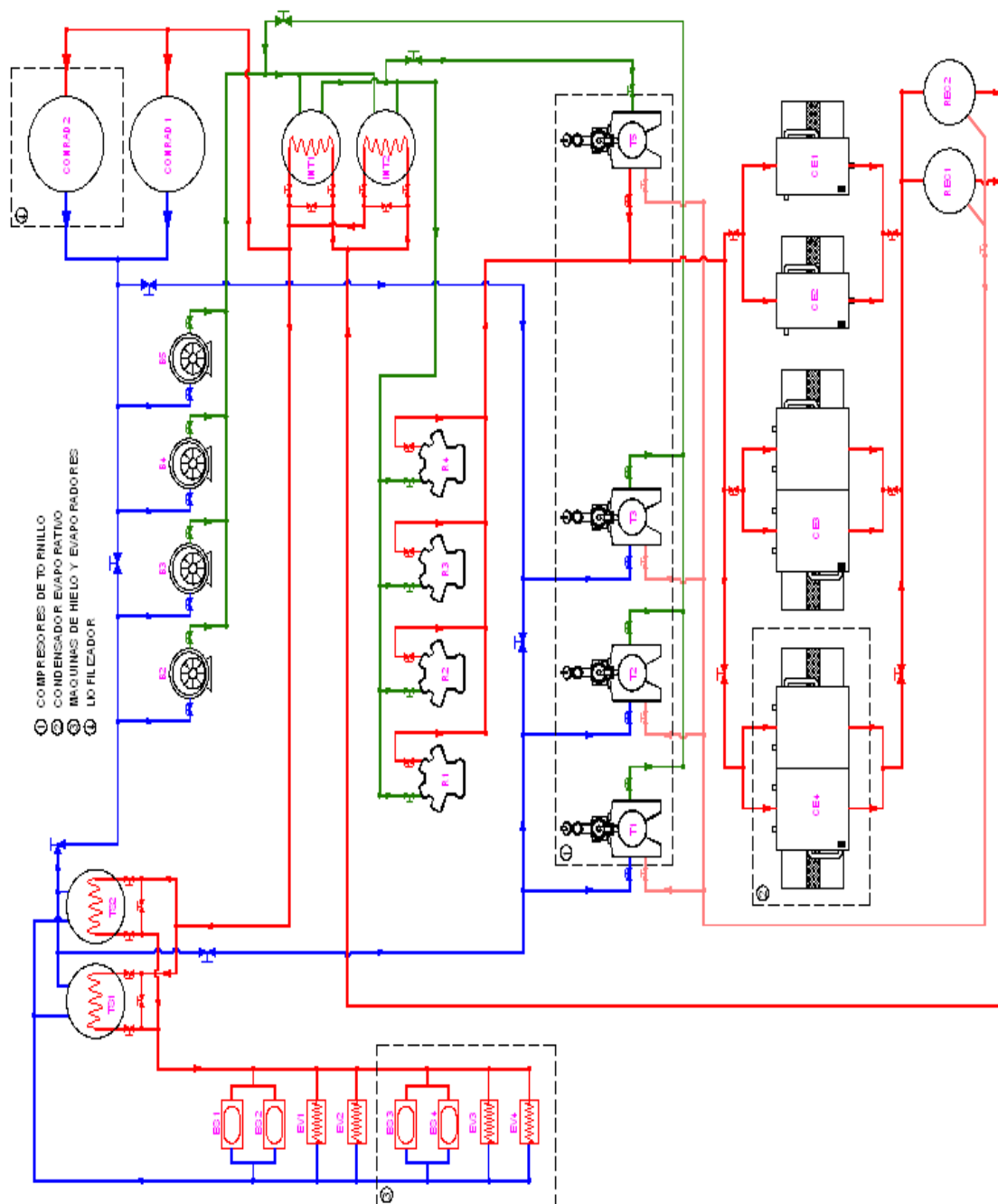


Figura 3.2 Diagrama Final de la Planta de Refrigeración

3.2 COMPARACIÓN DE PARÁMETROS DE OPERACIÓN DE LA PLANTA ANTES Y DESPUÉS

| | ANTES | DESPUES |
|---|--------------|----------------|
| Presión de evaporación sistema de congelamiento | 20”Hg | 18”Hg |
| Presión de evaporación sistema de congelamiento | 14”Hg | 12”Hg |
| Presión Intermedia | 15 psig | 15 psig |
| Presión de condensación | 180 psig | 160 psig |
| Temperatura de Descarga | 250°F | 140°F |
| COP | 1.53 | 1.82 |

El incremento en la presión de evaporación tanto en el sistema de congelamiento como en el de liofilización se debe a la eficiencia volumétrica de los compresores de tornillo, comparada al rendimiento de los compresores rotativos que tienen en funcionamiento aproximadamente 25 años.

El valor de presión intermedia no ha variado debido a que se ha mantenido el sistema de control de los compresores reciprocantes.

La presión de condensación ha descendido 20 psig. Debido a que se ha aumentado la capacidad de condensación al incluir un nuevo condensador evaporativo.

El descenso de la presión de condensación significa un ahorro energético porque también desciende el consumo eléctrico del motor.

El descenso de la temperatura de descarga del sistema se debe al sistema de enfriamiento de los compresores de tornillo, el cual inyecta amoníaco líquido para el enfriamiento del aceite y el gas de descarga.

El coeficiente de performance ha aumentado, lo que indica una mejor utilización del frío generado frente al consumo de energía eléctrica.

Si bien es cierto que el perfil de carga no ha variado, la respuesta de los equipos a esta carga lo ha hecho debido a que el microprocesador sensa la presión de succión del sistema y corrige su capacidad de acuerdo a la demanda, como lo indica la **figura 3.3**.

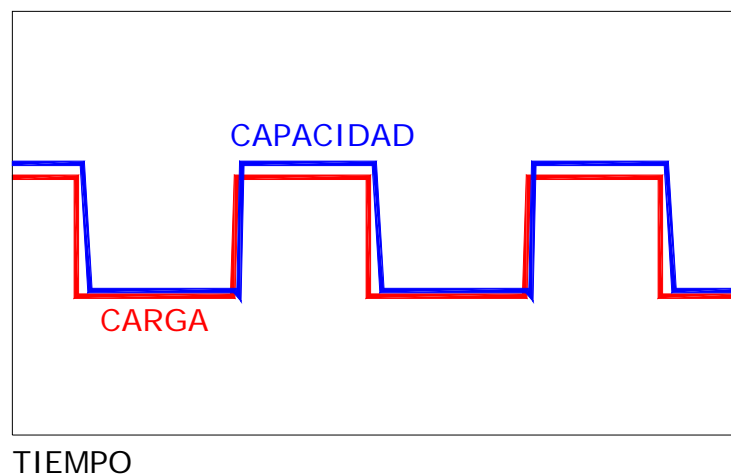


Figura 3.3 Comportamiento Carga vs. Capacidad final Planta de refrigeración

En la figura 3.4 se sobreponen el funcionamiento del sistema antes y después de la ampliación. El área rayada muestra el ahorro de energía logrado con los compresores de tornillo.

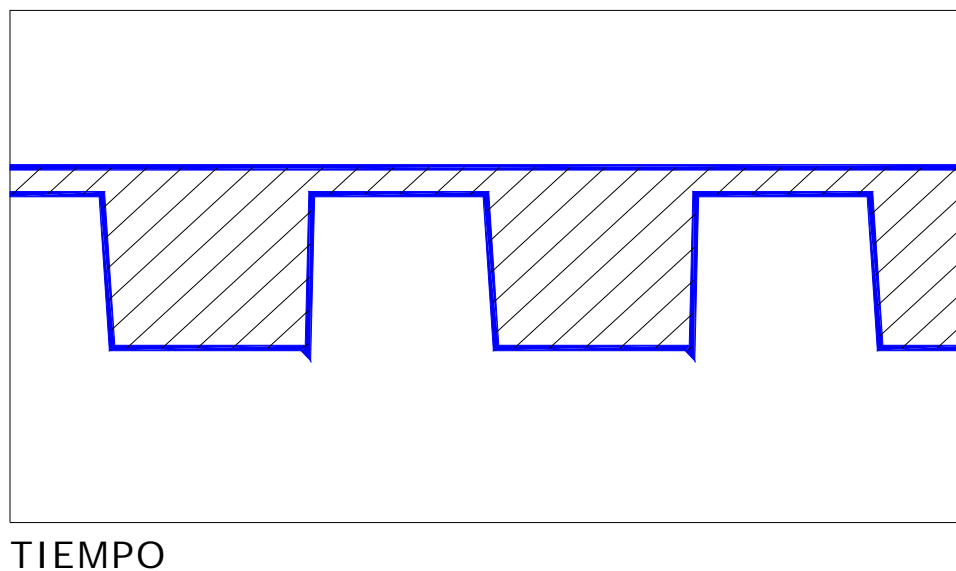


Figura 3.4 Comparación Comportamiento de Planta de Refrigeración Antes vs. Después

TABLA 13
COMPARACIÓN DE CAPACIDAD

| | Instalada | Necesaria | Actual |
|-------------------------------------|-----------|-----------|--------|
| 1ra eta comp. -60°F | 46 | 61,94 | 86.60 |
| 1ra eta comp. -50°F | 77 | 148,48 | 162.20 |
| 2da eta comp. 0°F | 209.6 | 328,26 | 420.50 |
| Condensación 95°F | 282 | 328,26 | 451.20 |

Capacidad en Toneladas de Refrigeración

TABLA 14
COMPARACIÓN DE LAS CARACTERÍSTICAS DE LOS COMPRESORES.

| | Reciprocante | Booster | Mono Tornillo VSS |
|--|-------------------|-------------------|-----------------------------------|
| Controlador | Operador | Operador | Microprocesador |
| Control de Capacidad | 0 - 50 -100 % | 0 - 60 - 100 % | 10 a 100 % |
| Control de Volumen | NO | NO | 10 a 100 % |
| Prelubricación | NO | NO | SI |
| Regulación de Presión de aceite | SI | NO | SI |
| Acople motor-compresor | DIRECTO | BANDAS | DIRECTO |
| Enfriamiento | AGUA | AGUA | Inyección de Refrigerante Líquido |
| Registro Histórico de Parámetros de Funcionamiento | NO | NO | SI |
| Controles de Operación y Seguridad | Electro Mecánicos | Electro Mecánicos | Sensores Digitales |
| Tipo de Arranque | Directo | Directo | Soft Start |

CAPITULO 4

4. CONCLUSIONES Y RECOMENDACIONES

4.1 Conclusiones

- Se cumplió con el objetivo general del proyecto, o sea el aumento de la capacidad de producción al doble al rehabilitar la segunda línea de producción.
- La planta de refrigeración se encuentra actualmente en capacidad de dar servicio a las dos líneas de producción.
- La selección de los equipos fue la correcta y ajustada a los cálculos realizados.
- Se ha logrado mejorar el Coeficiente de Performance del sistema.

4.2 Recomendaciones

- Implementar programas de mantenimiento predictivo.
- Integrar en un PLC la automatización del control total de la planta.
- Realizar capacitación y evaluación periódica a los operadores sobre el funcionamiento de los equipos nuevos y de la planta de refrigeración en general.



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APENDICE A: PROPIEDADES TERMODINAMICAS DEL AGUA

PROPIEDADES TERMODINAMICAS DEL AGUA

| | |
|-----------------------|-----------------|
| CALOR DE FUSION | 79,70 Kcal/Kg |
| CALOR DE VAPORIZACION | 540,00 Kcal/Kg |
| CALOR DE SUBLIMACION | 1000,00 Kcal/Kg |
| CALOR ESPECIFICO | |
| (68°F/20°C) | 1,00 Kcal/Kg°C |
| (-4°F/-20°C) | 0,466 Kcal/Kg°C |

**APENDICE B: PROPIEDADES TERMODINAMICAS DEL
AMONIACO**



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THERMODYNAMIC PROPERTIES OF REFRIGERANT 717 (AMMONIA)

| Temp. — ° F | Pressure — Lb. per Sq. In. | | Volume — Cu. Ft. per Lb. | | Density — Lb. per Cu. Ft. | | Enthalpy — Btu per Lb. | | | Entropy — Btu per (Lb.) (° R) | | Temp. — ° F |
|----------------|-------------------------------|-----------|-----------------------------|-------------------------|------------------------------|---------------------------|---------------------------|---------------------------|-------------------------|----------------------------------|-------------------------|----------------|
| | Absolute P | Gage P | Liquid v _f | Vapor v _g | Liquid l/v _f | Vapor l/v _g | Liquid h _f | Latent h _{fg} | Vapor h _g | Liquid s _f | Vapor s _g | |
| -60 | 5.55 | 18.6* | 0.02278 | 44.73 | 43.91 | 0.02235 | -21.2 | 610.8 | 589.6 | -0.0517 | 1.4769 | -60 |
| -59 | 5.74 | 18.2* | | 43.37 | | .02306 | -20.1 | 610.1 | 590.0 | -.0490 | 1.4741 | -59 |
| -58 | 5.93 | 17.8* | | 42.05 | | .02378 | -19.1 | 609.5 | 590.4 | -.0464 | 1.4713 | -58 |
| -57 | 6.13 | 17.4* | | 40.79 | | .02452 | -18.0 | 608.8 | 590.8 | -.0438 | 1.4686 | -57 |
| -56 | 6.33 | 17.0* | | 39.56 | | .02528 | -17.0 | 608.2 | 591.2 | -.0412 | 1.4658 | -56 |
| -55 | 6.54 | 16.6* | 0.02288 | 38.38 | 43.70 | 0.02605 | -15.9 | 607.5 | 591.6 | -0.0386 | 1.4631 | -55 |
| -54 | 6.75 | 16.2* | | 37.24 | | .02685 | -14.8 | 606.9 | 592.1 | -.0360 | 1.4604 | -54 |
| -53 | 6.97 | 15.7* | | 36.15 | | .02766 | -13.8 | 606.2 | 592.4 | -.0334 | 1.4577 | -53 |
| -52 | 7.20 | 15.3* | | 35.09 | | .02850 | -12.7 | 605.6 | 592.9 | -.0307 | 1.4551 | -52 |
| -51 | 7.43 | 14.8* | | 34.06 | | .02936 | -11.7 | 604.9 | 593.2 | -.0281 | 1.4524 | -51 |
| -50 | 7.67 | 14.3* | 0.02299 | 33.08 | 43.49 | 0.03023 | -10.6 | 604.3 | 593.7 | -0.0256 | 1.4497 | -50 |
| -49 | 7.91 | 13.8* | | 32.12 | | .03113 | - 9.6 | 603.6 | 594.0 | -.0230 | 1.4471 | -49 |
| -48 | 8.16 | 13.3* | | 31.20 | | .03205 | - 8.5 | 602.9 | 594.4 | -.0204 | 1.4445 | -48 |
| -47 | 8.42 | 12.8* | | 30.31 | | .03299 | - 7.4 | 602.3 | 594.9 | -.0179 | 1.4419 | -47 |
| -46 | 8.68 | 12.2* | | 29.45 | | .03395 | - 6.4 | 601.6 | 595.2 | -0.0153 | 1.4393 | -46 |
| -45 | 8.95 | 11.7* | 0.02310 | 28.62 | 43.28 | 0.03494 | - 5.3 | 600.9 | 595.6 | -0.0127 | 1.4368 | -45 |
| -44 | 9.23 | 11.1* | | 27.82 | | .03595 | - 4.3 | 600.3 | 596.0 | -.0102 | 1.4342 | -44 |
| -43 | 9.51 | 10.6* | | 27.04 | | .03698 | - 3.2 | 599.6 | 596.4 | -.0076 | 1.4317 | -43 |
| -42 | 9.81 | 10.0* | | 26.29 | | .03804 | - 2.1 | 598.9 | 596.8 | -.0051 | 1.4292 | -42 |
| -41 | 10.10 | 9.3* | | 25.56 | | .03912 | - 1.1 | 598.3 | 597.2 | -.0025 | 1.4267 | -41 |
| -40 | 10.41 | 8.7* | 0.02322 | 24.86 | 43.07 | 0.04022 | 0.0 | 597.6 | 597.6 | 0.0000 | 1.4242 | -40 |
| -39 | 10.72 | 8.1* | | 24.18 | | .04135 | 1.1 | 596.9 | 598.0 | .0025 | 1.4217 | -39 |
| -38 | 11.04 | 7.4* | | 23.53 | | .04251 | 2.1 | 596.2 | 598.3 | .0051 | 1.4193 | -38 |
| -37 | 11.37 | 6.8* | | 22.89 | | .04369 | 3.2 | 595.5 | 598.7 | .0076 | 1.4169 | -37 |
| -36 | 11.71 | 6.1* | | 22.27 | | .04489 | 4.3 | 594.8 | 599.1 | .0101 | 1.4144 | -36 |
| -35 | 12.05 | 5.4* | 0.02333 | 21.68 | 42.86 | 0.04613 | 5.3 | 594.2 | 599.5 | 0.0126 | 1.4120 | -35 |
| -34 | 12.41 | 4.7* | | 21.10 | | .04739 | 6.4 | 593.5 | 599.9 | .0151 | 1.4096 | -34 |
| -33 | 12.77 | 3.9* | | 20.54 | | .04868 | 7.4 | 592.8 | 600.2 | .0176 | 1.4072 | -33 |
| -32 | 13.14 | 3.2* | | 20.00 | | .04999 | 8.5 | 592.1 | 600.6 | .0201 | 1.4048 | -32 |
| -31 | 13.52 | 2.4* | | 19.48 | | .05134 | 9.6 | 591.4 | 601.0 | .0226 | 1.4025 | -31 |
| -30 | 13.90 | 1.6* | 0.02345 | 18.97 | 42.65 | 0.05271 | 10.7 | 590.7 | 601.4 | 0.0250 | 1.4001 | -30 |
| -29 | 14.30 | 0.8* | | 18.48 | | .05411 | 11.7 | 590.0 | 601.7 | .0275 | 1.3978 | -29 |
| -28 | 14.71 | 0.0 | | 18.00 | | .05555 | 12.8 | 589.3 | 602.1 | .0300 | 1.3955 | -28 |
| -27 | 15.12 | 0.4 | | 17.54 | | .05701 | 13.9 | 588.6 | 602.5 | .0325 | 1.3932 | -27 |
| -26 | 15.55 | 0.8 | | 17.09 | | .05850 | 14.9 | 587.9 | 602.8 | .0350 | 1.3909 | -26 |
| -25 | 15.98 | 1.3 | 0.02357 | 16.66 | 42.44 | 0.06003 | 16.0 | 587.2 | 603.2 | 0.0374 | 1.3886 | -25 |
| -24 | 16.42 | 1.7 | | 16.24 | | .06158 | 17.1 | 586.5 | 603.6 | .0399 | 1.3863 | -24 |
| -23 | 16.88 | 2.2 | | 15.83 | | .06317 | 18.1 | 585.8 | 603.9 | .0423 | 1.3840 | -23 |
| -22 | 17.34 | 2.6 | | 15.43 | | .06479 | 19.2 | 585.1 | 604.3 | .0448 | 1.3818 | -22 |
| -21 | 17.81 | 3.1 | | 15.05 | | .06644 | 20.3 | 584.3 | 604.6 | .0472 | 1.3796 | -21 |
| -20 | 18.30 | 3.6 | 0.02369 | 14.68 | 42.22 | 0.06813 | 21.4 | 583.6 | 605.0 | 0.0497 | 1.3774 | -20 |
| -19 | 18.79 | 4.1 | | 14.32 | | .06985 | 22.4 | 582.9 | 605.3 | .0521 | 1.3752 | -19 |
| -18 | 19.30 | 4.6 | | 13.97 | | .07161 | 23.5 | 582.2 | 605.7 | .0545 | 1.3729 | -18 |
| -17 | 19.81 | 5.1 | | 13.62 | | .07340 | 24.6 | 581.5 | 606.1 | .0570 | 1.3708 | -17 |
| -16 | 20.34 | 5.6 | | 13.29 | | .07522 | 25.6 | 580.8 | 606.4 | .0594 | 1.3686 | -16 |
| -15 | 20.88 | 6.2 | 0.02381 | 12.97 | 42.00 | 0.07709 | 26.7 | 580.0 | 606.7 | 0.0618 | 1.3664 | -15 |
| -14 | 21.43 | 6.7 | | 12.66 | | .07898 | 27.8 | 579.3 | 607.1 | .0642 | 1.3643 | -14 |
| -13 | 21.99 | 7.3 | | 12.36 | | .08092 | 28.9 | 578.6 | 607.5 | .0666 | 1.3621 | -13 |
| -12 | 22.56 | 7.9 | | 12.06 | | .08289 | 30.0 | 577.8 | 607.8 | .0690 | 1.3600 | -12 |
| -11 | 23.15 | 8.5 | | 11.78 | | .08490 | 31.0 | 577.1 | 608.1 | .0714 | 1.3579 | -11 |
| -10 | 23.74 | 9.0 | 0.02393 | 11.50 | 41.78 | 0.08695 | 32.1 | 576.4 | 608.5 | 0.0738 | 1.3558 | -10 |
| - 9 | 24.35 | 9.7 | | 11.23 | | .08904 | 33.2 | 575.6 | 608.8 | .0762 | 1.3537 | - 9 |
| - 8 | 24.97 | 10.3 | | 10.97 | | .09117 | 34.3 | 574.9 | 609.2 | .0786 | 1.3516 | - 8 |
| - 7 | 25.61 | 10.9 | | 10.71 | | .09334 | 35.4 | 574.1 | 609.5 | .0809 | 1.3495 | - 7 |
| - 6 | 26.26 | 11.6 | | 10.47 | | .09555 | 36.4 | 573.4 | 609.8 | .0833 | 1.3474 | - 6 |
| - 5 | 26.92 | 12.2 | 0.02406 | 10.23 | 41.56 | 0.09780 | 37.5 | 572.6 | 610.1 | 0.0857 | 1.3454 | - 5 |
| - 4 | 27.59 | 12.9 | | 9.991 | | .1001 | 38.6 | 571.9 | 610.5 | .0880 | 1.3433 | - 4 |
| - 3 | 28.28 | 13.6 | | 9.763 | | .1024 | 39.7 | 571.1 | 610.8 | .0904 | 1.3413 | - 3 |
| - 2 | 28.98 | 14.3 | | 9.541 | | .1048 | 40.7 | 570.4 | 611.1 | .0928 | 1.3393 | - 2 |
| - 1 | 29.69 | 15.0 | | 9.326 | | .1072 | 41.8 | 569.6 | 611.4 | .0951 | 1.3372 | - 1 |

* Inches of mercury below one atmosphere

Vilter



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THERMODYNAMIC PROPERTIES OF REFRIGERANT 717 (AMMONIA)

| Temp. - ° F | Pressure - Lb. per Sq. In. | | Volume - Cu. Ft. per Lb. | | Density - Lb. per Cu. Ft. | | Enthalpy - Btu per Lb. | | | Entropy - Btu per (Lb.) (° R) | | Temp. - ° F |
|----------------|-------------------------------|-----------|-----------------------------|-------------------------|------------------------------|---------------------------|---------------------------|---------------------------|-------------------------|----------------------------------|-------------------------|----------------|
| | Absolute P | Gage P | Liquid v _l | Vapor v _g | Liquid l/v _l | Vapor l/v _g | Liquid h _l | Latent h _{fg} | Vapor h _g | Liquid s _l | Vapor s _g | |
| 0 | 30.42 | 15.7 | 0.02419 | 9.116 | 41.34 | 0.1097 | 42.9 | 568.9 | 611.8 | 0.0975 | 1.3352 | 0 |
| 1 | 31.16 | 16.5 | | 8.912 | | .1122 | 44.0 | 568.1 | 612.1 | .0998 | 1.3332 | 1 |
| 2 | 31.92 | 17.2 | | 8.714 | | .1148 | 45.1 | 567.3 | 612.4 | .1022 | 1.3312 | 2 |
| 3 | 32.69 | 18.0 | | 8.521 | | .1174 | 46.2 | 566.5 | 612.7 | .1045 | 1.3292 | 3 |
| 4 | 33.47 | 18.8 | | 8.333 | | .1200 | 47.2 | 565.8 | 613.0 | .1069 | 1.3273 | 4 |
| 5 | 34.27 | 19.6 | 0.02432 | 8.150 | 41.11 | 0.1227 | 48.3 | 565.0 | 613.3 | 0.1092 | 1.3253 | 5 |
| 6 | 35.09 | 20.4 | | 7.971 | | .1254 | 49.4 | 564.2 | 613.5 | .1115 | 1.3234 | 6 |
| 7 | 35.92 | 21.2 | | 7.798 | | .1282 | 50.5 | 563.4 | 613.9 | .1138 | 1.3214 | 7 |
| 8 | 36.77 | 22.1 | | 7.629 | | .1311 | 51.6 | 562.7 | 614.3 | .1162 | 1.3195 | 8 |
| 9 | 37.63 | 22.9 | | 7.464 | | .1340 | 52.7 | 561.9 | 614.6 | .1185 | 1.3176 | 9 |
| 10 | 38.51 | 23.8 | 0.02446 | 7.304 | 40.89 | 0.1369 | 53.8 | 561.1 | 614.9 | 0.1208 | 1.3157 | 10 |
| 11 | 39.40 | 24.7 | | 7.148 | | .1399 | 54.9 | 560.3 | 615.2 | .1231 | 1.3137 | 11 |
| 12 | 40.31 | 25.6 | | 6.996 | | .1429 | 56.0 | 559.5 | 615.5 | .1254 | 1.3118 | 12 |
| 13 | 41.24 | 26.5 | | 6.847 | | .1460 | 57.1 | 558.7 | 615.8 | .1277 | 1.3099 | 13 |
| 14 | 42.18 | 27.5 | | 6.703 | | .1492 | 58.2 | 557.9 | 616.1 | .1300 | 1.3081 | 14 |
| 15 | 43.14 | 28.4 | 0.02460 | 6.562 | 40.66 | 0.1524 | 59.2 | 557.1 | 616.3 | 0.1323 | 1.3062 | 15 |
| 16 | 44.12 | 29.4 | | 6.425 | | .1556 | 60.3 | 556.3 | 616.6 | .1346 | 1.3043 | 16 |
| 17 | 45.12 | 30.4 | | 6.291 | | .1590 | 61.4 | 555.5 | 616.9 | .1369 | 1.3025 | 17 |
| 18 | 46.13 | 31.4 | | 6.161 | | .1623 | 62.5 | 554.7 | 617.2 | .1392 | 1.3006 | 18 |
| 19 | 47.16 | 32.5 | | 6.034 | | 0.1657 | 63.6 | 553.9 | 617.5 | 0.1415 | 1.2988 | 19 |
| 20 | 48.21 | 33.5 | 0.02474 | 5.910 | 40.43 | 0.1692 | 64.7 | 553.1 | 617.8 | 0.1437 | 1.2969 | 20 |
| 21 | 49.28 | 34.6 | | 5.789 | | .1728 | 65.8 | 552.2 | 618.0 | .1460 | 1.2951 | 21 |
| 22 | 50.36 | 35.7 | | 5.671 | | .1763 | 66.9 | 551.4 | 618.3 | .1483 | 1.2933 | 22 |
| 23 | 51.47 | 36.8 | | 5.556 | | .1800 | 68.0 | 550.6 | 618.6 | .1505 | 1.2915 | 23 |
| 24 | 52.59 | 37.9 | | 5.443 | | .1837 | 69.1 | 549.8 | 618.9 | .1528 | 1.2897 | 24 |
| 25 | 53.73 | 39.0 | 0.02488 | 5.334 | 40.20 | 0.1875 | 70.2 | 548.9 | 619.1 | 0.1551 | 1.2879 | 25 |
| 26 | 54.90 | 40.2 | | 5.227 | | .1913 | 71.3 | 548.1 | 619.4 | .1573 | 1.2861 | 26 |
| 27 | 56.08 | 41.4 | | 5.123 | | .1952 | 72.4 | 547.3 | 619.7 | .1596 | 1.2843 | 27 |
| 28 | 57.28 | 42.6 | | 5.021 | | .1992 | 73.5 | 546.4 | 619.9 | .1618 | 1.2825 | 28 |
| 29 | 58.50 | 43.8 | | 4.922 | | .2032 | 74.6 | 545.6 | 620.2 | .1641 | 1.2808 | 29 |
| 30 | 59.74 | 45.0 | 0.02503 | 4.825 | 39.96 | 0.2073 | 75.7 | 544.8 | 620.5 | 0.1663 | 1.2790 | 30 |
| 31 | 61.00 | 46.3 | | 4.730 | | .2114 | 76.8 | 543.9 | 620.7 | .1686 | 1.2773 | 31 |
| 32 | 62.29 | 47.6 | | 4.637 | | .2156 | 77.9 | 543.1 | 621.0 | .1708 | 1.2755 | 32 |
| 33 | 63.59 | 48.9 | | 4.547 | | .2199 | 79.0 | 542.2 | 621.2 | .1730 | 1.2738 | 33 |
| 34 | 64.91 | 50.2 | | 4.459 | | .2243 | 80.1 | 541.4 | 621.5 | .1753 | 1.2721 | 34 |
| 35 | 66.26 | 51.6 | 0.02518 | 4.373 | 39.72 | 0.2287 | 81.2 | 540.5 | 621.7 | 0.1775 | 1.2704 | 35 |
| 36 | 67.63 | 52.9 | | 4.289 | | .2332 | 82.3 | 539.7 | 622.0 | .1797 | 1.2686 | 36 |
| 37 | 69.02 | 54.3 | | 4.207 | | .2377 | 83.4 | 538.8 | 622.2 | .1819 | 1.2669 | 37 |
| 38 | 70.43 | 55.7 | | 4.126 | | .2423 | 84.6 | 537.9 | 622.5 | .1841 | 1.2652 | 38 |
| 39 | 71.87 | 57.2 | | 4.048 | | .2470 | 85.7 | 537.0 | 622.7 | .1863 | 1.2635 | 39 |
| 40 | 73.32 | 58.6 | 0.02533 | 3.971 | 39.49 | 0.2518 | 86.8 | 536.2 | 623.0 | 0.1885 | 1.2618 | 40 |
| 41 | 74.80 | 60.1 | | 3.897 | | .2566 | 87.9 | 535.3 | 623.2 | .1908 | 1.2602 | 41 |
| 42 | 76.31 | 61.6 | | 3.823 | | .2616 | 89.0 | 534.4 | 623.4 | .1930 | 1.2585 | 42 |
| 43 | 77.83 | 63.1 | | 3.752 | | .2665 | 90.1 | 533.6 | 623.7 | .1952 | 1.2568 | 43 |
| 44 | 79.38 | 64.7 | | 3.682 | | .2716 | 91.2 | 532.7 | 623.9 | .1974 | 1.2552 | 44 |
| 45 | 80.96 | 66.3 | 0.02548 | 3.614 | 39.24 | 0.2767 | 92.3 | 531.8 | 624.1 | 0.1996 | 1.2535 | 45 |
| 46 | 82.55 | 67.9 | | 3.547 | | .2819 | 93.5 | 530.9 | 624.4 | .2018 | 1.2519 | 46 |
| 47 | 84.18 | 69.5 | | 3.481 | | .2872 | 94.6 | 530.0 | 624.6 | .2040 | 1.2502 | 47 |
| 48 | 85.82 | 71.1 | | 3.418 | | .2926 | 95.7 | 529.1 | 624.8 | .2062 | 1.2486 | 48 |
| 49 | 87.49 | 72.8 | | 3.355 | | .2981 | 96.8 | 528.2 | 625.0 | .2083 | 1.2469 | 49 |
| 50 | 89.19 | 74.5 | 0.02564 | 3.294 | 39.00 | 0.3036 | 97.9 | 527.3 | 625.2 | 0.2105 | 1.2453 | 50 |
| 51 | 90.91 | 76.2 | | 3.234 | | .3092 | 99.1 | 526.4 | 625.5 | .2127 | 1.2437 | 51 |
| 52 | 92.66 | 78.0 | | 3.176 | | .3149 | 100.2 | 525.5 | 625.7 | .2149 | 1.2421 | 52 |
| 53 | 94.43 | 79.7 | | 3.119 | | .3207 | 101.3 | 524.6 | 625.9 | .2171 | 1.2405 | 53 |
| 54 | 96.23 | 81.5 | | 3.063 | | .3265 | 102.4 | 523.7 | 626.1 | .2192 | 1.2389 | 54 |
| 55 | 98.06 | 83.4 | 0.02581 | 3.008 | 38.75 | 0.3325 | 103.5 | 522.8 | 626.3 | 0.2214 | 1.2373 | 55 |
| 56 | 99.91 | 85.2 | | 2.954 | | .3385 | 104.7 | 521.8 | 626.5 | .2236 | 1.2357 | 56 |
| 57 | 101.8 | 87.1 | | 2.902 | | .3446 | 105.8 | 520.9 | 626.7 | .2257 | 1.2341 | 57 |
| 58 | 103.7 | 89.0 | | 2.851 | | .3508 | 106.9 | 520.0 | 626.9 | .2279 | 1.2325 | 58 |
| 59 | 105.6 | 90.9 | | 2.800 | | .3571 | 108.1 | 519.0 | 627.1 | .2301 | 1.2310 | 59 |

Vilter

THERMODYNAMIC PROPERTIES OF REFRIGERANT 717 (AMMONIA)

| Temp. - ° F | Pressure - Lb. per Sq. In. | | Volume - Cu. Ft. per Lb. | | Density - Lb. per Cu. Ft. | | Enthalpy - Btu per Lb. | | | Entropy - Btu per (Lb.) (° R) | | Temp. - ° F |
|----------------|-------------------------------|---------------|-----------------------------|--------------------------|------------------------------|----------------------------|---------------------------|--------------------------|---------------------------|----------------------------------|--------------------------|----------------|
| | t | Absolute P | Gage p | Liquid v _f | Vapor v _g | Liquid 1/v _f | Vapor 1/v _g | Liquid h _f | Latent h _{fg} | Vapor h _g | Liquid s _f | |
| 60 | 107.6 | 92.9 | 0.02597 | 2.751 | 38.50 | 0.3635 | 109.2 | 518.1 | 627.3 | 0.2322 | 1.2294 | 60 |
| 61 | 109.6 | 94.9 | | 2.703 | | .3700 | 110.3 | 517.2 | 627.5 | .2344 | 1.2278 | 61 |
| 62 | 111.6 | 96.9 | | 2.656 | | .3765 | 111.5 | 516.2 | 627.7 | .2365 | 1.2262 | 62 |
| 63 | 113.6 | 98.9 | | 2.610 | | .3832 | 112.6 | 515.3 | 627.9 | .2387 | 1.2247 | 63 |
| 64 | 115.7 | 101.0 | | 2.565 | | .3899 | 113.7 | 514.3 | 628.0 | .2408 | 1.2231 | 64 |
| 65 | 117.8 | 103.1 | 0.02614 | 2.520 | 38.25 | 0.3968 | 114.8 | 513.4 | 628.2 | 0.2430 | 1.2216 | 65 |
| 66 | 120.0 | 105.3 | | 2.477 | | .4037 | 116.0 | 512.4 | 628.4 | .2451 | 1.2201 | 66 |
| 67 | 122.1 | 107.4 | | 2.435 | | .4108 | 117.1 | 511.5 | 628.6 | .2473 | 1.2186 | 67 |
| 68 | 124.3 | 109.6 | | 2.393 | | .4179 | 118.3 | 510.5 | 628.8 | .2494 | 1.2170 | 68 |
| 69 | 126.5 | 111.8 | | 2.352 | | .4251 | 119.4 | 509.5 | 628.9 | .2515 | 1.2155 | 69 |
| 70 | 128.8 | 114.1 | 0.02632 | 2.312 | 38.00 | 0.4325 | 120.5 | 508.6 | 629.1 | 0.2537 | 1.2140 | 70 |
| 71 | 131.1 | 116.4 | | 2.273 | | .4399 | 121.7 | 507.6 | 629.3 | .2558 | 1.2125 | 71 |
| 72 | 133.4 | 118.7 | | 2.235 | | .4474 | 122.8 | 506.6 | 629.4 | .2579 | 1.2110 | 72 |
| 73 | 135.7 | 121.0 | | 2.197 | | .4551 | 124.0 | 505.6 | 629.6 | .2601 | 1.2095 | 73 |
| 74 | 138.1 | 123.4 | | 2.161 | | .4628 | 125.1 | 504.7 | 629.8 | .2622 | 1.2080 | 74 |
| 75 | 140.5 | 125.8 | 0.02650 | 2.125 | 37.74 | 0.4707 | 126.2 | 503.7 | 629.9 | 0.2643 | 1.2065 | 75 |
| 76 | 143.0 | 128.3 | | 2.089 | | .4786 | 127.4 | 502.7 | 630.1 | .2664 | 1.2050 | 76 |
| 77 | 145.4 | 130.7 | | 2.055 | | .4867 | 128.5 | 501.7 | 630.2 | .2685 | 1.2035 | 77 |
| 78 | 147.9 | 133.2 | | 2.021 | | .4949 | 129.7 | 500.7 | 630.4 | .2706 | 1.2020 | 78 |
| 79 | 150.5 | 135.8 | | 1.988 | | .5031 | 130.8 | 499.7 | 630.5 | .2728 | 1.2006 | 79 |
| 80 | 153.0 | 138.3 | 0.02668 | 1.955 | 37.48 | 0.5115 | 132.0 | 498.7 | 630.7 | 0.2749 | 1.1991 | 80 |
| 81 | 155.6 | 140.9 | | 1.923 | | .5200 | 133.1 | 497.7 | 630.8 | .2769 | 1.1976 | 81 |
| 82 | 158.3 | 143.6 | | 1.892 | | .5287 | 134.3 | 496.7 | 631.0 | .2791 | 1.1962 | 82 |
| 83 | 161.0 | 146.3 | | 1.861 | | .5374 | 135.4 | 495.7 | 631.1 | .2812 | 1.1947 | 83 |
| 84 | 163.7 | 149.0 | | 1.831 | | .5462 | 136.6 | 494.7 | 631.3 | 0.2833 | 1.1933 | 84 |
| 85 | 166.4 | 151.7 | 0.02687 | 1.801 | 37.21 | 0.5552 | 137.8 | 493.6 | 631.4 | 0.2854 | 1.1918 | 85 |
| 86 | 169.2 | 154.5 | | 1.772 | | .5643 | 138.9 | 492.6 | 631.5 | .2875 | 1.1904 | 86 |
| 87 | 172.0 | 157.3 | | 1.744 | | .5735 | 140.1 | 491.6 | 631.7 | .2895 | 1.1889 | 87 |
| 88 | 174.8 | 160.1 | | 1.716 | | .5828 | 141.2 | 490.6 | 631.8 | .2917 | 1.1875 | 88 |
| 89 | 177.7 | 163.0 | | 1.688 | | .5923 | 142.4 | 489.5 | 631.9 | .2937 | 1.1860 | 89 |
| 90 | 180.6 | 165.9 | 0.02707 | 1.661 | 36.94 | 0.6019 | 143.5 | 488.5 | 632.0 | 0.2958 | 1.1846 | 90 |
| 91 | 183.6 | 168.9 | | 1.635 | | .6116 | 144.7 | 487.4 | 632.1 | .2979 | 1.1832 | 91 |
| 92 | 186.6 | 171.9 | | 1.609 | | .6214 | 145.8 | 486.4 | 632.2 | .3000 | 1.1818 | 92 |
| 93 | 189.6 | 174.9 | | 1.584 | | .6314 | 147.0 | 485.3 | 632.3 | .3021 | 1.1804 | 93 |
| 94 | 192.7 | 178.0 | | 1.559 | | .6415 | 148.2 | 484.3 | 632.5 | .3041 | 1.1789 | 94 |
| 95 | 195.8 | 181.1 | 0.02727 | 1.534 | 36.67 | 0.6517 | 149.4 | 483.2 | 632.6 | 0.3062 | 1.1775 | 95 |
| 96 | 198.9 | 184.2 | | 1.510 | | .6620 | 150.5 | 482.1 | 632.6 | .3083 | 1.1761 | 96 |
| 97 | 202.1 | 187.4 | | 1.487 | | .6725 | 151.7 | 481.1 | 632.8 | .3104 | 1.1747 | 97 |
| 98 | 205.3 | 190.6 | | 1.464 | | .6832 | 152.9 | 480.0 | 632.9 | .3125 | 1.1733 | 98 |
| 99 | 208.6 | 193.9 | | 1.441 | | .6939 | 154.0 | 478.9 | 632.9 | .3145 | 1.1719 | 99 |
| 100 | 211.9 | 197.2 | 0.02748 | 1.419 | 36.40 | 0.7048 | 155.2 | 477.8 | 633.0 | 0.3166 | 1.1705 | 100 |
| 101 | 215.2 | 200.5 | | 1.397 | | .7159 | 156.4 | 476.7 | 633.1 | .3187 | 1.1691 | 101 |
| 102 | 218.6 | 203.9 | | 1.375 | | .7270 | 157.6 | 475.6 | 633.2 | .3207 | 1.1677 | 102 |
| 103 | 222.0 | 207.3 | | 1.354 | | .7384 | 158.7 | 474.6 | 633.3 | .3228 | 1.1663 | 103 |
| 104 | 225.4 | 210.7 | | 1.334 | | .7498 | 159.9 | 473.5 | 633.4 | .3248 | 1.1649 | 104 |
| 105 | 228.9 | 214.2 | 0.02769 | 1.313 | 36.12 | 0.7615 | 161.1 | 472.3 | 633.4 | 0.3269 | 1.1635 | 105 |
| 106 | 232.5 | 217.8 | | 1.293 | | .7732 | 162.3 | 471.2 | 633.5 | .3289 | 1.1621 | 106 |
| 107 | 236.0 | 221.3 | | 1.274 | | .7852 | 163.5 | 470.1 | 633.6 | .3310 | 1.1607 | 107 |
| 108 | 239.7 | 225.0 | | 1.254 | | .7972 | 164.6 | 469.0 | 633.6 | .3330 | 1.1593 | 108 |
| 109 | 243.3 | 228.6 | | 1.235 | | .8095 | 165.8 | 467.9 | 633.7 | .3351 | 1.1580 | 109 |
| 110 | 247.0 | 232.3 | 0.02790 | 1.217 | 35.84 | 0.8219 | 167.0 | 466.7 | 633.7 | 0.3372 | 1.1566 | 110 |
| 111 | 250.8 | 236.1 | | 1.198 | | .8344 | 168.2 | 465.6 | 633.8 | .3392 | 1.1552 | 111 |
| 112 | 254.5 | 239.8 | | 1.180 | | .8471 | 169.4 | 464.4 | 633.8 | .3413 | 1.1538 | 112 |
| 113 | 258.4 | 243.7 | | 1.163 | | .8600 | 170.6 | 463.3 | 633.9 | .3433 | 1.1524 | 113 |
| 114 | 262.2 | 247.5 | | 1.145 | | .8730 | 171.8 | 462.1 | 633.9 | .3453 | 1.1510 | 114 |
| 115 | 266.2 | 251.5 | 0.02813 | 1.128 | 35.55 | 0.8862 | 173.0 | 460.9 | 633.9 | 0.3474 | 1.1497 | 115 |
| 116 | 270.1 | 255.4 | | 1.112 | | .8996 | 174.2 | 459.8 | 634.0 | .3495 | 1.1483 | 116 |
| 117 | 274.1 | 259.4 | | 1.095 | | .9132 | 175.4 | 458.6 | 634.0 | .3515 | 1.1469 | 117 |
| 118 | 278.2 | 263.5 | | 1.079 | | .9269 | 176.6 | 457.4 | 634.0 | .3535 | 1.1455 | 118 |
| 119 | 282.3 | 267.6 | | 1.063 | | .9408 | 177.8 | 456.2 | 634.0 | .3556 | 1.1441 | 119 |
| 120 | 286.4 | 271.7 | 0.02836 | 1.047 | 35.26 | 0.9549 | 179.0 | 455.0 | 634.0 | 0.3576 | 1.1427 | 120 |

Vilter

APENDICE C: DIAGRAMA PRESION ENTALPIA DEL
AMONIACO



180 psig 95°F

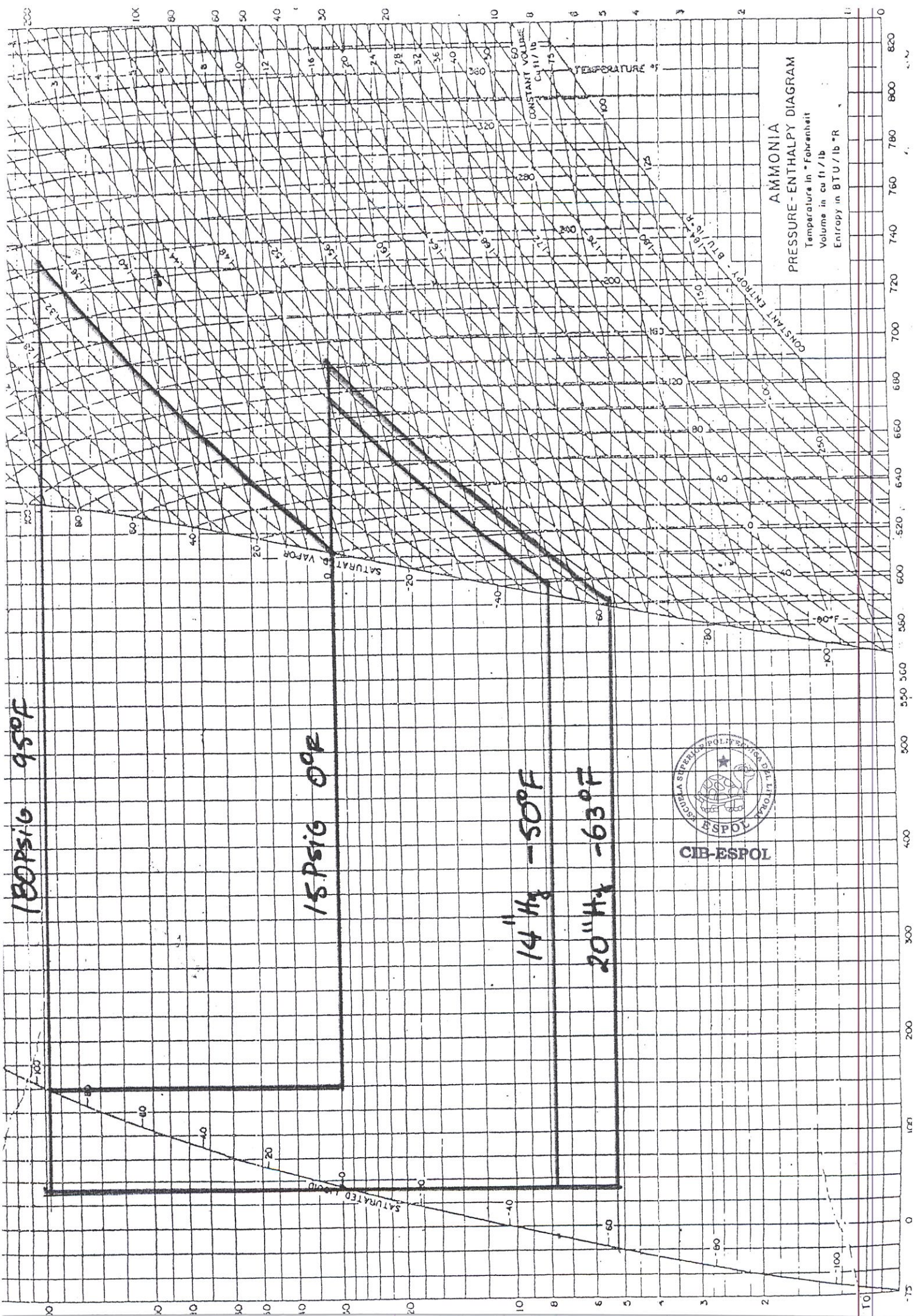
15 psig 0°F

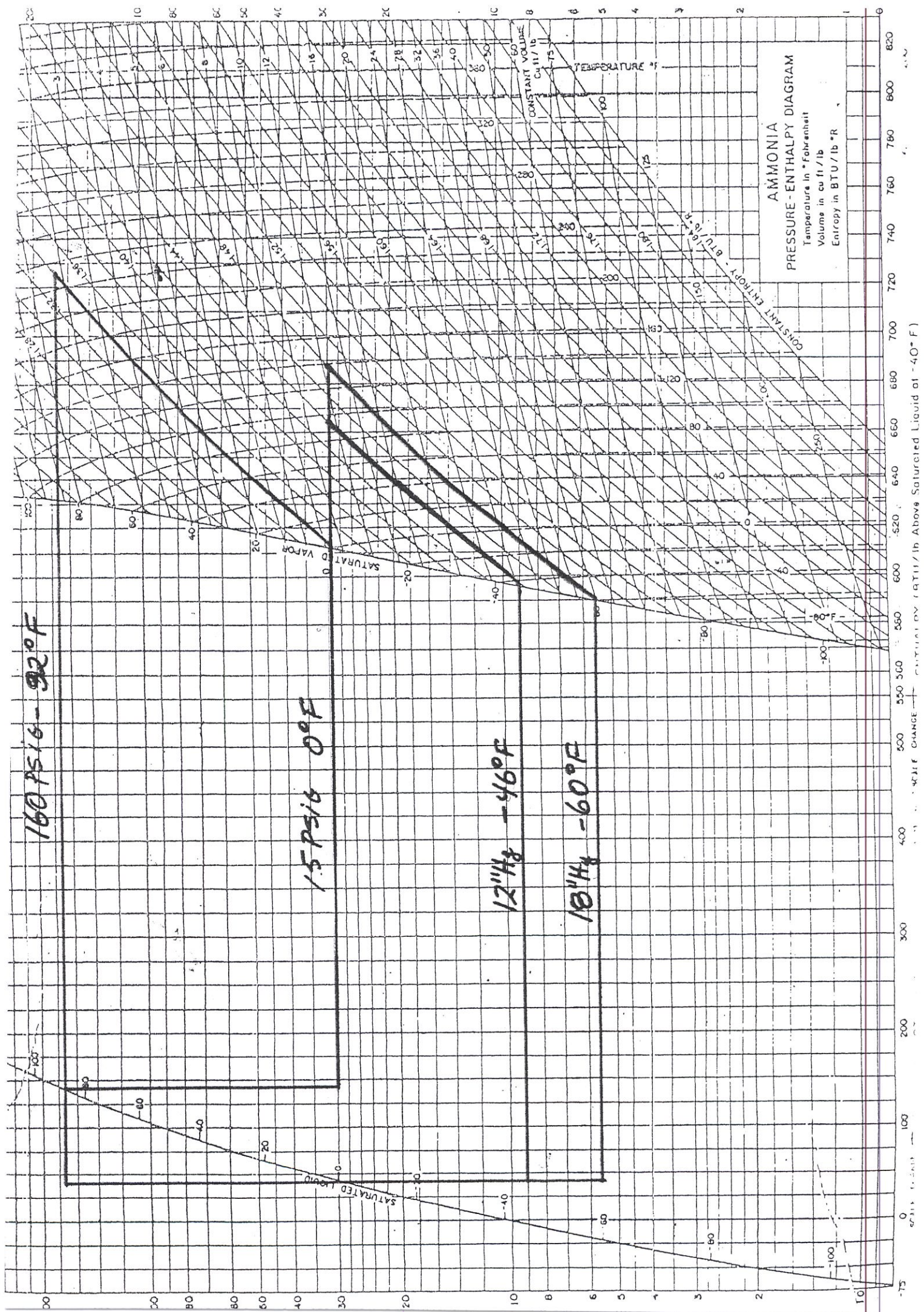
14" H₂O - 50°F

20" H₂O - 63°F



AMMONIA
PRESSURE-ENTHALPY DIAGRAM
Temperature in ° Fahrenheit
Volume in cu ft / lb
Entropy in BTU / lb ° R





AMMONIA
 PRESSURE-ENTHALPY DIAGRAM
 Temperature in ° Fahrenheit
 Volume in cu ft / lb
 Entropy in BTU / lb ° R

APENDICE D: DIAGRAMAS



CIB-ESPOL

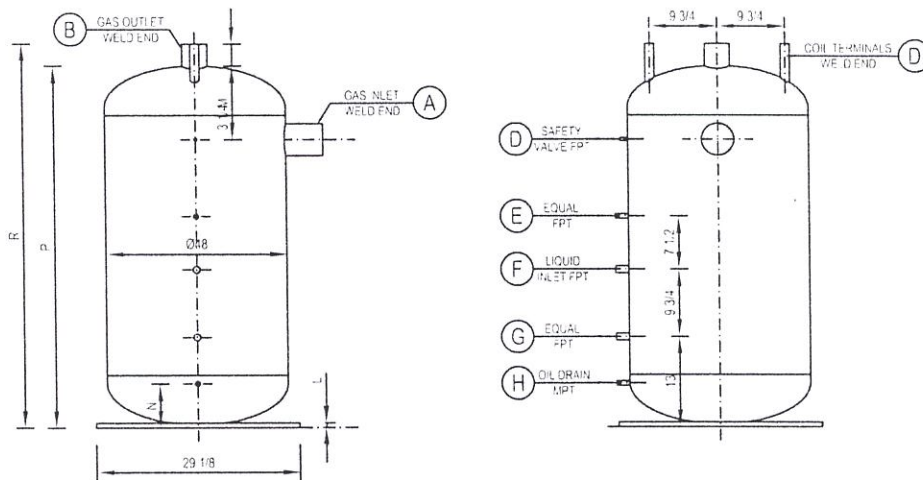
VILTER MG. CORP. MILWAUKEE

DR. BY. GMR
CHKD. BY

DATE:
1/12/2001

T60309

STANDARD AMMONIA INTERCOOLER
150 P.S.I. DESIGN PRESS



ALL DIMENSIONS IN INCHES

| O.D. SIZE | PART NUMBER | CONNECTION SIZE | | | | | | | | DIMENSIONS | | | | | | | |
|-----------|--------------------|-----------------|-------|-------|-----|-----|-------|-------|-------|------------|----|-------|--------|--------|------|------|--|
| | | A | B | C | D | E | F | G | H | J | K | L | M | N | P | R | |
| 10 3/4 | A93107A | 2 | 2 | 1/2 | 1/2 | 3/4 | 1/2 | 1 | 3/4 | 4 | 18 | 1/2 | 7 3/4 | 2 3/4 | 7'0" | 7'8" | |
| 12 3/4 | A93108A | 2 1/2 | 2 1/2 | 3/4 | 3/4 | 3/4 | 1/2 | 1 | 3/4 | 4 | 18 | 1/2 | 8 3/4 | 3 3/4 | 7'0" | 7'8" | |
| 16 | A93109A | 3 | 3 | 1 | 1/2 | 3/4 | 1/2 | 1 | 3/4 | 5 3/4 | 22 | 3/4 | 10 | 4 1/4 | 7'0" | 7'8" | |
| 20 | A93110A | 3 | 3 | 1 | 1/2 | 3/4 | 3/4 | 1 | 1 | 7 1/2 | 28 | 3/4 | 11 | 5 | 7'0" | 7'8" | |
| 24 | A93111A | 5 | 5 | 1 1/4 | 1/2 | 3/4 | 3/4 | 1 | 1 | 9 1/2 | 30 | 3/4 | 13 | 6 | 7'0" | 7'8" | |
| 30 | A93112B | 5 | 5 | 1 1/2 | 1/2 | 1 | 1 1/4 | 1 1/2 | 1 | 11 1/2 | 36 | 1 | 14 3/4 | 7 3/4 | 7'6" | 8'0" | |
| 36 | A93113A A93113B | 5 | 5 | 2 | 1/2 | 1 | 1 1/4 | 1 1/2 | 1 | 14 | 42 | 1 | 16 1/2 | 8 3/4 | 7'6" | 8'0" | |
| 42 | A93114A | 6 | 6 | 2 | 1/2 | 1 | 1 1/2 | 1 1/2 | 1 | 16 1/2 | 48 | 1 1/4 | 18 1/4 | 10 1/4 | 7'6" | 8'0" | |
| 48 | A93115A | 6 | 6 | 2 | 1/2 | 1 | 1 1/2 | 1 1/2 | 1 | 18 | 54 | 1 1/4 | 19 3/4 | 11 1/4 | 8'0" | 8'6" | |
| 54 | A93127A | 8 | 8 | 3 | 1/2 | 1 | 1 1/2 | 1 1/2 | 1 1/4 | 20 | 60 | 1 1/4 | 22 1/4 | 12 | 8'0" | 8'6" | |
| 60 | A93128A | 8 | 8 | 3 | 1/2 | 1 | 2 | 1 1/2 | 1 1/4 | 22 | 66 | 1 1/4 | 23 3/4 | 14 | 8'0" | 8'6" | |

NOTE: SAFETY VALVE CONN. SIZE BASED ON USE OF VILTER RELIEF VALVE.
CONN. MUST BE CHECKED FOR USE WITH OTHER RELIEF VALVE

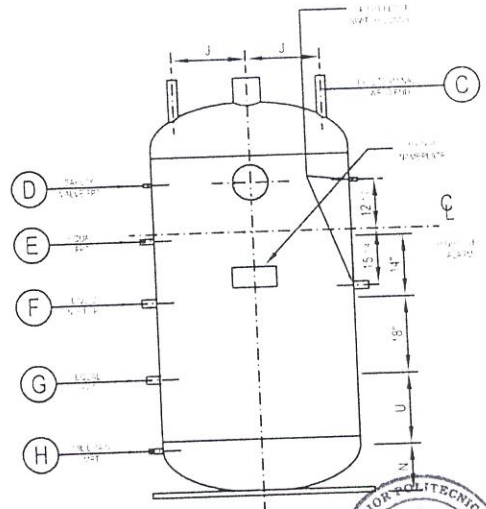
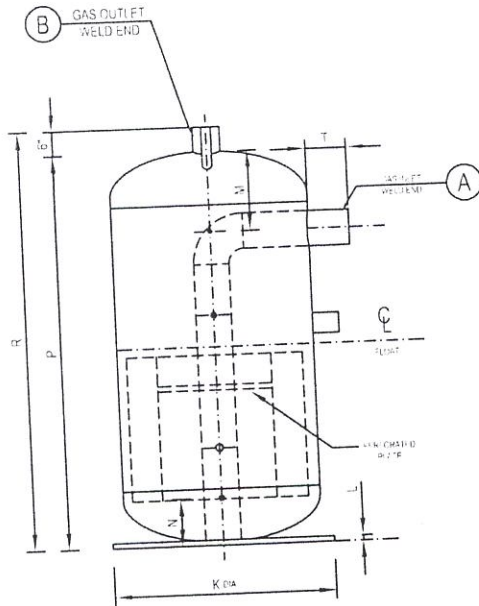
VILTER MG. CORP. MILWAUKEE

DR. BY. GMR
CHKD. BY

DATE:
1/12/2001

T60340-A

VAPORITER MODEL VR-BCD
150PSI DESIGN PRESS.

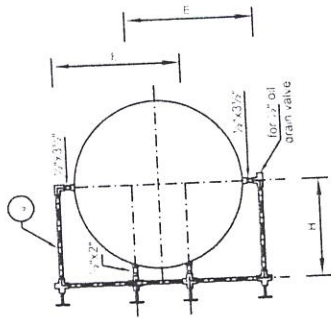


ALL DIMENSIONS IN INCHES

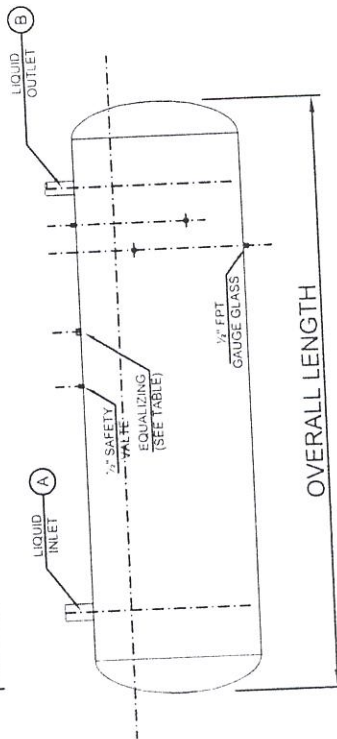
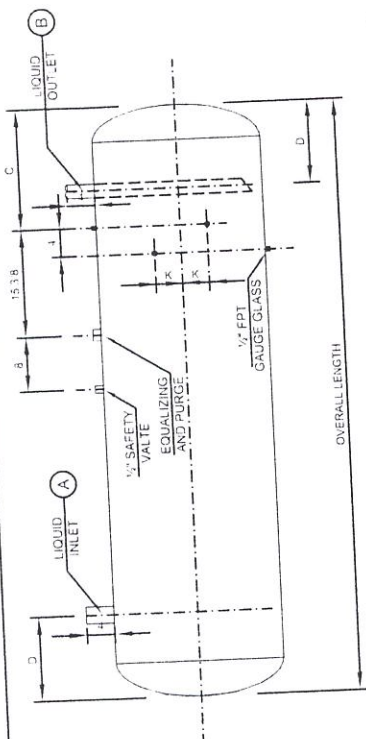
CIB-ESPOL

| O.D. SIZE | PART NUMBER | CONNECTION SIZE | | | | | | | | DIMENSIONS | | | | | | | | | |
|-----------|-------------|-----------------|-------|-------|-----|-----|-----|---|-----|------------|----|-------|--------|--------|----|----|---|----|--|
| | | A | B | C | D | E | F | G | H | J | K | L | M | N | P | R | T | U | |
| 8 3/4 | A93162A | 2 | 2 | 1/2 | 1/2 | 3/4 | 1/2 | 1 | 3/4 | 2 3/4 | 16 | 1/2 | 7 | 2 3/4 | 84 | 90 | 6 | 24 | |
| 10 3/4 | A93163A | 2 | 2 | 3/4 | 1/2 | 3/4 | 1/2 | 1 | 3/4 | 4 | 16 | 1/2 | 7 3/4 | 2 3/4 | 84 | 90 | 6 | 24 | |
| 12 3/4 | A93164A | 2 1/2 | 2 1/2 | 3/4 | 1/2 | 3/4 | 1/2 | 1 | 3/4 | 4 | 18 | 1/2 | 8 3/4 | 3 3/4 | 84 | 90 | 6 | 24 | |
| 16 | A93165A | 3 | 3 | 1 | 1/2 | 3/4 | 1/2 | 1 | 3/4 | 5 3/4 | 22 | 3/4 | 10 | 6 3/4 | 84 | 90 | 6 | 24 | |
| 20 | A93166A | 4 | 4 | 1 | 1/2 | 3/4 | 1/2 | 1 | 1 | 7 1/2 | 26 | 3/4 | 11 1/2 | 5 | 84 | 90 | 6 | 24 | |
| 24 | A93167A | 4 | 4 | 1 1/4 | 1/2 | 3/4 | 1/2 | 1 | 1 | 9 3/8 | 30 | 3/4 | 12 3/8 | 6 | 84 | 90 | 6 | 24 | |
| 30 | 75B113 | 5 | 5 | 1 1/2 | 1/2 | 3/4 | 3/4 | 1 | 1 | 11 1/2 | 36 | 1 | 14 1/2 | 7 1/8 | 90 | 96 | 8 | 24 | |
| 36 | A93275A | 6 | 6 | 2 | 1/2 | 3/4 | 3/4 | 1 | 1 | 14 | 42 | 1 | 16 3/8 | 7 1/8 | 90 | 96 | 8 | 24 | |
| 42 | A93273A | 8 | 8 | 2 | 1/2 | 3/4 | 1 | 1 | 1 | 16 1/2 | 48 | 1 1/4 | 10 3/8 | 10 1/4 | 90 | 96 | 8 | 24 | |

STANDARD AMMONIA LIQUID RECEIVERS



VESSEL CONSTRUCTED TO ASME SECTION VIII, DIV. I
PARTICULAR X-RAY AS15 OR 70 MATERIAL
CONNECTIONS 7" & LARGER ARE WELD
SAFETY VALVE SIZED FOR VILTER AF VALVE
ALL CONNECTIONS NOT WELD ARE FPT



| DIA. & OVERALL | PART NUMBER | LBS. A MIN. @ 70°F FULL | BARE WEIGHT LBS | DESIGN WEIGHT LBS | A. LIQ. INLET | B. LIQ. INLET | C | D | E | LGT. GUARD | LGT. GLASS | H | J | K | EQUAL PURGE |
|----------------|-------------|-------------------------|-----------------|-------------------|---------------|---------------|----|----|--------|------------|------------|--------|-------------|-------|-------------|
| | | | | | | | | | | | | | | | |
| 36" x 12FT | A67397A | 2600 | 1830 | 3100 | 3 | 2 1/2 | 26 | 18 | 27 1/2 | 24 1/2 | 27 | 21 | 19 x 19 | 5 1/2 | 1 |
| 36" x 14FT | A67397B | 3060 | 2150 | 3600 | 3 | 2 1/2 | 26 | 18 | 27 1/2 | 24 1/2 | 27 | 21 | 19 x 19 | 5 1/2 | 1 |
| 36" x 16FT | A67397C | 3520 | 2400 | 4000 | 3 | 2 1/2 | 26 | 18 | 27 1/2 | 24 1/2 | 27 | 21 | 19 x 19 | 5 1/2 | 1 |
| 36" x 18FT | A67397D | 3940 | 2700 | 4600 | 3 | 2 1/2 | 26 | 18 | 27 1/2 | 24 1/2 | 27 | 21 | 19 x 19 | 5 1/2 | 1 |
| 42" x 12FT | A67398A | 4210 | 2500 | 4800 | 4 | 3 | 26 | 19 | 27 1/2 | 24 1/2 | 27 | 24 1/2 | 19 x 22 1/2 | 2 1/2 | 1 |
| 42" x 14FT | A67398B | 4740 | 2830 | 5300 | 4 | 3 | 26 | 19 | 27 1/2 | 24 1/2 | 27 | 24 1/2 | 19 x 22 1/2 | 2 1/2 | 1 |
| 42" x 16FT | A67398C | 5500 | 3200 | 6000 | 4 | 3 | 26 | 19 | 27 1/2 | 24 1/2 | 27 | 24 1/2 | 19 x 22 1/2 | 2 1/2 | 1 |
| 42" x 18FT | A67398D | 6110 | 3500 | 6600 | 4 | 3 | 26 | 19 | 27 1/2 | 24 1/2 | 27 | 24 1/2 | 19 x 22 1/2 | 2 1/2 | 1 |
| 48" x 12FT | A67399A | 5340 | 3180 | 5800 | 5 | 4 | 29 | 21 | 31 1/2 | 28 1/2 | 31 | 27 1/2 | 19 x 25 1/2 | 3 1/2 | 1 1/2 |
| 48" x 14FT | A67399B | 6180 | 3620 | 6600 | 5 | 4 | 29 | 21 | 31 1/2 | 28 1/2 | 31 | 27 1/2 | 19 x 25 1/2 | 3 1/2 | 1 1/2 |
| 48" x 16FT | A67399C | 7040 | 4060 | 7500 | 5 | 4 | 29 | 21 | 31 1/2 | 28 1/2 | 31 | 27 1/2 | 19 x 25 1/2 | 3 1/2 | 1 1/2 |
| 48" x 18FT | A67399D | 7810 | 4500 | 8300 | 5 | 4 | 29 | 21 | 31 1/2 | 28 1/2 | 31 | 27 1/2 | 19 x 25 1/2 | 3 1/2 | 1 1/2 |

consideration on the receipt of this document, the recipient agrees to indemnify and hold the manufacturer harmless from any and all claims, damages, losses, expenses, attorney's fees, and costs of litigation, including reasonable costs of defense, for such action by another for any purpose, except with the written permission of the manufacturer.

| I.D. | SIZE | CONNECTION | FUNCTION |
|------|-------------|--------------------------|---------------------------------------|
| A | SEE CHART A | BUTT WELD (SCH-40) | SUCTION INLET |
| B | 5" | ANSI 300# SLIP-ON FLANGE | DISCHARGE OUTLET |
| C | SEE CHART B | NPT (FEMALE) | HI-PRESS. LIQUID INLET |
| D | AMM. 1/2" | NPT (FEMALE) | PRESSURE RELIEF |
| E | HALD. 1" | NPT (FEMALE) | PRESSURE RELIEF |
| F | 1/4" | NPT (FEMALE) | OIL DRAIN |
| G | 1/4" | NPT (FEMALE) | OIL DRAIN |
| H | 1/4" | NPT (FEMALE) | FILTER TANK VENT |
| I | 1/4" | NPT (FEMALE) | GAUGE PORT FOR LIQ. INJ. REG. |
| J | 1/4" | NPT (FEMALE) | OIL CHARGING |
| K | 1/4" | NPT (FEMALE) | HI-STAGE GAS INLET FOR LIQ. INJ. REG. |
| L | 1/4" | NPT (FEMALE) | TRANSUCER BLOCK/VALVE |

DUAL RELIEF VALVE ASSEMBLY TO BE SHIPPED LOOSE.
 AMMONIA VALVES SET AT 250 PSIG. (1" NPT FEM. OUTLETS)
 HALD. VALVES SET AT 300 PSIG. (1" NPT FEM. OUTLETS)
 DISCHARGE STOP-CHECK VALVE TO BE SHIPPED LOOSE.
 MOUNT AS CLOSE TO CONDENSER AS POSSIBLE.
 VALVE IS SIZED PER OPERATING CONDITIONS.
 A REDUCER WILL BE SUPPLIED BY VILTER IF REQUIRED.
 PIPING TO BE SUPPLIED BY CUSTOMER.

OIL CHARGE (BY CUSTOMER)

| | |
|---|-------------|
| U.S. GALS. (LBS.) | DUAL FILTER |
| 23.25 GALS. (24.90 GALS. (618.34 LBS.)) (194.21 LBS.) | |

OIL PUMP MOTOR DATA

| | |
|-------------------------|-------------|
| HORSE VOLTAGE (3 PHASE) | SPEED (RPM) |
| 208/240/277 | 34 575 1500 |

CHART B

| | |
|-----------------------|--------------|
| AMM. | HALD. |
| 5-20 | 5.5-11.16-26 |
| LIQ. INLET VALVE SIZE | 3/4" 1" |

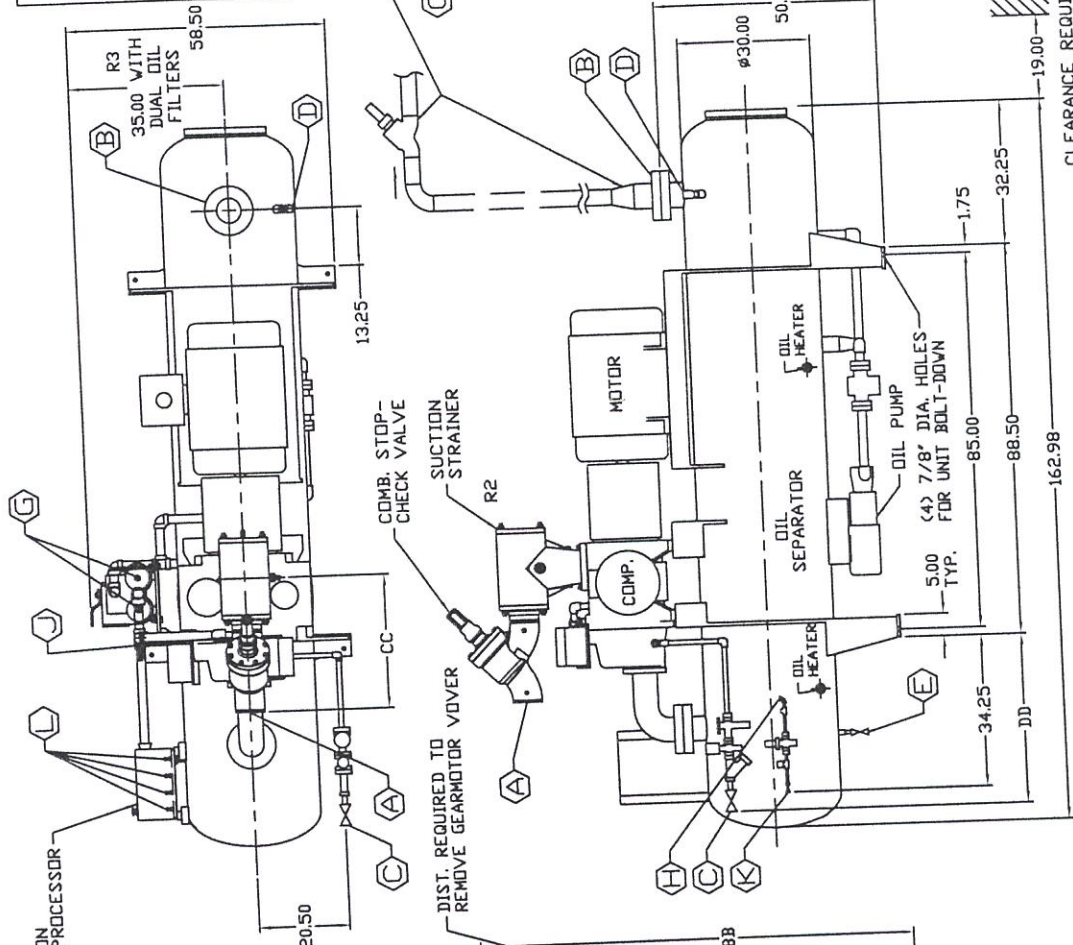
DIMENSIONS (INCHES)

| | | | | |
|-----------------|---------|---------|-------------------|------------|
| SUCT. LINE SIZE | AA | BB | CC | DD |
| 4" | 79-1/8 | 91 | 20-1/2 (23-1/4) | AMM. HALD. |
| 5" | 81-1/4 | 98-3/4 | 26-7/8 (32-5/16) | |
| 6" | 81-1/4 | 98-3/4 | 31-3/4 (39-13/16) | |
| 8" | 84-1/4 | 101-3/4 | 26-7/8 (32-5/16) | |
| | 84-1/4 | 101-3/4 | 31-3/4 (39-13/16) | |
| | 87-3/8 | 102-1/2 | 26-7/8 (32-5/16) | |
| | 87-3/8 | 102-1/2 | 31-3/4 (39-13/16) | |
| | 109-3/8 | 109-3/8 | 27-7/8 (41-7/8) | |

VILTER D

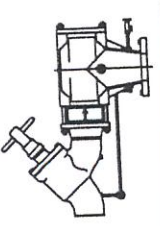
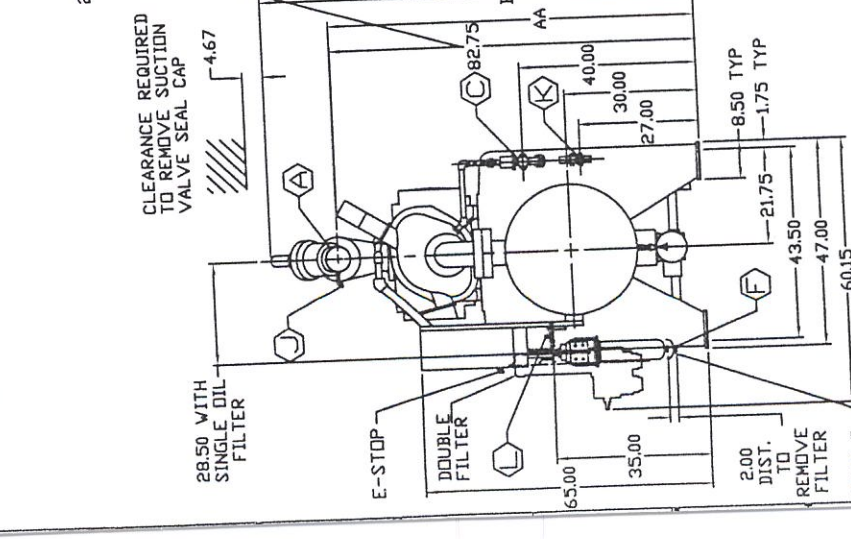
| | |
|--------------------------------|--------------------------------|
| REVISED TO MEET STANDARDS | REVISED TO MEET STANDARDS |
| AMM. ONLY UNIT FILTER & Valve | AMM. ONLY UNIT FILTER & Valve |
| HALD. ONLY UNIT FILTER & Valve | HALD. ONLY UNIT FILTER & Valve |
| REVISED PACKING | REVISED PACKING |

27018



WEIGHT ADDITION FOR OPTIONS (LBS.)

| COMPRESSOR SIZE | SUCT. LINE SIZE | SHIPPING WEIGHT (LESS MOTOR) (LBS.) | WEIGHT ADDITION FOR OPTIONS (LBS.) |
|-----------------|-----------------|-------------------------------------|------------------------------------|
| VSS-451/601 | 4" | 5,460 | |
| | 5" | 5,520 | |
| | 6" | 5,610 | |
| VSS-751/901 | 5" | 6,200 | 274 |
| | 6" | 6,290 | |
| | 8" | 6,520 | |
| VSS-1051/1201 | 6" | 6,730 | |
| | 8" | 6,940 | |



SUCTION VALVE AND CAST TEE USED FOR -30° AND BELOW

CHART A

| COMPR. SIZE | SUCT. LINE SIZE | OPTIONS | MOTOR DATA | OPERATING CONDITIONS |
|-------------|-----------------|--------------|------------|---------------------------------------|
| VSS-451 | 4" | DUAL FILTERS | YES NO HP | CONDENSING SUCT. PRESS. TEMP. PSIG/°F |
| VSS-601 | 5" | | | CONDENSING SUCT. PRESS. TEMP. PSIG/°F |
| VSS-751 | 6" | | | CONDENSING SUCT. PRESS. TEMP. PSIG/°F |
| VSS-901 | 8" | | | CONDENSING SUCT. PRESS. TEMP. PSIG/°F |

CLEARANCE REQUIRED TO REMOVE OIL SEP. ELEMENTS

consideration on the receipt of this document, the user assumes all responsibility for any action by another party for any purpose, except with the written permission of Vilter Manufacturing Company.

| I.D. | SIZE | CONNECTION | FUNCTION |
|------|-------------|--------------------------|-------------------------------|
| A | SEE CHART A | BUTT WELD (SCH.40) | SUCTION INLET |
| B | 4" | ANSI 300# SLIP-ON FLANGE | DISCHARGE OUTLET |
| C | SEE CHART B | NPT (FEMALE) | HI-PRESS. LIQUID INLET |
| D | AMM. 1/2" | NPT (FEMALE) | PRESSURE RELIEF |
| E | HALD. 1" | NPT (FEMALE) | PRESSURE RELIEF |
| F | 1/2" | NPT (FEMALE) | OIL DRAIN |
| G | 1/4" | NPT (FEMALE) | OIL DRAIN |
| H | 1/4" | NPT (FEM. PLUGGED) | FILTER TANK VENT |
| I | 1/4" | NPT (FEMALE) | GAUGE PORT FOR LIQ. INJ. REG. |
| J | 1/4" | NPT (FEMALE) | OIL CHARGING |
| K | 1/4" | NPT (FEMALE) | TRANSDUCER BLOCK/BLEED |
| L | 1-1/2" | ANSI 300# R.F. FLANGE | ECONOMIZER PORT |

DUAL RELIEF VALVE ASSEMBLY TO BE SHIPPED LOOSE.
 AMMONIA VALVES SET AT 250 PSIG. (1" NPT FEM. OUTLETS)
 HALD. VALVES SET AT 300 PSIG. (1" NPT FEM. OUTLETS)
 DISCHARGE STOP-CHECK VALVE TO BE SHIPPED LOOSE.
 MOUNT AS CLOSE TO CONDENSER AS POSSIBLE.
 VALVE IS SIZED PER OPERATING CONDITIONS.
 A REDUCER WILL BE SUPPLIED BY VILTER IF REQUIRED.
 PIPING TO BE SUPPLIED BY CUSTOMER.

OIL CHARGE (BY CLUST.)
 U.S. GALS. (LBS.)

| | |
|-----------------------------|--|
| DUAL FILTER | |
| SINGLE FILTER | |
| 23.25 GALS. (24.90 LBS.) | |
| (181.34 LBS.) (194.21 LBS.) | |

R3

CHART B

| LIQ. INLET VALVE SIZE | AMM. TX VALVE TR. RATING | HALD. TX VALVE TR. RATING |
|-----------------------|--------------------------|---------------------------|
| 10-20 | 30-50 | 75-100 |
| 1/2" | 3/4" | 1" |
| 3/4" | 1" | 1-1/4" |
| 1" | 1-1/4" | 1-1/2" |

CHART A

| COMPRESSOR SIZE | SUCT. LINE SIZE | AA | BB | CC | DD |
|-----------------|-----------------|--------|--------|--------|----------|
| VSS-451/601 | 4" | 74-7/8 | 86-7/8 | 20-1/2 | 23-1/4 |
| VSS-601 | 5" | 90 | 90 | 26-7/8 | 32-5/16 |
| VSS-751 | 6" | 94-1/8 | 94-1/8 | 31-3/4 | 39-13/16 |
| VSS-901 | 6" | 97-1/8 | 97-1/8 | 31-3/4 | 39-13/16 |

CHART A

| OPERATING CONDITIONS | CONDENSING TEMP. °F | SUCTION TEMP. °F | COMPRESSOR CAPACITY TONS | BHP | PSIG/HG | PSIG/HG |
|----------------------|---------------------|------------------|--------------------------|-----|---------|---------|
| | | | | | | |

MOTOR DATA

| HP | RPM | VOLTS | WEIGHT (LBS.) |
|----|-----|-------|---------------|
| | | | |

OPTIONS

| YES | NO |
|-----|----|
| | |

COMPRESSOR SIZE

| 4" | 5" | 6" |
|----|----|----|
| | | |

OPERATING CONDITIONS

| TEMP. °F | PSIG/HG | PSIG/HG |
|----------|---------|---------|
| | | |

OPERATING CONDITIONS

| TEMP. °F | PSIG/HG | PSIG/HG |
|----------|---------|---------|
| | | |

OPERATING CONDITIONS

| TEMP. °F | PSIG/HG | PSIG/HG |
|----------|---------|---------|
| | | |

OPERATING CONDITIONS

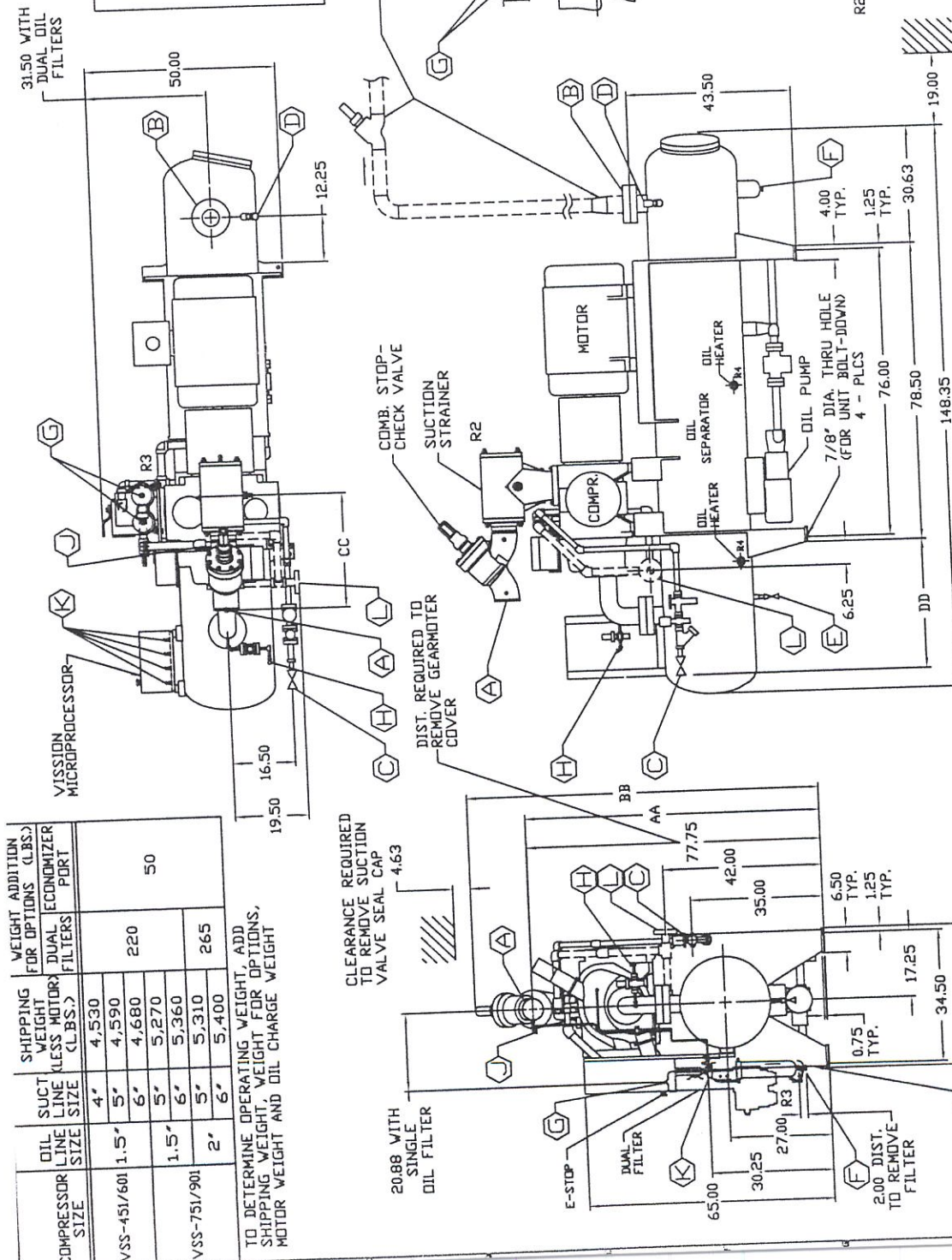
| TEMP. °F | PSIG/HG | PSIG/HG |
|----------|---------|---------|
| | | |

OPERATING CONDITIONS

| TEMP. °F | PSIG/HG | PSIG/HG |
|----------|---------|---------|
| | | |

OPERATING CONDITIONS

| TEMP. °F | PSIG/HG | PSIG/HG |
|----------|---------|---------|
| | | |

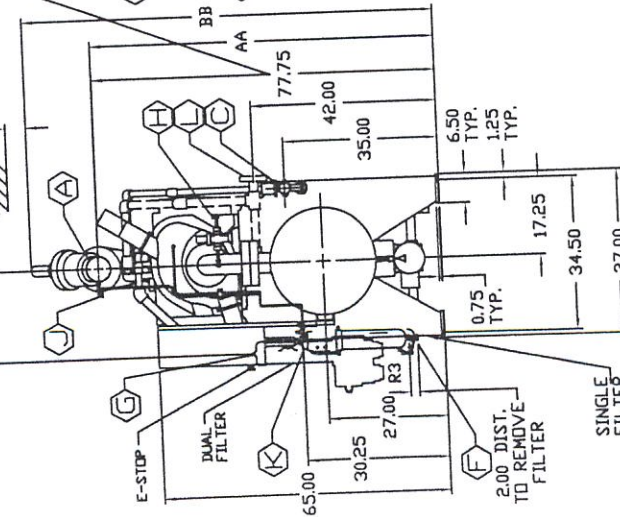


WEIGHT ADDITION FOR OPTIONS (LBS.)

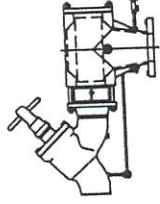
| COMPRESSOR SIZE | SUCT. LINE SIZE | SHIPPING WEIGHT (LESS MOTOR) (LBS.) | DUAL ECONOMIZER PORT | WEIGHT ADDITION FOR OPTIONS (LBS.) |
|-----------------|-----------------|-------------------------------------|----------------------|------------------------------------|
| VSS-451/601 | 1.5" | 4,530 | | 50 |
| | 5" | 4,590 | | 220 |
| | 6" | 4,680 | | |
| | 1.5" | 5,270 | | |
| | 6" | 5,360 | | |
| VSS-751/901 | 2" | 5,310 | | 265 |
| | 6" | 5,400 | | |

TO DETERMINE OPERATING WEIGHT, ADD SHIPPING WEIGHT, WEIGHT FOR OPTIONS, MOTOR WEIGHT AND OIL CHARGE WEIGHT

CLEARANCE REQUIRED TO REMOVE SUCTION VALVE SEAL CAP 4.63



CLEARANCE REQUIRED TO REMOVE OIL SEPARATOR ELEMENT.



SUCTION VALVE AND CAST TEE USED FOR -30° AND BELOW



VILTER MANUFACTURING COMPANY

451 THRU 901 1/2" SEP. & LL

27013

APENDICE E: TABLA DE CAPACIDAD DE COMPRESORES
ROTATIVOS VRB VILTER



CIB-ESPOL

**APENDICE F: TABLA DE CAPACIDAD DE COMPRESORES
RECIPROCANTES VMC 440 VILTER**



CIB-ESPOL

Vilter 440 VMC®

COMPRESSORS

Refrigerating capacities and BHP requirements
Based on 1200 RPM

RATING CONDITIONS AND LIMITATIONS

Capacities for R-22, R-502 and R-717 are based on saturated vapor conditions. Ratings for R-12 are based on +65 F suction temperature, superheated by doing useful work in the cylinder. All ratings are based on 1200 rpm. For other refrigerants use direct ratio. BHP's for sizes 2 thru 8 do not include belt losses. BHP's for sizes 12 and 16 do not include belt losses.

MAXIMUM LIMITS

Maximum superheat:
R-22, R-502, R-717: 85°F
R-12 (actual gas temp.): +65°F
Maximum compression ratio:
R-22, R-717: 8:1
R-502: 10:1
Maximum pressure differential: 175 PSI
Maximum discharge temperature: 300°F
Maximum discharge pressure: 300 PSI
Maximum suction pressure: 150 PSI
Maximum discharge temperature: 150°F
Maximum drive motor HP: 300 HP
Maximum drive:

| Compressor Size | RPM | Maximum BHP* |
|-----------------|------|--------------|
| 442 | 1200 | 100 |
| 444 | 1130 | 100 |
| 448 | | |
| 448HD | 1200 | 125 |
| 452 | 1130 | 120 |
| 416 | | |

*Increase 15% when shot peened crankshaft is ordered.

RATINGS

for Refrigerants 12 - 22 - 502 - 717 (Ammonia)



CIB-ESPOL

| CONDENSING Pressure psig and Corresponding Temperature °F | | REFRIGERANT 717 (AMMONIA) <i>Filter.</i> | | | | | | | | | | | | BASED ON 1200 RPM | |
|--|-------------|--|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------------------|--|
| | | COMPRESSOR MODEL | | | | | | | | | | | | | |
| | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | 4416 | |
| Temp. °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | |
| 95# 61.1° | -25 | 1.3 | 5.4 | 13.6 | 12.0 | 25.8 | 19.3 | 37.8 | 25.8 | 49.1 | 38.7 | 72.3 | 51.5 | 95.5 | |
| | -20 | 3.6 | 8.0 | 14.5 | 16.0 | 27.4 | 24.0 | 40.2 | 32.1 | 52.3 | 48.1 | 75.9 | 64.2 | 101.5 | |
| | -15 | 6.2 | 9.8 | 15.4 | 19.7 | 29.4 | 29.5 | 42.9 | 39.5 | 55.9 | 59.2 | 82.3 | 79.0 | 108.5 | |
| | -10 | 9.0 | 11.9 | 16.5 | 23.8 | 31.4 | 35.7 | 45.9 | 47.6 | 59.6 | 71.4 | 87.7 | 95.2 | 114.0 | |
| | -5 | 12.2 | 14.1 | 17.8 | 28.2 | 33.7 | 42.3 | 49.3 | 56.5 | 64.2 | 84.7 | 94.5 | 113.0 | 124.5 | |
| | 0 | 15.7 | 16.5 | 19.1 | 33.1 | 36.2 | 49.6 | 53.0 | 66.2 | 68.9 | 99.3 | 101.2 | 133.2 | 134.0 | |
| | 5 | 19.6 | 19.3 | 20.2 | 38.7 | 38.2 | 58.0 | 56.0 | 77.5 | 72.9 | 116.2 | 107.0 | 155.0 | 141.7 | |
| | 10 | 23.8 | 22.4 | 20.8 | 44.8 | 39.6 | 67.2 | 57.9 | 89.6 | 75.3 | 134.4 | 110.7 | 179.2 | 146.1 | |
| | 15 | 28.4 | 25.6 | 20.9 | 51.3 | 39.6 | 76.9 | 58.0 | 102.6 | 75.4 | 152.9 | 110.8 | 205.2 | 149.3 | |
| | 20 | 32.5 | 28.4 | 20.4 | 56.8 | 38.8 | 85.2 | 57.0 | 113.7 | 74.0 | 170.5 | 108.9 | 227.4 | 144.0 | |
| | 25 | 39.0 | 32.7 | 19.1 | 65.5 | 36.3 | 98.2 | 53.2 | 131.0 | 69.2 | 196.5 | 101.8 | 262.4 | 134.3 | |
| 30 | 45.0 | 36.9 | 17.2 | 73.8 | 32.6 | 110.7 | 47.9 | 147.6 | 62.4 | 222.4 | 91.8 | 295.2 | 121.1 | | |
| 115# 70.4° | -25 | 1.3 | 5.9 | 14.3 | 11.9 | 27.2 | 17.8 | 39.7 | 23.9 | 51.7 | 35.8 | 76.1 | 47.8 | 100.2 | |
| | -20 | 3.6 | 7.5 | 15.4 | 15.0 | 29.3 | 22.5 | 42.9 | 30.1 | 55.8 | 45.1 | 82.2 | 60.2 | 108.2 | |
| | -15 | 6.2 | 9.3 | 16.7 | 18.6 | 32.5 | 27.9 | 46.2 | 37.2 | 60.2 | 55.8 | 88.5 | 74.4 | 117.0 | |
| | -10 | 9.0 | 11.2 | 18.0 | 22.5 | 34.1 | 33.7 | 49.9 | 45.0 | 64.9 | 67.5 | 99.3 | 90.0 | 126.0 | |
| | -5 | 12.2 | 13.4 | 19.3 | 26.8 | 36.7 | 40.2 | 53.7 | 53.6 | 69.9 | 80.4 | 102.8 | 107.2 | 135.8 | |
| | 0 | 15.7 | 15.7 | 20.6 | 31.4 | 39.2 | 47.1 | 59.3 | 62.8 | 74.6 | 93.8 | 109.7 | 124.8 | 145.0 | |
| | 5 | 19.6 | 18.4 | 21.8 | 36.8 | 41.4 | 54.3 | 70.5 | 73.6 | 78.8 | 110.4 | 116.0 | 147.2 | 153.0 | |
| | 10 | 23.8 | 21.3 | 22.7 | 42.6 | 43.2 | 63.9 | 83.0 | 85.2 | 82.2 | 127.8 | 120.9 | 170.4 | 159.5 | |
| | 15 | 28.4 | 24.4 | 23.1 | 48.8 | 43.9 | 73.2 | 97.6 | 83.6 | 83.6 | 146.4 | 122.8 | 195.2 | 162.2 | |
| | 20 | 32.5 | 27.1 | 23.1 | 54.2 | 43.9 | 81.3 | 108.5 | 83.7 | 83.7 | 162.7 | 123.0 | 217.0 | 162.4 | |
| | 25 | 39.0 | 31.3 | 22.6 | 62.7 | 42.9 | 94.0 | 125.4 | 81.8 | 81.8 | 188.1 | 120.2 | 250.8 | 158.8 | |
| 30 | 45.0 | 35.3 | 21.7 | 70.6 | 41.2 | 105.9 | 141.3 | 76.5 | 76.5 | 211.9 | 115.3 | 282.6 | 152.2 | | |
| 135# 78.7° | -25 | 1.3 | 5.5 | 15.2 | 11.1 | 27.8 | 16.6 | 42.2 | 22.3 | 54.8 | 33.4 | 80.7 | 44.6 | 109.7 | |
| | -20 | 3.6 | 7.0 | 16.4 | 14.1 | 31.1 | 21.1 | 45.6 | 28.3 | 59.3 | 42.4 | 87.3 | 56.6 | 115.0 | |
| | -15 | 6.2 | 8.9 | 17.8 | 17.9 | 33.8 | 26.8 | 49.6 | 35.8 | 64.4 | 53.7 | 94.5 | 71.6 | 125.0 | |
| | -10 | 9.0 | 10.6 | 19.2 | 21.2 | 36.6 | 31.8 | 53.6 | 42.5 | 69.6 | 63.7 | 102.3 | 85.0 | 135.2 | |
| | -5 | 12.2 | 12.7 | 20.7 | 25.4 | 39.4 | 38.1 | 57.7 | 50.8 | 75.0 | 76.2 | 110.2 | 101.6 | 145.9 | |
| | 0 | 15.7 | 14.9 | 22.1 | 29.9 | 42.0 | 44.8 | 61.6 | 59.8 | 80.0 | 89.7 | 117.6 | 119.6 | 155.2 | |
| | 5 | 19.6 | 17.5 | 23.2 | 35.0 | 44.2 | 52.5 | 64.9 | 70.0 | 84.3 | 105.0 | 123.8 | 140.0 | 163.8 | |
| | 10 | 23.8 | 20.2 | 24.3 | 40.4 | 46.3 | 60.6 | 67.9 | 80.9 | 88.2 | 121.3 | 129.8 | 161.8 | 171.2 | |
| | 15 | 28.4 | 23.2 | 25.2 | 46.4 | 47.8 | 69.6 | 70.2 | 92.8 | 91.1 | 139.2 | 134.0 | 185.6 | 177.0 | |
| | 20 | 32.5 | 25.8 | 25.5 | 51.6 | 48.5 | 77.4 | 71.3 | 103.2 | 92.5 | 154.8 | 136.0 | 206.4 | 180.0 | |
| | 25 | 39.0 | 30.0 | 25.6 | 60.0 | 49.0 | 90.0 | 72.0 | 120.0 | 93.4 | 180.0 | 137.2 | 240.0 | 181.8 | |
| 30 | 45.0 | 33.7 | 25.8 | 67.5 | 49.2 | 101.2 | 72.2 | 135.0 | 93.7 | 202.5 | 137.8 | 270.0 | 182.0 | | |
| 155# 86.1° | -25 | 1.3 | 5.1 | 15.6 | 10.2 | 29.6 | 15.3 | 43.5 | 20.4 | 56.4 | 30.6 | 82.9 | 40.8 | 109.7 | |
| | -20 | 3.6 | 6.5 | 16.9 | 13.1 | 32.1 | 19.6 | 47.1 | 26.2 | 61.1 | 39.3 | 89.8 | 52.4 | 118.4 | |
| | -15 | 6.2 | 8.1 | 18.3 | 16.3 | 34.8 | 24.4 | 51.0 | 32.6 | 66.3 | 48.9 | 97.5 | 65.2 | 128.8 | |
| | -10 | 9.0 | 9.9 | 19.8 | 19.9 | 37.7 | 29.8 | 55.3 | 39.9 | 71.8 | 59.8 | 105.6 | 79.8 | 139.4 | |
| | -5 | 12.2 | 12.0 | 21.4 | 24.0 | 40.6 | 36.0 | 58.6 | 48.0 | 77.4 | 72.0 | 113.8 | 96.0 | 150.2 | |
| | 0 | 15.7 | 14.2 | 22.8 | 28.4 | 43.4 | 42.6 | 63.7 | 56.8 | 82.6 | 85.2 | 121.5 | 113.6 | 160.2 | |
| | 5 | 19.6 | 16.9 | 24.2 | 33.3 | 46.1 | 49.9 | 67.5 | 66.7 | 87.7 | 100.0 | 129.0 | 133.4 | 170.2 | |
| | 10 | 23.8 | 19.2 | 25.4 | 38.5 | 48.3 | 57.7 | 70.8 | 77.1 | 91.9 | 115.6 | 135.0 | 154.2 | 178.4 | |
| | 15 | 28.4 | 22.1 | 26.3 | 44.3 | 50.0 | 66.4 | 73.3 | 88.3 | 95.2 | 132.9 | 140.0 | 177.2 | 185.6 | |
| | 20 | 32.5 | 24.7 | 26.8 | 49.4 | 51.0 | 74.1 | 75.0 | 98.8 | 97.2 | 148.2 | 143.0 | 197.0 | 188.8 | |
| | 25 | 39.0 | 28.7 | 27.2 | 57.5 | 51.8 | 86.2 | 76.0 | 115.0 | 98.6 | 172.5 | 145.0 | 230.0 | 191.6 | |
| 30 | 45.0 | 32.3 | 27.3 | 64.7 | 51.9 | 97.0 | 76.1 | 129.4 | 98.8 | 194.1 | 145.2 | 258.8 | 192.0 | | |

Ratings above line for extrapolation only.

| CONDENSING Pressure psig and Corresponding Temperature °F | | REFRIGERANT 717 (AMMONIA) <i>Filter.</i> | | | | | | | | | | | | BASED ON 1200 RPM | |
|--|-------------|--|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------------------|--|
| | | COMPRESSOR MODEL | | | | | | | | | | | | | |
| | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | 4416 | |
| Temp °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | |
| 165# 89.6° | -15 | 6.2 | 7.8 | 18.8 | 15.7 | 35.8 | 23.5 | 52.5 | 31.4 | 68.2 | 47.1 | 100.2 | 62.8 | 132.3 | |
| | -10 | 9.0 | 9.6 | 20.3 | 19.2 | 38.6 | 28.8 | 56.7 | 38.4 | 73.5 | 57.5 | 108.3 | 75.8 | 143.0 | |
| | -5 | 12.2 | 11.6 | 21.7 | 23.2 | 41.4 | 34.9 | 60.6 | 45.4 | 78.7 | 69.8 | 115.8 | 92.8 | 153.0 | |
| | 0 | 15.7 | 13.7 | 23.1 | 27.5 | 44.0 | 41.2 | 64.5 | 55.0 | 83.7 | 82.5 | 123.1 | 110.0 | 162.3 | |
| | 5 | 19.6 | 16.1 | 24.6 | 32.3 | 46.7 | 48.4 | 68.5 | 64.7 | 89.0 | 97.0 | 131.0 | 129.4 | 172.8 | |
| | 10 | 23.8 | 18.8 | 25.9 | 37.6 | 49.3 | 56.4 | 72.3 | 75.2 | 93.8 | 112.8 | 138.0 | 150.4 | 182.0 | |
| | 15 | 28.4 | 21.6 | 26.9 | 43.3 | 51.1 | 64.9 | 75.0 | 86.6 | 97.4 | 129.9 | 143.3 | 173.2 | 189.0 | |
| | 20 | 33.5 | 24.1 | 27.4 | 48.3 | 52.7 | 72.4 | 76.6 | 96.6 | 99.4 | 144.9 | 146.0 | 193.2 | 193.8 | |
| | 25 | 39.0 | 29.2 | 27.9 | 56.4 | 53.1 | 84.6 | 77.7 | 112.8 | 101.0 | 169.2 | 148.6 | 225.6 | 196.0 | |
| | 30 | 45.0 | 31.6 | 28.0 | 63.3 | 53.2 | 94.9 | 77.9 | 126.6 | 131.2 | 189.9 | 148.9 | 253.2 | 196.4 | |
| 175# 93.0° | -15 | 6.2 | 7.6 | 19.3 | 15.2 | 36.8 | 22.8 | 53.9 | 30.4 | 69.9 | 45.6 | 102.8 | 60.8 | 135.8 | |
| | -10 | 9.0 | 9.3 | 20.8 | 18.5 | 39.6 | 27.9 | 58.0 | 37.2 | 75.4 | 55.8 | 110.9 | 74.4 | 146.7 | |
| | -5 | 12.2 | 11.2 | 22.3 | 22.5 | 42.4 | 33.7 | 62.0 | 45.0 | 80.5 | 67.5 | 118.3 | 90.0 | 156.0 | |
| | 0 | 15.7 | 13.4 | 23.7 | 26.8 | 45.0 | 40.2 | 66.0 | 53.7 | 85.7 | 80.5 | 126.0 | 107.4 | 166.3 | |
| | 5 | 19.6 | 15.8 | 25.2 | 31.6 | 47.7 | 47.4 | 70.0 | 63.3 | 91.0 | 94.9 | 134.0 | 126.6 | 176.7 | |
| | 10 | 23.8 | 18.4 | 26.4 | 36.8 | 50.2 | 55.2 | 73.5 | 73.7 | 95.5 | 110.5 | 140.4 | 147.4 | 185.2 | |
| | 15 | 28.4 | 21.2 | 27.4 | 42.4 | 52.2 | 63.6 | 76.6 | 84.9 | 98.4 | 127.3 | 146.0 | 169.8 | 193.8 | |
| | 20 | 33.5 | 23.7 | 28.1 | 47.4 | 53.4 | 71.1 | 78.3 | 94.8 | 101.7 | 142.2 | 149.6 | 189.6 | 197.3 | |
| | 25 | 39.0 | 27.5 | 28.9 | 55.3 | 55.0 | 82.9 | 80.5 | 110.6 | 104.6 | 165.9 | 154.0 | 221.2 | 203.0 | |
| | 30 | 45.0 | 31.1 | 29.3 | 62.2 | 55.9 | 93.3 | 81.8 | 124.5 | 106.2 | 186.7 | 156.2 | 249.0 | 206.0 | |
| 185# 96.2° | -15 | 6.2 | 7.3 | 19.6 | 14.7 | 37.2 | 22.0 | 54.6 | 29.4 | 71.0 | 44.1 | 104.2 | 58.8 | 136.0 | |
| | -10 | 9.0 | 9.0 | 21.1 | 18.0 | 40.2 | 27.0 | 58.7 | 36.0 | 76.4 | 54.0 | 112.0 | 72.0 | 148.0 | |
| | -5 | 12.2 | 10.9 | 22.6 | 21.8 | 42.9 | 32.7 | 62.8 | 43.7 | 81.7 | 65.5 | 120.0 | 87.4 | 158.5 | |
| | 0 | 15.7 | 13.1 | 24.1 | 26.2 | 45.8 | 39.3 | 67.1 | 52.4 | 87.2 | 78.6 | 128.0 | 104.8 | 169.0 | |
| | 5 | 19.6 | 15.5 | 25.6 | 31.1 | 48.7 | 46.6 | 71.4 | 62.2 | 92.8 | 93.3 | 136.2 | 124.4 | 180.0 | |
| | 10 | 23.8 | 18.0 | 26.9 | 36.1 | 51.4 | 54.1 | 75.2 | 72.2 | 97.7 | 108.3 | 143.6 | 144.4 | 189.5 | |
| | 15 | 28.4 | 20.8 | 28.0 | 41.6 | 53.4 | 62.4 | 78.3 | 83.3 | 101.6 | 124.9 | 149.3 | 156.6 | 198.0 | |
| | 20 | 33.5 | 23.2 | 28.9 | 46.5 | 54.9 | 69.7 | 80.4 | 93.0 | 104.4 | 139.5 | 154.8 | 186.0 | 203.5 | |
| | 25 | 39.0 | 27.0 | 29.8 | 54.1 | 56.7 | 81.1 | 83.4 | 108.3 | 108.0 | 162.4 | 159.0 | 216.6 | 210.0 | |
| | 30 | 45.0 | 30.6 | 30.7 | 61.2 | 58.4 | 91.8 | 85.7 | 122.5 | 111.1 | 183.7 | 163.5 | 245.0 | 216.5 | |
| 205# 102.3° | -5 | 12.2 | 10.3 | 23.6 | 20.7 | 44.8 | 31.0 | 65.7 | 41.5 | 85.4 | 62.2 | 125.5 | 83.0 | 165.5 | |
| | 0 | 15.7 | 12.4 | 25.2 | 25.0 | 47.9 | 37.5 | 70.2 | 50.0 | 91.2 | 75.0 | 134.0 | 100.0 | 177.0 | |
| | 5 | 19.6 | 14.8 | 26.6 | 29.6 | 50.6 | 44.4 | 74.2 | 59.2 | 96.4 | 88.8 | 141.7 | 118.4 | 186.7 | |
| | 10 | 23.8 | 17.3 | 27.9 | 34.7 | 53.3 | 52.0 | 78.0 | 69.5 | 101.2 | 104.2 | 149.0 | 139.0 | 197.5 | |
| | 15 | 28.4 | 20.0 | 29.1 | 40.1 | 55.5 | 60.1 | 81.2 | 80.3 | 105.6 | 120.4 | 155.0 | 160.6 | 206.0 | |
| | 20 | 33.5 | 22.5 | 30.1 | 45.0 | 57.3 | 67.5 | 84.0 | 90.0 | 109.0 | 135.0 | 160.0 | 180.0 | 212.3 | |
| | 25 | 39.0 | 26.3 | 31.4 | 52.6 | 59.8 | 78.9 | 87.7 | 105.2 | 113.8 | 157.8 | 167.3 | 210.4 | 222.0 | |
| | 30 | 45.0 | 29.7 | 32.9 | 59.5 | 62.0 | 89.2 | 91.0 | 119.1 | 118.0 | 178.6 | 173.5 | 238.2 | 230.0 | |
| 225# 108.0° | 20 | 33.5 | 21.7 | 31.5 | 43.4 | 60.0 | 65.1 | 88.0 | 86.9 | 114.2 | 130.3 | 168.1 | 173.8 | 223.0 | |
| | 25 | 39.0 | 25.4 | 33.0 | 50.9 | 62.7 | 76.3 | 92.0 | 101.9 | 119.4 | 152.8 | 175.5 | 203.8 | 233.0 | |
| | 30 | 45.0 | 28.9 | 34.1 | 57.9 | 65.0 | 86.8 | 95.2 | 115.8 | 123.8 | 173.7 | 182.0 | 231.6 | 241.5 | |
| | 35 | 51.6 | 32.7 | 35.6 | 65.4 | 67.7 | 98.1 | 99.2 | 130.8 | 128.8 | 196.2 | 189.7 | 261.6 | 251.0 | |

Ratings above line for extrapolation only.

| CONDENSING Temperature °F and Corresponding Pressure psig | | | REFRIGERANT 12 <i>Filter</i> | | | | | | | | | | | | BASED ON 1200 RPM | |
|--|-------------|------|------------------------------|------|------|------|------|-------|------|-------|-------|-------|-------|-------|-------------------|--|
| | | | COMPRESSOR MODEL | | | | | | | | | | | | | |
| | | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | 4416 | |
| Temp. °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | | |
| 80° 84.1 # | -20 | 0.58 | 5.6 | 11.3 | 11.3 | 23.7 | 16.9 | 34.8 | 22.6 | 45.1 | 33.9 | 66.4 | 45.2 | 87.4 | | |
| | -10 | 4.5 | 7.6 | 14.9 | 15.2 | 28.4 | 22.8 | 41.6 | 30.4 | 54.1 | 45.6 | 79.7 | 60.8 | 105.0 | | |
| | 0 | 9.2 | 10.0 | 19.2 | 20.0 | 30.8 | 30.0 | 45.3 | 40.0 | 58.8 | 60.0 | 86.5 | 80.0 | 114.0 | | |
| | 5 | 11.8 | 11.3 | 16.8 | 22.7 | 31.9 | 34.0 | 46.8 | 45.4 | 60.9 | 68.1 | 89.5 | 90.8 | 118.2 | | |
| | 10 | 14.7 | 13.0 | 17.3 | 26.1 | 33.1 | 39.1 | 48.5 | 52.2 | 63.0 | 78.3 | 92.6 | 104.4 | 122.2 | | |
| | 15 | 17.8 | 14.3 | 17.4 | 28.7 | 33.6 | 43.0 | 49.2 | 57.4 | 64.0 | 86.1 | 94.1 | 114.8 | 124.2 | | |
| | 20 | 21.1 | 16.0 | 17.9 | 32.1 | 34.1 | 48.1 | 50.0 | 64.2 | 65.1 | 96.3 | 95.7 | 128.4 | 126.3 | | |
| | 25 | 24.7 | 17.9 | 18.3 | 35.9 | 34.6 | 53.8 | 50.9 | 71.8 | 66.1 | 107.7 | 97.3 | 143.6 | 128.3 | | |
| | 30 | 28.5 | 20.0 | 18.5 | 40.0 | 35.3 | 60.0 | 51.6 | 80.0 | 67.2 | 120.0 | 98.8 | 160.0 | 130.3 | | |
| | 35 | 32.6 | 22.2 | 18.5 | 44.5 | 35.3 | 66.7 | 51.6 | 89.0 | 67.2 | 133.5 | 98.8 | 178.0 | 130.3 | | |
| | 40 | 37.0 | 24.5 | 18.5 | 49.0 | 35.3 | 73.5 | 51.6 | 98.0 | 67.2 | 147.0 | 98.8 | 196.0 | 130.3 | | |
| 50 | 46.7 | 29.5 | 18.5 | 59.0 | 35.3 | 88.4 | 51.6 | 118.0 | 67.2 | 177.0 | 98.8 | 236.0 | 130.3 | | | |
| 85° 91.7 # | -20 | 0.58 | 5.4 | 12.5 | 13.7 | 23.8 | 15.1 | 35.0 | 21.5 | 45.3 | 32.2 | 66.6 | 43.0 | 88.0 | | |
| | -10 | 4.5 | 7.2 | 15.0 | 14.5 | 28.6 | 21.7 | 41.8 | 29.0 | 54.4 | 43.5 | 80.0 | 58.0 | 105.5 | | |
| | 0 | 9.2 | 9.6 | 16.5 | 19.1 | 31.4 | 28.7 | 46.0 | 38.3 | 59.8 | 57.4 | 88.0 | 76.6 | 116.0 | | |
| | 5 | 11.8 | 10.9 | 17.2 | 21.8 | 32.8 | 32.7 | 48.0 | 43.8 | 62.5 | 65.4 | 91.8 | 87.2 | 121.2 | | |
| | 10 | 14.7 | 12.4 | 17.7 | 24.9 | 33.8 | 37.3 | 49.6 | 49.8 | 64.5 | 74.7 | 96.0 | 90.6 | 125.3 | | |
| | 15 | 17.8 | 14.8 | 18.1 | 27.5 | 34.4 | 41.4 | 50.4 | 55.2 | 65.6 | 82.8 | 96.5 | 110.4 | 127.2 | | |
| | 20 | 21.1 | 16.5 | 18.5 | 30.9 | 35.3 | 46.4 | 51.6 | 61.9 | 67.2 | 92.8 | 98.8 | 123.8 | 130.3 | | |
| | 25 | 24.7 | 18.3 | 18.8 | 34.7 | 35.8 | 52.0 | 52.5 | 69.3 | 68.2 | 103.9 | 100.4 | 138.6 | 132.3 | | |
| | 30 | 28.5 | 20.3 | 19.0 | 38.9 | 36.3 | 58.0 | 53.2 | 77.3 | 69.4 | 115.9 | 101.8 | 154.6 | 134.7 | | |
| | 35 | 32.6 | 21.5 | 19.1 | 43.0 | 36.4 | 64.5 | 53.4 | 86.0 | 69.6 | 129.0 | 102.0 | 172.0 | 135.0 | | |
| | 40 | 37.0 | 24.7 | 19.2 | 47.4 | 36.6 | 71.1 | 53.6 | 94.8 | 69.8 | 142.2 | 102.8 | 189.0 | 135.6 | | |
| 50 | 46.7 | 29.5 | 19.3 | 57.3 | 36.8 | 85.9 | 54.1 | 114.6 | 70.4 | 171.9 | 103.3 | 229.2 | 136.5 | | | |
| 90° 99.6 # | -20 | 0.58 | 5.1 | 12.5 | 10.2 | 23.9 | 15.3 | 35.1 | 20.4 | 45.5 | 30.6 | 67.0 | 40.8 | 88.3 | | |
| | -10 | 4.5 | 6.9 | 15.0 | 13.8 | 28.7 | 20.7 | 42.0 | 27.6 | 54.6 | 41.4 | 80.3 | 55.2 | 106.0 | | |
| | 0 | 9.2 | 9.1 | 16.8 | 18.3 | 31.9 | 27.4 | 46.8 | 36.6 | 60.9 | 54.9 | 89.5 | 73.2 | 118.1 | | |
| | 5 | 11.8 | 10.4 | 17.7 | 20.9 | 33.6 | 31.3 | 49.2 | 41.8 | 64.0 | 62.7 | 94.1 | 83.6 | 124.2 | | |
| | 10 | 14.7 | 11.8 | 18.2 | 23.7 | 34.6 | 35.5 | 50.9 | 47.4 | 66.1 | 71.1 | 97.4 | 94.8 | 128.2 | | |
| | 15 | 17.8 | 13.2 | 18.5 | 26.5 | 35.3 | 39.7 | 51.6 | 53.0 | 67.2 | 79.5 | 99.8 | 106.0 | 130.3 | | |
| | 20 | 21.1 | 14.9 | 19.1 | 29.8 | 36.3 | 44.7 | 53.3 | 59.6 | 69.4 | 89.4 | 101.8 | 119.2 | 134.5 | | |
| | 25 | 24.7 | 16.7 | 19.3 | 33.4 | 36.8 | 50.1 | 54.0 | 66.8 | 70.4 | 100.2 | 103.3 | 133.6 | 136.5 | | |
| | 30 | 28.5 | 18.5 | 19.6 | 37.3 | 37.4 | 55.9 | 55.0 | 74.6 | 71.4 | 111.9 | 105.0 | 149.2 | 138.4 | | |
| | 35 | 32.6 | 20.7 | 19.8 | 41.5 | 37.7 | 62.2 | 55.4 | 83.0 | 71.9 | 124.5 | 105.8 | 166.0 | 139.4 | | |
| | 40 | 37.0 | 22.9 | 19.9 | 45.8 | 38.0 | 68.7 | 55.7 | 91.6 | 72.5 | 137.4 | 106.6 | 183.2 | 140.7 | | |
| 50 | 46.7 | 27.8 | 20.2 | 55.8 | 38.5 | 81.4 | 56.5 | 111.2 | 73.5 | 166.8 | 108.1 | 222.4 | 142.6 | | | |
| 95° 108.1 # | -20 | 0.58 | 4.8 | 12.6 | 9.5 | 24.0 | 14.3 | 35.3 | 19.1 | 45.7 | 28.6 | 67.4 | 38.2 | 88.7 | | |
| | -10 | 4.5 | 6.5 | 15.1 | 13.0 | 28.8 | 19.6 | 42.2 | 26.1 | 54.8 | 39.1 | 80.5 | 52.2 | 106.3 | | |
| | 0 | 9.2 | 8.7 | 17.4 | 17.4 | 32.6 | 26.2 | 47.6 | 34.9 | 62.0 | 52.3 | 91.0 | 69.8 | 120.2 | | |
| | 5 | 11.8 | 10.0 | 17.7 | 19.9 | 33.8 | 29.9 | 49.6 | 39.9 | 64.6 | 59.8 | 95.0 | 79.8 | 125.3 | | |
| | 10 | 14.7 | 11.3 | 18.4 | 22.7 | 35.0 | 34.0 | 51.2 | 45.4 | 66.6 | 68.1 | 98.1 | 90.8 | 129.2 | | |
| | 15 | 17.8 | 12.7 | 18.9 | 25.5 | 36.1 | 38.2 | 52.9 | 51.0 | 68.8 | 76.5 | 101.2 | 102.0 | 133.6 | | |
| | 20 | 21.1 | 14.3 | 19.6 | 28.7 | 37.4 | 43.0 | 54.9 | 57.4 | 71.4 | 86.1 | 105.0 | 114.8 | 138.4 | | |
| | 25 | 24.7 | 16.1 | 20.0 | 32.1 | 38.2 | 48.2 | 56.1 | 64.3 | 73.0 | 96.4 | 107.3 | 128.6 | 141.7 | | |
| | 30 | 28.5 | 18.0 | 20.4 | 36.0 | 38.8 | 54.0 | 56.9 | 72.0 | 74.0 | 108.0 | 108.9 | 144.0 | 143.5 | | |
| | 35 | 32.6 | 20.0 | 20.6 | 40.0 | 39.0 | 60.1 | 57.4 | 80.1 | 74.6 | 120.1 | 109.8 | 160.2 | 144.7 | | |
| | 40 | 37.0 | 22.1 | 20.7 | 44.2 | 39.4 | 66.4 | 57.7 | 86.5 | 75.1 | 132.7 | 110.7 | 177.0 | 145.8 | | |
| 50 | 46.7 | 26.9 | 20.8 | 53.9 | 39.7 | 80.8 | 58.1 | 107.8 | 75.5 | 161.7 | 111.1 | 215.6 | 146.4 | | | |
| 100° 116.9 # (cont) | -20 | 0.58 | 4.5 | 12.7 | 8.9 | 24.1 | 13.4 | 35.4 | 17.9 | 46.0 | 26.8 | 67.6 | 35.8 | 89.3 | | |
| | -10 | 4.5 | 6.1 | 15.1 | 12.3 | 28.9 | 18.4 | 42.3 | 24.6 | 55.0 | 36.9 | 80.9 | 49.2 | 106.7 | | |
| | 0 | 9.2 | 8.3 | 17.3 | 16.6 | 33.1 | 24.9 | 48.4 | 33.2 | 63.0 | 49.8 | 92.6 | 66.4 | 122.2 | | |
| | 5 | 11.8 | 9.5 | 17.9 | 19.0 | 34.1 | 28.5 | 50.0 | 38.0 | 65.1 | 57.0 | 95.8 | 76.0 | 126.3 | | |
| | 10 | 14.7 | 10.8 | 18.5 | 21.7 | 35.3 | 32.5 | 51.6 | 43.4 | 67.2 | 65.1 | 98.8 | 86.8 | 130.3 | | |
| | 15 | 17.8 | 12.2 | 19.3 | 24.5 | 37.0 | 36.7 | 54.1 | 49.0 | 70.4 | 73.5 | 103.4 | 98.0 | 136.5 | | |
| | 20 | 21.1 | 13.8 | 20.2 | 27.6 | 38.6 | 41.4 | 56.5 | 55.2 | 73.5 | 82.8 | 108.1 | 110.4 | 142.6 | | |
| 25 | 24.7 | 15.4 | 20.9 | 30.9 | 39.7 | 46.3 | 58.1 | 61.8 | 75.6 | 92.7 | 111.1 | 123.6 | 146.7 | | | |

Ratings above line for extrapolation only. 4



CIB-ESPOL

| CONDENSING Temperature °F and Corresponding Pressure psig | | | REFRIGERANT 12 | | | | | | | | | | | | Filter. | | BASED ON 1200 RPM | | | |
|--|----------------|------|------------------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|---------|--|-------------------|--|------|--|
| | | | COMPRESSOR MODEL | | | | | | | | | | | | | | | | | |
| | | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | | | | | 4416 | |
| Temp. °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | | | | | | |
| (cont) 100° 116.9 # | 30 | 28.5 | 17.3 | 21.1 | 34.7 | 40.2 | 52.0 | 59.0 | 69.4 | 74.6 | 104.1 | 117.9 | 138.8 | 148.7 | | | | | | |
| | 35 | 32.6 | 19.3 | 21.4 | 38.6 | 40.7 | 57.6 | 59.8 | 77.2 | 77.7 | 115.8 | 114.1 | 154.4 | 150.8 | | | | | | |
| | 40 | 37.0 | 21.3 | 21.4 | 42.7 | 40.7 | 64.0 | 59.9 | 85.4 | 77.7 | 128.1 | 114.1 | 170.8 | 150.8 | | | | | | |
| | 50 | 46.7 | 26.1 | 21.4 | 52.2 | 40.7 | 78.3 | 59.9 | 104.4 | 77.7 | 150.6 | 114.1 | 208.8 | 150.8 | | | | | | |
| 105° 126.2 # | -20 | 0.58 | 4.1 | 12.7 | 8.3 | 24.1 | 12.4 | 35.5 | 16.5 | 45.1 | 24.9 | 67.8 | 33.2 | 89.5 | | | | | | |
| | -10 | 4.5 | 5.8 | 15.2 | 11.7 | 29.0 | 17.5 | 42.6 | 23.4 | 55.2 | 35.1 | 81.4 | 46.8 | 107.2 | | | | | | |
| | 0 | 9.2 | 7.9 | 17.4 | 15.8 | 33.2 | 23.8 | 49.0 | 31.7 | 63.3 | 47.5 | 93.1 | 63.4 | 122.8 | | | | | | |
| | 5 | 11.8 | 9.1 | 18.1 | 18.2 | 34.4 | 27.3 | 50.9 | 36.4 | 65.6 | 54.6 | 96.5 | 72.8 | 127.2 | | | | | | |
| | 10 | 14.7 | 10.4 | 18.6 | 20.7 | 35.5 | 31.1 | 52.5 | 41.5 | 67.7 | 62.2 | 99.5 | 83.0 | 131.7 | | | | | | |
| | 15 | 17.8 | 11.7 | 19.5 | 23.4 | 37.2 | 35.2 | 54.9 | 45.9 | 70.9 | 70.3 | 104.3 | 93.8 | 137.6 | | | | | | |
| | 20 | 21.1 | 13.2 | 20.6 | 26.5 | 39.0 | 39.7 | 58.1 | 53.0 | 74.5 | 79.5 | 109.8 | 105.0 | 144.5 | | | | | | |
| | 25 | 24.7 | 14.9 | 21.1 | 29.7 | 40.2 | 44.6 | 59.9 | 59.5 | 76.5 | 89.2 | 112.8 | 119.0 | 148.7 | | | | | | |
| | 30 | 28.5 | 16.7 | 21.5 | 33.4 | 41.0 | 50.1 | 61.4 | 66.8 | 78.2 | 100.2 | 115.0 | 133.6 | 151.8 | | | | | | |
| | 35 | 32.6 | 18.6 | 22.0 | 37.1 | 41.8 | 55.7 | 63.0 | 74.3 | 79.8 | 111.4 | 117.2 | 148.6 | 154.8 | | | | | | |
| | 40 | 37.0 | 20.5 | 22.1 | 41.1 | 42.2 | 61.6 | 63.8 | 82.2 | 80.4 | 123.3 | 118.1 | 164.4 | 158.0 | | | | | | |
| 50 | 46.7 | 25.2 | 22.2 | 50.3 | 42.4 | 75.5 | 64.5 | 100.7 | 80.9 | 151.0 | 119.0 | 201.4 | 157.0 | | | | | | | |
| 110° 136.0 # | -20 | 0.58 | 3.8 | 12.7 | 7.7 | 24.2 | 11.5 | 35.6 | 15.4 | 46.2 | 23.1 | 68.0 | 30.8 | 84.7 | | | | | | |
| | -10 | 4.5 | 5.5 | 15.2 | 11.1 | 29.1 | 16.6 | 42.6 | 22.2 | 55.4 | 33.3 | 81.6 | 44.4 | 107.4 | | | | | | |
| | 0 | 9.2 | 7.5 | 17.5 | 15.1 | 33.4 | 22.6 | 49.0 | 30.2 | 63.6 | 45.3 | 93.6 | 60.4 | 123.3 | | | | | | |
| | 5 | 11.8 | 8.7 | 18.3 | 17.4 | 34.6 | 26.1 | 50.9 | 34.8 | 66.1 | 52.2 | 97.2 | 67.6 | 128.2 | | | | | | |
| | 10 | 14.7 | 9.9 | 18.8 | 19.8 | 35.8 | 29.7 | 52.5 | 39.6 | 68.3 | 58.4 | 100.4 | 79.2 | 132.5 | | | | | | |
| | 15 | 17.8 | 11.2 | 19.6 | 22.4 | 37.4 | 33.6 | 54.9 | 44.8 | 71.4 | 67.2 | 105.0 | 89.6 | 138.4 | | | | | | |
| | 20 | 21.1 | 12.7 | 20.8 | 25.4 | 39.7 | 38.1 | 58.1 | 50.8 | 75.6 | 76.2 | 111.1 | 101.6 | 146.7 | | | | | | |
| | 25 | 24.7 | 14.3 | 21.4 | 28.6 | 40.7 | 42.9 | 59.9 | 57.2 | 77.6 | 85.8 | 114.0 | 114.4 | 150.8 | | | | | | |
| | 30 | 28.5 | 16.0 | 22.0 | 32.1 | 41.8 | 48.1 | 61.4 | 64.2 | 79.8 | 96.3 | 117.1 | 126.4 | 154.8 | | | | | | |
| | 35 | 32.6 | 17.8 | 22.8 | 35.7 | 43.0 | 53.5 | 63.0 | 71.4 | 81.9 | 107.1 | 120.3 | 142.8 | 158.8 | | | | | | |
| | 40 | 37.0 | 19.7 | 22.9 | 39.5 | 43.5 | 59.2 | 63.8 | 79.0 | 83.0 | 116.5 | 122.0 | 159.0 | 161.0 | | | | | | |
| 50 | 46.7 | 24.2 | 23.1 | 48.5 | 44.0 | 72.7 | 64.5 | 97.0 | 84.0 | 145.5 | 123.5 | 194.0 | 163.0 | | | | | | | |
| 115° 146.3 # | -10 | 4.5 | 5.2 | 15.3 | 10.4 | 29.2 | 15.6 | 42.7 | 20.8 | 55.5 | 31.2 | 81.8 | 41.6 | 107.9 | | | | | | |
| | 0 | 9.2 | 7.1 | 17.6 | 14.2 | 33.5 | 21.3 | 49.2 | 28.4 | 64.0 | 42.6 | 94.0 | 56.8 | 124.1 | | | | | | |
| | 5 | 11.8 | 8.2 | 18.4 | 16.4 | 35.0 | 24.7 | 51.2 | 32.9 | 66.6 | 49.3 | 98.1 | 65.8 | 129.2 | | | | | | |
| | 10 | 14.7 | 9.3 | 18.9 | 18.6 | 36.1 | 27.9 | 52.9 | 37.2 | 68.8 | 55.8 | 101.2 | 74.4 | 133.1 | | | | | | |
| | 15 | 17.8 | 10.6 | 19.9 | 21.3 | 38.0 | 31.9 | 55.8 | 42.6 | 72.4 | 63.0 | 106.5 | 85.2 | 140.4 | | | | | | |
| | 20 | 21.1 | 12.1 | 21.1 | 24.2 | 40.1 | 36.3 | 59.0 | 48.4 | 76.5 | 72.6 | 112.8 | 96.8 | 148.7 | | | | | | |
| | 25 | 24.7 | 13.7 | 21.6 | 27.4 | 41.4 | 41.1 | 60.5 | 54.8 | 78.7 | 82.2 | 116.0 | 109.6 | 152.7 | | | | | | |
| | 30 | 28.5 | 15.3 | 22.6 | 30.6 | 43.0 | 46.0 | 63.0 | 61.3 | 81.9 | 91.9 | 120.4 | 122.6 | 158.8 | | | | | | |
| | 35 | 32.6 | 17.1 | 23.1 | 34.2 | 44.0 | 51.3 | 64.5 | 68.4 | 84.0 | 102.6 | 123.4 | 136.8 | 163.0 | | | | | | |
| | 40 | 37.0 | 18.9 | 23.5 | 37.8 | 44.8 | 56.8 | 65.9 | 75.7 | 85.5 | 113.5 | 125.8 | 151.4 | 165.9 | | | | | | |
| | 50 | 46.7 | 23.4 | 24.0 | 46.7 | 45.6 | 70.1 | 67.0 | 93.5 | 87.1 | 140.2 | 128.1 | 187.0 | 169.0 | | | | | | |
| 125° 169.0 # | -10 | 4.5 | 4.5 | 15.4 | 9.0 | 29.4 | 13.6 | 43.1 | 18.1 | 56.0 | 27.1 | 82.5 | 36.2 | 108.7 | | | | | | |
| | 0 | 9.2 | 6.2 | 17.7 | 12.5 | 33.8 | 18.7 | 49.6 | 25.0 | 64.5 | 37.5 | 95.0 | 50.0 | 125.3 | | | | | | |
| | 5 | 11.8 | 7.3 | 18.6 | 14.6 | 35.5 | 22.0 | 52.1 | 29.3 | 67.7 | 43.9 | 99.5 | 58.6 | 131.3 | | | | | | |
| | 10 | 14.7 | 8.5 | 19.2 | 17.0 | 36.5 | 25.6 | 53.8 | 34.1 | 69.8 | 51.1 | 102.8 | 68.1 | 135.7 | | | | | | |
| | 15 | 17.8 | 9.6 | 20.5 | 19.2 | 39.0 | 28.8 | 57.4 | 38.4 | 74.5 | 57.6 | 109.6 | 76.8 | 144.5 | | | | | | |
| | 20 | 21.1 | 10.9 | 21.6 | 21.9 | 41.3 | 32.8 | 60.5 | 43.8 | 78.7 | 64.7 | 116.0 | 87.6 | 152.7 | | | | | | |
| | 25 | 24.7 | 12.5 | 22.4 | 24.9 | 42.6 | 37.4 | 62.5 | 49.9 | 81.4 | 74.8 | 119.8 | 99.8 | 157.8 | | | | | | |
| | 30 | 28.5 | 13.8 | 23.5 | 27.7 | 46.0 | 41.5 | 65.6 | 55.4 | 85.6 | 82.4 | 125.9 | 110.8 | 166.1 | | | | | | |
| | 35 | 32.6 | 15.6 | 24.2 | 31.3 | 46.2 | 46.9 | 67.8 | 62.6 | 88.2 | 93.9 | 129.8 | 125.2 | 171.0 | | | | | | |
| | 40 | 37.0 | 17.3 | 25.0 | 34.6 | 47.6 | 52.0 | 69.8 | 69.3 | 90.9 | 103.9 | 133.8 | 138.6 | 176.3 | | | | | | |
| | 50 | 46.7 | 21.4 | 25.7 | 42.8 | 50.0 | 64.3 | 71.9 | 85.7 | 93.4 | 128.5 | 137.1 | 171.4 | 181.1 | | | | | | |
| 135° 193.5 # | 15 | 17.8 | 8.6 | 21.1 | 17.2 | 40.1 | 25.9 | 59.0 | 34.5 | 76.6 | 51.7 | 112.8 | 69.0 | 148.7 | | | | | | |
| | 20 | 21.1 | 9.8 | 22.3 | 19.7 | 42.4 | 29.5 | 62.1 | 39.4 | 80.9 | 59.1 | 118.9 | 78.8 | 156.9 | | | | | | |
| | 25 | 24.7 | 11.2 | 23.2 | 22.4 | 44.4 | 33.6 | 65.0 | 44.8 | 84.5 | 67.2 | 124.2 | 89.6 | 164.0 | | | | | | |
| | 30 | 28.5 | 12.5 | 24.4 | 25.0 | 46.5 | 37.5 | 68.2 | 50.0 | 88.7 | 75.0 | 130.5 | 100.0 | 172.2 | | | | | | |
| | 35 | 32.6 | 14.1 | 23.4 | 28.3 | 48.5 | 42.4 | 71.0 | 56.6 | 92.4 | 84.9 | 136.0 | 113.2 | 179.2 | | | | | | |
| | 40 | 37.0 | 15.7 | 26.2 | 31.4 | 50.0 | 47.2 | 73.5 | 62.9 | 95.5 | 94.3 | 140.8 | 125.8 | 185.3 | | | | | | |
| 50 | 46.7 | 19.3 | 27.3 | 38.6 | 52.0 | 57.9 | 76.4 | 77.2 | 99.2 | 115.8 | 146.0 | 154.4 | 192.3 | | | | | | | |

Ratings above line for extrapolation only.



CIB-ESPOL

| CONDENSING Temperature °F and Corresponding Pressure psig | | REFRIGERANT 22 <i>Filter.</i> BASED ON 1200 RPM | | | | | | | | | | | | | |
|--|----------------|--|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | COMPRESSOR MODEL | | | | | | | | | | | | | |
| | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | 4416 | |
| Temp. °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | |
| 60° 102.5 # | -40 | 0.61 | 5.4 | 13.1 | 12.7 | 24.8 | 19.1 | 35.3 | 25.5 | 47.3 | 38.2 | 69.4 | 51.0 | 91.8 | |
| | -30 | 5.02 | 8.6 | 16.1 | 17.1 | 30.6 | 25.7 | 45.0 | 34.3 | 58.5 | 51.4 | 86.0 | 68.9 | 111.9 | |
| | -20 | 10.31 | 11.4 | 18.7 | 22.8 | 34.5 | 34.2 | 50.7 | 45.6 | 70.1 | 68.4 | 97.0 | 91.2 | 128.2 | |
| | -10 | 16.59 | 14.9 | 20.2 | 29.8 | 38.5 | 44.8 | 59.5 | 59.7 | 73.5 | 89.5 | 108.1 | 119.8 | 142.5 | |
| | 0 | 24.09 | 19.0 | 21.3 | 38.0 | 40.5 | 57.0 | 59.5 | 74.0 | 77.5 | 114.0 | 113.8 | 152.0 | 170.3 | |
| | 10 | 32.93 | 24.0 | 22.3 | 47.9 | 42.6 | 71.9 | 72.5 | 95.9 | 81.3 | 143.8 | 119.2 | 191.8 | 197.9 | |
| | 20 | 43.28 | 29.8 | 22.6 | 59.7 | 43.2 | 89.5 | 63.4 | 119.4 | 82.5 | 179.1 | 121.0 | 239.8 | 190.0 | |
| | 30 | 55.23 | 36.6 | 22.2 | 73.3 | 42.4 | 109.9 | 62.2 | 146.0 | 80.9 | 219.9 | 119.0 | 293.2 | 197.0 | |
| | 40 | 69.02 | 44.5 | 20.3 | 89.0 | 38.0 | 123.5 | 56.7 | 178.0 | 73.7 | 267.0 | 108.5 | 356.0 | 143.0 | |
| | 50 | 84.70 | 54.0 | 18.1 | 108.1 | 30.6 | 162.1 | 45.0 | 216.2 | 58.5 | 324.3 | 89.9 | 432.4 | 113.9 | |
| | 70° 122.5 # | -40 | 0.61 | 5.3 | 14.1 | 10.6 | 27.0 | 16.0 | 35.6 | 21.3 | 51.5 | 31.9 | 75.6 | 42.3 | 99.9 |
| -30 | | 5.02 | 7.5 | 16.4 | 15.0 | 31.2 | 22.6 | 45.8 | 30.1 | 59.3 | 45.1 | 87.0 | 60.2 | 115.0 | |
| -20 | | 10.31 | 10.3 | 18.6 | 20.6 | 35.4 | 31.0 | 52.1 | 41.3 | 67.7 | 61.9 | 99.5 | 82.5 | 131.3 | |
| -10 | | 16.59 | 13.5 | 20.6 | 27.1 | 39.6 | 40.6 | 58.1 | 54.2 | 75.7 | 81.2 | 111.2 | 108.4 | 146.3 | |
| 0 | | 24.09 | 17.5 | 22.3 | 35.0 | 42.1 | 52.5 | 61.7 | 70.0 | 80.5 | 105.0 | 118.3 | 140.0 | 156.1 | |
| 10 | | 32.93 | 22.2 | 23.4 | 44.4 | 44.6 | 66.7 | 65.4 | 88.9 | 85.1 | 133.3 | 125.1 | 177.8 | 165.0 | |
| 20 | | 43.28 | 28.0 | 24.0 | 56.0 | 45.6 | 84.0 | 66.9 | 112.0 | 87.0 | 168.0 | 128.0 | 224.0 | 168.7 | |
| 30 | | 55.23 | 34.3 | 23.8 | 68.7 | 45.4 | 103.0 | 66.5 | 137.4 | 86.5 | 206.1 | 127.5 | 274.8 | 167.3 | |
| 40 | | 69.02 | 42.0 | 22.5 | 84.0 | 42.7 | 126.0 | 62.8 | 168.0 | 81.6 | 252.0 | 120.0 | 336.0 | 158.3 | |
| 50 | | 84.70 | 50.9 | 18.8 | 101.8 | 35.6 | 152.8 | 52.2 | 203.7 | 68.0 | 305.5 | 99.8 | 407.4 | 131.8 | |
| 80° 145.0 # | | -40 | 0.61 | 4.5 | 15.0 | 9.0 | 29.2 | 13.6 | 42.7 | 18.0 | 55.8 | 27.1 | 80.3 | 36.2 | 108.9 |
| | -30 | 5.02 | 6.6 | 16.7 | 13.2 | 31.8 | 19.8 | 46.7 | 25.4 | 60.7 | 39.6 | 89.4 | 52.8 | 117.8 | |
| | -20 | 10.31 | 9.3 | 19.2 | 18.7 | 36.4 | 28.0 | 53.5 | 37.4 | 69.5 | 56.1 | 102.0 | 74.8 | 134.6 | |
| | -10 | 16.59 | 12.4 | 21.5 | 24.8 | 40.7 | 37.2 | 59.8 | 49.6 | 77.8 | 74.4 | 114.2 | 99.2 | 150.9 | |
| | 0 | 24.09 | 16.1 | 23.3 | 32.3 | 44.3 | 48.4 | 65.0 | 64.6 | 84.5 | 96.9 | 124.2 | 129.2 | 164.0 | |
| | 10 | 32.93 | 20.7 | 24.8 | 41.4 | 47.1 | 62.1 | 69.1 | 82.8 | 89.9 | 124.2 | 132.0 | 165.6 | 174.4 | |
| | 20 | 43.28 | 26.1 | 25.7 | 52.3 | 49.0 | 78.4 | 71.7 | 104.6 | 93.4 | 156.9 | 137.2 | 209.2 | 181.1 | |
| | 30 | 55.23 | 32.2 | 26.5 | 64.4 | 50.0 | 96.7 | 73.4 | 128.9 | 95.5 | 193.3 | 140.4 | 257.8 | 185.3 | |
| | 40 | 69.02 | 39.5 | 25.9 | 79.1 | 49.3 | 118.6 | 72.3 | 158.2 | 94.2 | 237.3 | 138.5 | 316.4 | 182.7 | |
| | 50 | 84.70 | 48.0 | 23.9 | 96.0 | 45.5 | 144.0 | 66.8 | 192.0 | 87.0 | 288.0 | 127.8 | 384.0 | 168.8 | |
| | 85° 157.2 # | -30 | 5.02 | 6.2 | 16.9 | 12.4 | 32.0 | 18.6 | 47.0 | 24.8 | 61.1 | 37.2 | 89.9 | 49.6 | 118.6 |
| -20 | | 10.31 | 8.9 | 19.4 | 17.8 | 36.8 | 26.8 | 54.1 | 35.7 | 70.4 | 53.5 | 103.2 | 71.4 | 136.7 | |
| -10 | | 16.59 | 11.9 | 21.7 | 23.9 | 41.4 | 35.8 | 60.7 | 47.8 | 79.0 | 71.7 | 116.1 | 95.6 | 153.3 | |
| 0 | | 24.09 | 15.5 | 23.8 | 31.1 | 45.2 | 46.6 | 66.5 | 62.2 | 86.5 | 93.3 | 127.9 | 124.4 | 167.8 | |
| 10 | | 32.93 | 20.0 | 25.4 | 40.1 | 48.5 | 60.1 | 71.2 | 80.2 | 92.7 | 120.3 | 136.1 | 160.4 | 180.0 | |
| 20 | | 43.28 | 25.2 | 26.8 | 50.5 | 50.9 | 75.7 | 74.7 | 101.0 | 97.1 | 151.5 | 143.0 | 202.0 | 186.4 | |
| 30 | | 55.23 | 31.2 | 28.0 | 62.5 | 53.1 | 93.7 | 78.2 | 125.0 | 101.5 | 187.5 | 149.6 | 250.0 | 197.0 | |
| 40 | | 69.02 | 38.4 | 28.3 | 76.7 | 53.9 | 115.1 | 79.2 | 153.5 | 102.9 | 230.2 | 151.2 | 307.0 | 199.5 | |
| 50 | 84.70 | 46.6 | 27.8 | 93.2 | 53.0 | 139.9 | 77.7 | 186.5 | 101.0 | 279.7 | 148.8 | 373.0 | 196.0 | | |

Ratings above line for extrapolation only.

| CONDENSING Temperature °F and Corresponding Pressure psig | | REFRIGERANT 22 <i>Filter.</i> BASED ON 1200 RPM | | | | | | | | | | | | | |
|--|----------------|--|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| | | COMPRESSOR MODEL | | | | | | | | | | | | | |
| | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | 4416 | |
| Temp. °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | |
| 90° 170.1 # | -30 | 5.02 | 5.9 | 17.0 | 11.7 | 32.4 | 17.6 | 47.4 | 23.5 | 61.6 | 35.2 | 90.5 | 47.0 | 119.4 | |
| | -20 | 10.31 | 8.4 | 19.6 | 16.9 | 37.2 | 25.3 | 54.6 | 33.8 | 71.1 | 50.7 | 104.5 | 67.6 | 138.0 | |
| | -10 | 16.59 | 11.4 | 22.1 | 22.8 | 42.1 | 34.2 | 61.7 | 45.6 | 80.2 | 68.4 | 118.0 | 91.2 | 155.6 | |
| | 0 | 24.09 | 14.9 | 24.3 | 29.9 | 46.5 | 44.8 | 68.2 | 59.8 | 88.6 | 89.7 | 130.2 | 119.5 | 172.0 | |
| | 10 | 32.93 | 19.2 | 26.4 | 38.4 | 50.2 | 57.7 | 73.8 | 76.9 | 96.0 | 115.3 | 141.0 | 153.8 | 186.3 | |
| | 20 | 43.28 | 24.3 | 27.9 | 48.5 | 53.2 | 72.8 | 78.0 | 97.1 | 101.3 | 145.6 | 149.0 | 194.2 | 196.5 | |
| | 30 | 55.23 | 30.2 | 29.4 | 60.3 | 56.0 | 90.5 | 82.2 | 120.7 | 106.9 | 181.0 | 157.0 | 241.4 | 207.5 | |
| | 40 | 69.02 | 37.2 | 30.0 | 74.3 | 57.2 | 111.5 | 83.8 | 148.7 | 109.0 | 223.0 | 160.2 | 297.4 | 211.5 | |
| 50 | 84.70 | 45.2 | 29.8 | 90.3 | 56.7 | 135.5 | 83.2 | 180.7 | 108.2 | 271.0 | 159.1 | 361.4 | 210.0 | | |
| 95° 183.7 # | -30 | 5.02 | 5.5 | 17.1 | 11.1 | 32.6 | 16.6 | 47.8 | 22.2 | 62.0 | 33.3 | 91.1 | 44.4 | 120.3 | |
| | -20 | 10.31 | 8.0 | 19.8 | 15.9 | 37.5 | 23.9 | 55.3 | 31.9 | 71.8 | 47.8 | 105.8 | 63.8 | 139.3 | |
| | -10 | 16.59 | 10.8 | 22.4 | 21.7 | 42.6 | 32.5 | 62.6 | 43.4 | 81.4 | 65.1 | 119.8 | 86.8 | 157.8 | |
| | 0 | 24.09 | 14.4 | 25.6 | 28.7 | 47.5 | 43.1 | 69.5 | 57.5 | 90.5 | 86.2 | 133.1 | 115.0 | 175.6 | |
| | 10 | 32.93 | 19.4 | 27.3 | 36.8 | 51.9 | 55.3 | 75.2 | 73.7 | 99.1 | 110.5 | 145.8 | 147.4 | 192.2 | |
| | 20 | 43.28 | 23.3 | 29.0 | 46.6 | 55.3 | 69.9 | 81.1 | 93.2 | 105.5 | 139.8 | 155.0 | 186.4 | 204.5 | |
| | 30 | 55.23 | 29.1 | 30.8 | 58.2 | 58.6 | 87.4 | 85.8 | 116.5 | 111.9 | 174.7 | 164.3 | 233.0 | 217.0 | |
| | 40 | 69.02 | 36.0 | 31.7 | 72.0 | 60.2 | 108.0 | 88.5 | 144.0 | 115.0 | 216.0 | 169.0 | 288.0 | 223.0 | |
| 50 | 84.70 | 43.7 | 31.8 | 87.5 | 60.5 | 131.2 | 88.7 | 175.0 | 115.5 | 262.5 | 169.7 | 350.0 | 224.0 | | |
| 100° 197.9 # | -10 | 16.59 | 10.3 | 22.8 | 20.6 | 43.4 | 30.9 | 63.6 | 41.2 | 82.9 | 61.8 | 122.0 | 82.4 | 160.8 | |
| | 0 | 24.09 | 13.7 | 25.5 | 27.3 | 48.5 | 41.0 | 71.2 | 54.7 | 92.7 | 82.0 | 136.3 | 109.4 | 180.0 | |
| | 10 | 32.93 | 17.6 | 28.1 | 35.3 | 53.5 | 52.9 | 78.5 | 70.6 | 102.0 | 105.9 | 150.2 | 141.2 | 198.0 | |
| | 20 | 43.28 | 22.4 | 30.0 | 44.8 | 57.2 | 67.3 | 83.8 | 89.7 | 109.2 | 134.5 | 160.2 | 179.4 | 212.0 | |
| | 30 | 55.23 | 28.0 | 32.0 | 56.1 | 60.9 | 84.1 | 89.5 | 112.2 | 116.5 | 168.3 | 171.1 | 224.4 | 226.0 | |
| | 40 | 69.02 | 34.7 | 33.2 | 68.1 | 63.2 | 102.1 | 92.7 | 138.2 | 120.6 | 207.3 | 177.5 | 276.4 | 234.0 | |
| | 50 | 84.70 | 42.4 | 33.8 | 84.8 | 64.4 | 127.2 | 94.4 | 169.6 | 122.8 | 254.4 | 180.4 | 339.2 | 238.0 | |
| 105° 212.9 # | 10 | 32.93 | 16.9 | 29.0 | 33.8 | 55.1 | 50.7 | 80.9 | 67.6 | 105.1 | 101.4 | 154.9 | 135.2 | 204.0 | |
| | 20 | 43.28 | 21.6 | 31.1 | 43.1 | 59.1 | 64.7 | 86.7 | 86.3 | 113.0 | 129.4 | 166.0 | 172.6 | 219.0 | |
| | 30 | 55.23 | 27.0 | 33.2 | 54.1 | 63.4 | 81.0 | 93.0 | 108.0 | 121.0 | 162.0 | 177.8 | 216.0 | 235.0 | |
| | 40 | 69.02 | 33.4 | 34.8 | 66.7 | 66.4 | 100.1 | 97.5 | 133.5 | 126.7 | 200.2 | 186.0 | 267.0 | 245.8 | |
| | 50 | 84.70 | 41.1 | 35.8 | 82.1 | 68.2 | 123.2 | 100.0 | 164.3 | 130.1 | 246.4 | 191.1 | 328.6 | 252.3 | |
| 110° 228.7 # | 20 | 43.28 | 20.6 | 32.2 | 41.2 | 61.3 | 61.9 | 90.0 | 82.5 | 117.1 | 123.7 | 172.0 | 165.0 | 227.3 | |
| | 30 | 55.23 | 25.9 | 34.7 | 51.7 | 65.9 | 77.6 | 96.9 | 103.5 | 126.5 | 155.2 | 185.0 | 207.0 | 245.5 | |
| | 40 | 69.02 | 32.1 | 36.3 | 64.2 | 69.2 | 96.3 | 101.7 | 128.4 | 132.2 | 192.6 | 194.3 | 256.8 | 256.4 | |
| | 50 | 84.70 | 39.4 | 37.6 | 78.8 | 71.4 | 118.2 | 104.9 | 157.6 | 136.2 | 236.4 | 200.2 | 315.2 | 264.2 | |
| 115° 245.3 # | 40 | 69.02 | 30.8 | 37.9 | 61.6 | 72.1 | 92.5 | 106.0 | 123.3 | 137.8 | 184.9 | 202.5 | 246.6 | 267.2 | |
| | 50 | 84.70 | 37.7 | 39.2 | 75.5 | 74.5 | 113.2 | 109.3 | 151.0 | 142.2 | 226.4 | 209.0 | 302.2 | 276.0 | |

Ratings above line for extrapolation only.



CIB-ESPOL

| CONDENSING Temperature °F and Corresponding Pressure psig | | REFRIGERANT 502 <i>Vilter.</i> BASED ON 1200 RPM | | | | | | | | | | | | | |
|--|----------------|--|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|--|
| | | COMPRESSOR MODEL | | | | | | | | | | | | | |
| | | SUCTION | | 442 | | 444 | | 446 | | 448 | | 4412 | | 4416 | |
| Temp. °F | Press. psig | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP | | |
| 65° 125.8 # | -50 | 0.04 | 3.2 | 11.4 | 6.4 | 21.7 | 9.6 | 31.9 | 12.8 | 41.5 | 19.2 | 63.8 | 25.6 | 85.2 | |
| | -40 | 4.28 | 5.0 | 14.1 | 10.1 | 26.9 | 15.1 | 39.5 | 20.1 | 51.4 | 30.2 | 79.0 | 40.3 | 105.5 | |
| | -30 | 9.40 | 7.4 | 16.7 | 14.7 | 31.9 | 22.1 | 46.9 | 29.5 | 61.0 | 44.2 | 93.8 | 59.0 | 125.2 | |
| | -20 | 15.52 | 10.1 | 19.3 | 20.2 | 36.9 | 30.2 | 54.2 | 40.3 | 70.5 | 60.4 | 108.4 | 80.6 | 144.7 | |
| | -15 | 18.99 | 11.7 | 20.6 | 23.4 | 39.4 | 35.1 | 57.7 | 46.8 | 75.3 | 70.2 | 115.8 | 93.7 | 154.6 | |
| | -10 | 22.76 | 13.4 | 21.9 | 26.9 | 41.8 | 40.3 | 61.4 | 53.7 | 79.8 | 80.6 | 122.8 | 107.6 | 163.9 | |
| -5 | 26.84 | 15.4 | 23.2 | 30.8 | 44.3 | 46.2 | 65.1 | 61.6 | 84.6 | 92.4 | 130.2 | 123.4 | 173.8 | | |
| 70° 136.6 # | -50 | 0.04 | 2.8 | 11.2 | 5.6 | 21.5 | 8.4 | 31.6 | 11.2 | 41.1 | 16.8 | 63.2 | 22.4 | 84.4 | |
| | -40 | 4.28 | 4.6 | 14.1 | 9.2 | 26.9 | 13.8 | 39.5 | 18.4 | 51.4 | 27.6 | 79.0 | 36.8 | 105.5 | |
| | -30 | 9.40 | 6.8 | 16.9 | 13.5 | 32.2 | 20.3 | 47.4 | 27.1 | 61.6 | 40.6 | 94.8 | 54.2 | 126.6 | |
| | -20 | 15.52 | 9.4 | 19.6 | 18.7 | 37.5 | 28.1 | 55.1 | 37.5 | 71.6 | 56.2 | 110.2 | 75.0 | 147.1 | |
| | -15 | 18.99 | 10.9 | 20.9 | 21.9 | 40.0 | 32.8 | 58.8 | 43.7 | 76.4 | 65.6 | 117.6 | 87.6 | 157.0 | |
| | -10 | 22.76 | 12.7 | 22.2 | 25.3 | 42.4 | 38.0 | 62.4 | 50.7 | 81.1 | 76.0 | 124.8 | 101.5 | 166.6 | |
| -5 | 26.84 | 14.6 | 23.5 | 29.1 | 44.9 | 43.7 | 66.0 | 58.3 | 85.3 | 87.4 | 132.0 | 116.7 | 176.2 | | |
| 75° 148.0 # | -40 | 4.28 | 4.6 | 14.1 | 9.1 | 26.9 | 13.7 | 39.5 | 18.3 | 51.4 | 27.4 | 79.0 | 35.6 | 105.5 | |
| | -30 | 9.40 | 6.4 | 17.1 | 12.7 | 32.6 | 19.1 | 47.9 | 25.5 | 62.3 | 38.2 | 95.8 | 51.0 | 127.9 | |
| | -20 | 15.52 | 8.8 | 19.9 | 17.7 | 38.0 | 26.5 | 55.9 | 35.3 | 72.7 | 53.0 | 111.8 | 70.8 | 149.3 | |
| | -15 | 18.99 | 10.3 | 21.3 | 20.6 | 40.7 | 30.9 | 59.8 | 41.2 | 77.7 | 61.8 | 119.6 | 82.5 | 159.7 | |
| | -10 | 22.76 | 12.0 | 22.6 | 24.0 | 43.2 | 35.0 | 63.5 | 48.0 | 82.6 | 72.0 | 127.0 | 96.1 | 169.5 | |
| | -5 | 26.84 | 13.9 | 23.9 | 27.8 | 45.6 | 41.7 | 67.1 | 55.6 | 87.2 | 83.4 | 134.2 | 111.3 | 179.2 | |
| 0 | 31.24 | 16.0 | 25.1 | 31.9 | 47.9 | 47.9 | 70.4 | 63.9 | 91.5 | 95.8 | 140.8 | 127.9 | 188.0 | | |
| 10 | 41.09 | 20.4 | 27.2 | 41.0 | 52.0 | 61.4 | 76.4 | 81.8 | 99.3 | 122.8 | 152.8 | 163.9 | 204.0 | | |
| 80° 159.9 # | -40 | 4.28 | 3.8 | 13.6 | 7.5 | 26.0 | 11.3 | 38.2 | 15.1 | 49.7 | 22.6 | 76.4 | 30.2 | 102.0 | |
| | -30 | 9.40 | 5.9 | 16.9 | 11.9 | 32.4 | 17.8 | 47.6 | 23.7 | 61.9 | 35.6 | 95.2 | 47.5 | 127.1 | |
| | -20 | 15.52 | 8.3 | 20.0 | 16.7 | 38.3 | 25.0 | 56.3 | 33.3 | 73.2 | 50.0 | 112.6 | 66.8 | 150.3 | |
| | -15 | 18.99 | 9.7 | 21.5 | 19.4 | 41.0 | 29.1 | 60.3 | 38.8 | 78.4 | 58.2 | 120.6 | 77.7 | 161.0 | |
| | -10 | 22.76 | 11.2 | 22.9 | 22.5 | 43.7 | 33.7 | 64.3 | 44.9 | 83.6 | 67.4 | 128.6 | 90.0 | 171.7 | |
| | -5 | 26.84 | 13.0 | 24.2 | 26.0 | 46.2 | 39.0 | 67.9 | 52.0 | 88.3 | 78.0 | 135.8 | 104.2 | 181.3 | |
| 0 | 31.24 | 15.0 | 25.4 | 29.9 | 48.6 | 44.9 | 71.4 | 59.9 | 92.8 | 89.8 | 142.8 | 119.9 | 190.6 | | |
| 10 | 41.09 | 19.3 | 27.6 | 39.8 | 52.8 | 58.1 | 77.6 | 77.4 | 100.9 | 116.2 | 155.2 | 155.1 | 207.2 | | |
| 85° 172.5 # | -40 | 4.28 | 3.4 | 12.7 | 6.9 | 24.3 | 10.3 | 35.7 | 13.7 | 46.4 | 20.6 | 71.4 | 27.5 | 95.3 | |
| | -30 | 9.40 | 5.6 | 16.4 | 11.2 | 31.3 | 16.8 | 46.1 | 22.4 | 59.9 | 33.6 | 92.2 | 44.9 | 123.1 | |
| | -20 | 15.52 | 7.8 | 19.9 | 15.7 | 38.1 | 23.5 | 56.0 | 31.3 | 72.8 | 47.0 | 112.0 | 62.7 | 149.5 | |
| | -15 | 18.99 | 9.2 | 21.6 | 18.3 | 41.3 | 27.5 | 60.8 | 36.7 | 79.0 | 55.0 | 121.6 | 73.4 | 162.3 | |
| | -10 | 22.76 | 10.6 | 23.2 | 21.3 | 44.3 | 31.9 | 65.1 | 42.5 | 84.6 | 63.8 | 130.2 | 85.2 | 173.8 | |
| | -5 | 26.84 | 12.1 | 24.7 | 24.3 | 47.3 | 36.4 | 69.5 | 48.5 | 90.4 | 72.8 | 139.0 | 97.2 | 185.6 | |
| 0 | 31.24 | 14.1 | 26.2 | 28.2 | 50.1 | 42.2 | 73.7 | 56.3 | 95.8 | 84.4 | 147.4 | 112.7 | 196.8 | | |
| 10 | 41.09 | 18.4 | 28.9 | 37.0 | 55.3 | 55.4 | 81.3 | 73.8 | 105.7 | 110.8 | 162.6 | 147.9 | 217.1 | | |
| 20 | 52.45 | 23.6 | 31.1 | 47.2 | 59.4 | 70.8 | 87.4 | 94.4 | 113.6 | 141.6 | 174.8 | 189.0 | 233.4 | | |
| 90° 185.8 # | -40 | 4.28 | 3.0 | 12.1 | 6.0 | 23.1 | 9.0 | 33.9 | 12.0 | 44.1 | 18.0 | 67.8 | 24.0 | 90.5 | |
| | -30 | 9.40 | 5.0 | 16.1 | 10.1 | 30.7 | 15.1 | 45.2 | 20.1 | 58.8 | 30.2 | 90.4 | 40.3 | 120.7 | |
| | -20 | 15.52 | 7.3 | 20.0 | 14.7 | 38.1 | 22.0 | 56.1 | 29.3 | 72.9 | 44.0 | 112.2 | 58.7 | 149.8 | |
| | -15 | 18.99 | 8.6 | 21.8 | 17.3 | 41.6 | 25.9 | 61.2 | 34.5 | 79.6 | 51.8 | 122.4 | 69.2 | 163.4 | |
| | -10 | 22.76 | 10.0 | 23.5 | 20.0 | 44.9 | 30.0 | 66.0 | 40.0 | 85.8 | 60.0 | 132.0 | 80.1 | 176.2 | |
| | -5 | 26.84 | 11.6 | 25.1 | 23.2 | 47.9 | 34.8 | 70.5 | 46.4 | 91.7 | 69.6 | 141.0 | 92.9 | 188.2 | |
| 0 | 31.24 | 13.4 | 26.7 | 26.7 | 50.9 | 40.1 | 74.9 | 53.5 | 97.4 | 80.0 | 149.8 | 107.1 | 200.0 | | |
| 10 | 41.09 | 17.6 | 29.5 | 35.4 | 56.4 | 53.0 | 82.9 | 70.6 | 107.8 | 106.0 | 165.8 | 141.5 | 221.3 | | |
| 20 | 52.45 | 22.6 | 31.9 | 45.3 | 60.9 | 67.9 | 89.6 | 90.5 | 116.5 | 135.8 | 179.2 | 181.3 | 239.2 | | |
| 95° 199.7 # | -5 | 26.84 | 11.0 | 25.2 | 22.0 | 48.1 | 33.0 | 70.7 | 44.0 | 91.9 | 66.0 | 141.4 | 88.1 | 188.8 | |
| | 0 | 31.24 | 12.8 | 26.9 | 25.5 | 51.4 | 38.3 | 75.6 | 51.1 | 98.3 | 76.6 | 151.2 | 102.3 | 201.9 | |
| | 10 | 41.09 | 16.8 | 30.0 | 33.7 | 57.3 | 50.5 | 84.3 | 67.3 | 109.6 | 101.0 | 168.6 | 134.8 | 225.1 | |
| | 20 | 52.45 | 21.7 | 32.7 | 43.5 | 62.5 | 65.2 | 91.9 | 86.9 | 119.5 | 130.4 | 183.8 | 174.1 | 245.4 | |
| 100° 214.4 # | 30 | 65.44 | 27.3 | 34.7 | 54.7 | 66.2 | 82.0 | 97.4 | 109.3 | 126.6 | 154.0 | 194.8 | 219.0 | 260.1 | |
| | 10 | 41.09 | 15.7 | 30.5 | 31.5 | 58.3 | 47.2 | 85.8 | 62.9 | 111.5 | 94.4 | 171.6 | 126.0 | 229.1 | |
| | 20 | 52.45 | 20.4 | 33.5 | 40.9 | 64.0 | 61.3 | 94.1 | 81.7 | 122.3 | 122.6 | 188.2 | 163.7 | 251.2 | |
| 105° 229.7 # | 30 | 65.44 | 25.8 | 35.7 | 51.6 | 68.2 | 77.4 | 100.3 | 103.2 | 130.4 | 154.8 | 200.6 | 206.7 | 267.8 | |
| | 20 | 52.45 | 19.1 | 34.0 | 38.4 | 65.0 | 57.5 | 95.6 | 76.6 | 124.3 | 115.0 | 191.2 | 153.5 | 255.3 | |
| | 30 | 65.44 | 24.5 | 36.8 | 49.1 | 70.3 | 73.6 | 103.4 | 98.1 | 134.4 | 147.2 | 206.8 | 196.5 | 276.1 | |
| | 40 | 80.20 | 30.4 | 39.2 | 60.9 | 74.9 | 82.2 | 107.0 | 109.6 | 139.1 | 164.4 | 214.0 | 219.5 | 295.7 | |

**APENDICE G: TABLA DE CAPACIDAD DE CONDENSADORES
EVAPORATIVOS VGC VILTER**

DATA AND DIMENSION CHART

| Model No. | T. R. Cap(s): Base Rat. Cond. | | No. Fans | Fan Motor HP | Pump HP | GPM | CFM | A | B | C | D | E | Refrig. Inlet | Refrig. Outlet | Remote Models** | | G Water Make-up F.P.T. | H Drain M.P.T. | J Over-flow F.P.T. | Refrigerant Charge (lbs.) | | | Ap. Prox. Shipping Wt. | Ap. Prox. Operating Wt. | |
|--------------|----------------------------------|---------------|----------|--------------|-----------|-----|--------|----------|----------|----------|---------|---------|---------------|----------------|---------------------|--------------------|------------------------|----------------|--------------------|---------------------------|------|-----------------|------------------------|-------------------------|-------|
| | R-12 | R-22 or R-502 | | | | | | | | | | | | | Bottom Drain M.P.T. | Water Inlet M.P.T. | | | | R-12 | R-22 | NH ₃ | | | |
| 120 | 120 | 85.2 | 2 | 15 | 2 | 160 | 23600 | 58 1/2" | 104" | 52 1/2" | 29 1/4" | — | 1-4" | 1-4" | 5" | 2 1/2" | 3/4" | 2 1/2" | 2 1/2" | 460 | 388 | 405 | 195 | 7300 | 9300 |
| 150 | 150 | 106.5 | 2 | 15 | 2 | 160 | 28500 | 78 1/2" | 124" | 72 1/2" | 19 5/8" | 39 1/4" | 2-4" | 2-4" | 5" | 2 1/2" | 3/4" | 2 1/2" | 612 | 518 | 540 | 204 | 10000 | 12800 | |
| 180 | 180 | 127.8 | 4 | Two 7 1/2 | 2 | 160 | 34200 | 85 1/2" | 150 1/2" | 79 1/4" | 21 3/8" | 42 3/4" | 2-4" | 2-4" | 5" | 3" | 3/4" | 2 3/2" | 666 | 564 | 585 | 283 | 11400 | 14700 | |
| 220 | 220 | 156.2 | 4 | Two 7 1/2 | 1 1/2 | 240 | 41800 | 117" | 197" | 111" | 29 1/4" | 58 1/2" | 2-4" | 2-4" | 6" | 4" | 1" | 2 1/2" | 920 | 778 | 810 | 392 | 14300 | 17800 | |
| 260 | 260 | 184.6 | 4 | Two 10 | 1 1/2 | 240 | 49400 | 132 1/2" | 212 1/2" | 126 1/2" | 33 3/8" | 66 1/4" | 2-4" | 2-4" | 6" | 4" | 1" | 2 1/2" | 1050 | 884 | 918 | 445 | 16200 | 21200 | |
| 300 | 300 | 213.0 | 4 | Two 15 | Two 2 | 320 | 57000 | 157" | 237" | 151" | 19 3/8" | 39 1/4" | 4-4" | 4-4" | 6" | Two 3 | 1" | 3" | 2-3" | 1230 | 1030 | 1060 | 520 | 18300 | 25300 |
| 360 | 360 | 255.6 | 4 | Two 20 | Two 2 | 320 | 68400 | 171" | 251" | 165" | 21 3/8" | 42 1/4" | 4-4" | 4-4" | 6" | Two 3 | 1" | 3" | 2-3" | 1330 | 1130 | 1170 | 568 | 20400 | 27400 |
| 400 VGC only | 400 | 284.0 | 4 | Two 20 | Two 1 1/2 | 480 | 76000 | 193" | 293" | 187" | 24 3/8" | 48 1/4" | 4-4" | 4-4" | 8" | Two 4 | 1" | 4" | 2-4" | 1512 | 1280 | 1328 | 644 | 22500 | 31000 |
| 460 VGC only | 460 | 326.6 | 4 | Two 25 | Two 1 1/2 | 480 | 88000 | 234" | 334" | 228" | 29 1/4" | 58 1/2" | 4-4" | 4-4" | 8" | Two 4 | 1" | 4" | 7-4" | 1840 | 1552 | 1620 | 780 | 27000 | 36000 |
| 525 VGC only | 525 | 372.7 | 4 | Two 25 | Two 1 1/2 | 480 | 100000 | 256 1/2" | 356" | 250 1/2" | 21 3/8" | 42 3/4" | 6-4" | 6-4" | 8" | Two 4 | 1" | 4" | 2-4" | 1992 | 1632 | 1752 | 852 | 30000 | 39000 |

Base Rating Conditions: R-12, R-22 and R-502 - 105° Cond. temp., 40° Suct. temp., 78° W. B. Ammonia - 96.3 Cond. temp., 20° Suct. temp., 78° W. B. For other conditions see capacity charts on pages 6 and 7.

Rated tons are tons of refrigeration effect and are not to be construed as tons corresponding to heat rejected in the condensers.

*Ends for welding.

**Remote models are shipped less pump, water strainer, float valve and water connections from pump up to main spray header. Condenser tank section provided with bottom drain connection.

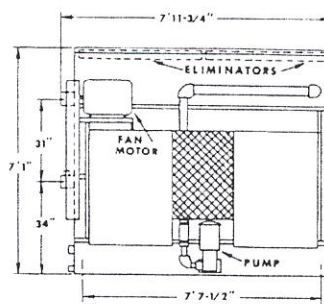
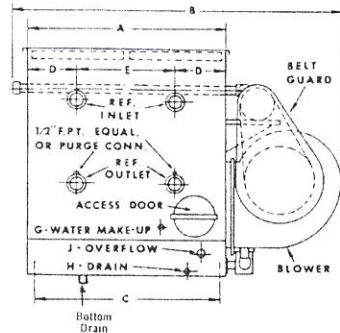
†Approximate operating weight based upon using Halocarbon refrigerant. All dimensions are approximate and are not to be used for construction for which certified prints will be furnished.





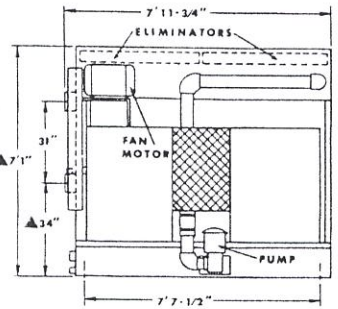
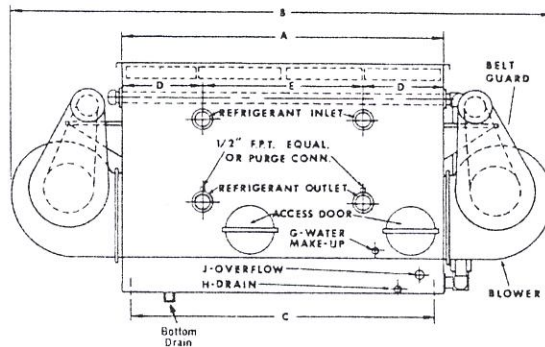
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Condenser data and dimensions



**MODELS
120-150**
(model 150 shown)

**MODELS
180-525**
(model 220 shown)



▲ 7'-7" and 40" For VGC 400, 460 and 525

| DATA AND DIMENSION CHART | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------|--------------------------|------|-------|----------|--------------|------------|-----|--------|----------|----------|----------|---------|---------|----------------|-----------------|---------------------|--------------------|------------------------|----------------|--------------------|--------------------------|------|-------|-----------------|----------------------|-----------------------|
| Model No. | T R Capa/ Base Rat Cond. | | | No. Fans | Fan Motor HP | Pump HP | GPM | CFM | A | B | C | D | E | Refrig. Inlet* | Refrig. Outlet* | Remote Models** | | G Water Make-up F.P.T. | H Drain M.P.T. | J Over-flow F.P.T. | Refrigerant Charge (lbs) | | | | Approx. Shipping Wt. | Approx. Operating Wt. |
| | R-12 | R-22 | R-502 | | | | | | | | | | | | | Bottom Drain M.P.T. | Water Inlet M.P.T. | | | | R-12 | R-22 | R-502 | NH ₃ | | |
| 120 | 120 | 85 | 2 | 2 | 15 | 2 | 160 | 23600 | 58 1/2" | 104" | 52 1/2" | 29 1/2" | 1-4" | 1-4" | 5" | 2 1/2" | 1/4" | 2 1/2" | 2 1/2" | 460 | 388 | 405 | 195 | 7300 | 9300 | |
| 150 | 150 | 106 | 5 | 2 | 15 | 2 | 160 | 28500 | 78 1/2" | 124" | 72 1/2" | 19 1/2" | 39 1/2" | 2-4" | 2-4" | 5" | 2 1/2" | 1/4" | 2 1/2" | 2 1/2" | 612 | 518 | 540 | 204 | 10000 | 12800 |
| 180 | 180 | 127 | 8 | 4 | Two 7 1/2" | 2 | 160 | 34200 | 85 1/2" | 150 1/2" | 79 1/2" | 21 1/2" | 42 1/2" | 2-4" | 2-4" | 5" | 3" | 1/4" | 2 1/2" | 2 1/2" | 666 | 564 | 585 | 283 | 11400 | 14700 |
| 220 | 220 | 156 | 2 | 4 | Two 7 1/2" | 1 1/2 | 240 | 41800 | 117" | 197" | 111" | 29 1/2" | 58 1/2" | 2-4" | 2-4" | 6" | 4" | 1" | 2 1/2" | 2 1/2" | 920 | 778 | 810 | 392 | 14300 | 17800 |
| 260 | 260 | 184 | 6 | 4 | Two 10" | 1 1/2 | 240 | 49400 | 132 1/2" | 212 1/2" | 126 1/2" | 33 1/2" | 66 1/2" | 2-4" | 2-4" | 6" | 4" | 1" | 2 1/2" | 2 1/2" | 1050 | 884 | 914 | 445 | 16200 | 21200 |
| 300 | 300 | 213 | 0 | 4 | Two 15" | Two 2" | 320 | 57000 | 157" | 237" | 151" | 19 1/2" | 39 1/2" | 4-4" | 4-4" | 6" | Two 3" | 1" | 3" | 2-3" | 1230 | 1030 | 1060 | 520 | 18300 | 25300 |
| 360 | 360 | 255 | 6 | 4 | Two 20" | Two 2" | 320 | 68400 | 171" | 251" | 165" | 21 1/2" | 42 1/2" | 4-4" | 4-4" | 6" | Two 3" | 1" | 3" | 2-3" | 1330 | 1130 | 1170 | 568 | 20400 | 27400 |
| 400 | 400 | 284 | 0 | 4 | Two 20" | Two 1 1/2" | 480 | 76000 | 193" | 293" | 187" | 24 1/2" | 48 1/2" | 4-4" | 4-4" | 8" | Two 4" | 1 1/4" | 4" | 2-4" | 1512 | 1280 | 1328 | 544 | 22500 | 31000 |
| VGC only | 460 | 326 | 6 | 4 | Two 25" | Two 1 1/2" | 480 | 88000 | 234" | 334" | 228" | 29 1/2" | 58 1/2" | 4-4" | 4-4" | 8" | Two 4" | 1 1/4" | 4" | 2-4" | 1840 | 1552 | 1620 | 780 | 27000 | 36000 |
| VGC only | 525 | 377 | 7 | 4 | Two 25" | Two 1 1/2" | 480 | 100000 | 256 1/2" | 356" | 250 1/2" | 21 1/2" | 42 1/2" | 6-4" | 6-4" | 8" | Two 4" | 1 1/4" | 4" | 2-4" | 1992 | 1692 | 1752 | 852 | 30000 | 39000 |

Base Rating Conditions: R-12, R-22 and R-502 105° Cond. temp., 40° Suct. temp., 78° W. B. Ammonia 96.3 Cond. temp., 20° Suct. temp., 78° W. B. For other conditions see capacity charts on pages 6 and 7.
 Rated tons are tons of refrigeration effect and are not to be construed as tons corresponding to heat rejected in the condensers.
 *Ends for welding.
 **Remote models are shipped less pump, water strainer, float valve and water connections from pump up to main spray header. Condenser tank section provided with bottom drain connection.
 † Approximate operating weight based upon using Halocarbon refrigerant.
 ‡ All dimensions are approximate and are not to be used for construction for which certified prints will be furnished.

evaporative
condenser

WET OPERATION PERFORMANCE CHART

USE MODEL NUMBERS
WHEN APPLYING CAPACITY
AND SUCTION CORRECTION
FACTORS

Enter chart at design wet bulb temperature and proceed vertically to intersection with desired condensing temperature line.

From this intersection, proceed horizontally left or right to vertical margin depending upon refrigerant being used to obtain appropriate refrigerant capacity factor. The suction correction factor is obtained from the table below the chart depending upon refrigerant used and suction temperature desired.

The compressor load expressed in tons of refrigeration is divided by these factors to obtain the required condenser size. (Also correct for altitude if necessary. See table at bottom of page 7.) The Model Number equal to or larger than this required condenser size must be selected. If the condenser selected produces more capacity than required at the given conditions it may be necessary to adjust the condensing temperature.

EXAMPLE

Req. 150 T.R. load, 75°F Wet Bulb temp., 95°F Condensing temp., 0°F Suction temp., Ammonia.

Capacity factor = 0.74 (from chart)
Suction correction factor = 0.94 (from table)

$$\text{Req. cond. size} = \frac{150}{0.74 \times 0.94} = 215.6$$

Use a Model No. 220 condenser. At the above conditions a Model No. 220 condenser will produce: $220 \div 0.74 \div 0.94 = 153$ tons.

Since this standard condenser selection produces slightly more capacity than required and assuming that the wet bulb temperature and suction temperature will remain as specified, the condensing temperature may be adjusted.

First, determine which capacity factor would be required to produce 150 tons of refrigeration.

$$\text{Capacity factor required} = \frac{150 (\text{required load})}{\text{Model No. 220} \times 0.94 (\text{suction factor})}$$

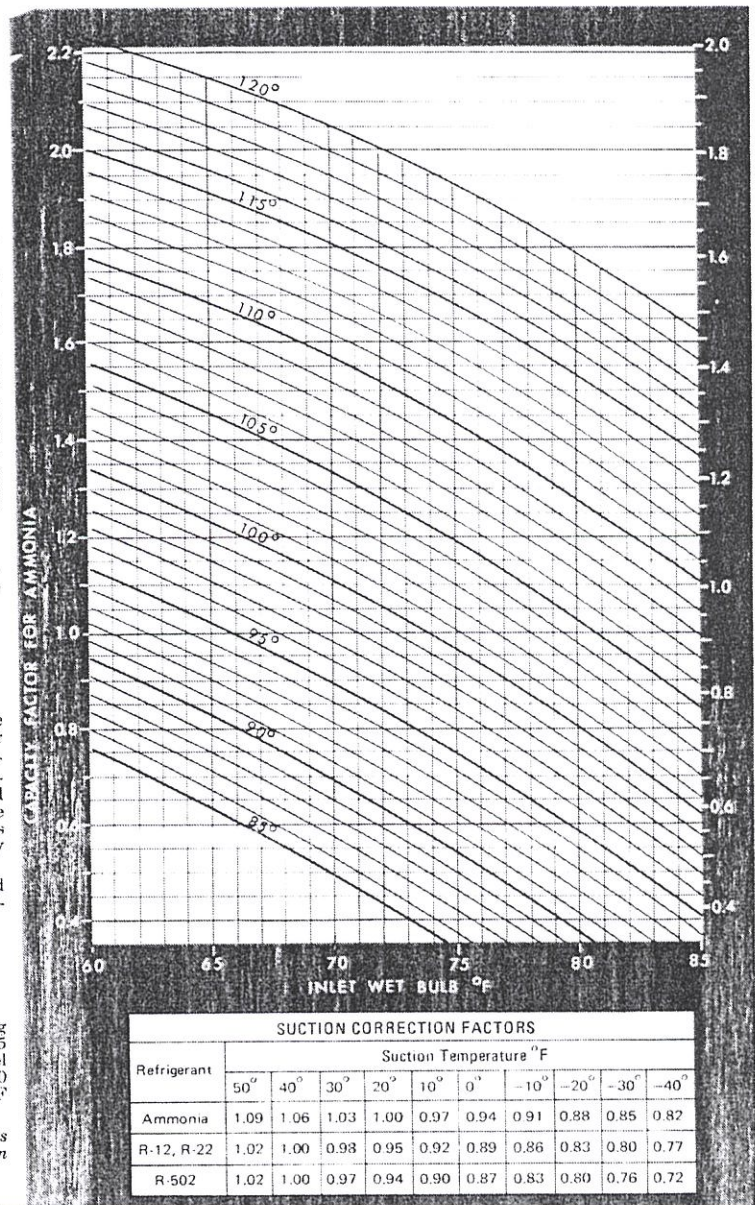
$$\text{Capacity factor required} = 0.725$$

Referring to the chart, the correct condensing temperature at 75°F W.B. and with a 0.725 factor should be 94.5°F. Therefore, a Model Number 220 condenser will produce the 150 tons at 75°F W.B., 0°F suction and 94.5°F condensing.

Important — Be sure to use Model Numbers when applying capacity and suction correction factors.

6

Vilter Centrifugal Fan



**APENDICE H: TABLAS DE CAPACIDAD DE COMPRESORES
DE TORNILLO VSS**



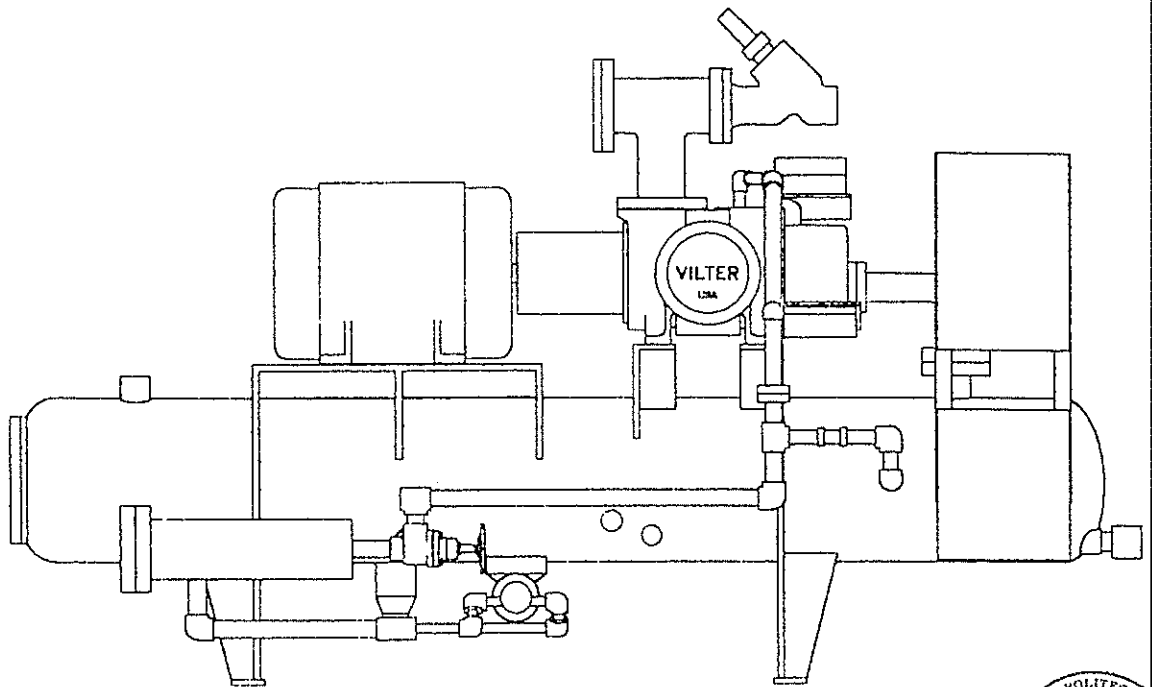
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VSS SINGLE SCREW
 COMPRESSORS
 VSS 451 THRU VSS 180

HIGH STAGE COMPRESSOR RATINGS

BOOSTER COMPRESSOR RATINGS



for Refrigerants R-717(Ammonia), R-22



CIB-ESPOL

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SECTION 111

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VSS SINGLE SCREW COMPRESSOR RATINGS

BASE RATING CONDITION AND CORRECTION FACTORS

SUCTION SUPERHEAT: Ratings are based on 0°F suction superheat.

- a. Reduce capacity 0.15% per °F of superheat.

LIQUID SUBCOOLING: Ratings are based on 10°F liquid subcooling.

- a. For less liquid subcooling, reduce capacity 0.25% per °F of liquid subcooling for R-717.
- b. For less liquid subcooling, reduce capacity 0.50% per °F of liquid subcooling for R-22.

ECONOMIZER UNITS: Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer and on 10°F liquid subcooling from the condenser.

BOOSTER UNITS: Booster compressor ratings are based on the following.

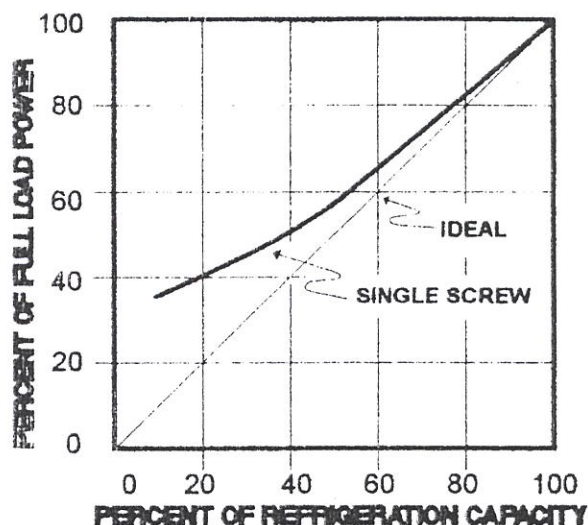
- a. Liquid temperature at intermediate temperature with 0°F liquid subcooling. (ie. flash type intercooler).
 1. Reduce capacity 1% for shell and coil or shell and tube intercoolers.

METHOD OF OIL COOLING: Rating based on use of water or thermo syphon oil cooling.

- a. For liquid injection oil cooling penalty with suction temperature of 0°F and above increase BHP 5%.
- b. For liquid Injection Oil Cooling penalty with suction temperature below 0°F, contact the Home Office.

FULL TIME OIL PUMPS: Full time oil pumps are required on all Booster Units and on High Stage Units with pressure ratios less than 3:1.

TYPICAL PART LOAD PERFORMANCE



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Notes: The curves above apply at constant condensing temperature. A considerable reduction in part load power occurs if the condensing temperature reduces under part load. For this special case, consult the Home Office for part load performance.

VSS SINGLE SCREW COMPRESSOR RATINGS

OPTIMUM INTERMEDIATE TEMPERATURE

The tables below show the optimum intermediate temperature for different operating conditions. The tables are intended for use in connection with Econ-o-Mizer® systems.

High Stage - Refrigerant: R-717 (Ammonia)

Optimum Intermediate Temperature (°F)

| Suction Temp. (°F) | Condensing Pressure (PSIG) | | | | | | |
|--------------------|----------------------------|--------|--------|--------|--------|--------|--------|
| | 135# | 155# | 165# | 175# | 185# | 205# | 225# |
| -40° | -21.0° | -20.0° | -19.5° | -19.0° | -18.5° | -17.5° | -16.5° |
| -30° | -12.0° | -11.0° | -10.5° | -10.0° | -9.5° | -8.5° | -7.5° |
| -20° | -2.5° | -1.5° | -1.0° | -0.5° | 0.0° | 1.0° | 2.0° |
| -10° | 8.0° | 9.0° | 9.5° | 10.0° | 10.5° | 11.5° | 12.5° |
| 0° | 19.0° | 20.0° | 20.5° | 21.0° | 21.5° | 22.5° | 23.5° |
| +10° | 31.0° | 32.0° | 32.5° | 33.0° | 33.5° | 34.5° | 35.5° |
| +20° | 43.5° | 44.5° | 45.0° | 45.5° | 46.0° | 47.0° | 48.0° |
| +30° | 56.5° | 57.5° | 58.0° | 58.5° | 59.0° | 60.0° | 61.0° |

High Stage - Refrigerant: R-22

Optimum Intermediate Temperature (°F)

| Suction Temp. (°F) | Condensing Temperature (°F) | | | | | | |
|--------------------|-----------------------------|-------|-------|-------|-------|-------|-------|
| | 85° | 90° | 95° | 100° | 105° | 110° | 115° |
| -40° | -2.0° | -1.0° | 0.0° | 1.0° | 2.0° | 3.0° | 4.0° |
| -30° | 6.0° | 7.0° | 8.5° | 9.5° | 10.5° | 12.0° | 13.0° |
| -20° | 14.0° | 15.0° | 16.5° | 18.0° | 19.0° | 20.0° | 21.5° |
| -10° | 21.5° | 23.0° | 24.5° | 26.0° | 27.5° | 29.0° | 30.5° |
| 0° | 29.5° | 31.0° | 32.5° | 34.0° | 35.5° | 37.0° | 38.5° |
| +10° | 37.0° | 38.5° | 40.0° | 42.0° | 44.0° | 46.0° | 48.0° |
| +20° | 44.0° | 46.0° | 48.0° | 50.0° | 52.0° | 54.0° | 56.0° |
| +30° | 51.0° | 53.0° | 55.0° | 57.0° | 59.0° | 61.0° | 63.0° |



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-717 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|--|--------------|-----------------|------------------|-------|---------|-------|--------|-------|---------|-------|
| | | | VSS451 | | VSS451E | | VSS801 | | VSS601E | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 75°F 125.5# | -40° | 8.8* | 37.1 | 97.8 | 44.1 | 110.9 | 43.7 | 111.8 | 51.9 | 126.7 |
| | -30° | 1.7* | 52.2 | 109.4 | 60.7 | 121.8 | 61.4 | 125.0 | 71.4 | 139.2 |
| | -20° | 3.5 | 70.8 | 119.9 | 80.8 | 131.3 | 83.3 | 137.0 | 95.0 | 150.1 |
| | -10° | 9.0 | 93.7 | 129.9 | 104.8 | 140.0 | 110.2 | 148.5 | 123.1 | 150.0 |
| | 0° | 15.8 | 121.4 | 139.5 | 132.9 | 147.9 | 142.8 | 159.4 | 156.4 | 159.0 |
| | 10° | 23.7 | 154.8 | 147.4 | 166.2 | 153.8 | 182.1 | 188.4 | 195.5 | 175.8 |
| | 20° | 33.4 | 194.7 | 151.8 | 204.8 | 156.2 | 229.0 | 173.5 | 240.9 | 178.5 |
| | 30° | 44.9 | 241.7 | 150.5 | 249.3 | 152.8 | 284.4 | 172.0 | 293.3 | 174.8 |
| 40° | 58.4 | 297.2 | 140.9 | 300.3 | 141.4 | 349.8 | 161.0 | 353.3 | 161.6 | |
| 85°F 151.3# | -40° | 8.8* | 34.7 | 108.4 | 42.0 | 124.9 | 40.8 | 123.9 | 49.4 | 142.7 |
| | -30° | 1.7* | 49.3 | 121.3 | 58.6 | 137.3 | 58.0 | 138.8 | 68.9 | 156.8 |
| | -20° | 3.5 | 67.5 | 134.1 | 78.8 | 149.1 | 79.4 | 153.2 | 92.5 | 170.4 |
| | -10° | 9.0 | 89.8 | 145.8 | 102.5 | 159.4 | 105.7 | 168.8 | 120.8 | 182.2 |
| | 0° | 15.8 | 117.0 | 157.2 | 130.8 | 169.1 | 137.7 | 179.8 | 153.9 | 193.2 |
| | 10° | 23.7 | 149.7 | 167.7 | 164.0 | 177.5 | 178.1 | 191.6 | 192.9 | 202.8 |
| | 20° | 33.4 | 188.7 | 175.8 | 202.5 | 183.2 | 222.0 | 200.9 | 238.2 | 209.4 |
| | 30° | 44.9 | 237.3 | 179.8 | 248.8 | 184.5 | 279.2 | 205.2 | 290.4 | 210.8 |
| 40° | 58.4 | 288.9 | 178.5 | 297.6 | 178.9 | 339.9 | 201.7 | 350.1 | 204.5 | |
| 95°F 180.8# | -40° | 8.8* | 32.0 | 120.8 | 39.6 | 141.2 | 37.8 | 137.8 | 46.8 | 161.4 |
| | -30° | 1.7* | 48.3 | 133.4 | 56.3 | 153.5 | 54.5 | 152.4 | 66.2 | 175.4 |
| | -20° | 3.5 | 64.1 | 148.4 | 76.2 | 167.7 | 75.4 | 169.8 | 89.7 | 191.7 |
| | -10° | 9.0 | 85.9 | 162.4 | 100.1 | 180.3 | 101.1 | 185.6 | 117.8 | 206.1 |
| | 0° | 15.8 | 112.5 | 175.5 | 128.4 | 191.6 | 132.3 | 200.8 | 151.0 | 219.0 |
| | 10° | 23.7 | 144.4 | 188.1 | 161.4 | 202.1 | 169.9 | 215.0 | 189.9 | 231.0 |
| | 20° | 33.4 | 182.5 | 199.4 | 190.3 | 210.8 | 214.7 | 227.9 | 235.1 | 240.9 |
| | 30° | 44.9 | 227.5 | 207.8 | 244.0 | 216.1 | 267.7 | 237.3 | 287.1 | 247.0 |
| 40° | 58.4 | 280.5 | 210.4 | 294.6 | 215.9 | 330.0 | 240.4 | 346.6 | 248.7 | |
| 105°F 213.7# | -40° | 8.8* | 29.2 | 133.6 | 37.0 | 159.2 | 34.3 | 152.8 | 43.5 | 181.8 |
| | -30° | 1.7* | 43.1 | 148.7 | 53.6 | 171.8 | 50.7 | 167.6 | 63.1 | 196.1 |
| | -20° | 3.5 | 60.5 | 162.8 | 73.6 | 187.1 | 71.2 | 186.1 | 86.8 | 213.8 |
| | -10° | 9.0 | 81.9 | 179.5 | 97.5 | 202.8 | 96.3 | 205.1 | 114.7 | 231.5 |
| | 0° | 15.8 | 107.8 | 194.7 | 125.7 | 216.0 | 128.8 | 222.5 | 147.9 | 246.8 |
| | 10° | 23.7 | 139.0 | 209.3 | 158.7 | 228.2 | 163.5 | 239.2 | 186.7 | 260.8 |
| | 20° | 33.4 | 176.2 | 223.1 | 196.9 | 239.3 | 207.3 | 255.0 | 231.7 | 273.5 |
| | 30° | 44.9 | 220.2 | 235.0 | 241.1 | 248.1 | 259.0 | 268.8 | 283.6 | 283.5 |
| 40° | 58.4 | 271.9 | 242.9 | 291.4 | 252.4 | 319.9 | 277.8 | 342.8 | 288.5 | |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).
Standard ratings are based on saturated suction and 10° liquid subcooling.
Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer
and on 10°F liquid subcooling from the condenser.



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-717 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|--|--------------|-----------------|------------------|-------|---------|-------|--------|-------|-------|
| | | | VSS751 | | VSS751E | | VSS901 | | VSS90 |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS |
| 75°F 125.5# | -40° | 8.8* | 61.6 | 162.3 | 73.2 | 184.0 | 69.7 | 178.2 | 82.7 |
| | -30° | 1.7* | 88.6 | 181.5 | 100.7 | 202.1 | 97.9 | 199.3 | 113.8 |
| | -20° | 3.5 | 117.5 | 198.9 | 134.0 | 217.9 | 132.8 | 218.4 | 151.4 |
| | -10° | 9.0 | 155.4 | 215.6 | 173.6 | 232.3 | 175.7 | 236.7 | 196.2 |
| | 0° | 15.8 | 201.3 | 231.4 | 220.5 | 245.4 | 227.6 | 254.1 | 249.3 |
| | 10° | 23.7 | 256.8 | 244.5 | 275.7 | 255.3 | 290.3 | 268.4 | 311.6 |
| | 20° | 33.4 | 322.9 | 251.9 | 339.7 | 259.2 | 365.0 | 276.6 | 384.0 |
| | 30° | 44.9 | 401.0 | 249.7 | 413.6 | 253.5 | 453.3 | 274.2 | 467.5 |
| | 40° | 58.4 | 492.9 | 233.8 | 498.2 | 234.6 | 557.3 | 256.6 | 563.2 |
| 85°F 151.3# | -40° | 8.8* | 57.5 | 179.9 | 69.7 | 207.2 | 65.0 | 197.5 | 78.7 |
| | -30° | 1.7* | 81.8 | 201.2 | 97.1 | 227.8 | 92.5 | 220.9 | 109.8 |
| | -20° | 3.5 | 112.0 | 222.4 | 130.4 | 247.4 | 126.8 | 244.2 | 147.4 |
| | -10° | 9.0 | 149.0 | 241.9 | 170.0 | 264.6 | 168.5 | 265.6 | 192.2 |
| | 0° | 15.8 | 194.2 | 260.8 | 217.0 | 280.5 | 219.5 | 286.3 | 245.3 |
| | 10° | 23.7 | 248.3 | 278.2 | 272.0 | 294.5 | 280.7 | 305.4 | 307.5 |
| | 20° | 33.4 | 313.0 | 291.7 | 335.9 | 304.0 | 353.9 | 320.2 | 379.7 |
| | 30° | 44.9 | 393.7 | 298.0 | 409.5 | 306.1 | 445.0 | 327.1 | 462.9 |
| | 40° | 58.4 | 479.3 | 292.9 | 493.6 | 296.9 | 541.8 | 321.5 | 558.1 |
| 95°F 180.6# | -40° | 8.8* | 53.0 | 200.1 | 65.7 | 234.4 | 59.9 | 219.7 | 74.3 |
| | -30° | 1.7* | 78.8 | 221.3 | 93.3 | 254.7 | 86.9 | 242.9 | 105.5 |
| | -20° | 3.5 | 106.3 | 246.3 | 126.5 | 278.3 | 120.2 | 270.3 | 143.0 |
| | -10° | 9.0 | 142.6 | 269.5 | 166.1 | 299.3 | 161.2 | 295.8 | 187.8 |
| | 0° | 15.8 | 186.5 | 291.3 | 212.9 | 318.0 | 210.9 | 319.8 | 240.7 |
| | 10° | 23.7 | 239.8 | 312.2 | 267.8 | 335.4 | 270.8 | 342.7 | 302.7 |
| | 20° | 33.4 | 302.7 | 330.9 | 331.5 | 349.8 | 342.2 | 363.3 | 374.7 |
| | 30° | 44.9 | 377.5 | 344.6 | 404.3 | 358.6 | 426.7 | 378.3 | 457.6 |
| | 40° | 58.4 | 465.3 | 349.1 | 483.7 | 358.2 | 526.0 | 383.2 | 552.5 |
| 105°F 213.7# | -40° | 8.8* | 48.4 | 221.6 | 61.3 | 264.1 | 54.7 | 243.3 | 69.3 |
| | -30° | 1.7* | 71.5 | 243.4 | 89.0 | 284.7 | 80.8 | 267.2 | 100.6 |
| | -20° | 3.5 | 100.4 | 270.2 | 122.1 | 310.4 | 113.5 | 296.6 | 138.0 |
| | -10° | 9.0 | 135.8 | 297.8 | 161.7 | 336.1 | 153.5 | 326.9 | 182.8 |
| | 0° | 15.8 | 178.8 | 323.1 | 208.5 | 358.4 | 202.1 | 354.7 | 235.8 |
| | 10° | 23.7 | 230.5 | 347.3 | 263.2 | 378.7 | 260.6 | 381.3 | 297.6 |
| | 20° | 33.4 | 292.3 | 370.3 | 326.7 | 397.1 | 330.4 | 406.5 | 369.3 |
| | 30° | 44.9 | 365.2 | 390.0 | 399.9 | 411.6 | 412.8 | 428.1 | 452.1 |
| | 40° | 58.4 | 451.1 | 403.1 | 483.3 | 418.9 | 509.9 | 442.5 | 546.4 |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).
Standard ratings are based on saturated suction and 10°F liquid subcooling.
Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer
and on 10°F liquid subcooling from the condenser.



CIB-ESPOL



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-717 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|--|--------------|-----------------|------------------|-------|----------|-------|---------|-------|----------|-------|
| | | | VSS1051 | | VSS1051E | | VSS1201 | | VSS1201E | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 75°F 125.5# | -40° | 8.8* | 86.0 | 226.5 | 102.1 | 256.7 | 95.9 | 245.3 | 113.9 | 278.0 |
| | -30° | 1.7* | 120.8 | 253.3 | 140.4 | 282.0 | 134.7 | 274.3 | 156.7 | 305.4 |
| | -20° | 3.5 | 163.9 | 277.6 | 186.9 | 304.1 | 182.8 | 300.6 | 208.4 | 329.3 |
| | -10° | 9.0 | 216.8 | 300.9 | 242.1 | 324.2 | 241.8 | 325.8 | 270.1 | 351.0 |
| | 0° | 15.6 | 280.9 | 322.9 | 307.6 | 342.4 | 313.3 | 349.7 | 343.1 | 370.8 |
| | 10° | 23.7 | 358.2 | 341.2 | 384.5 | 356.2 | 399.5 | 369.5 | 428.9 | 385.7 |
| | 20° | 33.4 | 450.4 | 351.5 | 473.9 | 361.6 | 502.4 | 380.7 | 528.5 | 391.6 |
| | 30° | 44.9 | 559.4 | 348.5 | 576.9 | 353.7 | 624.0 | 377.4 | 643.5 | 383.1 |
| 85°F 151.3# | -40° | 8.8* | 80.3 | 251.0 | 97.2 | 289.1 | 89.5 | 271.8 | 108.4 | 313.1 |
| | -30° | 1.7* | 114.1 | 280.8 | 135.5 | 317.9 | 127.3 | 304.1 | 151.2 | 344.2 |
| | -20° | 3.5 | 158.2 | 310.4 | 181.9 | 345.2 | 174.2 | 336.1 | 202.9 | 373.9 |
| | -10° | 9.0 | 207.9 | 337.5 | 237.2 | 369.1 | 231.9 | 365.5 | 264.6 | 399.7 |
| | 0° | 15.6 | 270.9 | 363.9 | 302.7 | 391.4 | 302.1 | 394.0 | 337.7 | 423.9 |
| | 10° | 23.7 | 348.4 | 383.2 | 379.4 | 410.9 | 386.4 | 420.4 | 423.2 | 444.9 |
| | 20° | 33.4 | 438.7 | 407.0 | 438.5 | 424.2 | 487.1 | 440.8 | 522.6 | 459.4 |
| | 30° | 44.9 | 549.2 | 415.7 | 571.2 | 427.1 | 612.6 | 450.2 | 637.1 | 462.5 |
| 95°F 180.6# | -40° | 8.8* | 74.0 | 279.2 | 91.7 | 327.0 | 82.5 | 302.3 | 102.2 | 354.1 |
| | -30° | 1.7* | 107.2 | 308.8 | 130.2 | 355.4 | 119.6 | 334.4 | 145.2 | 384.8 |
| | -20° | 3.5 | 148.3 | 343.6 | 176.4 | 388.4 | 165.4 | 372.1 | 196.8 | 420.6 |
| | -10° | 9.0 | 198.9 | 376.0 | 231.7 | 417.6 | 221.8 | 407.2 | 258.5 | 452.2 |
| | 0° | 15.6 | 280.2 | 408.4 | 297.0 | 443.7 | 290.3 | 440.1 | 331.3 | 480.5 |
| | 10° | 23.7 | 334.2 | 435.6 | 373.5 | 468.0 | 372.8 | 471.7 | 416.6 | 506.8 |
| | 20° | 33.4 | 422.3 | 461.7 | 462.4 | 488.1 | 471.1 | 500.0 | 515.8 | 528.5 |
| | 30° | 44.9 | 526.6 | 480.8 | 564.7 | 500.4 | 587.3 | 520.6 | 629.9 | 541.9 |
| 105°F 213.7# | -40° | 8.8* | 67.5 | 309.3 | 85.6 | 368.5 | 75.3 | 334.9 | 95.4 | 399.1 |
| | -30° | 1.7* | 99.7 | 339.6 | 124.1 | 397.3 | 111.2 | 367.7 | 138.4 | 430.2 |
| | -20° | 3.5 | 140.1 | 377.0 | 170.3 | 433.2 | 156.2 | 408.3 | 190.0 | 469.1 |
| | -10° | 9.0 | 189.4 | 415.5 | 225.6 | 469.0 | 211.3 | 450.0 | 251.7 | 507.9 |
| | 0° | 15.6 | 249.4 | 450.8 | 290.9 | 500.0 | 278.2 | 488.2 | 324.5 | 541.5 |
| | 10° | 23.7 | 321.6 | 484.6 | 367.2 | 528.4 | 358.7 | 524.8 | 409.6 | 572.2 |
| | 20° | 33.4 | 407.8 | 516.0 | 455.8 | 554.1 | 454.8 | 559.5 | 508.3 | 600.1 |
| | 30° | 44.9 | 509.5 | 544.2 | 557.8 | 574.4 | 568.2 | 589.3 | 622.2 | 622.0 |
| | 40° | 58.4 | 629.2 | 562.4 | 674.3 | 534.5 | 701.9 | 609.1 | 752.1 | 633.0 |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).
Standard ratings are based on saturated suction and 10°F liquid subcooling.
Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer
and on 10°F liquid subcooling from the condenser.



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-717 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|--|--------------|-----------------|------------------|-------|----------|-------|---------|-------|---------|
| | | | VSS1501 | | VSS1501E | | VSS1801 | | VSS1801 |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS |
| 75°F 125.5# | -40° | 8.8* | 120.2 | 316.8 | 142.8 | 359.1 | 140.7 | 359.9 | 167.1 |
| | -30° | 1.7* | 188.9 | 354.3 | 196.4 | 394.5 | 197.6 | 402.4 | 229.8 |
| | -20° | 3.5 | 229.2 | 388.3 | 261.3 | 425.4 | 268.1 | 441.0 | 305.8 |
| | -10° | 9.0 | 303.2 | 420.8 | 338.6 | 453.4 | 354.7 | 478.0 | 396.3 |
| | 0° | 15.6 | 392.8 | 451.7 | 430.3 | 478.9 | 459.7 | 513.1 | 503.5 |
| | 10° | 23.7 | 501.0 | 477.2 | 537.8 | 498.2 | 586.2 | 542.1 | 629.3 |
| | 20° | 33.4 | 630.0 | 491.7 | 662.7 | 505.9 | 737.2 | 558.5 | 775.5 |
| | 30° | 44.9 | 782.4 | 487.4 | 806.9 | 494.8 | 915.5 | 553.7 | 944.1 |
| | 40° | 58.4 | 961.7 | 456.3 | 971.9 | 458.0 | 1125.4 | 518.3 | 1137.3 |
| 85°F 151.3# | -40° | 8.8* | 112.2 | 351.1 | 135.9 | 404.4 | 131.3 | 398.8 | 159.0 |
| | -30° | 1.7* | 159.6 | 392.8 | 189.5 | 444.7 | 186.7 | 446.2 | 221.8 |
| | -20° | 3.5 | 218.4 | 434.2 | 254.5 | 482.9 | 255.6 | 493.2 | 297.8 |
| | -10° | 9.0 | 290.8 | 472.1 | 331.8 | 516.4 | 340.2 | 536.3 | 388.2 |
| | 0° | 15.6 | 378.8 | 509.0 | 423.4 | 547.5 | 443.3 | 578.1 | 495.4 |
| | 10° | 23.7 | 484.5 | 543.0 | 530.7 | 574.7 | 588.9 | 616.8 | 620.9 |
| | 20° | 33.4 | 610.7 | 569.4 | 655.3 | 593.4 | 714.6 | 646.7 | 766.8 |
| | 30° | 44.9 | 788.1 | 581.5 | 798.9 | 597.4 | 898.7 | 660.5 | 934.8 |
| | 40° | 58.4 | 935.1 | 571.6 | 963.1 | 579.6 | 1094.1 | 649.3 | 1127.0 |
| 95°F 180.6# | -40° | 8.8* | 103.4 | 390.5 | 123.2 | 457.4 | 121.0 | 443.6 | 150.0 |
| | -30° | 1.7* | 149.9 | 431.9 | 182.1 | 497.1 | 175.4 | 490.6 | 213.1 |
| | -20° | 3.5 | 207.4 | 480.6 | 246.8 | 543.3 | 242.7 | 545.9 | 288.7 |
| | -10° | 9.0 | 278.1 | 526.0 | 324.1 | 584.1 | 325.4 | 597.4 | 379.2 |
| | 0° | 15.6 | 364.0 | 568.5 | 415.4 | 620.8 | 425.9 | 645.7 | 486.1 |
| | 10° | 23.7 | 487.4 | 609.3 | 522.4 | 654.7 | 548.9 | 692.1 | 611.3 |
| | 20° | 33.4 | 590.6 | 645.9 | 646.8 | 682.7 | 691.1 | 733.6 | 756.8 |
| | 30° | 44.9 | 736.4 | 672.5 | 769.8 | 700.0 | 861.7 | 763.9 | 924.2 |
| | 40° | 58.4 | 907.8 | 681.3 | 953.5 | 699.1 | 1062.3 | 773.8 | 1115.7 |
| 105°F 213.7# | -40° | 8.8* | 94.4 | 432.8 | 119.7 | 515.5 | 110.4 | 491.4 | 140.0 |
| | -30° | 1.7* | 139.5 | 475.0 | 173.6 | 555.7 | 163.2 | 539.5 | 203.1 |
| | -20° | 3.5 | 195.9 | 527.4 | 233.2 | 605.9 | 229.2 | 599.1 | 278.8 |
| | -10° | 9.0 | 264.9 | 581.3 | 315.5 | 656.1 | 310.0 | 660.2 | 369.2 |
| | 0° | 15.6 | 348.8 | 630.6 | 406.9 | 699.4 | 408.2 | 716.2 | 476.1 |
| | 10° | 23.7 | 449.8 | 677.9 | 513.6 | 739.1 | 526.3 | 770.0 | 601.0 |
| | 20° | 33.4 | 570.3 | 722.7 | 637.4 | 775.1 | 667.3 | 820.8 | 745.8 |
| | 30° | 44.9 | 712.5 | 761.2 | 780.2 | 803.4 | 853.7 | 864.6 | 912.9 |
| | 40° | 58.4 | 880.0 | 766.7 | 943.0 | 817.6 | 1029.8 | 893.6 | 1103.5 |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).
Standard ratings are based on saturated suction and 10°F liquid subcooling.
Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer
and on 10°F liquid subcooling from the condenser.



CIB-ESPOL



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-22 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|--|--------------|-----------------|------------------|-------|---------|-------|--------|-------|---------|-------|
| | | | VSS451 | | VSS451E | | VSS601 | | VSS601E | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 85°F 155.7# | -40° | 0.8 | 40.0 | 128.9 | 50.4 | 137.6 | 47.1 | 145.1 | 59.3 | 157.2 |
| | -30° | 4.9 | 53.9 | 140.0 | 65.8 | 149.9 | 63.4 | 160.1 | 77.4 | 171.3 |
| | -20° | 10.2 | 71.0 | 150.7 | 84.3 | 158.9 | 83.5 | 172.2 | 99.2 | 181.6 |
| | -10° | 16.5 | 91.5 | 158.9 | 105.8 | 165.4 | 107.6 | 181.6 | 124.5 | 189.1 |
| | 0° | 24.0 | 117.0 | 185.4 | 130.5 | 171.2 | 137.6 | 189.1 | 153.5 | 195.6 |
| | 10° | 32.8 | 146.4 | 172.0 | 159.1 | 176.1 | 172.2 | 196.8 | 187.2 | 201.2 |
| | 20° | 43.1 | 180.6 | 172.0 | 192.5 | 175.3 | 212.5 | 196.6 | 226.5 | 200.3 |
| | 30° | 54.9 | 221.2 | 170.4 | 230.7 | 172.8 | 260.2 | 194.7 | 271.4 | 197.5 |
| 40° | 68.6 | 268.9 | 163.8 | 274.5 | 164.6 | 316.4 | 187.2 | 322.9 | 188.1 | |
| 95°F 181.8# | -40° | 0.8 | 37.1 | 138.4 | 48.5 | 151.5 | 43.6 | 158.2 | 57.0 | 173.2 |
| | -30° | 4.9 | 50.2 | 151.5 | 63.4 | 163.8 | 59.1 | 173.2 | 74.6 | 187.2 |
| | -20° | 10.2 | 66.5 | 163.3 | 81.2 | 177.7 | 78.2 | 190.0 | 95.5 | 203.1 |
| | -10° | 16.5 | 85.9 | 178.9 | 102.8 | 186.7 | 101.1 | 202.2 | 120.7 | 213.4 |
| | 0° | 24.0 | 109.8 | 184.3 | 128.5 | 192.5 | 129.2 | 210.8 | 148.8 | 220.0 |
| | 10° | 32.8 | 138.4 | 192.5 | 155.1 | 199.0 | 162.9 | 220.0 | 182.5 | 227.4 |
| | 20° | 43.1 | 171.8 | 197.4 | 187.0 | 203.1 | 202.2 | 225.8 | 220.0 | 232.1 |
| | 30° | 54.9 | 210.8 | 198.2 | 224.4 | 201.5 | 248.0 | 226.5 | 264.0 | 230.3 |
| 40° | 68.6 | 256.2 | 194.9 | 266.5 | 197.4 | 301.4 | 222.8 | 313.6 | 225.6 | |
| 105°F 210.8# | -40° | 0.8 | 34.3 | 151.5 | 46.5 | 168.7 | 40.3 | 173.2 | 54.8 | 192.8 |
| | -30° | 4.9 | 46.6 | 164.8 | 61.0 | 179.4 | 54.8 | 188.1 | 71.8 | 205.0 |
| | -20° | 10.2 | 62.1 | 181.0 | 78.4 | 194.9 | 73.0 | 206.9 | 92.3 | 222.8 |
| | -10° | 16.5 | 81.2 | 194.1 | 98.7 | 207.2 | 95.5 | 221.8 | 116.1 | 236.8 |
| | 0° | 24.0 | 103.4 | 207.2 | 122.5 | 217.9 | 121.7 | 236.8 | 144.1 | 249.0 |
| | 10° | 32.8 | 130.5 | 213.8 | 150.4 | 222.8 | 153.5 | 244.3 | 178.9 | 254.6 |
| | 20° | 43.1 | 163.1 | 221.9 | 182.2 | 229.3 | 191.9 | 253.7 | 214.3 | 262.1 |
| | 30° | 54.9 | 200.5 | 226.0 | 218.0 | 231.8 | 235.9 | 258.3 | 256.5 | 264.9 |
| 40° | 68.6 | 243.5 | 226.0 | 259.4 | 230.1 | 286.4 | 258.3 | 305.1 | 263.0 | |
| 115°F 242.8# | -40° | 0.8 | 31.6 | 167.1 | 44.7 | 188.4 | 37.2 | 190.9 | 52.6 | 215.3 |
| | -30° | 4.9 | 43.0 | 178.5 | 58.6 | 197.4 | 50.0 | 204.0 | 68.9 | 225.6 |
| | -20° | 10.2 | 57.6 | 194.1 | 75.6 | 212.1 | 67.8 | 221.8 | 88.9 | 242.4 |
| | -10° | 16.5 | 75.5 | 213.8 | 95.5 | 230.1 | 83.6 | 244.3 | 112.3 | 263.0 |
| | 0° | 24.0 | 97.1 | 226.0 | 118.5 | 240.8 | 114.2 | 258.3 | 139.5 | 275.2 |
| | 10° | 32.8 | 123.3 | 236.7 | 145.6 | 249.0 | 145.1 | 270.5 | 171.3 | 284.5 |
| | 20° | 43.1 | 153.6 | 245.7 | 176.6 | 255.5 | 180.6 | 280.8 | 207.8 | 292.0 |
| | 30° | 54.9 | 189.4 | 256.3 | 211.6 | 264.5 | 222.8 | 293.0 | 249.0 | 302.3 |
| 40° | 68.6 | 230.7 | 258.0 | 251.4 | 263.7 | 271.4 | 294.8 | 295.8 | 301.4 | |

Notes: Standard ratings are based on saturated suction and 10°F liquid subcooling.
 Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer
 and on 10° liquid subcooling from the condenser.



CIB-ESPOL



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-22 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|---|-----------|--------------|------------------|-------|---------|-------|--------|-------|-------|
| | | | VSS751 | | VSS751E | | VSS901 | | VSS90 |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS |
| 85°F 155.7# | -40° | 0.8 | 66.4 | 210.7 | 83.7 | 228.3 | 75.0 | 231.3 | 94.6 |
| | -30° | 4.9 | 89.3 | 232.4 | 109.1 | 248.7 | 101.0 | 255.1 | 123.4 |
| | -20° | 10.2 | 117.7 | 250.1 | 139.9 | 263.7 | 133.1 | 274.5 | 158.2 |
| | -10° | 16.5 | 151.8 | 263.7 | 175.5 | 274.5 | 171.6 | 289.4 | 198.4 |
| | 0° | 24.0 | 194.0 | 274.5 | 216.4 | 284.0 | 219.3 | 301.4 | 244.7 |
| | 10° | 32.8 | 242.8 | 285.4 | 264.0 | 292.2 | 274.5 | 313.3 | 298.4 |
| | 20° | 43.1 | 299.8 | 285.4 | 319.4 | 290.8 | 338.7 | 313.3 | 361.1 |
| | 30° | 54.9 | 368.9 | 282.7 | 382.7 | 286.8 | 414.8 | 310.3 | 432.7 |
| | 40° | 68.8 | 446.1 | 271.8 | 455.3 | 273.2 | 504.3 | 298.4 | 514.7 |
| 95°F 181.8# | -40° | 0.8 | 61.5 | 229.7 | 80.4 | 251.4 | 69.5 | 252.1 | 90.9 |
| | -30° | 4.9 | 83.3 | 251.4 | 105.2 | 271.8 | 94.1 | 276.0 | 118.9 |
| | -20° | 10.2 | 110.3 | 275.9 | 134.6 | 294.9 | 124.7 | 302.9 | 152.2 |
| | -10° | 16.5 | 142.5 | 293.6 | 170.2 | 309.9 | 161.1 | 322.3 | 192.5 |
| | 0° | 24.0 | 182.1 | 305.8 | 209.3 | 319.4 | 205.9 | 335.7 | 237.2 |
| | 10° | 32.8 | 229.6 | 319.4 | 257.4 | 330.3 | 259.6 | 350.6 | 290.9 |
| | 20° | 43.1 | 285.1 | 327.5 | 310.1 | 337.0 | 322.3 | 359.6 | 350.6 |
| | 30° | 54.9 | 349.7 | 328.9 | 372.2 | 334.3 | 395.4 | 361.1 | 420.7 |
| | 40° | 68.8 | 425.0 | 323.5 | 442.1 | 327.5 | 480.4 | 355.1 | 499.8 |
| 105°F 210.8# | -40° | 0.8 | 58.9 | 251.4 | 77.2 | 280.0 | 64.3 | 276.0 | 87.3 |
| | -30° | 4.9 | 77.3 | 273.2 | 101.2 | 297.5 | 87.4 | 299.9 | 114.4 |
| | -20° | 10.2 | 102.9 | 300.4 | 130.1 | 323.5 | 116.4 | 329.7 | 147.1 |
| | -10° | 16.5 | 134.6 | 322.1 | 163.7 | 343.8 | 152.2 | 353.6 | 185.0 |
| | 0° | 24.0 | 171.6 | 343.8 | 203.2 | 361.5 | 194.0 | 377.5 | 229.8 |
| | 10° | 32.8 | 216.4 | 354.7 | 249.4 | 369.7 | 244.7 | 389.4 | 282.0 |
| | 20° | 43.1 | 270.6 | 368.3 | 302.2 | 380.5 | 305.9 | 404.3 | 341.7 |
| | 30° | 54.9 | 332.3 | 375.1 | 361.6 | 384.6 | 376.0 | 411.8 | 408.8 |
| | 40° | 68.8 | 403.8 | 375.1 | 430.2 | 381.9 | 456.5 | 411.8 | 486.4 |
| 115°F 242.8# | -40° | 0.8 | 52.4 | 277.3 | 74.2 | 312.6 | 59.2 | 304.4 | 85.8 |
| | -30° | 4.9 | 71.4 | 298.3 | 97.1 | 327.5 | 80.7 | 325.3 | 109.8 |
| | -20° | 10.2 | 95.6 | 322.1 | 125.4 | 352.0 | 108.0 | 353.6 | 141.7 |
| | -10° | 16.5 | 125.2 | 354.7 | 158.4 | 381.9 | 141.6 | 389.4 | 179.0 |
| | 0° | 24.0 | 161.0 | 375.1 | 198.6 | 399.8 | 182.0 | 411.8 | 222.3 |
| | 10° | 32.8 | 204.6 | 392.8 | 241.5 | 413.2 | 231.3 | 431.2 | 273.0 |
| | 20° | 43.1 | 250.7 | 407.7 | 293.0 | 424.0 | 288.0 | 447.6 | 331.2 |
| | 30° | 54.9 | 314.1 | 425.4 | 351.1 | 439.0 | 355.1 | 467.0 | 396.9 |
| | 40° | 68.8 | 382.7 | 428.1 | 417.0 | 437.6 | 432.7 | 470.0 | 471.5 |

Notes: Standard ratings are based on saturated suction and 10°F liquid subcooling.
 Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer and on 10°F liquid subcooling from the condenser.



VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-22 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|---|-----------|--------------|------------------|-------|----------|-------|---------|-------|----------|-------|
| | | | VSS1051 | | VSS1051E | | VSS1201 | | VSS1201E | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 85°F 155.7# | -40° | 0.8 | 92.6 | 293.9 | 116.7 | 318.6 | 103.3 | 318.3 | 130.2 | 345.0 |
| | -30° | 4.9 | 124.8 | 324.3 | 152.3 | 347.0 | 139.0 | 351.2 | 169.8 | 375.8 |
| | -20° | 10.2 | 164.2 | 348.9 | 195.2 | 367.9 | 183.2 | 377.9 | 217.7 | 398.4 |
| | -10° | 16.5 | 211.7 | 367.9 | 244.9 | 383.1 | 236.2 | 398.4 | 273.1 | 414.8 |
| | 0° | 24.0 | 270.8 | 383.1 | 301.9 | 398.3 | 301.9 | 414.8 | 338.8 | 429.2 |
| | 10° | 32.8 | 338.8 | 398.2 | 368.2 | 407.7 | 377.9 | 431.3 | 410.7 | 441.5 |
| | 20° | 43.1 | 417.9 | 398.2 | 445.5 | 405.8 | 466.2 | 431.3 | 497.0 | 489.5 |
| | 30° | 54.9 | 511.8 | 394.4 | 533.9 | 400.1 | 570.9 | 427.1 | 595.5 | 483.3 |
| | 40° | 68.8 | 622.3 | 379.3 | 635.2 | 381.2 | 694.1 | 410.7 | 708.5 | 412.8 |
| 95°F 181.8# | -40° | 0.8 | 85.8 | 320.5 | 112.1 | 350.8 | 95.7 | 347.1 | 125.1 | 379.9 |
| | -30° | 4.9 | 116.2 | 350.8 | 146.7 | 379.3 | 128.8 | 379.9 | 163.7 | 410.7 |
| | -20° | 10.2 | 153.9 | 385.0 | 187.8 | 411.5 | 171.7 | 416.9 | 209.5 | 445.6 |
| | -10° | 16.5 | 198.3 | 408.6 | 237.5 | 432.4 | 221.3 | 443.6 | 264.9 | 468.2 |
| | 0° | 24.0 | 254.1 | 426.7 | 292.7 | 445.6 | 283.4 | 462.1 | 326.5 | 482.6 |
| | 10° | 32.8 | 320.4 | 445.6 | 359.0 | 460.8 | 357.3 | 482.6 | 400.4 | 499.0 |
| | 20° | 43.1 | 397.7 | 457.0 | 432.7 | 470.3 | 443.6 | 494.9 | 482.8 | 509.3 |
| | 30° | 54.9 | 487.9 | 458.9 | 519.2 | 466.5 | 544.2 | 497.0 | 579.1 | 505.2 |
| | 40° | 68.8 | 592.8 | 451.3 | 618.8 | 457.0 | 661.3 | 488.8 | 688.0 | 494.9 |
| 105°F 210.8# | -40° | 0.8 | 79.4 | 350.8 | 107.7 | 390.6 | 88.5 | 379.9 | 120.1 | 423.0 |
| | -30° | 4.9 | 107.9 | 381.2 | 141.2 | 415.3 | 120.3 | 412.8 | 157.5 | 449.7 |
| | -20° | 10.2 | 143.6 | 419.1 | 181.5 | 451.3 | 160.2 | 453.8 | 202.5 | 488.8 |
| | -10° | 16.5 | 187.8 | 448.4 | 228.3 | 479.8 | 209.5 | 486.7 | 254.6 | 519.6 |
| | 0° | 24.0 | 239.3 | 479.8 | 283.5 | 504.4 | 267.0 | 519.8 | 318.3 | 546.3 |
| | 10° | 32.8 | 301.9 | 494.9 | 348.0 | 515.8 | 336.8 | 536.0 | 388.1 | 558.6 |
| | 20° | 43.1 | 377.4 | 513.9 | 421.6 | 531.0 | 421.0 | 556.5 | 470.3 | 575.0 |
| | 30° | 54.9 | 464.0 | 523.4 | 504.5 | 536.7 | 517.5 | 566.8 | 562.7 | 581.2 |
| | 40° | 68.8 | 565.4 | 523.4 | 600.2 | 532.9 | 628.4 | 566.8 | 669.5 | 577.1 |
| 115°F 242.8# | -40° | 0.8 | 73.1 | 386.9 | 103.5 | 436.2 | 81.5 | 418.9 | 115.4 | 472.3 |
| | -30° | 4.9 | 99.8 | 419.4 | 135.5 | 457.0 | 111.1 | 447.7 | 151.1 | 494.9 |
| | -20° | 10.2 | 133.3 | 449.4 | 174.9 | 481.2 | 148.7 | 488.7 | 195.1 | 531.9 |
| | -10° | 16.5 | 174.7 | 494.9 | 220.9 | 532.9 | 194.9 | 536.0 | 246.4 | 577.1 |
| | 0° | 24.0 | 224.6 | 523.4 | 274.3 | 557.5 | 250.5 | 566.8 | 306.0 | 603.8 |
| | 10° | 32.8 | 285.4 | 548.0 | 338.9 | 576.5 | 318.3 | 593.5 | 375.8 | 624.3 |
| | 20° | 43.1 | 355.3 | 568.9 | 406.7 | 591.7 | 396.3 | 616.1 | 455.9 | 640.7 |
| | 30° | 54.9 | 438.2 | 560.6 | 469.7 | 612.5 | 488.8 | 642.8 | 546.3 | 663.3 |
| | 40° | 68.8 | 533.0 | 597.3 | 561.6 | 610.6 | 585.5 | 646.9 | 648.9 | 661.3 |

Notes: Standard ratings are based on saturated suction and 10°F liquid subcooling.
 Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer and on 10°F liquid subcooling from the condenser.



CIB-ESPOL

VSS SINGLE SCREW COMPRESSOR RATINGS
HIGH STAGE
R-22 - 3550 RPM

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|---|-----------|--------------|------------------|-------|----------|-------|---------|-------|--------|
| | | | VSS1501 | | VSS1501E | | VSS1801 | | VSS18 |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS |
| 85°F 155.7# | -40° | 0.6 | 129.5 | 411.2 | 183.3 | 445.6 | 151.6 | 467.0 | 191.0 |
| | -30° | 4.9 | 174.3 | 453.6 | 212.9 | 485.4 | 204.0 | 515.2 | 249.2 |
| | -20° | 10.2 | 229.7 | 488.1 | 272.9 | 514.6 | 268.8 | 554.4 | 319.4 |
| | -10° | 16.5 | 296.1 | 514.6 | 342.5 | 535.8 | 346.5 | 584.5 | 400.7 |
| | 0° | 24.0 | 378.5 | 535.8 | 422.3 | 554.4 | 442.9 | 608.6 | 494.1 |
| | 10° | 32.8 | 473.8 | 557.1 | 515.0 | 570.3 | 554.4 | 632.7 | 602.6 |
| | 20° | 43.1 | 584.5 | 557.1 | 623.1 | 567.7 | 683.9 | 632.7 | 729.1 |
| | 30° | 54.9 | 715.8 | 551.7 | 746.7 | 559.7 | 837.6 | 626.7 | 873.8 |
| | 40° | 68.6 | 870.3 | 530.5 | 888.4 | 533.2 | 1018.4 | 602.6 | 1039.5 |
| 95°F 181.8# | -40° | 0.8 | 120.0 | 448.3 | 156.8 | 490.7 | 140.4 | 509.2 | 183.5 |
| | -30° | 4.9 | 162.5 | 490.7 | 205.2 | 530.5 | 190.1 | 557.4 | 240.1 |
| | -20° | 10.2 | 215.3 | 538.5 | 262.6 | 575.8 | 251.9 | 611.6 | 307.3 |
| | -10° | 16.5 | 278.1 | 573.0 | 332.2 | 604.8 | 325.4 | 650.8 | 386.7 |
| | 0° | 24.0 | 355.3 | 596.8 | 409.4 | 623.4 | 415.8 | 677.9 | 479.1 |
| | 10° | 32.8 | 448.0 | 623.4 | 502.1 | 644.6 | 524.3 | 708.1 | 587.5 |
| | 20° | 43.1 | 556.2 | 639.3 | 605.1 | 657.9 | 650.8 | 726.1 | 708.1 |
| | 30° | 54.9 | 682.4 | 641.9 | 726.1 | 652.5 | 798.4 | 729.1 | 849.7 |
| | 40° | 68.6 | 820.1 | 631.3 | 852.6 | 639.3 | 970.2 | 717.1 | 1009.3 |
| 105°F 210.8# | -40° | 0.8 | 111.0 | 490.7 | 150.8 | 548.4 | 129.9 | 557.4 | 176.3 |
| | -30° | 4.9 | 150.9 | 533.2 | 197.5 | 580.9 | 176.6 | 605.6 | 231.1 |
| | -20° | 10.2 | 200.8 | 586.2 | 253.9 | 631.3 | 235.0 | 665.9 | 297.1 |
| | -10° | 16.5 | 262.8 | 628.7 | 319.3 | 671.1 | 307.3 | 714.1 | 373.6 |
| | 0° | 24.0 | 333.7 | 671.1 | 396.5 | 705.8 | 391.7 | 762.3 | 464.0 |
| | 10° | 32.8 | 422.3 | 692.3 | 486.7 | 721.5 | 494.1 | 786.4 | 569.5 |
| | 20° | 43.1 | 527.9 | 718.9 | 589.7 | 742.7 | 617.7 | 816.5 | 690.0 |
| | 30° | 54.9 | 648.9 | 732.1 | 705.5 | 750.7 | 759.3 | 831.6 | 825.6 |
| | 40° | 68.6 | 787.9 | 732.1 | 839.4 | 745.4 | 922.0 | 831.6 | 982.2 |
| 115°F 242.8# | -40° | 0.6 | 102.2 | 541.1 | 144.7 | 610.1 | 119.6 | 614.6 | 169.3 |
| | -30° | 4.9 | 137.3 | 578.3 | 189.5 | 639.3 | 163.0 | 656.8 | 221.8 |
| | -20° | 10.2 | 188.4 | 628.7 | 244.8 | 667.0 | 218.1 | 714.1 | 286.2 |
| | -10° | 16.5 | 244.4 | 682.3 | 309.0 | 745.4 | 285.0 | 788.4 | 361.6 |
| | 0° | 24.0 | 314.1 | 732.1 | 383.7 | 779.9 | 367.8 | 831.6 | 448.9 |
| | 10° | 32.8 | 399.1 | 763.6 | 471.2 | 806.4 | 467.0 | 870.8 | 551.4 |
| | 20° | 43.1 | 497.0 | 795.8 | 571.3 | 827.6 | 581.5 | 903.9 | 668.9 |
| | 30° | 54.9 | 612.3 | 833.3 | 684.9 | 856.3 | 717.1 | 943.1 | 801.5 |
| | 40° | 68.6 | 743.7 | 835.8 | 813.7 | 854.1 | 873.8 | 949.1 | 952.1 |

Notes: Standard ratings are based on saturated suction and 10°F liquid subcooling.
 Econ-o-Mizer® Ratings are based on saturated suction, DX type Econ-o-Mizer and on 10°F liquid subcooling from the condenser.



V3S SINGLE SCREW COMPRESSOR RATINGS BOOSTER

HIGH STAGE MULTIPLIERS FOR TWO STAGE SYSTEMS (1)

REFRIGERANT R-717 - (Ammonia) No Desuperheating but with Subcooling (2)

| BOOSTER DISCHARGE | | BOOSTER SUCTION TEMPERATURE (°F) | | | | | | |
|-------------------|-------------------------------|----------------------------------|------|------|------|------|------|------|
| Temp. (°F) | Corresponding Pressure (PSIG) | -70° | -60° | -50° | -40° | -30° | -20° | -10° |
| 0° | 15.8 | 1.89 | 1.50 | 1.44 | 1.37 | 1.31 | 1.27 | --- |
| 10° | 23.7 | 1.78 | 1.62 | 1.48 | 1.39 | 1.32 | 1.28 | --- |
| 20° | 33.4 | 1.90 | 1.70 | 1.53 | 1.42 | 1.35 | 1.29 | 1.25 |
| 30° | 44.9 | 1.79 | 1.79 | 1.59 | 1.46 | 1.37 | 1.31 | 1.26 |

REFRIGERANT R-717 - (Ammonia) Desuperheating and Subcooling

| BOOSTER DISCHARGE | | BOOSTER SUCTION TEMPERATURE (°F) | | | | | | |
|-------------------|-------------------------------|----------------------------------|------|------|------|------|------|------|
| Temp. (°F) | Corresponding Pressure (PSIG) | -70° | -60° | -50° | -40° | -30° | -20° | -10° |
| 0° | 15.8 | 1.45 | 1.35 | 1.26 | 1.20 | 1.14 | 1.12 | --- |
| 10° | 23.7 | 1.56 | 1.42 | 1.31 | 1.23 | 1.18 | 1.14 | --- |
| 20° | 33.4 | 1.68 | 1.51 | 1.37 | 1.27 | 1.21 | 1.16 | 1.13 |
| 30° | 44.9 | 1.82 | 1.61 | 1.43 | 1.33 | 1.25 | 1.19 | 1.15 |

REFRIGERANT R-22 No Desuperheating but with Subcooling (2)

| BOOSTER DISCHARGE | | BOOSTER SUCTION TEMPERATURE (°F) | | | | | | |
|-------------------|-------------------------------|----------------------------------|------|------|------|------|------|------|
| Temp. (°F) | Corresponding Pressure (PSIG) | -70° | -60° | -50° | -40° | -30° | -20° | -10° |
| 0° | 24.0 | 1.55 | 1.41 | 1.33 | 1.31 | 1.30 | --- | --- |
| 10° | 32.8 | 1.60 | 1.47 | 1.37 | 1.31 | 1.30 | --- | --- |
| 20° | 43.1 | 1.70 | 1.54 | 1.42 | 1.33 | 1.31 | 1.26 | 1.25 |
| 30° | 54.9 | 1.82 | 1.63 | 1.49 | 1.38 | 1.31 | 1.26 | 1.25 |

REFRIGERANT R-22 Desuperheating and Subcooling

| BOOSTER DISCHARGE | | BOOSTER SUCTION TEMPERATURE (°F) | | | | | | |
|-------------------|-------------------------------|----------------------------------|------|------|------|------|------|------|
| Temp. (°F) | Corresponding Pressure (PSIG) | -70° | -60° | -50° | -40° | -30° | -20° | -10° |
| 0° | 24.0 | 1.60 | 1.31 | 1.24 | 1.19 | 1.15 | --- | --- |
| 10° | 32.8 | 1.68 | 1.37 | 1.28 | 1.22 | 1.17 | --- | --- |
| 20° | 43.1 | 1.57 | 1.44 | 1.34 | 1.26 | 1.21 | 1.17 | 1.13 |
| 30° | 54.9 | 1.69 | 1.52 | 1.40 | 1.31 | 1.25 | 1.20 | 1.15 |

- Notes: (1) These multipliers include booster oil cooling load.
 (2) With no desuperheating, high stage capacity requirement is increased since the volume of gas is greater at 120°F. (Booster discharge temperature with discharge line liquid injection) than if desuperheated to within 10°F. of saturated suction temperature. Thus the higher multipliers.



CIB-ESPOL



**VSS SINGLE SCREW COMPRESSOR RATINGS
BOOSTER
R-717 - 3550 RPM**

| DISCHARGE Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|---|--------------|-----------------|------------------|------|--------|------|--------|-------|--------|
| | | | VSS451 | | VSS801 | | VSS751 | | VSS901 |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS |
| 0°F 15.6# | -70° | 21.9* | 18.1 | 41.4 | 21.2 | 47.4 | 30.0 | 68.8 | 33.9 |
| | -60° | 18.7* | 26.1 | 43.1 | 30.7 | 49.2 | 43.3 | 71.5 | 48.9 |
| | -50° | 14.4* | 33.8 | 44.4 | 43.3 | 50.7 | 61.1 | 73.7 | 69.1 |
| | -40° | 8.8* | 50.4 | 46.4 | 59.3 | 53.0 | 83.7 | 78.9 | 94.6 |
| | -30° | 1.7* | 67.7 | 46.0 | 79.7 | 52.6 | 112.3 | 76.4 | 127.0 |
| | -20° | 3.5 | 89.1 | 42.1 | 104.8 | 48.1 | 147.8 | 69.9 | 167.1 |
| 10°F 23.7# | -70° | 21.9* | 16.9 | 48.4 | 19.9 | 53.1 | 28.1 | 77.1 | 31.8 |
| | -60° | 18.7* | 24.8 | 47.7 | 29.2 | 54.5 | 41.2 | 79.1 | 46.5 |
| | -50° | 14.4* | 35.3 | 49.3 | 41.6 | 58.3 | 58.8 | 81.8 | 68.2 |
| | -40° | 8.8* | 48.8 | 52.2 | 57.2 | 59.6 | 80.6 | 86.8 | 91.2 |
| | -30° | 1.7* | 65.5 | 54.0 | 77.0 | 61.7 | 108.6 | 89.6 | 122.8 |
| | -20° | 3.5 | 86.7 | 53.1 | 102.0 | 60.7 | 143.9 | 88.1 | 162.6 |
| 20°F 33.4# | -70° | 21.9* | 15.8 | 50.8 | 18.6 | 58.0 | 26.3 | 84.3 | 29.7 |
| | -60° | 18.7* | 23.5 | 53.2 | 27.8 | 60.8 | 38.9 | 88.3 | 44.0 |
| | -50° | 14.4* | 33.7 | 56.1 | 39.6 | 64.1 | 55.8 | 93.1 | 63.1 |
| | -40° | 8.8* | 46.7 | 57.8 | 54.9 | 66.1 | 77.5 | 96.0 | 87.6 |
| | -30° | 1.7* | 63.2 | 61.4 | 74.3 | 70.2 | 104.8 | 101.9 | 118.5 |
| | -20° | 3.5 | 83.5 | 62.9 | 98.3 | 71.0 | 138.8 | 104.4 | 156.7 |
| 30°F 44.9# | -70° | 21.9* | 109.0 | 61.2 | 128.2 | 69.9 | 180.8 | 101.5 | 204.4 |
| | -60° | 18.7* | 22.0 | 59.0 | 25.9 | 67.5 | 36.8 | 98.0 | 41.3 |
| | -50° | 14.4* | 31.9 | 62.5 | 37.5 | 71.4 | 52.9 | 103.7 | 59.8 |
| | -40° | 8.8* | 44.8 | 66.3 | 52.5 | 75.8 | 74.0 | 110.1 | 83.7 |
| | -30° | 1.7* | 60.8 | 68.8 | 71.5 | 78.4 | 100.8 | 113.9 | 114.0 |
| | -20° | 3.5 | 81.2 | 72.4 | 95.5 | 82.7 | 134.6 | 120.1 | 152.2 |
| | -10° | 9.0 | 105.8 | 73.5 | 124.5 | 84.0 | 175.5 | 121.9 | 198.4 |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).



CIB-ESPOL



**VSS SINGLE SCREW COMPRESSOR RATINGS
BOOSTER
R-717 - 3550 RPM**

| DISCHARGE Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|---|--------------|-----------------|------------------|-------|---------|-------|---------|-------|---------|-------|
| | | | VSS1051 | | VSS1201 | | VSS1501 | | VSS1801 | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 0°F 15.6# | -70° | 21.9* | 41.8 | 96.0 | 46.6 | 103.9 | 58.5 | 134.2 | 68.4 | 152.5 |
| | -60° | 18.7* | 60.4 | 99.7 | 67.4 | 108.0 | 84.5 | 139.5 | 98.8 | 158.5 |
| | -50° | 14.4* | 85.2 | 102.8 | 95.1 | 111.3 | 119.2 | 143.8 | 139.5 | 163.3 |
| | -40° | 8.8* | 116.7 | 107.3 | 130.2 | 116.2 | 163.3 | 150.1 | 191.0 | 170.5 |
| | -30° | 1.7* | 158.7 | 106.6 | 174.8 | 115.4 | 219.1 | 149.1 | 256.4 | 169.3 |
| | -20° | 3.5 | 206.2 | 97.5 | 230.0 | 105.6 | 288.4 | 136.3 | 337.5 | 154.9 |
| 10°F 23.7# | -70° | 21.9* | 39.2 | 107.5 | 43.7 | 116.4 | 54.8 | 150.4 | 64.2 | 170.8 |
| | -60° | 18.7* | 57.4 | 110.4 | 64.1 | 119.5 | 80.3 | 154.4 | 94.0 | 175.4 |
| | -50° | 14.4* | 81.7 | 114.2 | 91.2 | 123.8 | 114.3 | 159.7 | 133.8 | 181.4 |
| | -40° | 8.8* | 112.5 | 120.8 | 125.5 | 130.8 | 157.3 | 169.0 | 184.1 | 191.9 |
| | -30° | 1.7* | 151.5 | 125.0 | 169.0 | 135.3 | 211.9 | 174.8 | 248.0 | 198.6 |
| | -20° | 3.5 | 200.7 | 122.9 | 223.8 | 133.1 | 280.7 | 171.9 | 328.4 | 195.2 |
| 20°F 33.4# | -70° | 21.9* | 38.6 | 117.6 | 40.9 | 127.3 | 51.2 | 164.5 | 60.0 | 186.8 |
| | -60° | 18.7* | 54.3 | 123.3 | 60.6 | 133.5 | 78.0 | 172.4 | 88.9 | 195.8 |
| | -50° | 14.4* | 77.9 | 129.9 | 86.9 | 140.7 | 108.9 | 181.7 | 127.4 | 206.4 |
| | -40° | 8.8* | 108.1 | 133.9 | 120.5 | 145.0 | 151.1 | 187.3 | 176.9 | 212.7 |
| | -30° | 1.7* | 146.2 | 142.2 | 163.1 | 154.0 | 204.4 | 198.9 | 239.2 | 226.0 |
| | -20° | 3.5 | 193.3 | 145.6 | 215.8 | 157.7 | 270.4 | 203.7 | 316.4 | 231.4 |
| 30°F 44.9# | -70° | 21.9* | 51.0 | 138.7 | 56.9 | 148.1 | 71.3 | 191.3 | 83.5 | 217.2 |
| | -60° | 18.7* | 73.8 | 144.7 | 82.3 | 156.7 | 103.3 | 202.4 | 120.8 | 229.9 |
| | -50° | 14.4* | 103.3 | 153.6 | 115.2 | 166.3 | 144.5 | 214.9 | 169.0 | 244.1 |
| | -40° | 8.8* | 140.7 | 159.9 | 156.9 | 172.1 | 196.7 | 222.3 | 230.2 | 252.5 |
| | -30° | 1.7* | 187.3 | 167.8 | 209.5 | 181.5 | 262.6 | 234.5 | 307.3 | 266.3 |
| | -20° | 3.5 | 244.9 | 170.1 | 273.1 | 184.2 | 342.5 | 237.9 | 400.7 | 270.3 |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).



**VSS SINGLE SCREW COMPRESSOR RATINGS
BOOSTER
R-22 - 3550 RPM**

| DISCHARGE Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|---|--------------|-----------------|------------------|------|--------|------|--------|-------|--------|-----|
| | | | VSS451 | | VSS801 | | VSS751 | | VSS901 | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 0°F 24.0# | -70° | 16.8* | 25.4 | 48.2 | 29.9 | 55.0 | 42.1 | 79.9 | 47.8 | |
| | -60° | 11.9* | 35.1 | 50.0 | 41.3 | 57.1 | 58.2 | 82.9 | 65.8 | |
| | -50° | 6.1* | 47.3 | 52.5 | 55.8 | 60.0 | 78.4 | 87.1 | 88.6 | |
| | -40° | 0.8 | 62.3 | 54.8 | 73.3 | 62.4 | 103.3 | 90.7 | 116.8 | |
| | -30° | 4.9 | 80.4 | 54.9 | 94.5 | 62.7 | 133.3 | 91.1 | 150.7 | |
| | -20° | 10.2 | 102.6 | 50.0 | 120.7 | 57.1 | 170.2 | 82.9 | 192.5 | |
| 10°F 32.8# | -70° | 16.8* | 23.9 | 53.3 | 28.2 | 60.9 | 39.7 | 88.5 | 44.9 | |
| | -60° | 11.9* | 33.3 | 55.8 | 39.2 | 63.8 | 55.3 | 92.3 | 62.5 | |
| | -50° | 6.1* | 45.1 | 58.3 | 53.1 | 68.8 | 74.8 | 96.8 | 84.6 | |
| | -40° | 0.8 | 59.7 | 61.0 | 70.2 | 69.7 | 99.0 | 101.3 | 111.9 | |
| | -30° | 4.9 | 77.8 | 63.0 | 91.3 | 72.0 | 128.7 | 104.5 | 145.5 | |
| | -20° | 10.2 | 99.5 | 62.4 | 117.0 | 71.3 | 165.0 | 103.6 | 186.5 | |
| 20°F 43.1# | -70° | 16.8* | 22.4 | 58.9 | 26.4 | 67.3 | 37.2 | 97.7 | 42.1 | |
| | -60° | 11.9* | 31.5 | 62.2 | 37.1 | 71.0 | 52.3 | 103.2 | 59.1 | |
| | -50° | 6.1* | 42.9 | 64.7 | 50.5 | 73.9 | 71.1 | 107.4 | 80.4 | |
| | -40° | 0.8 | 57.0 | 67.9 | 67.1 | 77.6 | 94.8 | 112.7 | 107.0 | |
| | -30° | 4.9 | 74.3 | 70.8 | 87.4 | 80.9 | 123.3 | 117.4 | 139.4 | |
| | -20° | 10.2 | 95.5 | 72.8 | 112.3 | 83.0 | 158.4 | 120.5 | 179.0 | |
| 30°F 54.9# | -70° | 16.8* | 20.0 | 64.1 | 24.8 | 73.3 | 34.7 | 108.4 | 39.2 | |
| | -60° | 11.9* | 29.8 | 68.1 | 34.8 | 77.9 | 49.1 | 113.1 | 55.5 | |
| | -50° | 6.1* | 40.8 | 72.3 | 47.7 | 82.8 | 67.3 | 120.0 | 78.1 | |
| | -40° | 0.8 | 54.3 | 75.3 | 63.3 | 86.1 | 90.0 | 125.0 | 101.8 | |
| | -30° | 4.9 | 71.0 | 79.0 | 83.5 | 90.3 | 117.7 | 131.2 | 133.1 | |
| | -20° | 10.2 | 91.5 | 82.7 | 107.6 | 94.5 | 151.8 | 137.3 | 171.8 | |
| | -10° | 16.5 | 118.2 | 83.5 | 138.7 | 95.5 | 192.7 | 138.6 | 217.8 | |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).



CIB-ESPOL



**VSS SINGLE SCREW COMPRESSOR RATINGS
BOOSTER
R-22 - 3550 RPM**

| DISCHARGE Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|---|--------------|-----------------|------------------|-------|---------|-------|---------|-------|---------|-------|
| | | | VSS1051 | | VSS1201 | | VSS1501 | | VSS1801 | |
| | TEMP (°F) | PRESS (PSIG) | TONS | BHP | TONS | BHP | TONS | BHP | TONS | BHP |
| 0°F 24.0# | -70° | 18.6* | 58.7 | 111.5 | 85.5 | 120.8 | 82.1 | 158.0 | 96.1 | 177.2 |
| | -80° | 11.9* | 81.2 | 115.7 | 90.6 | 125.3 | 113.6 | 161.8 | 132.9 | 183.8 |
| | -50° | 8.1* | 109.4 | 121.8 | 122.0 | 131.6 | 153.0 | 170.0 | 179.0 | 193.1 |
| | -40° | 0.6 | 144.2 | 126.5 | 160.8 | 137.0 | 201.8 | 176.9 | 235.9 | 201.0 |
| | -30° | 4.9 | 186.0 | 127.1 | 207.4 | 137.6 | 260.1 | 177.7 | 304.3 | 201.9 |
| | -20° | 10.2 | 237.5 | 115.7 | 264.9 | 125.3 | 332.2 | 161.8 | 388.7 | 183.8 |
| 10°F 32.8# | -70° | 18.6* | 55.4 | 123.5 | 61.8 | 133.7 | 77.5 | 172.7 | 90.7 | 196.1 |
| | -80° | 11.9* | 77.1 | 128.8 | 86.0 | 139.4 | 107.9 | 180.1 | 126.2 | 204.6 |
| | -50° | 8.1* | 104.4 | 135.0 | 116.4 | 146.2 | 146.0 | 188.9 | 170.8 | 214.5 |
| | -40° | 0.6 | 138.1 | 141.3 | 154.0 | 153.0 | 193.1 | 197.6 | 226.0 | 224.5 |
| | -30° | 4.9 | 179.5 | 145.8 | 200.2 | 157.9 | 251.1 | 204.0 | 293.8 | 231.7 |
| | -20° | 10.2 | 230.1 | 144.5 | 256.7 | 158.5 | 321.9 | 202.1 | 376.6 | 229.6 |
| 20°F 43.1# | -70° | 18.6* | 51.9 | 138.3 | 57.3 | 147.7 | 72.6 | 190.7 | 85.0 | 216.6 |
| | -80° | 11.9* | 72.9 | 143.9 | 81.3 | 155.9 | 102.0 | 201.3 | 119.3 | 226.7 |
| | -50° | 8.1* | 99.2 | 149.8 | 110.7 | 162.2 | 138.8 | 209.6 | 162.4 | 238.0 |
| | -40° | 0.6 | 132.0 | 157.2 | 147.2 | 170.2 | 184.6 | 219.9 | 216.0 | 249.8 |
| | -30° | 4.9 | 172.0 | 163.8 | 191.8 | 177.4 | 240.5 | 229.2 | 281.4 | 260.3 |
| | -20° | 10.2 | 220.9 | 169.2 | 246.4 | 182.2 | 309.0 | 235.3 | 361.6 | 267.3 |
| 30°F 54.9# | -70° | 18.6* | 48.4 | 148.5 | 54.0 | 160.8 | 67.7 | 207.7 | 79.2 | 235.9 |
| | -80° | 11.9* | 66.5 | 157.8 | 76.4 | 170.9 | 95.8 | 220.7 | 112.1 | 250.7 |
| | -50° | 8.1* | 93.9 | 167.4 | 104.7 | 181.3 | 131.3 | 234.2 | 153.7 | 266.0 |
| | -40° | 0.6 | 125.0 | 174.5 | 140.1 | 188.9 | 175.0 | 244.0 | 205.5 | 277.2 |
| | -30° | 4.9 | 164.2 | 183.0 | 183.2 | 198.2 | 229.7 | 256.0 | 268.8 | 290.8 |
| | -20° | 10.2 | 211.7 | 191.5 | 238.2 | 207.4 | 293.1 | 267.9 | 346.5 | 304.3 |
| | -10° | 16.5 | 266.9 | 199.4 | 299.8 | 209.5 | 375.9 | 270.6 | 439.9 | 307.3 |

Notes: * Inches of mercury below one standard atmosphere (29.92 inches).



CIB-ESPOL



**VSS SINGLE SCREW COMPRESSOR RATINGS
OIL COOLING REQUIREMENTS
HIGH STAGE R-717 - 3550 RPM**

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|---|-----------|--------------|------------------|---------|---------|---------|----------|----------|----------|
| | TEMP (°F) | PRESS (PSIG) | VSS 451 | VSS 601 | VSS 751 | VSS 901 | VSS 1051 | VSS 1201 | VSS 1501 |
| 75°F 125.5# | -40° | 8.8* | 13.8 | 18.3 | 22.8 | 25.5 | 31.1 | 34.8 | 42.8 |
| | -30° | 1.7* | 14.0 | 18.4 | 22.8 | 25.8 | 31.4 | 35.0 | 43.0 |
| | -20° | 3.5 | 13.8 | 18.0 | 22.2 | 25.1 | 30.5 | 34.0 | 41.8 |
| | -10° | 9.0 | 12.7 | 14.9 | 20.7 | 23.5 | 28.5 | 31.8 | 39.1 |
| | 0° | 15.8 | 11.3 | 13.3 | 18.4 | 20.9 | 25.4 | 28.3 | 34.8 |
| | 10° | 23.7 | 9.0 | 10.8 | 14.8 | 16.7 | 20.3 | 22.6 | 27.8 |
| | 20° | 33.4 | 4.9 | 5.7 | 8.0 | 9.0 | 11.0 | 12.2 | 15.0 |
| | 30° | 44.9 | 4.5 | 5.3 | 7.4 | 8.4 | 10.2 | 11.3 | 13.9 |
| 85°F 151.3# | -40° | 8.8* | 16.4 | 19.3 | 26.8 | 30.3 | 36.8 | 41.1 | 50.5 |
| | -30° | 1.7* | 16.8 | 19.8 | 27.5 | 31.1 | 37.8 | 42.2 | 51.8 |
| | -20° | 3.5 | 16.8 | 19.8 | 27.5 | 31.1 | 37.8 | 42.2 | 51.9 |
| | -10° | 9.0 | 16.3 | 19.1 | 26.6 | 30.1 | 36.8 | 40.8 | 50.1 |
| | 0° | 15.8 | 15.2 | 17.9 | 24.8 | 28.1 | 34.1 | 38.0 | 46.8 |
| | 10° | 23.7 | 13.4 | 15.8 | 21.9 | 24.8 | 30.2 | 33.8 | 41.3 |
| | 20° | 33.4 | 10.8 | 12.4 | 17.3 | 19.5 | 23.8 | 26.5 | 32.6 |
| | 30° | 44.9 | 4.8 | 5.7 | 7.9 | 8.9 | 10.8 | 12.0 | 14.8 |
| 95°F 180.6# | -40° | 8.8* | 19.3 | 22.8 | 31.8 | 35.3 | 43.5 | 48.5 | 59.8 |
| | -30° | 1.7* | 19.8 | 23.3 | 32.4 | 36.8 | 44.5 | 49.8 | 61.0 |
| | -20° | 3.5 | 20.3 | 23.9 | 33.1 | 37.5 | 45.8 | 50.8 | 62.5 |
| | -10° | 9.0 | 20.1 | 23.7 | 32.9 | 37.2 | 45.2 | 50.4 | 62.0 |
| | 0° | 15.8 | 19.4 | 22.8 | 31.8 | 35.8 | 43.5 | 48.5 | 59.7 |
| | 10° | 23.7 | 18.0 | 21.2 | 29.4 | 33.2 | 40.4 | 45.1 | 55.4 |
| | 20° | 33.4 | 15.8 | 18.5 | 25.7 | 29.1 | 35.4 | 39.5 | 48.5 |
| | 30° | 44.9 | 12.1 | 14.2 | 19.8 | 22.4 | 27.2 | 30.4 | 37.3 |
| 105°F 213.7# | -40° | 8.8* | 22.5 | 26.5 | 36.8 | 41.8 | 50.8 | 58.4 | 69.4 |
| | -30° | 1.7* | 23.1 | 27.2 | 37.7 | 42.7 | 51.9 | 57.9 | 71.2 |
| | -20° | 3.5 | 23.8 | 28.0 | 38.9 | 44.1 | 53.8 | 59.7 | 73.5 |
| | -10° | 9.0 | 24.2 | 28.5 | 39.5 | 44.7 | 54.4 | 60.8 | 74.6 |
| | 0° | 15.8 | 23.8 | 28.0 | 39.0 | 44.1 | 53.8 | 59.7 | 73.4 |
| | 10° | 23.7 | 22.8 | 26.9 | 37.3 | 42.2 | 51.3 | 57.2 | 70.3 |
| | 20° | 33.4 | 21.7 | 24.8 | 34.4 | 39.0 | 47.4 | 52.8 | 65.0 |
| | 30° | 44.9 | 18.2 | 21.5 | 29.8 | 33.7 | 41.0 | 45.7 | 56.2 |
| | 40° | 58.4 | 13.3 | 13.0 | 22.2 | 25.1 | 30.5 | 34.0 | 41.8 |

Notes

- * Inches of mercury below one standard atmosphere.
- ** Consult Home Office for recommendations on oil cooler load.
- For Econ-o-Mizer® oil cooler loads add 10% to the oil cooler requirements.
- Shaded areas indicate oil cooling requirement with mandatory oil-film oil pump.



CIB-ESPOL



**VSS SINGLE SCREW COMPRESSOR RATINGS
OIL COOLING REQUIREMENTS
HIGH STAGE R-22 - 3350 RPM**

| CONDENSING Temperature (°F) & Corresponding Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | | |
|---|-----------|--------------|------------------|---------|---------|---------|----------|----------|----------|----------|
| | TEMP (°F) | PRESS (PSIG) | VSS 451 | VSS 801 | VSS 751 | VSS 901 | VSS 1051 | VSS 1201 | VSS 1501 | VSS 1801 |
| 85°F 155.7# | -40° | 0.6 | 12.4 | 14.8 | 20.3 | 22.9 | 27.9 | 31.1 | 38.2 | 44.7 |
| | -30° | 4.9 | 11.8 | 13.9 | 19.4 | 21.9 | 26.6 | 29.7 | 36.5 | 42.7 |
| | -20° | 10.2 | 10.5 | 12.3 | 17.1 | 19.4 | 23.6 | 26.3 | 32.3 | 37.8 |
| | -10° | 16.5 | 8.9 | 10.5 | 14.5 | 16.5 | 20.0 | 22.3 | 27.4 | 32.1 |
| | 0° | 24.0 | 7.2 | 8.5 | 11.8 | 13.4 | 16.3 | 18.2 | 22.3 | 26.1 |
| | 10° | 32.8 | 5.8 | 6.8 | 9.4 | 10.7 | 13.0 | 14.4 | 17.8 | 20.8 |
| | 20° | 43.1 | 4.0 | 4.7 | 6.5 | 7.4 | 8.9 | 10.0 | 12.3 | 14.4 |
| | 30° | 54.9 | 2.4 | 2.9 | 4.0 | 4.5 | 5.5 | 6.1 | 7.5 | 8.8 |
| | 40° | 68.8 | ** | ** | ** | ** | ** | ** | ** | ** |
| 95°F 181.8# | -40° | 0.6 | 15.2 | 17.9 | 24.8 | 28.1 | 34.1 | 38.0 | 46.8 | 54.7 |
| | -30° | 4.9 | 14.5 | 17.1 | 23.8 | 26.9 | 32.7 | 36.4 | 44.8 | 52.5 |
| | -20° | 10.2 | 13.8 | 16.3 | 22.6 | 25.6 | 31.1 | 34.7 | 42.6 | 49.9 |
| | -10° | 16.5 | 12.4 | 14.8 | 20.3 | 22.9 | 27.9 | 31.1 | 38.2 | 44.7 |
| | 0° | 24.0 | 10.8 | 12.5 | 17.4 | 19.7 | 23.9 | 26.7 | 32.8 | 38.4 |
| | 10° | 32.8 | 9.1 | 10.7 | 14.8 | 16.7 | 20.4 | 22.7 | 27.9 | 32.7 |
| | 20° | 43.1 | 7.4 | 8.7 | 12.1 | 13.8 | 16.6 | 18.5 | 22.7 | 26.6 |
| | 30° | 54.9 | 5.5 | 6.5 | 9.1 | 10.3 | 12.5 | 13.9 | 17.1 | 20.0 |
| | 40° | 68.8 | 3.3 | 4.5 | 6.3 | 7.1 | 8.6 | 9.6 | 11.8 | 13.8 |
| 105°F 210.8# | -40° | 0.6 | 18.3 | 21.5 | 29.9 | 33.8 | 41.1 | 45.8 | 56.3 | 65.9 |
| | -30° | 4.9 | 17.5 | 20.8 | 28.8 | 32.3 | 39.3 | 43.8 | 53.9 | 63.1 |
| | -20° | 10.2 | 17.0 | 20.0 | 27.8 | 31.4 | 38.2 | 42.6 | 52.4 | 61.3 |
| | -10° | 16.5 | 15.9 | 18.7 | 26.0 | 29.4 | 35.7 | 39.8 | 49.0 | 57.3 |
| | 0° | 24.0 | 14.5 | 17.2 | 23.9 | 27.0 | 32.9 | 36.6 | 45.1 | 52.7 |
| | 10° | 32.8 | 12.7 | 15.0 | 20.8 | 23.5 | 28.6 | 31.9 | 39.2 | 45.9 |
| | 20° | 43.1 | 11.1 | 13.1 | 18.2 | 20.6 | 25.0 | 27.9 | 34.3 | 40.1 |
| | 30° | 54.9 | 9.3 | 10.9 | 15.2 | 17.2 | 20.9 | 23.3 | 28.7 | 33.5 |
| | 40° | 68.8 | 7.3 | 8.6 | 11.9 | 13.5 | 16.4 | 18.3 | 22.5 | 26.3 |
| 115°F 242.8# | -40° | 0.6 | 21.7 | 25.5 | 35.5 | 40.1 | 48.8 | 54.4 | 66.9 | 78.3 |
| | -30° | 4.9 | 20.8 | 24.5 | 34.0 | 38.5 | 46.8 | 52.2 | 64.2 | 75.1 |
| | -20° | 10.2 | 20.3 | 23.8 | 33.1 | 37.5 | 45.8 | 50.8 | 62.5 | 73.1 |
| | -10° | 16.5 | 19.9 | 23.4 | 32.5 | 36.7 | 44.7 | 49.8 | 61.2 | 71.7 |
| | 0° | 24.0 | 18.8 | 21.7 | 30.1 | 34.1 | 41.4 | 46.2 | 56.8 | 66.5 |
| | 10° | 32.8 | 16.9 | 19.8 | 27.5 | 31.1 | 37.9 | 42.2 | 51.9 | 60.8 |
| | 20° | 43.1 | 15.2 | 17.9 | 24.3 | 28.1 | 34.1 | 38.0 | 46.8 | 54.7 |
| | 30° | 54.9 | 13.6 | 16.0 | 22.2 | 25.1 | 30.5 | 34.1 | 41.9 | 49.0 |
| | 40° | 68.8 | 11.4 | 13.5 | 18.7 | 21.2 | 25.7 | 28.7 | 35.3 | 41.3 |

Notes ** Consult Home Office for recommendations on oil cooler load.
For Econ-o-Mizer® oil cooler loads add 10% to the oil cooler requirements.



CIB-ESPOL

**VSS SINGLE SCREW COMPRESSOR RATINGS
OIL COOLING REQUIREMENTS
BOOSTER R-717 - 3550 RPM**

| DISCHARGE Temp. (°F) & Corr. Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|--|--------------|-----------------|------------------|------------|------------|------------|-------------|-------------|-------------|
| | TEMP (°F) | PRESS (PSIG) | VSS 451 | VSS 601 | VSS 751 | VSS 901 | VSS 1051 | VSS 1201 | VSS 1501 |
| 0°F 15.6# | -70° | 21.9* | 5.3 | 8.2 | 8.8 | 9.7 | 11.8 | 13.2 | 16.2 |
| | -60° | 18.7* | 4.4 | 5.2 | 7.2 | 8.2 | 9.9 | 11.1 | 13.6 |
| | -50° | 14.4* | 3.3 | 3.9 | 5.4 | 6.1 | 7.4 | 8.2 | 10.1 |
| | -40° | 8.8* | 2.1 | 2.5 | 3.4 | 3.9 | 4.7 | 5.3 | 6.5 |
| | -30° | 1.7* | 0.4 | 0.4 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 |
| | -20° | 3.5 | ** | ** | ** | ** | ** | ** | ** |
| 10°F 23.7# | -70° | 21.9* | 6.4 | 7.6 | 10.5 | 11.9 | 14.4 | 16.1 | 19.8 |
| | -60° | 18.7* | 5.5 | 6.5 | 9.0 | 10.2 | 12.4 | 13.8 | 16.9 |
| | -50° | 14.4* | 4.4 | 5.2 | 7.2 | 8.1 | 9.9 | 11.0 | 13.6 |
| | -40° | 8.8* | 3.4 | 4.0 | 5.5 | 6.2 | 7.6 | 8.4 | 10.4 |
| | -30° | 1.7* | 2.0 | 2.3 | 3.2 | 3.6 | 4.4 | 4.9 | 6.0 |
| | -20° | 3.5 | ** | ** | ** | ** | ** | ** | ** |
| 20°F 33.4# | -70° | 21.9* | 7.5 | 8.8 | 12.2 | 13.8 | 16.8 | 18.7 | 23.0 |
| | -60° | 18.7* | 6.8 | 8.0 | 11.1 | 12.5 | 15.2 | 17.0 | 20.9 |
| | -50° | 14.4* | 5.9 | 6.9 | 9.6 | 10.8 | 13.2 | 14.7 | 18.1 |
| | -40° | 8.8* | 4.6 | 5.5 | 7.8 | 8.6 | 10.4 | 11.6 | 14.3 |
| | -30° | 1.7* | 3.5 | 4.1 | 5.8 | 6.5 | 7.9 | 8.8 | 10.8 |
| | -20° | 3.5 | 1.9 | 2.2 | 3.1 | 3.5 | 4.3 | 4.8 | 5.8 |
| 30°F 44.9# | -60° | 18.7* | 8.2 | 9.6 | 13.3 | 15.1 | 18.3 | 20.5 | 25.1 |
| | -50° | 14.4* | 7.4 | 8.7 | 12.0 | 13.8 | 16.5 | 18.4 | 22.7 |
| | -40° | 8.8* | 6.5 | 7.8 | 10.5 | 11.9 | 14.5 | 16.2 | 19.9 |
| | -30° | 1.7* | 5.1 | 6.0 | 8.3 | 9.4 | 11.4 | 12.7 | 15.7 |
| | -20° | 3.5 | 3.8 | 4.5 | 6.2 | 7.0 | 8.5 | 9.5 | 11.7 |
| | -10° | 9.0 | 2.0 | 2.4 | 3.3 | 3.7 | 4.5 | 5.0 | 6.2 |

BOOSTER R-22 - 3550 RPM

| DISCHARGE Temp. (°F) & Corr. Pressure (PSIG) | SUCTION | | COMPRESSOR MODEL | | | | | | |
|--|--------------|-----------------|------------------|------------|------------|------------|-------------|-------------|-------------|
| | TEMP (°F) | PRESS (PSIG) | VSS 451 | VSS 601 | VSS 751 | VSS 901 | VSS 1051 | VSS 1201 | VSS 1501 |
| 0°F 24.0# | -70° | 15.8* | 1.6 | 1.9 | 2.7 | 3.0 | 3.7 | 4.1 | 5.1 |
| | -60° | 11.9* | ** | ** | ** | ** | ** | ** | ** |
| | -50° | 8.1* | ** | ** | ** | ** | ** | ** | ** |
| | -40° | 0.6 | ** | ** | ** | ** | ** | ** | ** |
| | -30° | 4.0 | ** | ** | ** | ** | ** | ** | ** |
| | -20° | 10.2 | ** | ** | ** | ** | ** | ** | ** |
| 10°F 32.8# | -70° | 18.8* | 2.8 | 3.4 | 4.7 | 5.3 | 6.4 | 7.1 | 8.8 |
| | -60° | 11.9* | 1.1 | 1.3 | 1.8 | 2.0 | 2.4 | 2.7 | 3.4 |
| | -50° | 0.1* | ** | ** | ** | ** | ** | ** | ** |
| | -40° | 0.8 | ** | ** | ** | ** | ** | ** | ** |
| | -30° | 1.9 | ** | ** | ** | ** | ** | ** | ** |
| | -20° | 10.2 | ** | ** | ** | ** | ** | ** | ** |
| 20°F 43.1# | -70° | 18.8* | 4.1 | 4.9 | 6.7 | 7.8 | 9.2 | 10.2 | 12.6 |
| | -60° | 11.9* | 2.6 | 3.0 | 4.2 | 4.7 | 5.7 | 6.4 | 7.9 |
| | -50° | 3.7* | 0.6 | 0.8 | 1.1 | 1.2 | 1.5 | 1.6 | 2.0 |
| | -40° | 0.8 | ** | ** | ** | ** | ** | ** | ** |
| | -30° | 1.8 | ** | ** | ** | ** | ** | ** | ** |
| | -20° | 10.2 | ** | ** | ** | ** | ** | ** | ** |
| 30°F 54.9# | -70° | 18.8* | 5.4 | 6.4 | 8.9 | 10.1 | 12.2 | 13.7 | 16.8 |
| | -60° | 11.9* | 3.9 | 4.6 | 6.4 | 7.3 | 8.8 | 9.9 | 12.1 |
| | -50° | 3.1* | 2.3 | 2.7 | 3.7 | 4.2 | 5.1 | 5.7 | 7.0 |
| | -40° | 0.8 | 0.3 | 0.4 | 0.5 | 0.8 | 0.7 | 0.8 | 1.0 |
| | -30° | 1.9 | ** | ** | ** | ** | ** | ** | ** |
| | -20° | 10.2 | ** | ** | ** | ** | ** | ** | ** |

Notes * Inches of mercury below one standard atmosphere.
** Consult Home Office for recommendations on oil cooler load.



APENDICE I: TABLA DE TUBERIAS DE ACERO

ASTM – A53-Gr B



CIB-ESPOL

ACERO SIN COSTURA ASTM - A53-Gr.B PARA CONDUCCIÓN DE FLUIDOS

| CEDULA 40 | DIÁMETRO | | | ESPESOR | | PRESIÓN/PRUEBA | | PESO |
|-----------|----------|----------|-------|---------|-------|---------------------|----------------------|--------|
| | NOMINAL | EXTERIOR | | mm | pulg. | kg./cm ² | lb/pulg ² | kg/mt. |
| | | mm | pulg. | | | | | |
| ¼" | 13,7 | 0,540 | 2,24 | 0,088 | 49 | 700 | 0,63 | |
| 3/8" | 17,1 | 0,675 | 2,31 | 0,091 | 49 | 700 | 0,85 | |
| ½" | 21,3 | 0,840 | 2,77 | 0,109 | 49 | 700 | 1,27 | |
| ¾" | 26,7 | 1,050 | 2,87 | 0,113 | 49 | 700 | 1,68 | |
| 1" | 33,4 | 1,315 | 3,38 | 0,133 | 49 | 700 | 2,50 | |
| 1 ¼" | 42,2 | 1,660 | 3,56 | 0,14 | 91 | 1.300 | 3,38 | |
| 1 ½" | 48,3 | 1,900 | 3,68 | 0,145 | 91 | 1.300 | 4,05 | |
| 2" | 60,3 | 2,375 | 3,91 | 0,154 | 176 | 2.500 | 5,44 | |
| 2 ½" | 73,0 | 2,875 | 5,16 | 0,203 | 176 | 2.500 | 6,62 | |
| 3" | 88,9 | 3,500 | 5,49 | 0,216 | 176 | 2.500 | 11,29 | |
| 4" | 114,3 | 4,500 | 6,02 | 0,237 | 155 | 2.210 | 16,07 | |
| 5" | 141,3 | 5,563 | 6,55 | 0,258 | 137 | 1.950 | 21,78 | |
| 6" | 168,3 | 6,625 | 7,11 | 0,28 | 125 | 1.780 | 26,26 | |
| 8" | 219,1 | 8,625 | 8,18 | 0,322 | 110 | 1.570 | 42,53 | |
| 10" | 273,0 | 10,750 | 9,27 | 0,364 | 101 | 1.430 | 60,29 | |
| 12" | 323,8 | 12,750 | 10,31 | 0,406 | 94 | 1.340 | 79,65 | |

RESISTENCIAS MECANICAS

Resistencia a la tracción 60.000 PSI (42.2 Kg/mm²)
 Limite de elasticidad 35.000 PSI (24.6 Kg/mm²)
 Alargamiento 0.5%



CIB-ESPOL

| CEDULA 80 | DIÁMETRO | | | ESPESOR | | PRESIÓN/PRUEBA | | PESO |
|-----------|----------|----------|-------|---------|-------|---------------------|----------------------|--------|
| | NOMINAL | EXTERIOR | | mm | pulg. | kg./cm ² | lb/pulg ² | kg/mt. |
| | | mm | pulg. | | | | | |
| ¼" | 13,7 | 0,540 | 3,02 | 0,119 | 60 | 850 | 0,80 | |
| 3/8" | 17,1 | 0,675 | 3,2 | 0,126 | 60 | 850 | 1,10 | |
| ½" | 21,3 | 0,840 | 3,73 | 0,147 | 60 | 850 | 1,62 | |
| ¾" | 26,7 | 1,050 | 3,91 | 0,154 | 60 | 850 | 2,19 | |
| 1" | 33,4 | 1,315 | 4,55 | 0,179 | 60 | 850 | 3,23 | |
| 1 ¼" | 42,2 | 1,660 | 4,85 | 0,191 | 134 | 1.900 | 4,47 | |
| 1 ½" | 48,3 | 1,900 | 5,08 | 0,2 | 134 | 1.900 | 5,41 | |
| 2" | 60,3 | 2,375 | 5,54 | 0,218 | 176 | 2.500 | 7,48 | |
| 2 ½" | 73,0 | 2,875 | 7,01 | 0,276 | 176 | 2.500 | 11,41 | |
| 3" | 88,9 | 3,500 | 7,62 | 0,3 | 176 | 2.500 | 15,27 | |
| 4" | 114,3 | 4,500 | 8,56 | 0,337 | 197 | 2.800 | 22,31 | |
| 6" | 168,3 | 6,625 | 10,97 | 0,432 | 193 | 2.740 | 42,56 | |

COMPOSICIÓN

CARBON 0,30
 MANGANESO 1,20
 FOSFORO 0,05
 AZUFRE 0,06

**APENDICE J: TABLA DE ESPESOR RECOMENDADOS DE
AISLAMIENTO TERMICO**



CIB-ESPOL

Espesores recomendados de aislamiento

| Temperatura De Tubería | °C | -73 | -40 | -29 | -18 | -7 | 4 |
|------------------------|----|---------------------------------|-------|-------|-------|-------|-------|
| | °F | -100 | -40 | -20 | 0 | 20 | 40 |
| Diámetro Nominal | | Espesor Recomendado en pulgadas | | | | | |
| 1/2" | | 3 | 2 1/2 | 2 | 2 | 1 1/2 | 1 |
| 3/4" | | 3 | 2 1/2 | 2 | 2 | 1 1/2 | 1 |
| 1" | | 3 1/2 | 2 1/2 | 2 | 2 | 1 1/2 | 1 |
| 1 1/4" | | 3 1/2 | 2 1/2 | 2 1/2 | 2 | 1 1/2 | 1 1/2 |
| 1 1/2" | | 3 1/2 | 2 1/2 | 2 1/2 | 2 | 2 | 1 1/2 |
| 2" | | 4 | 3 | 2 1/2 | 2 | 2 | 1 1/2 |
| 2 1/2" | | 4 | 3 | 2 1/2 | 2 | 2 | 1 1/2 |
| 3" | | 4 1/2 | 3 1/2 | 2 1/2 | 2 1/2 | 2 | 1 1/2 |
| 4" | | 4 1/2 | 3 1/2 | 3 | 2 1/2 | 2 | 1 1/2 |
| 5" | | 4 1/2 | 3 1/2 | 3 | 2 1/2 | 2 | 1 1/2 |
| 6" | | 4 1/2 | 3 1/2 | 3 | 2 1/2 | 2 1/2 | 1 1/2 |
| 8" | | 5 1/2 | 4 | 3 1/2 | 3 | 2 1/2 | 1 1/2 |
| 10" | | 5 1/2 | 4 | 3 1/2 | 3 | 2 1/2 | 2 |
| 12" | | 6 | 4 | 3 1/2 | 3 | 2 1/2 | 2 |



Condiciones ambientales

Humedad Relativa de 90%

Temperatura Ambiente, 90°F

Velocidad del Aire 0 millas por hora

Temperatura Superficial Mínima para prevenir condensación 87°F

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