Contents

Refrigerants Physical Properties Tab

Physical Properties of Refrigerants

Calling RefCycle externally

Overview
Calculating Saturated Properties
Calculating SuperHeated Properties
Calculating Cycle Analysis Properties

Refrigerants in RefCycle

List of Included Refrigerants

Technical Disclaimer

Sources and Methods

Conversions

Technical Information

SPI License Agreement

Acceptance of Terms

Limited Warranty

Disclaimer

Introduction

Mechanical refrigeration could be defined as the process of transferring quantities of heat repeatedly and efficiently. This process will require a liquid which can be evaporated and condensed to achieve refrigeration. Practically any liquid can be used for refrigeration but certain substances (refrigerants) work better than others in making the refrigeration process economical and efficient.

Thermodynamic properties of refrigerants influence their selection and usage in refrigeration systems. System designers must know the properties of refrigerants in order to accurately determine the performance of refrigeration systems. Precise properties of refrigerants must be available to system designers in order to insure that their systems would satisfy their intended application.

Other characteristics of refrigerants, such as toxicity and other undesirable effects, must be considered. The CFC issue brought attention to the impact of some refrigerants on the ozone layer if released into the atmosphere. The HVAC industry, with the help of refrigerants manufacturers, is working hard to come up with replacement refrigerants that are safe to use and are environmentally responsible, they are also continuing to search for drop-in replacements that will not affect system performance.

A replacement refrigerant could be a single component or a mixture with other refrigerants. Properties for the mixture refrigerants vary and are impossible to calculate manually. They often require the assistance of computers and software packages such as RefCycle.

Various manufacturers provide software packages that calculate refrigerant properties for the users of their own refrigerants. Most of these packages are difficult to use since they were designed using non-graphical user interfaces. A user would need several different programs to calculate properties when comparing refrigerants from different manufacturers.

SPI created this program to give the user a single, user-friendly tool for refrigerant properties calculations. It is like having a handy calculator that gives access to all available refrigerant properties including new and popular mixtures.

RefCycle provides system designers with a valuable tool which is S**ystem Cycle Analysis**. The designer enters known system conditions and this program will calculate theoretical properties of different components around the system. We also provide an option that allows the user to compare up to 15 different conditions and refrigerants properties.

A very important feature is also incorporated which offers users great flexibility. Other programs can call RefCycle and execute any option automatically and retrieve the results. A sample **Excel** spreadsheet is included as a demonstration of this feature.

Reports are designed to give users flexibility. Users can print results directly to any printer supported by Windows or if they can send it to a file in the .CSV format, which is compatible with many spreadsheet programs. If results are sent to a file, the user would have the option of viewing that file from Microsoft Excel, Windows Notepad**,** or Wordpad provided with Windows 95 (depending on program availability).

The Setup tab offers a change in units used for calculations. Another useful feature is the SuperHeated tables calculations. This feature allows the user to use temperatures instead of pressure for SuperHeated tables calculations.

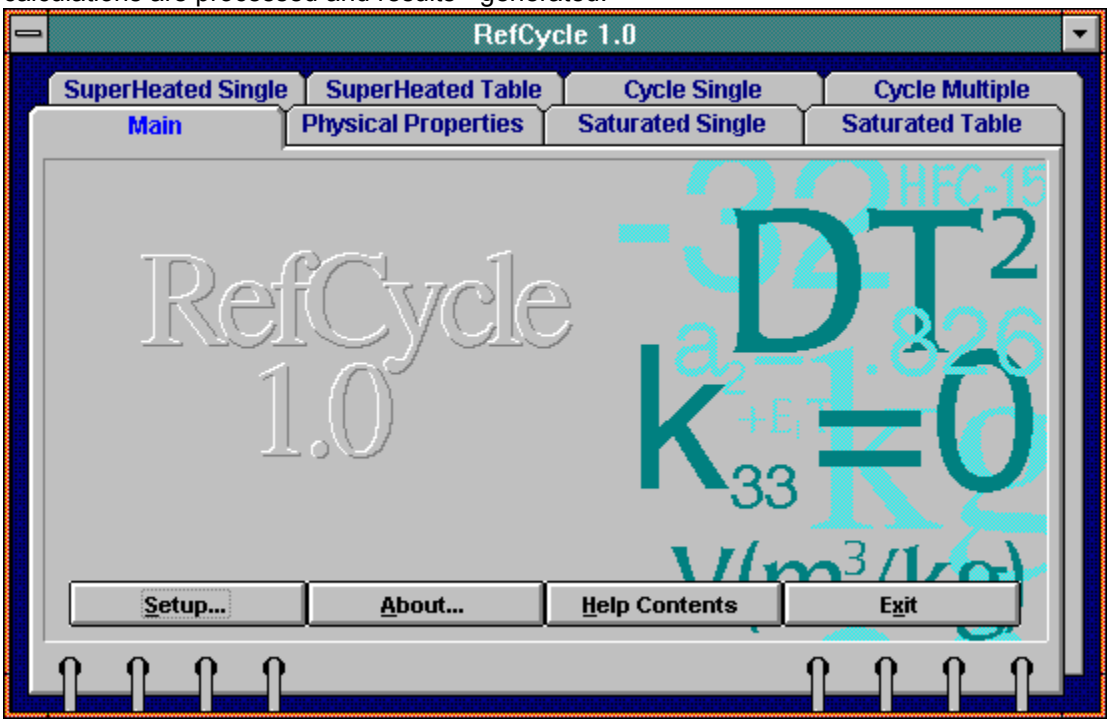
We designed this program in a manner that should be very user friendly. It is as if the user is flipping through pages of a book with tabs to mark distinctive features and functions. Active tabs always come up

to the top offering their own functions.

SPI hopes that this program will achieve its intended purpose, which is making life easier for users of refrigerant properties.

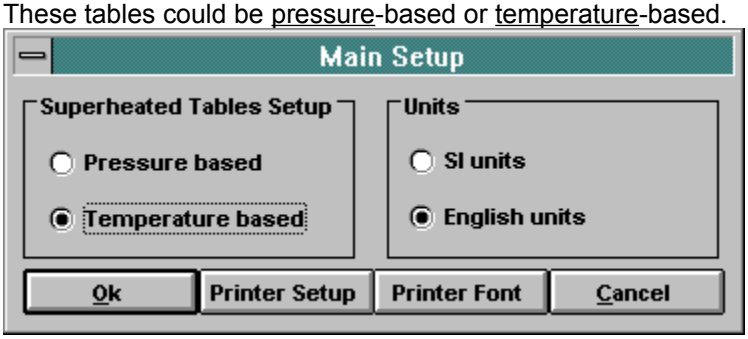
Startup

The Main tab (Figure below) displays important program configuration options that will influence the way calculations are processed and results generated.



Setup...

The Setup button allows the user to configure the units and basis for the SuperHeated tables calculations. These tables could be pressure-based or temperature-based.



The user set the scientific units for calculations and results by choosing SI units or English units.

Other setup options include selection of the printer used for printing results (Printer Setup) and an option for selecting printer fonts (Printer Font).

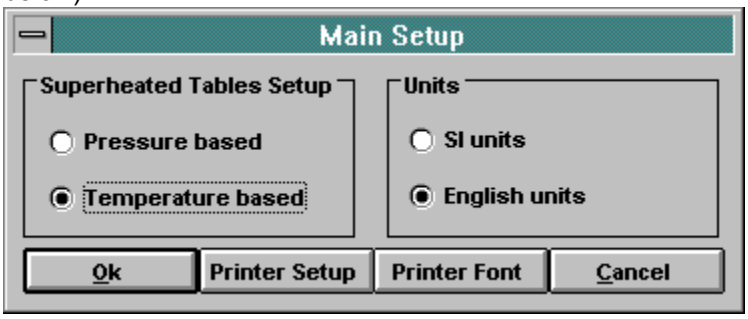
Setup changes become permanent until changed again. The program saves the choices in an initialization file for later recall when the program terminates.

SuperHeated Tables Setup

Temperature-based

You can choose to have SuperHeated properties tables referenced to temperatures or pressures. Make your choice by clicking on the radio button shown as a white circle.

To choose temperature-based tables click on the circle next to the temperature based label (Figure below):

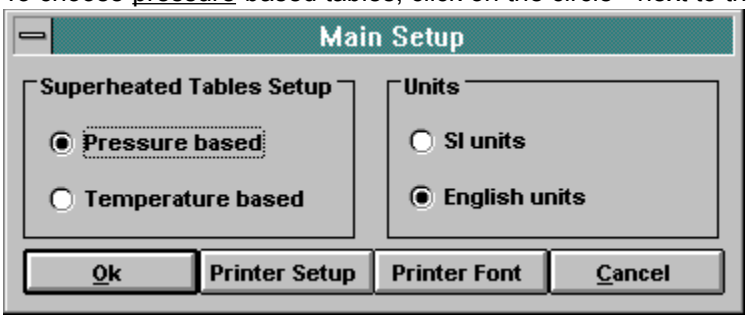


By choosing pressure-based tables, the output would resemble a format used by many refrigerant manufacturers. The temperature-based tables option was added to make your life easier.

Pressure-based

You can choose to have superheated properties tables referenced to temperatures or pressures. Make your choice by clicking on the radio button shown as a white circle.

To choose pressure-based tables, click on the circle next to the pressure based label (Figure below).



By choosing pressure based tables, the output would resemble a format used by many refrigerant manufacturers. The temperature based tables option was added to make your life easier.

Working Units

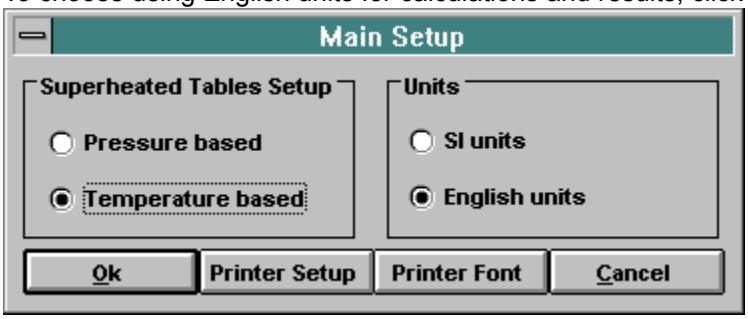
English Units

SI Units

English Units

When this option is selected (Figure below), all items with scientific units will use the English units.

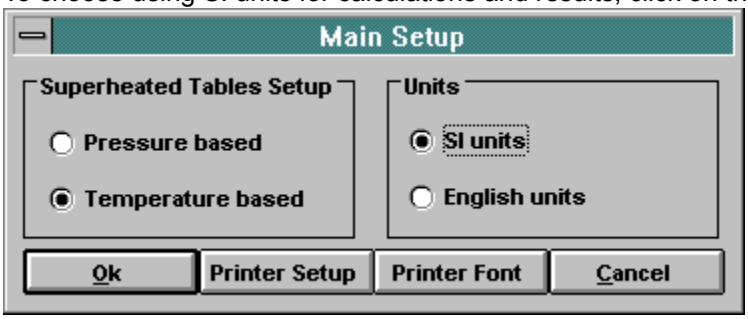
To choose using English units for calculations and results, click on the white circle next to English units.



SI Units

When this option is selected (Figure 6), all items with units in RefCycle will use the SI units.

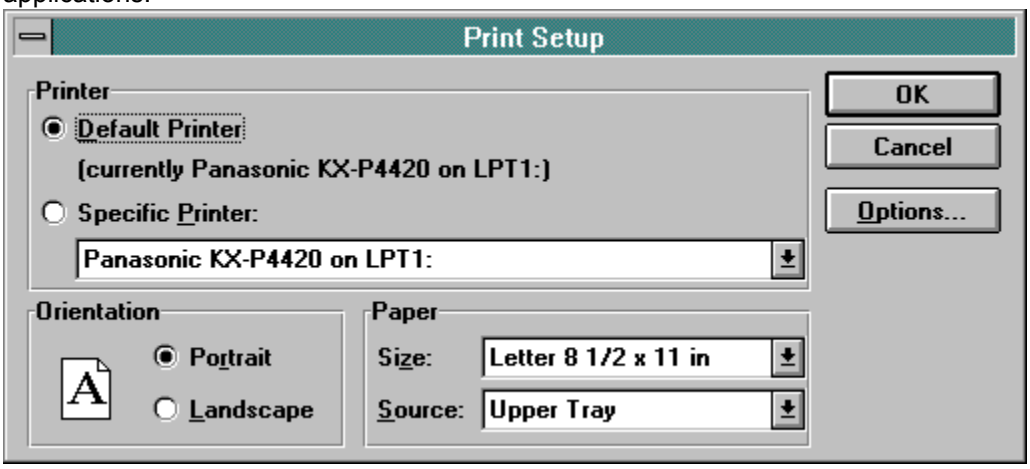
To choose using SI units for calculations and results, click on the white circle next to SI units.



Printer Setup

Printer setup can be accomplished using the Printer Setup option. Clicking on this button brings up a familiar Printer Setup dialog box (Figure below). It enables users to select their own printer type and settings. RefCycle is compatible with any printer supported by Windows.

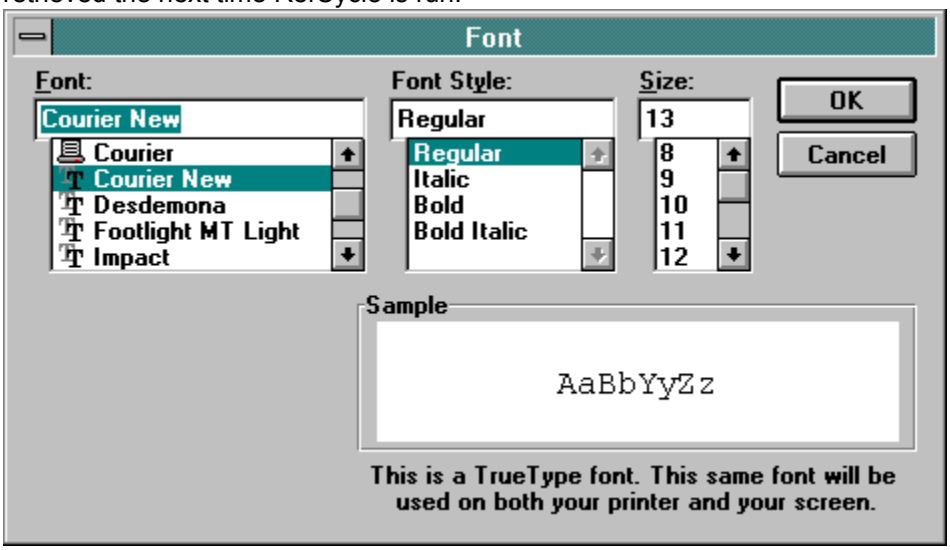
Default settings, including the printer setup, are stored and retrieved from the WIN.INI file in the Windows directory. Any changes will affect the setup of Windows Print Manager and the output of other Windows applications.



Printer Font

A font dialog box (Figure below) allows users to choose fonts appropriate for their printers which could be any font supported by Windows. This dialog box is accesses using the Printer Font button.

The output of RefCycle is based on your choice of font types and sizes using this option. When the OK button is clicked (in the fonts dialog window), settings are saved in a file called REFCYCLE.INI and are retrieved the next time RefCycle is run.



About RefCycle 1.0

Clicking on this button displays information about the author and user information (Figure below). Please refer to the serial number in the About dialog box for any correspondence with SPI.

Help Contents

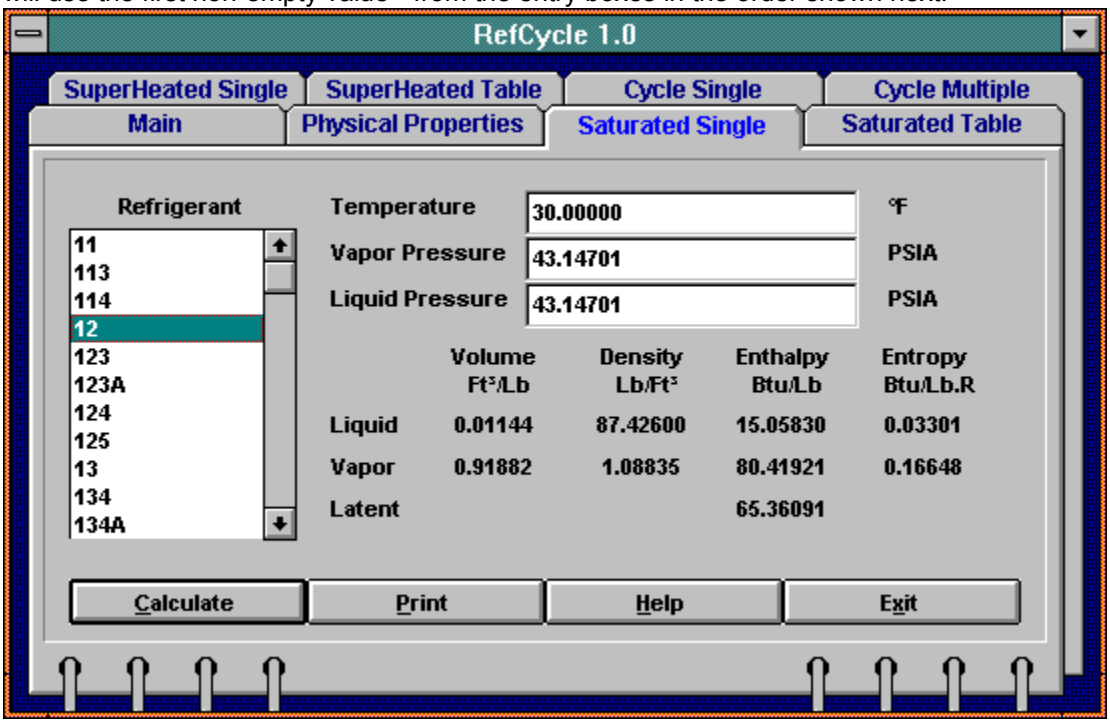
Users can exercise any option in this program without the help of a manual except when calling this program externally. We provided this manual as a reference and also made it available on-line as help. Pressing F1 at any time brings up this manual.

Exit

Exits RefCycle and returns the user to Windows.

Saturated Properties, Single Condition

This tab displays the saturated properties calculations options shown below. The user may calculate saturated refrigerant properties for a single condition. The user can enter a temperature or a pressure value in the appropriate box and then click on the Calculate button for calculations to occur. The program will use the first non-empty value from the entry boxes in the order shown next.



The user can choose another refrigerant and click on the Calculate button again to find results for the new selection using the same entry values.

Clicking on the Exit button terminates RefCycle and returns the user to Windows.

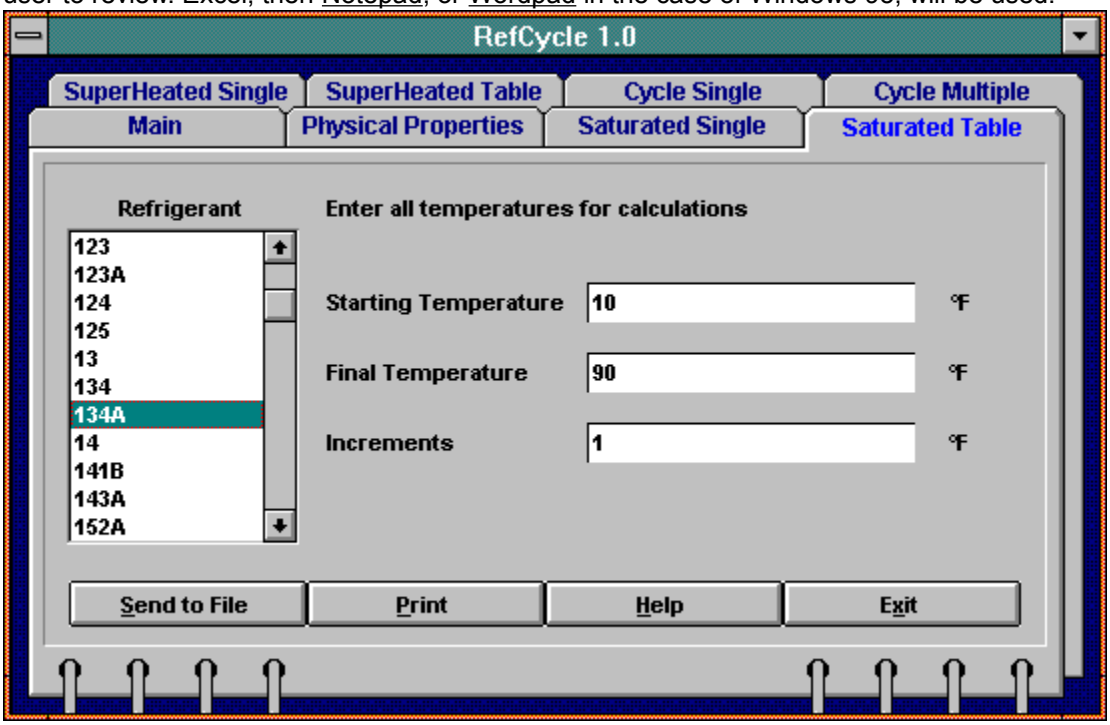
Saturated Properties, Multiple Condition

This tab displays the saturated table information entry box (Figure below). The user may calculate saturated refrigerant properties for a range of temperature values.

The user would enter a starting temperature, a final temperature and then the increments for calculations. The user would also click on the Print or Send to File buttons for calculations to proceed. Results will be directed to the printer or a file, depending on the button clicked.

When a user chooses to send data to a file, the output will be in a format that can be read by many spreadsheet programs (.CSV format) for additional formatting or manipulation if needed.

Users have the option of reviewing results after sending results to a file. If they choose to review results, then Excel will be used to read the results file and automatically executed to bring the results up for the user to review. Excel, then Notepad, or Wordpad in the case of Windows 95, will be used.



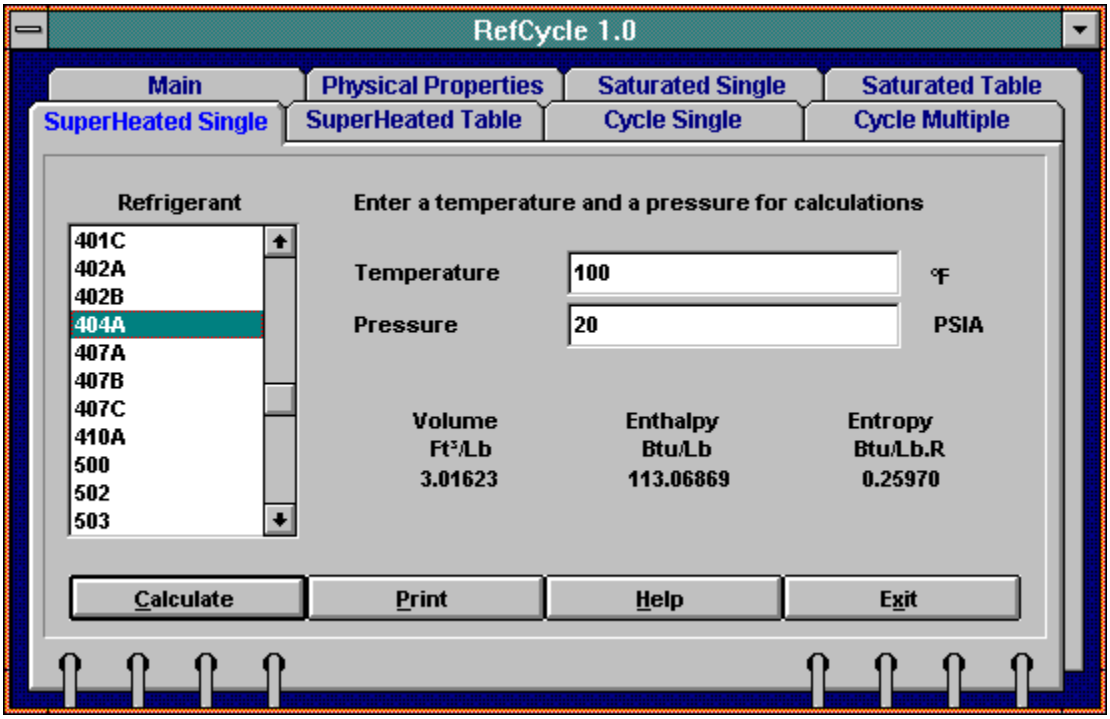
Clicking on the Exit button terminates RefCycle and returns the user to Windows.

SuperHeated Properties, Single Condition

This tab displays entry options as shown below (Figure below). The user may calculate SuperHeated refrigerant properties for a single condition.

The user is required to enter both a temperature and a pressure value in the entry boxes. The Calculate button can then be clicked on to show results of calculations.

If the resulting calculations show that the condition entered does not fall within the SuperHeated region, then a message feedback box will inform the user that the calculations are not possible for the values entered.



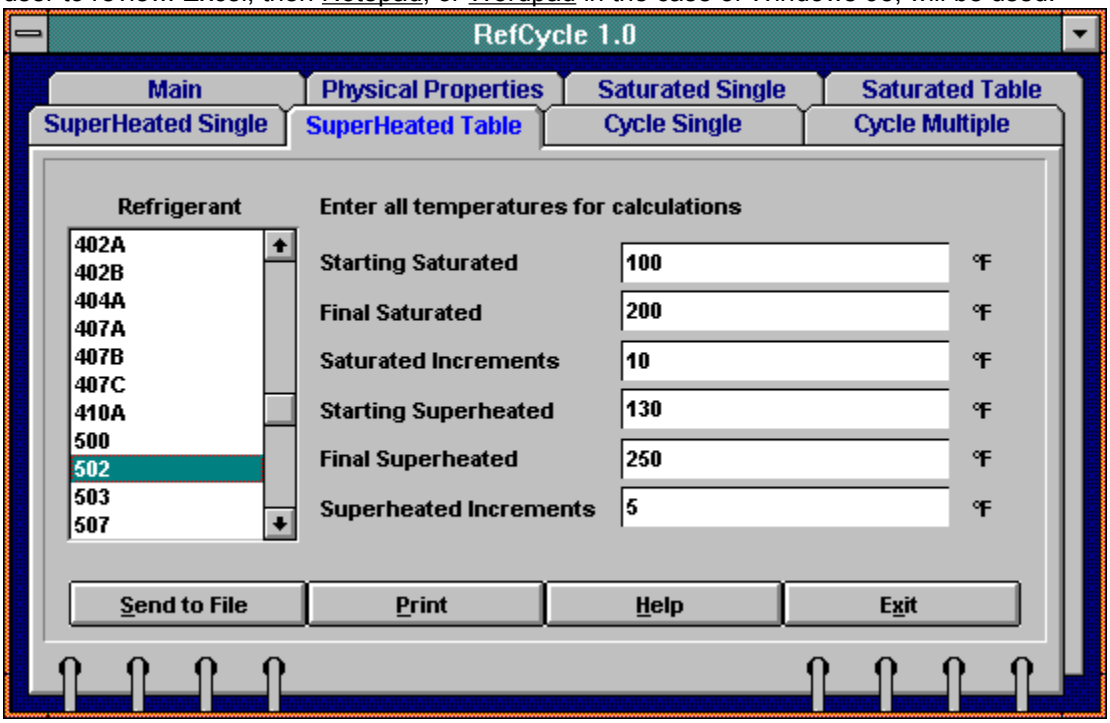
Clicking on the Exit button terminates RefCycle and returns the user to Windows.

SuperHeated Properties, Multiple Condition, Temperature-Based

The output of this tab varies depending on setup information. If the user selected temperature-based calculations and table then this tab displays the entry form for temperature-based SuperHeated table (Figure below). This tab allows users to calculate SuperHeated properties of refrigerants for a range of temperature values with temperature dependency. The user must enter values in all of the self-explanatory entry boxes in order for calculations to work correctly.

When a user chooses to send data to a file, the output will be in a format that can be read by many spreadsheet programs (.CSV format) for additional formatting or manipulation if needed.

Users have the option of reviewing results after sending results to a file. If they choose to review results, then Excel will be used to read the results file and automatically executed to bring the results up for the user to review. Excel, then Notepad, or Wordpad in the case of Windows 95, will be used.



Clicking on the Exit button terminates RefCycle and returns the user to Windows.

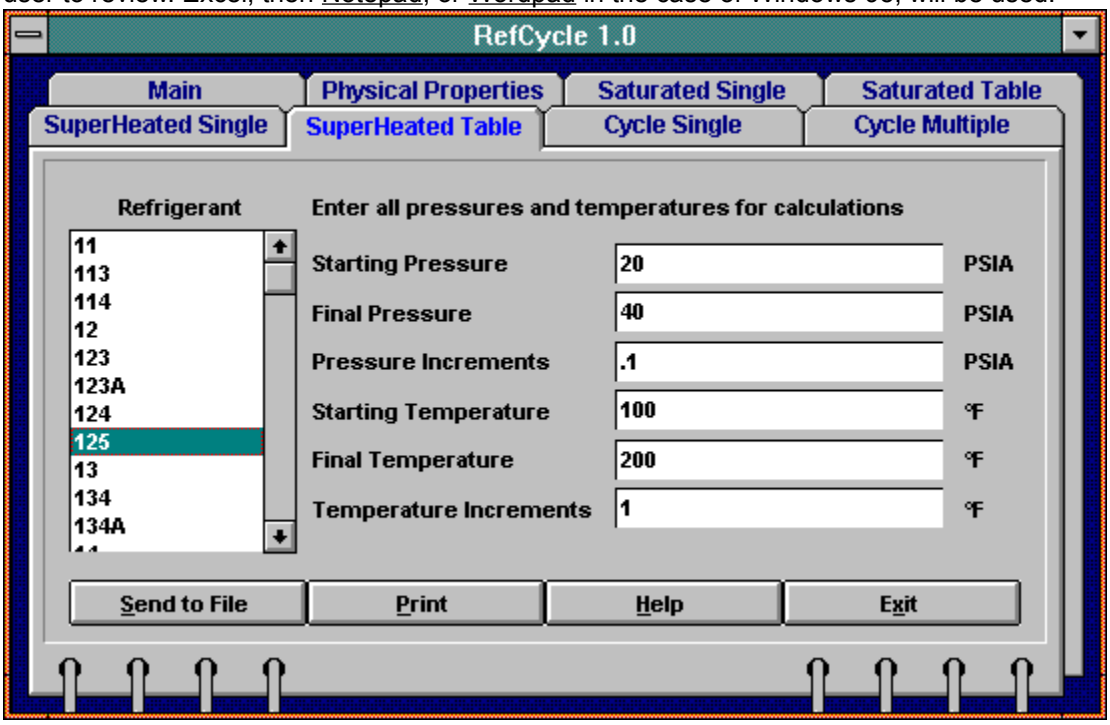
SuperHeated Properties, Multiple Condition, Pressure-Based

If the setup information was for pressure-based calculations and table, then this option would display the entry options needed to generate pressure based SuperHeated tables (Figure below). Users can calculate SuperHeated refrigerant properties for a range of pressure values with temperature dependency.

The user must enter values in all of the self-explanatory entry boxes in order for calculations to work correctly.

When a user chooses to send data to a file, the output will be in a format that can be read by many spreadsheet programs (.CSV format) for additional formatting or manipulation if needed.

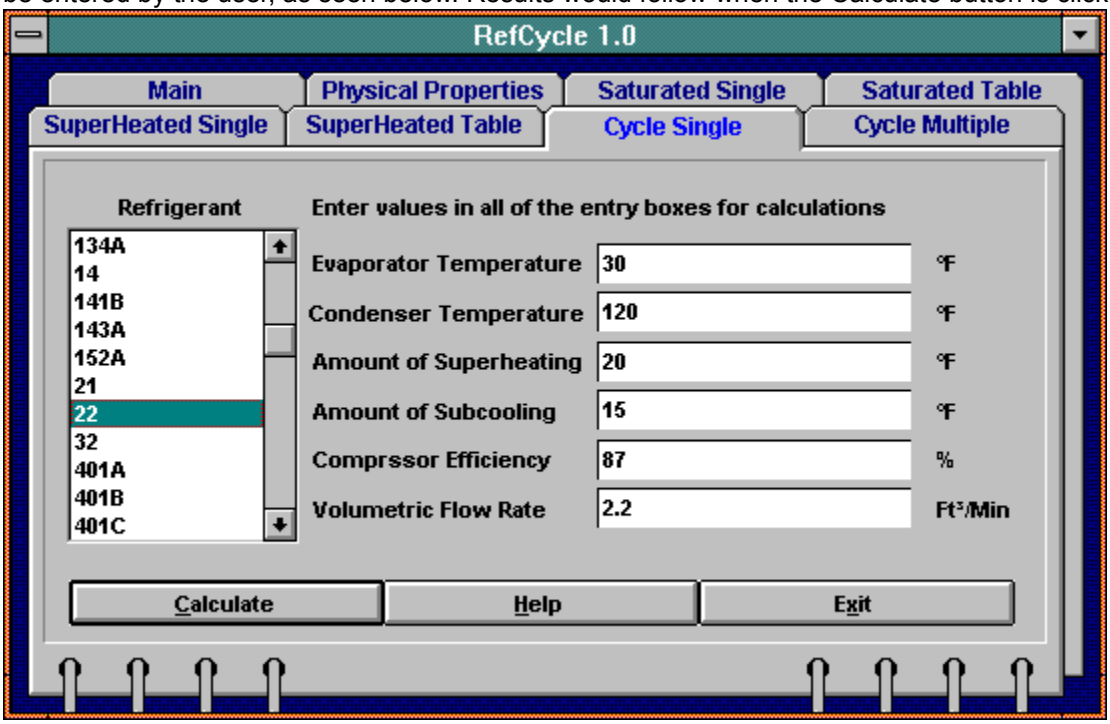
Users have the option of reviewing results after sending results to a file. If they choose to review results, then Excel will be used to read the results file and automatically executed to bring the results up for the user to review. Excel, then Notepad, or Wordpad in the case of Windows 95, will be used.



Clicking on the Exit button terminates RefCycle and returns the user to Windows.

Cycle Analysis, Single Condition

This tab requires a typical temperature-based condition, compressor efficiency and volumetric flowrate to be entered by the user, as seen below. Results would follow when the Calculate button is clicked on.



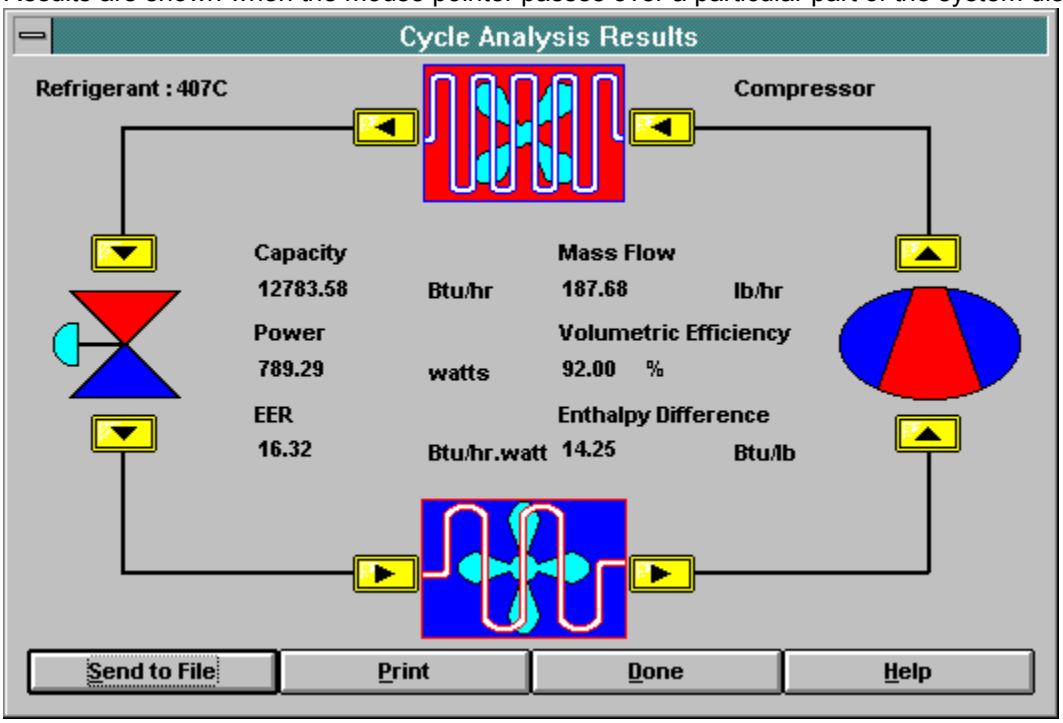
Clicking on the Exit button terminates RefCycle and returns the user to Windows.

Cycle Analysis Results Box

After clicking on the Calculate button in the cycle analysis, single condition tab, a system schematic appears (Figure below). A window shows the essential makeup of a refrigeration system.

Arrow boxes illustrate entrance and exit properties selection areas.

Results are shown when the mouse pointer passes over a particular part of the system display.



When a user chooses to send data to a file, the output will be in a format that can be read by many spreadsheet programs (.CSV format) for additional formatting or manipulation if needed.

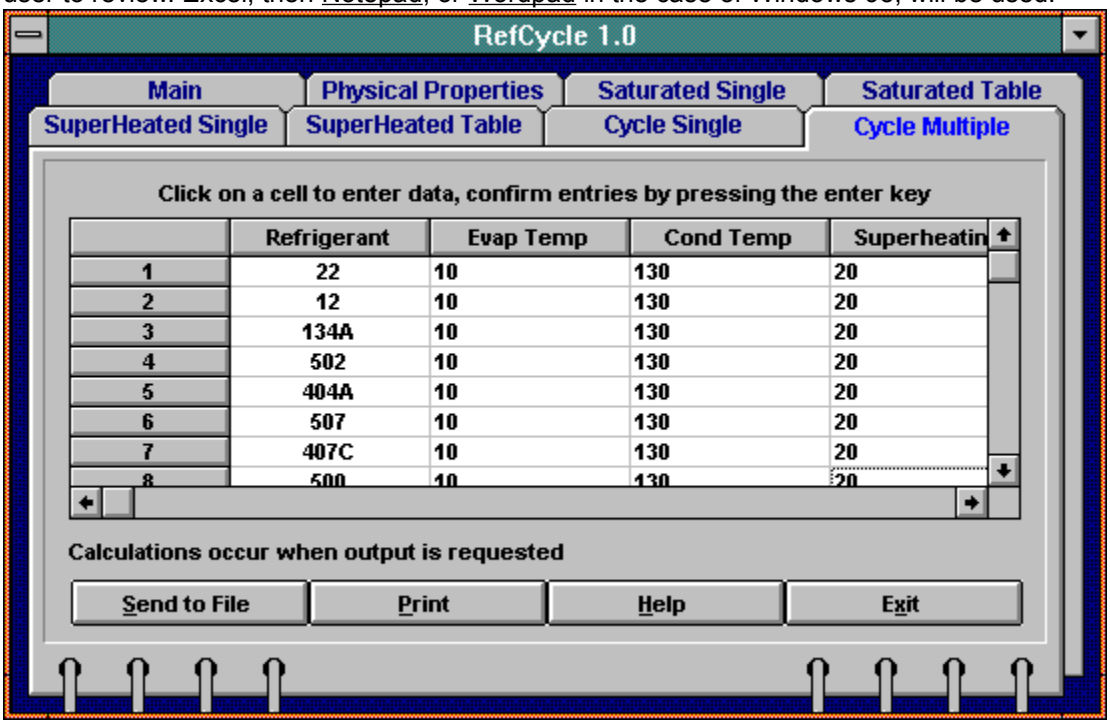
Users have the option of reviewing results after sending results to a file. If they choose to review results, then Excel will be used to read the results file and automatically executed to bring the results up for the user to review. Excel, then Notepad, or Wordpad in the case of Windows 95, will be used.

Cycle Analysis, Multiple Condition

Cycle analysis for multiple condition may be accomplished by entering required information into a spreadsheet shown below. Up to 15 refrigerants and conditions may be entered. Results then may be sent to a file or a printer.

When a user chooses to send data to a file, the output will be in a format that can be read by many spreadsheet programs (.CSV format) for additional formatting or manipulation if needed.

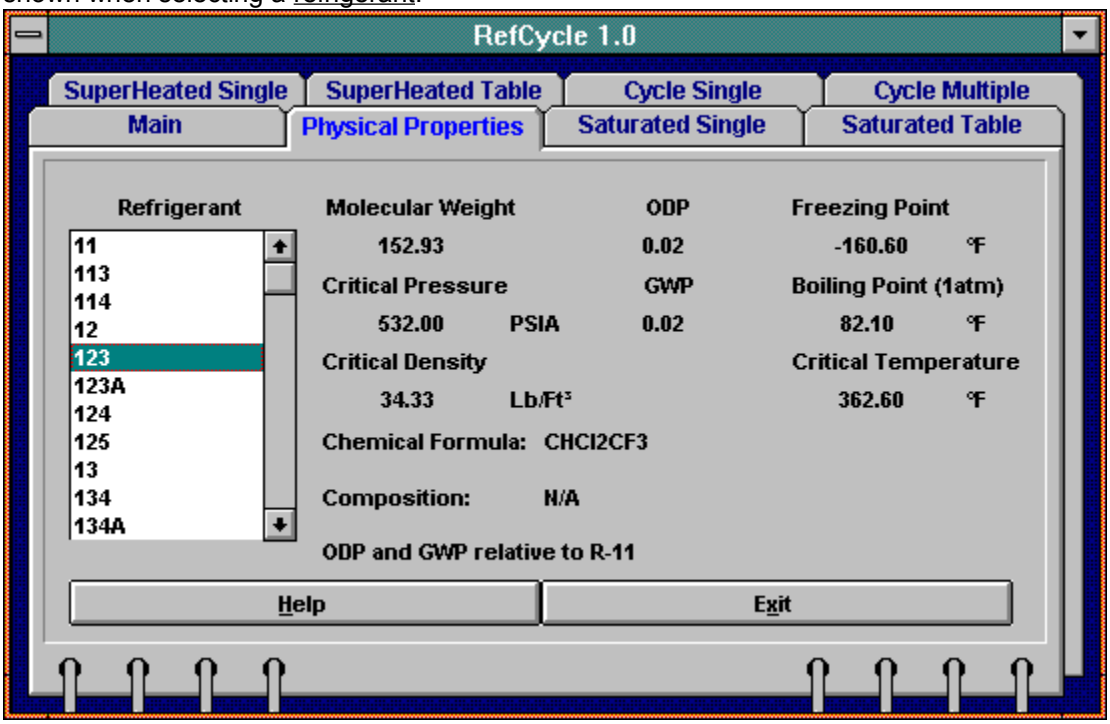
Users have the option of reviewing results after sending results to a file. If they choose to review results, then Excel will be used to read the results file and automatically executed to bring the results up for the user to review. Excel, then Notepad, or Wordpad in the case of Windows 95, will be used.



Clicking on the Exit button terminates RefCycle and returns the user to Windows.

Physical Properties of Refrigerants

This tab displays the screen seen below. Known physical properties of refrigerants used in RefCycle are shown when selecting a refrigerant.

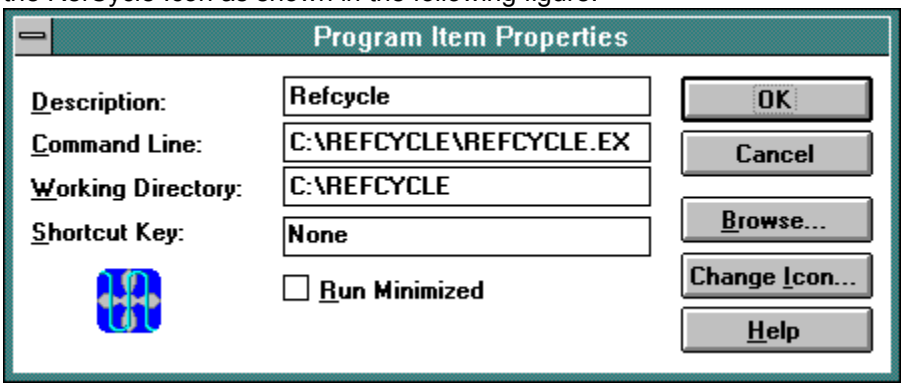


Clicking on the Exit button terminates RefCycle and returns the user to Windows.

Overview

We designed RefCycle with an option for automatic execution when needed. Users may call this program from other Windows applications repeatedly to do calculations as if the program was executed manually.

You can try this option by going to the file properties option in Windows program manager after selecting the RefCycle Icon as shown in the following figure.



In the box with the Command line label, enter the following after the REFCYCLE.EXE command keeping the same directory. The setup below is only an example assuming that RefCycle was installed on drive C in the directory REFCYCLE, which are the setup defaults:

C:\REFCYCLE\REFCYCLE.EXE SATURATED /R:22 /T:130 /U:E /F:OUTPUT.CSV

Choose the OK button to set up the automatic execution of RefCycle. Double clicking on the program icon will momentarily flash the program icon in a minimized fashion. A file called **OUTPUT.CSV** is created with saturated properties results of calculations done for a temperature of 130 °F.

The **Excel** sample spreadsheet provided with this program is another example of the automatic execution feature. Simple macros were written to show you how to calculate properties for different condition, using **Excel**.

Calling RefCycle externally was added for people who have some work done with other programs and need refrigerant properties without having to execute RefCycle and entering results manually. The following descriptions could be very useful for the computer savvy among our users.

We allowed the calculations for three different conditions : **SATURATED**, **SUPERHEATED** and **CYCLE**.

Calculating Saturated Properties

To calculate saturated properties for a given temperature X, the following convention must be used when calling RefCycle:

Program Arg1 Arg2 Arg3 Arg4 Arg5

An example for a temperature of **X**:

C:\REFCYCLE\REFCYCLE.EXE SATURATED /R:22 /T:X /U:E /F:OUTPUT.CSV

The explanation for the above follows:

C:\REFCYCLE\REFCYCLE.EXE : Call the program **REFCYCLE.EXE** which exists in the directory **REFCYCLE** on drive **"C".**

SATURATED : Request calculations for a saturated property.

/R:22 : The refrigerant is 22. (make sure to type in the refrigerant name just as you see it in the program, without adding any other characters. Otherwise, the program will fail to execute automatically).

/T: or **/V:** or **/L:** : These options indicate that the request is for a value of **X** which is a temperature **(/T:X)** or a vapor pressure **(/V:X)** or a liquid pressure **(/L:X).** Only one of the above mentioned options can be entered as an argument.

/U:E : This argument indicates that the request is for information in English units. Otherwise, for SI units, the argument would be **/U:M**.

/F:OUTPUT.CSV : The name of the file where results are stored.

Results in the OUTPUT.CSV file would appear as follows:

```
,,,,RefCycle 1.0
,,,Saturated Properties Report
,,,,,,English Units
Refrigerant,,22
TEMP,PRESSURE,,VOLUME,,DENSITY,,,ENTHALPY,,ENTROPY
°F,PSIA,,ft³/lb,,lb/ft³,,,Btu/lb,,Btu/lb.R
,LIQUID,VAPOR,LIQUID,VAPOR,LIQUID,VAPOR,LIQUID,LATENT,VAPOR,LIQUID,VAPOR
,Pf,Pv,vf,vg,1/vf,1/vg,hf,hfg,hg,sf,sg
100.0,210.604,210.604,0.014038,0.2570,71.236,3.8907 ,39.267,72.838,112.1
05,0.07942,0.20956
```

The existence of commas is for formatting purposes when the file is read into spreadsheet programs as a CSV file.

Calculating SuperHeated Properties

To calculate SuperHeated properties for a given temperature X and pressure Y, the following convention must be used when calling RefCycle:

Program Arg1 Arg2 Arg3 Arg4 Arg5 Arg6

An example for a temperature of **X and pressure Y**:

C:\REFCYCLE\REFCYCLE.EXE SUPERHEATED /R:HP80 /T:X /P:Y /U:M /F:SUPERPH.CSV

The explanation for the above follows:

C:\REFCYCLE\REFCYCLE.EXE : Call the program **REFCYCLE.EXE** which exists in the directory **REFCYCLE** on drive **"C".**

SUPERHEATED : Request calculations for a SuperHeated condition properties.

/R:HP80 : The refrigerant is HP80. (make sure to type in the refrigerant name just as you see it in the program, without adding any other characters, otherwise the program will fail to execute automatically).

/T:X : This option indicates that the condition requested has a temperature of X.

/P:Y : This option indicates that the condition requested has a pressure of Y.

/U:M : This argument indicates that the request is for information in SI units. Otherwise, for English units, the argument would be **/U:E**.

/F:SUPERH.CSV : The name of the file where results are stored.

Results in the file SUPERPH.CSV would appear as follows:

```
,,RefCycle 1.0
,SuperHeated Properties Report
,,,,SI Units
Refrigerant,,HP80
TEMP,PRESSURE,VOLUME,ENTHALPY,ENTROPY
-78.1,10.00 ,0.067  ,95.210 ,0.17313
°C,kPa,m³/kg,kJ/kg,kJ/kg.K
65.0 ,10.00 ,2.76584  ,419.9186 ,2.11621
```

The existence of commas is for formatting purposes when the file is read into spreadsheet programs as a CSV file.

Calculating Cycle Analysis Properties

To calculate cycle properties for a given condition, the following convention must be used when calling RefCycle:

Program Arg1 Arg2 Arg3 Arg4 Arg5 Arg6 Arg7 Arg8

An example for a condition:

10 °F Evaporating temperature

90 °F Condensing temperature

20 °F Amount of SuperHeat

15 °F Amount of subcooling

90% volumetric efficiency

.5 volumetric flowrate.

C:\REFCYCLE\REFCYCLE.EXE CYCLE /R:AC9000 /T:10 /C:90 /H:20 /S:15 /E:90 /V:.5 /U:E /F:CYCLEOUT.CSV

The explanation for the above follows:

C:\REFCYCLE\REFCYCLE.EXE : Call the program **REFCYCLE.EXE** which exists in the directory **REFCYCLE** on drive **"C".**

CYCLE : Request calculations for a SuperHeated condition properties.

/R:AC9000 : The refrigerant is AC9000. (make sure to type in the refrigerant name just as you see it in the program, without adding any other characters, otherwise the program would fail to execute automatically).

/T:X : This option indicates that the condition requested has an evaporating temperature of X.

/C:Y : This option indicates that the condition requested has a condensing temperature of Y.

/H:Z : This option indicates that the condition requested has a SuperHeat temperature of Z.

/S:W : This option indicates that the condition requested has a subcooling temperature of W.

/E:V : This option indicates that the compressor used has a volumetric efficiency of V.

/V:E : This option indicates that the compressor used has a volumetric flow rate of E.

/U:M : This argument indicates that the request is for information in English units. Otherwise, for SI units, the argument would be **/U:M**.

/F:CYCLEOUT.CSV : The name of the file where results are stored.

Results in the file CYCLEOUT.CSV would appear as follows:

```
,,,,RefCycle 1.0
,,,Cycle Analysis Report
,,,-------------------------,,,,English Units
Rfrigerant,AC9000
Evaporator Temperature,,,10.00     ,° F,,Condenser Temperature,,,90.00
```

,° F

Amount of SuperHeating,,,20.00 ,° F,,Amount of Subcooling,,,15.00 ,° F

Volumetric Flow Rate ,,,0.50 ,ft³/min,,Compressor Efficiency,,,90.00 ,%

Compressor

Capacity,,1755.70 ,Btu/hr,,Mass Flow,,21.99 ,lb/hr

Power,,101.15 ,watts,,Volumetric Eff.,,0.50 ,%

EER,,17.20 ,Btu/lb,,Enthalpy Difference,,15.85

Condenser

Heating Capacity,,2104.08 ,Btu/lb.°F,,Mass Flow,,21.99 ,lb/hr

COP,,0.83 ,,,Enthalpy Difference,,95.70 ,Btu/lb

Expansion Device

Mass Flow,,21.99 ,lb/hr,,Enthalpy Difference,,0.00,Btu/lb

The existence of commas is for formatting purposes when the file is read into spreadsheet programs as a CSV file.

List of Included Refrigerants

Some of the refrigerants are known to start as follows "R-". We did not use this type of designation knowing that users recognize these refrigerants. We did however mention the name of certain refrigerants as designated by some manufacturers and included the industry given designation (number) for reference. The following refrigerants are included in RefCycle and listed here as a reference :

12, 113, 114, 12, 123, 123a, 124, 125, 13

134, 134a, 14, 141B, 143a, 152a, 21, 22, 23, 32

401A or MP39 : a mixture (53% 22, 13% 152a, 34% 124)

401B or MP66 : a mixture (61% 22, 11% 152a, 28% 124)

401C or MP52 : a mixture (33% 22, 15% 152a, 52% 124)

402A or HP80 : a mixture (60% 125, 2% 290, 38% 22)

402B or HP81 : a mixture (38% 125, 2% 290, 60% 22)

404A or HP62 or FX70 : a mixture (44% 125, 52% 143a, 4% 134a)

407A or KLEA60 : a mixture (20% 32, 40% 125, 40% 134a)

407B or KLEA61 : a mixture (10% 32, 70% 125, 20% 134a)

407C or AC9000 or KLEA66 : or KLEA60 : a mixture (23% 32, 25% 125, 52% 134a)

410A or AZ20 : a mixture (50% 32, 50% 125)

500 : a mixture (73.8% 12, 26.2% 152a)

501 : a mixture (75% 22, 25% 12)

502 : a mixture (48.8% 22, 51.2% 115)

507 or AZ50 : a mixture (50% 125, 50% 143a)

All referenced percentages are in weight%. In the program refrigerants list we used capital letters for ease of search knowing that some of these refrigerants use small letters for designation. Examples of this notation are 134a and 152a which have small letter 'a' following their assigned number.

Sources and Methods

This program was developed using actual experiences of engineers who use refrigerant properties frequently to design and model HVAC systems or compressors. We based everything in this program on published and public information.

Though efforts were made to ensure the accuracy of results, we must emphasize that this program is not meant to replace the published literature from manufacturers of refrigerants. These manufacturers are the ultimate authority on the accuracy of the data for their particular refrigerants.

Some data comes from published manufacturer's information. Other data come from books and magazines. We did not reference anyone specifically, since multiple sources of the same information can be found.

We will try to keep up with the changes of properties as they become public and are published by the manufacturers. Registered users will be informed of any updates to this program as they occur. We encourage users written comments and registration.

The user must understand that refrigerant properties from manufacturers change with time, especially with new refrigerants. The change occurs mainly because the accuracy of data improves with time and with additional testing by different people and organizations.

In our calculations, we used common equations as published and sometimes used our own modeling techniques to come up with equations more suitable for programming. Data used was always from tables published by manufacturers who might use different methods that possibly provide better accuracy than RefCycle.

When operating near the critical regions for any property, we advise the user to confirm results with published or unpublished manufacturers data.

Testing was done to guard against mistakes as much as possible. We have tested all the calculations extensively against different published data sheets and released programs from different refrigerants manufacturers, magazine articles, and published reference books. We have used the maximum possible numeric precision with all the calculations, but the results for these calculations might include some rounding of results that might differ from others depending on the precision in their calculations. The user might need to confirm a difference with the manufacturer of the refrigerant if any was found. When differences arise it is the position of SPI that the manufacturers data is the correct data and the user must use the manufacturers data.

Known refrigerants manufacturers data were compared to RefCycle with satisfactory results and comparisons were made to the following sources :

For refrigerants starting with HP, MP and AC. Literature published by Dupont Company were referenced for comparisons.

Refrigerants starting with KLEA. Literature published by ICI were referenced for comparisons.

Refrigerants starting with AZ. Literature published by Allied Chemicals were referenced for comparisons.

SPI does not claim to match or replace data from the mentioned references used for comparisons. Data from manufacturers of refrigerants are the only valid source of accurate information. The user must use manufacturers data published or unpublished when data generated by RefCycle differ from manufacturers.

Technical Information

P(kPa) = P(psia) * 6.89465

T(°C) = (T(°F) - 32.0) / 1.8

D(kg/m ^{3}) = D(lb/ft ^{3}) * 16.01845

V(m ^{3}/kg) = V(ft ^{3}/lb) * .062428

H(kJ/kg) = (H(Btu/lb) * 2.32445) + H(reference)

S(kJ/kg . K) = (S(Btu/lb . °R) * 4.18392) + S(reference)

Cp(kJ/kg . K) = Cp(Btu/lb . °F) * 4.18392

Cv(kJ/kg . K) = Cv(Btu/lb . °F) * 4.18392

H(reference) : saturated liquid enthalpy at -40 degrees.

S(reference) : saturated liquid entropy at -40 degrees.

We used common reference points for the enthalpy and entropy calculations :

At -40 °F

Liquid enthalpy = 0.0 Btu/lb.

Liquid entropy = 0.0 Btu/(lb)(°R)

At 0 °C

Liquid enthalpy = 200 KJ/kg

Liquid entropy = 1.0 KJ/(kg)(K)

The cycle analysis calculations were based on some assumptions listed below :

For ideal calculations, the cycle is assumed to be polytropic, in other words and mathematically

$$(P1V1)n = (P2V2)n$$

Some people might not agree with this approach, but our experience showed that it gives close results for most applications. The purist might give us feedback and we would be willing to listen and learn.

For refrigerants with temperature glides the following was applied :

The condensing temperature will be based on the mid point temperature between the bubble line and the dew line.

The evaporating temperature will be based on a mid point temperature between the evaporator inlet temperature and the dew line.

The superheat is defined from the dew line.

The subcooling is defined from the bubble line.

Definitions for a given condition :

EER : Compressor capacity / Compressor power.

COP : Refrigeration capacity / Heat pump capacity

CAPACITY : Mass Flow (lbs/hr) * H (lbs/BTU)

Acceptance of Terms

Using this software (RefCycle) for any purpose indicates your acceptance of the terms and conditions of this license agreement. If you do not agree with them you should return all software, documentation and the copy protection keys within seven days of shipment, unopened.

You are granted a personal license to use this program (RefCycle) under the terms of this agreement.

You May :

Install and use this program (RefCycle) on a single machine.

Make an archival back-up copy of the program for the sole purpose of using this program on a single machine.

You may not use, copy , modify or transfer this program (RefCycle), or transfer any copy, in whole or in part, except as expressly mentioned in this license, or with a permission from SPI.

Disclaimer

SPI warrants the physical diskette, on which the program was provided, and physical documentation to be free of defects in materials under normal use for a period of ninety days from the date of delivery to you as evidence by your receipt.

This program is provided "as is" without warranty of any kind, either expressed or implied, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. The entire risk as to the quality and performance of the program is with you. Should the program prove defective, you assume the entire responsibility for cost of all necessary servicing, repair, or correction.

SPI specifically disclaims all other warranties, expressed or implied, including but not limited to, implies warranties of merchantability and fitness for a particular purpose. In particular, with respect to any particular application, use or purpose. In no event shall SPI be liable for any commercial damage, including but not limited to special, incidental, consequential or other damages.

SPI does not warrant that the functions included in the program (RefCycle) will meet your requirements or that the operation and results of this program will be uninterrupted or error free.

Glossary of Terms

CFC

Chlorofluorocarbon. A chemical containing at least one atom each of chlorine, fluorine and carbon. These are the major contributors to the ozone depletion.

Critical pressure

It is the pressure of a substance at which a substance stays in liquid form regardless of increase in its temperature. At this pressure and above it, adding heat to the substance cannot turn it into vapor.

Critical temperature

The highest temperature to which a substance can get and at which it could liquefy at some pressure. Above this temperature, the substance can't be liquefied regardless of pressure.

CSV

Comma Separated Variables. A file format used by many programs to exchange information.

Density

Weight or mass per unit volume.

Enthalpy

A measure of the energy content of a substance. Specific enthalpy is the enthalpy per unit mass.

Entropy

Used mainly for engineering calculations. It is the heat available measured in Btu per pound degree change for a substance. For refrigeration purposes, it could be explained as a measure of the heat energy transferred which is not available for work.

Excel

A spreadsheet program that is sold by Microsoft Corp. It is becoming the standard and most popular spreadsheet program on the market.

Greenhouse Effect

An atmospheric effect which help the earth's retention of solar energy by reflecting earth's heat back to the surface.

GWP

Global Warming Potential. It is a number that provides an indication of the contribution a refrigerant might have on the greenhouse effect.

Notepad

A program distributed with Microsoft's Windows. It is a small editor used by many programs to display files for users to read.

ODP

Ozone Depletion Potential. It is a number ranging from 0 to 1 that provides an indication of the impact a refrigerant has on the ozone depletion. The larger the ODP, the greater this impact.

Ozone

A thin layer of energetic oxygen which exists in the higher atmosphere which responsible for blocking some of the sun's harmful ultraviolet radiation. This layer protects humans from this radiation which can cause skin cancer and cause damage to food crops.

Pressure

Pressure is the force per unit area.

PSIA

Pounds per square inch absolute. It equals gauge pressure plus atmospheric pressure.

PSIG

Pounds per square inch gauge.

RefCycle

This program. It is a refrigerant properties calculations and cycle analysis program that runs under Windows.

REFCYCLE.INI

A special file used by RefCycle to store and retrieve setup information such as font types and sizes.

Refrigerant

Any fluid in refrigeration systems which absorbs heat inside an enclosed space and release it outside that space is called a refrigerant.

Refrigerant cycle

Continuous refrigeration is achieved when refrigerants pass through at least 4 processes. The components making up these processes are a compressor, an expander and two heat exchangers.

A very simple description of a refrigeration cycle could be as follows :

The compressor would compress a refrigerant into a high pressure vapor that feeds into a heat exchanger which removes enough heat from the refrigerant and transforms it into a high pressure liquid. The refrigerant is then expanded into low pressure vapor and passed through to a heat exchanger where it absorbs heat from a load and continue on to the compressor.

Saturation

A saturated refrigerant is one that exist as a liquid and vapor in contact with each other in a state of equilibrium.

Refrigerant temperature corresponding to the refrigerant saturation pressure.

e.g.

R-22

Refrigerant condition :

45 F at 90.718 PSIA.

130 F at 311.14 PSIA.

SI

Syteme International d'Unites. Scientific units of measurements used all over the world.

Specific Volume

It is the reciprocal of the density.

SPI

Software Professionals Inc. The author of this program and other scientific applications.

Subcooling

Absolute temperature difference. It is the decrease in temperature resulting from the removal of heat from the liquid refrigerant that results in its temperature to drop below its saturation temperature with the pressure remaining constant.

e.g.

R-22

Refrigerant condition : 115 F at 311.14 PSIA.

Subcooling is then 130 - 115 = 15 F

You can measure a refrigerant subcooling by measuring it is pressure and temperature and finding the corresponding saturation temperature corresponding to the measured pressure and calculating the difference in temperatures.

SuperHeat

Absolute temperature difference. It is the increase in temperature resulting from heat which added to the refrigerant vapor which causes its temperature to rise above its saturation temperature while the pressure is kept constant.

e.g.

R-22

Refrigerant condition :

65 F at 90.718 PSIA.

Superheat is then 65 - 45 = 20 F

190 F at 311.14 PSIA.

Superheat is then 190 - 130 = 60 F

You can measure a refrigerant superheat by measuring it is pressure and temperature and finding the corresponding saturation temperature corresponding to the measured pressure and calculating the difference in temperatures.

On most systems another method is used successfully to find superheat in a system which is done by measuring the temperature after the expander and any other location before the compressor. Any increase in temperature assuming the pressure is constant would be the amount of superheat for the refrigerant at that condition.

Temperature

A measure of heat intensity or heat level.

Volumetric Efficiency

The ratio of the actual refrigerant gas pumped by the compressor to the total volume of refrigerant displaced by the compressor.

WIN.INI

A file included and used by Windows. It contains setup information for many applications running under Windows.

Wordpad

A program that is distributed with Microsoft's Windows 95. Has enhanced features when compared with the older Notepad program.