



Carwin

COMPRESSOR

SELECTION

PROGRAM



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- **INTRODUCTION**

Carlyle Compressor Company is proud to present the Carlyle Selection Program

It includes the most recent oil cooler recommendations for our screw compressors (oil coolers have been eliminated from many applications), and fixes the bugs found in earlier versions of the program. It is recommended that everyone update to the latest version.

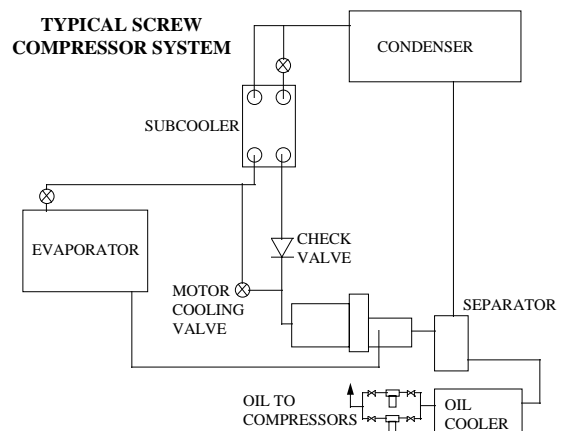
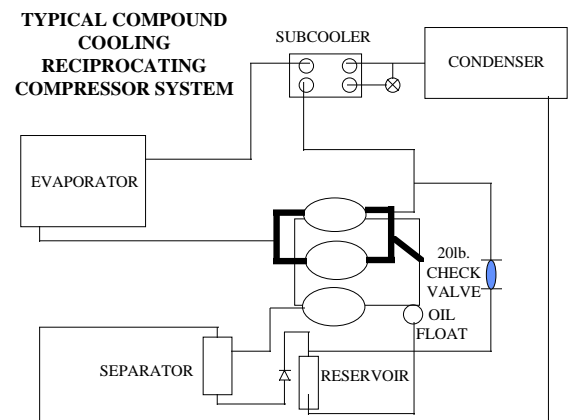
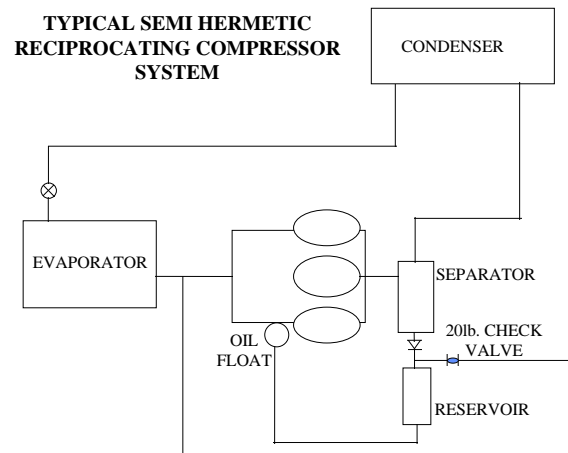
This Windows based selection program offers many improvements from our earlier EPC selection programs. Many user interfaces have been redesigned making the selection program quicker and easier to use. The program includes performance data for the entire line of Carlyle compressors, which includes 05T/06T screw compressors, the 06D/E/CC reciprocating compressors and the 5F/H reciprocating compressors. The range of refrigerants has also been expanded to include CFC's, HCFC's and HFC's, depending on which compressors is selected.

Upon opening CSP, a graphical representation of a simple refrigeration system appears on the screen. This is the first and most obvious improvement from the earlier programs. In the *Graphics* mode, along with the *Load Match* and *Display Model* modes, compressor performance data may be obtained. The output for these three modes has been expanded and rearranged into an easy to follow format. A detail write-up of the program output can be found further in these instructions.

Carlyle's CSP has incorporated the latest Windows resources to provide useful and accurate information in a user friendly format. If you have any questions or comments regarding the program, please

contact Carlyle Application Engineering at (800) 462-2759.

Below are the three schematics that are now incorporated in the Carlyle Selection Program graphics mode.



1.

Note: To avoid any execution problem, it is recommended to delete any previous versions of Carlyle's windows based selection program from your computer.

Starting The Program

After initial setup and/or installation the program can be restarted by from the Programs menu.

MENU INSTRUCTIONS

INITIAL SCREEN

Upon accessing the selection program, a graphical representation of a simple 06T system will appear. At the top of the screen there is a menu bar. Below the menu bar and to the right there are six windows with drop down menus and along the left side of the screen there are three tabs. By using the mouse, the menu bar, windows and tabs can be accessed.

There are four headings in the menu bar; *File*, *Load Match*, *Print*, *Help*. With the *File* option files can be opened or saved, and the program can be exited with this option. *Load Match* restarts the load matching portion of the selection program. The display model and the load match output can be printed using the *Print* option. Finally, any question that may arise can be answered using the *Help* option.

The six window below the menu bar are used to set general system parameters. These windows are labeled *Compressor*, *Model*, *Refrigerant*, *Voltage*, *Units*, and *Frequency*. These drop down menus are explained in further detail later in these instructions.

The three tabs, *Graphic*, *Display Model* and *Load Match*, on the side of the screen are

used to toggle between the different options in the selection program. These options will be discussed later.

COMPRESSOR SELECTION

The *Compressor* window allows the user to select from four different compressor families. They are 06D/E semi-hermetic reciprocating compressors, 06CC Compound Cooling compressors, 05T/06T screw compressors, and the 5F/H open drive reciprocating compressor. Using the *Model* window, specific model compressors can be selected.

Depending on which compressor is selected, the refrigerants available will appear in the window labeled *Refrigerant*. This selection program has refrigerants ranging from the CFC R-502 to the environmentally friendly HFC R-507.

The *Voltage*, *Frequency* and the *Units* in which the selection program display the data can be adjusted with the remaining three drop down menus.

DESIGN CONDITIONS

The user can input the required conditions within Carlyle's approved operating range and receive the data necessary to properly select compressors. The design conditions can be set by either inputting the temperatures manually or by using the up and down arrow button for each corresponding condition. To manually input the temperature use the mouse to double-click on the window and input the desired temperature using the keyboard. Once the desired operating condition has been inputted into the program, click on the *Run Calculation* button to execute the program.

Note: If the program is operating in English units the inputs will be rounded to the closest integer. In Metric units, the

inputs will be rounded to the nearest tenth.

Saturated Suction Temperature (SST)

Input the required saturated suction temperature for the application.

SST Increment

Under the *Display Model* option (explained later) five saturated suction temperatures will be displayed. This option allows the user to adjust the incremental increase in saturated suction temperature. The five saturated suction temperatures can be set individually or at even increments.

Saturated Condensing Temperature (SCT)

Input the required saturated condensing temperature for the application.

Liquid Temperature Leaving Condenser

The liquid temperature leaving the condenser is used to ensure the subcooler is sized properly. It allows for subcooling which may occur in the condenser, or “ambient subcooling”.

Liquid Temperature Leaving Economizer

If the application involves using a subcooler, simply lower the liquid temperature leaving the subcooler to the desired subcooled temperature. The liquid temperature leaving the subcooler will determine the subcooler size. To toggle between economized and non-economized in the *Graphic* mode, use the mouse to click on the *Economized/Non-Economized* button just above the evaporator. In the *Display Model* or *Load Match* mode, if there is no subcooler, adjust this variable to equal the liquid temperature leaving the condenser.

Liquid Temperature Entering TXV

The liquid temperature entering the evaporator can be altered. The 06D/E

compressors are single stage reciprocating compressors and the computer program will default the liquid temperature entering the evaporator TXV to be equal to the saturated condensing temperature. If the application involves using a subcooler, simply lower the liquid temperature entering the TXV to the desired subcooled temperature and the program will calculate the increased capacity. The compound cooling default is 40°F liquid (4.4°C), and the screw compressor default is 10°F above saturated interstage temperature. Remember to increase this temperature above the temperature exiting the subcooler if heat gain in the liquid line is expected.

Superheat Leaving Evaporator

The evaporator refrigeration effect is calculated using the mass flow and the change in enthalpy across the evaporator. The liquid temperature entering the evaporator TXV provides an enthalpy and the superheat leaving the evaporator will determine the second enthalpy. The program will default to 10°F of superheat.

Return Gas Temperature

The default return gas temperature is 65°F (18°C). Lowering the value will increase the evaporator mass flow.

Heat Rejection Factor

The heat rejection factor determines what percentage of the motor input power is rejected at the condenser. The default is 100%. If the application requires 90% of the input power be rejected at the condenser, enter an integer and not a decimal (90 not .90).

GRAPHIC MODE

The *Graphic* mode is the same as the initial start up screen. This mode provides a visual representation of a simple refrigeration system. In this mode the output can be

retrieved by moving the cursor over the desired component in the system. For example, to get the compressor capacity, move the cursor over the compressor in the system. The power, current, and EER that corresponds to the desired operating condition will appear in the lower right hand corner of the screen. The compressor Horse Power and the number of cylinders is also be displayed.

Note: Before clicking on the *Run Calculation* button be sure that none of the inputs have changed. Under certain circumstances the selection program will default some of the inputs.

DISPLAY MODEL

This option will display the performance data for one compressor at five different saturated suction temperatures. The different SST's can be set individually or at even increments. Using the mouse, selected the desired model and design condition. The performance data for the design conditions will be displayed on the screen. Again, be sure that all of the inputs are correct before clicking on the *Run Calculation* button.

LOAD MATCH

This portion of the program will match the system load at a specific condition with the necessary compressor(s). This can be done automatically or manually. First enter the system load and the number of compressors when prompted. If the load can't be satisfied by the number of compressor selected a warning will appear on the screen. If the compressor(s) selected by the computer program is not acceptable for the application, compressors may be added or removed by double-clicking on the desired compressor. The computer selects the compressors based on the evaporator refrigeration effect, not compressor capacity.

Send To Printer

If a hard copy is needed, select the *Print* option in the menu bar and choose whichever option was run, *Display Model* or *Load Match*. **Always Run Calculation before printing.** Do not change any design conditions and then print without re-running.

- **EXIT THE PROGRAM**

To exit the program, simply hit the close button or use the *File* option in the menu bar and select *Exit*.

- **INTERPRETING OUTPUT**

COMPRESSOR CAPACITY, EVAPORATOR REFRIGERATION EFFECT & MASS FLOW

Please see section that follows.

CURRENT, POWER & EER

Although the compressor capacity can be altered, the current & power will remain the same as the standard default conditions for 06D/E and 06CC systems. The 06T (screw) data is adjusted from the default conditions when the design conditions are altered. Because EER is equal to compressor capacity divided by power, the EER will not be accurate for the 06CC applications when the compressor capacity is modified. Keep in mind that many variables affect EER and it is very difficult to model.

SUBCOOLER

The subcooler calculation is the evaporator mass flow multiplied by the difference between the liquid enthalpy leaving the subcooler and the liquid enthalpy leaving the condenser. If the system is not designed to have a subcooler, change the liquid

temperature leaving the subcooler to make it equal to the liquid temperature leaving the condenser or use the *Economized/Non-Economized* button in the *Graphics* mode.

TOTAL HEAT REJECTED by oil cooler

For most screw compressor systems, an oil cooler is required. The variables used in the heat rejection calculation for the oil cooler is mass flow, specific heat of the oil, and the change in temperature. The mass flow is a function of the pressure differential across the compressor. The specific heat used in this calculation is that of Castrol's SW100 Polyolester oil. The low temperature is set at 130°F (54°C) while the high temperature is calculated based on design conditions. Although certain conditions will show no oil cooler required, Carlyle Compressor recommends oil coolers on all low and medium temperature systems.

by condenser

The condenser heat rejected calculation is a summation of the compressor capacity and compressor power. If there is an oil cooler in a screw compressor system, its load is subtracted from the condenser heat rejection. The percentage of compressor power added to the condenser heat rejected can be reduced with the heat rejection factor. The default setting is 100. To reduce the value, input the number as a percentage (90) and not a decimal (.90). Be sure to take into account the oil cooler when sizing the condenser. A system in which the oil is not cooled down to 130°F (54°C) will need a larger condenser. Be sure to take this into consideration when designing a system.

- **COMPRESSOR CAPACITY vs.
EVAPORATOR REFRIGERATION
EFFECT**

CSP Windows version 1.0 calculates both compressor capacity and evaporator refrigeration effect. The intention of including both capacities is to improve the understanding of how altering certain variables can influence system capacities and to ensure that compressor selections will meet the required load. In the past, Carlyle Compressor has rated all its performance data as compressor capacity. Compressor capacity was rated in most occasions with 65°F (18.3°C) return gas temperature considering all of the superheat useful. Industry has used this information to size systems even though it is not usually the true capacity at the evaporator. Systems were sized with extra compressor capacity to ensure there would be enough evaporator capacity, or evaporator refrigeration effect, for the system. There are three major values which determine capacity. They are evaporator mass flow, entering enthalpy, and leaving enthalpy.

Enthalpy is the amount of energy generated per pound of refrigerant. Below is the equation to determine capacity.

$$\text{Capacity} = \text{Evaporator Mass Flow} \times (\text{Leaving Enthalpy} - \text{Entering Enthalpy})$$

The Compressor Capacity (**C.C.**) is equal to the mass flow through the evaporator (**Me**) multiplied by the difference between the enthalpy of the return gas temperature entering the compressor (**Hrgt**) and the enthalpy of the liquid entering the evaporator expansion valve (**HI**).

$$\text{C.C.} = \text{Me} \times (\text{Hrgt} - \text{HI})$$

The Evaporator Refrigeration Effect (**E.R.E.**) is equal to the mass flow through the evaporator (**Me**) multiplied by the difference between the enthalpy of the vapor leaving the evaporator (**Hsh**) and the

enthalpy of the liquid entering the evaporator expansion valve (**HI**).

$$E.R.E. = Me \times (Hsh - HI)$$

Diagram 1 displays the correlation between pressure and enthalpy for a compound cooling or screw compressor. A reciprocating compressor would not have the subcooler mass flow.

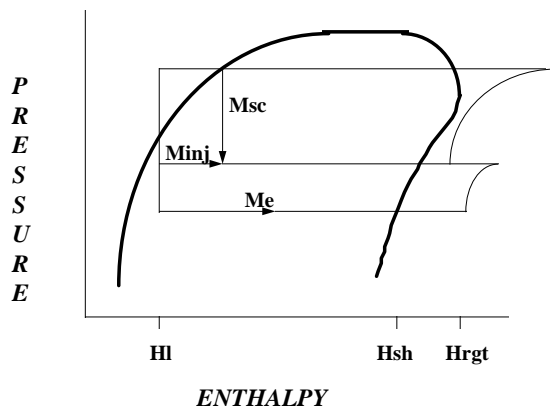


Diagram 1

The change in enthalpy (leaving enthalpy - entering enthalpy) is not usually the same for compressor capacity and evaporator capacity. The difference between the two capacities occur because of heat gain in the suction lines from the evaporator to the compressors. The entering enthalpy (HI) will be the same for both. That is determined by the liquid temperature entering the thermostatic expansion valve (TXV), or other metering device, at the evaporator.

HI is determined by liquid temperature entering evaporator expansion valve

As the liquid temperature decreases, HI decreases & Compressor Capacity and Evaporator Refrigeration Effect increases

The difference occurs with the different leaving enthalpies. The enthalpy leaving the evaporator (Hsh) determines the evaporator capacity. 5°F to 10°F of superheat leaving the evaporator, which is the same as 5°F to 10°F above saturated suction temperature, is usually normal operation.

Hsh is determined by saturated suction temperature & superheat leaving evaporator

As superheat increases, Hsh increases & Evaporator Refrigeration Effect increases (as long as the superheat does not become higher than the desired cooling temperature for the unit)

Once the refrigerant leaves the evaporator, it will usually gain temperature due to long and poorly insulated suction lines. The temperature of the refrigerant vapor returning to the compressor, or return gas temperature, dictates leaving enthalpy for compressor capacity.

Hrgt is determined by saturated suction temperature & return gas temperature to the compressor

As the return gas temperature increases, Hrgt increases & Evaporator Refrigeration Effect decreases

Table 1 indicates what will happen when certain changes occur within a system. Notice that varying return gas temperature affects compressor & evaporator capacity. Return gas temperature not only affects the change in enthalpy for the compressor capacity, but also the evaporator mass flow.

SYSTEM CHANGE	COMPRESSOR CAPACITY	EVAPORATOR CAPACITY
liquid temp. entering evap. TXV decreases	increases	increases
liquid temp. entering evap. TXV increases	decreases	decreases
superheat leaving evap. increases (but < desired cooling temperature)	no change	increases
superheat leaving evap. decreases (but < desired cooling temperature)	no change	decreases
return gas temp. to comp. decreases	increase or decrease	increase
return gas temp. to comp. increases	increase or decrease	decrease

Table 1

The major components that determine evaporator mass flow are compressor displacement (CFM), which is a constant for each machine size; refrigerant density entering the compressor which is determined by saturated suction temperature and return gas temperature; and volumetric efficiency which is dependent upon the compressor design and operating conditions.

$$Me = CFM \times \text{Density} \times V.E. \times 60(\text{min/hr})$$

Lowering the return gas temperature will increase the density entering the compressor, thus increasing the evaporator mass flow. This will increase the evaporator refrigeration effect. Increasing the evaporator mass flow will also increase compressor capacity but the return gas temperature enthalpy (Hrgt) will decrease reducing the change in enthalpy. This leads

to a lower compressor capacity. In most instances, the enthalpy decrease will be greater than the mass flow increase which will result in lower compressor capacities.

- **PROBLEMS**

If at any time the program appears to display confusing output or unusual models in the model menus, exit the program and start over.

If there is a problem with the program, please contact Carlyle Application Engineering at (800) 462-2759.