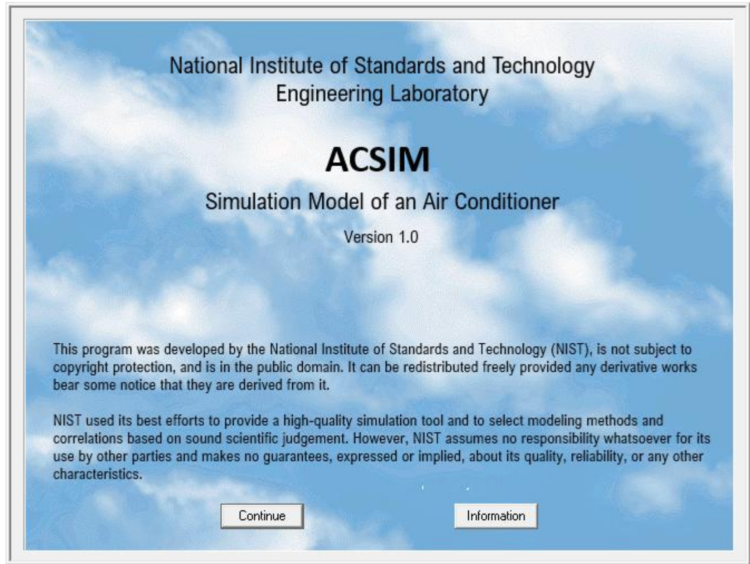
ACSIM INSTRUCTION PAGES



ACSIM is a simulation model of a single-stage air conditioner consisted of a compressor, finned-tube evaporator and condenser, expansion device and connecting tubing.

The capabilities of ACSIM include:

- Map-based compressor simulation
- Finned-tube heat exchangers modeled using the tube-by-tube approach with simulation of refrigerant distribution
- TXV or EEV
- REFPROP Ver. 10 refrigerant properties
- Preloaded 16 refrigerants and refrigerant blends: R22, R32, R134a, R290 (propane), R152a, R404A, R407C, R410A, R444A, R450A, R454B, R507A, R513A, R515B, R600a (isobutane) and R1234yf

The following pages provide basic instructions on how to use this program. They include software installation, preparation of input data, execution of the program, examination of simulation results, and general information on the program features and capabilities. The content of these instruction pages was derived from ACSIM Help installed with the program.

DISCLAIMER

HOW TO USE THESE INSTRUCTION PAGES

These Instruction Pages are set up as a tutorial, and we recommend that you proceed through them sequentially. You will benefit most if you print these pages, install **ACSIM**, and try to use the functionalities presented in this document.

This tutorial starts with **ACSIM** installation, execution of a simulation run for a preloaded AC system, and with a review of simulation results. Then, the tutorial presents how to input data for operating conditions and data required for simulating individual system components. The tutorial also explains how to set up and execute batch simulations.

Note that only basic information needed to use the model is provided in these instruction pages. For more detailed information the reader should refer to the list of references.

CONTENTS

ACSIM INSTALLATION

System Requirements

- Personal computer running Microsoft Windows 10 or 11
- Free space on the hard disk for complete installation: 100 MB
- Memory required: at least 64 MB
- Printer: optional and should be Windows compatible

Installation Procedure

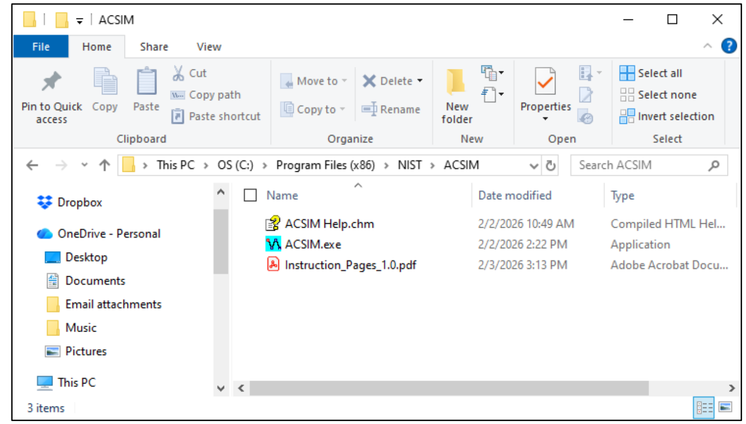
Two files, setup.exe and ACSIM_Setup.msi, are needed to install ACSIM. Place them in a folder of your choice, double-click on setup.exe, and follow the prompts.

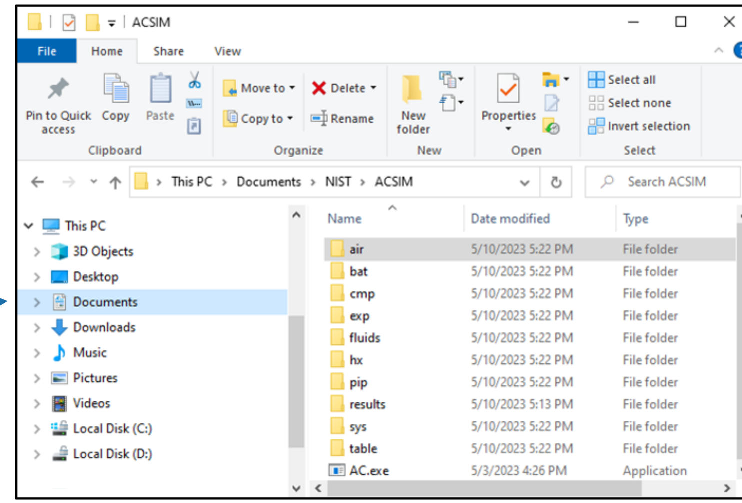
ACSIM graphical user interface (GUI, ACSIM.exe) and ACSIM Help file (ACSIM Help.chm) are installed in the same folder (the default location (recommended) or in a folder of your choice).

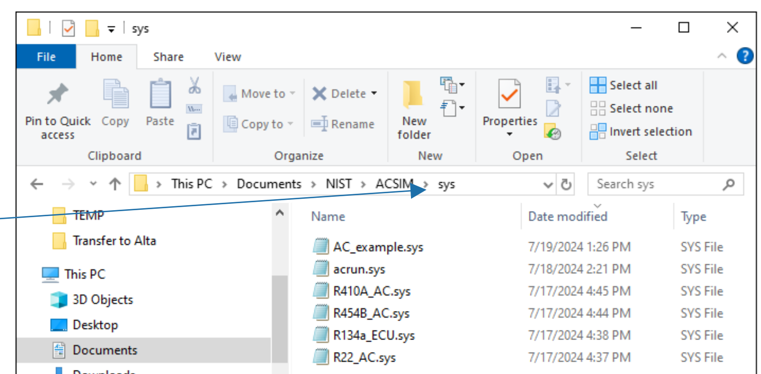
The simulator file (AC.exe) is installed in a predetermined folder C:>...>Documents>NIST>ACSIM along with ten subfolders containing various 'read' and 'write' files required by ACSIM. The installation module does not install files with refrigerant constants. These files need to be provided by the user. Refer to the next page on Installation of Refrigerant Files.

Note

It is important to note that data files containing system data are placed in the folder C: >...>Documents>NIST>ACSIM>sys, and files containing heat exchanger data are placed in the folder C:>...>Documents> NIST>ACSIM>hx. The screen to the right shows folder C:>...> Documents>NIST>ACSIM>sys with preloaded files containing data for several systems. Also, example of several heat exchangers and operating conditions are preloaded in respective subfolders.

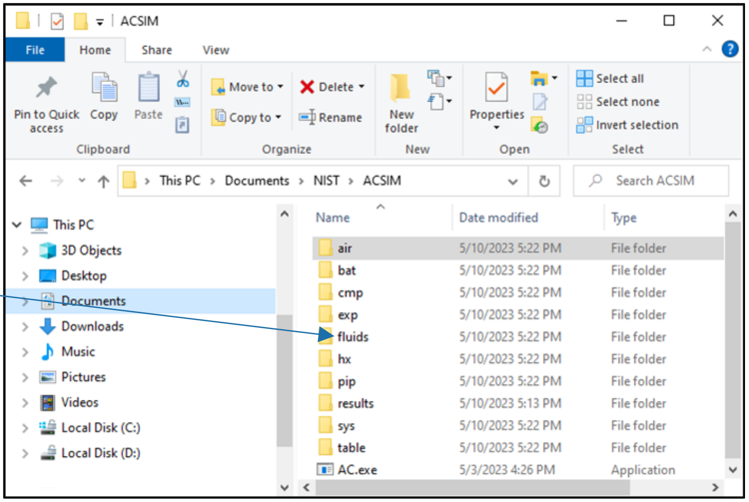






INSTALLATION OF REFRIGERANT FILES

ACSIM uses refrigerant thermophysical properties based on the NIST Standard Reference Data 23; NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 10.0 (https://www.nist.gov/srd/refprop), with refrigerant coefficients provided in individual files for each fluid. These fluid files must reside in a designated folder named 'fluids'. The arrow shows the location of the 'fluids' folder in ACSIM.



The ACSIM installation module does not install fluid files in the 'fluids' folder except those for R32 and R125 (component fluids of R410A), which allow the user to perform tutorial simulations of an R410A air conditioner presented later in these Instruction Pages.

To be able to simulate systems using other refrigerants, the user needs to manually load the ACSIM 'fluids' folder with REFPROP-compatible data files for other fluids of interest. These files can be obtained from a 'fluids' folder of any one of the following NIST Standard Reference Data (SRD) programs:

SRD 23, REFPROP, Ver. 10.0 https://www.nist.gov/srd/refprop, Location: C:>Program Files (x86)>REFPROP>fluids

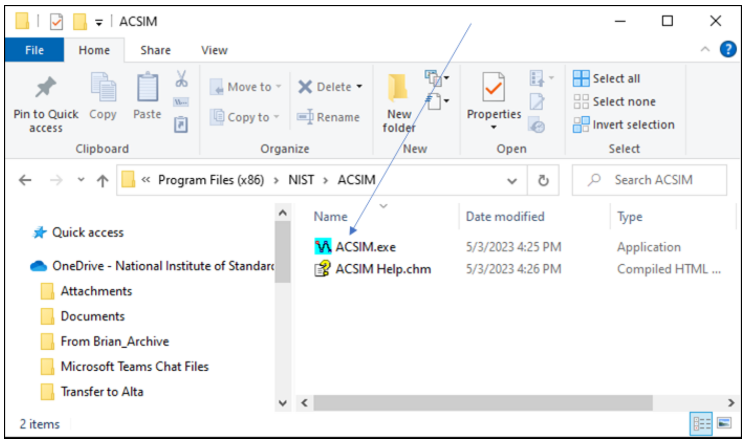
SRD 49, CYCLE_D, Ver. 6.0 https://www.nist.gov/srd/nist-standard-reference-database-49,
Location: C:>Program Files (x86)>NIST>CYCLE_D 6.0>fluids

SRD 73, REFLEAK, Ver. 6.0 https://www.nist.gov/srd/nist-standard-reference-database-73,
Location: C:>Program Files (x86)>NIST>REFLEAK 6.0>fluids.

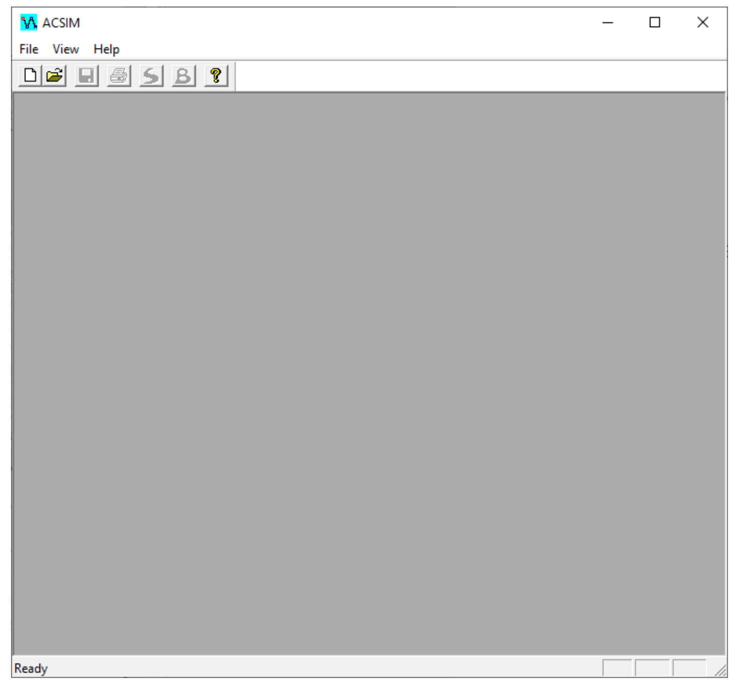
START ACSIM

ACSIM can be started up by a double-click on the ACSIM icon located on the desktop or by a left double-click on file ACSIM.exe.

For a default installation, the path to ACSIM.exe is C: > Program Files (x86) > NIST > ACSIM.



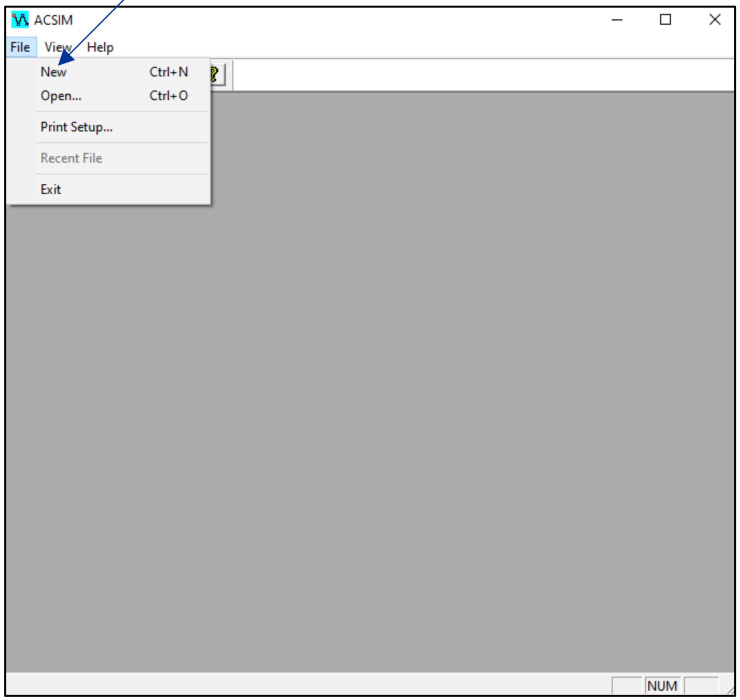
An empty ACSIM main screen will appear.

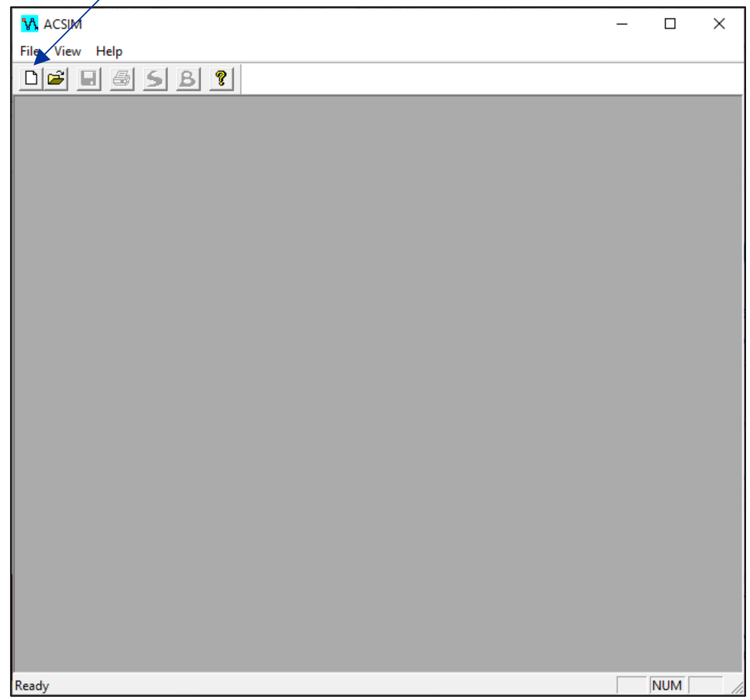


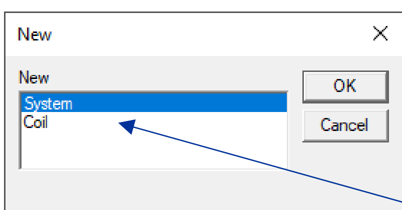
To simulate an AC system, you need to prepare a system file that defines the system to be simulated (i.e., all system components) and a file with operating conditions. This can be done either from 'scratch' or by loading one of existing system files and modifying it.

PREPARE A SYSTEM FILE FROM 'SCRATCH'

Starting with the empty main window shown on the previous page, click on the "New" button on the power bar or select "New" on the "File" pull-down menu.







A small window will pop up. Select "System" and left-click on the "OK" button.
A system schematic will pop-up with features allowing data entry for operating conditions and all system components (shown on the next page).

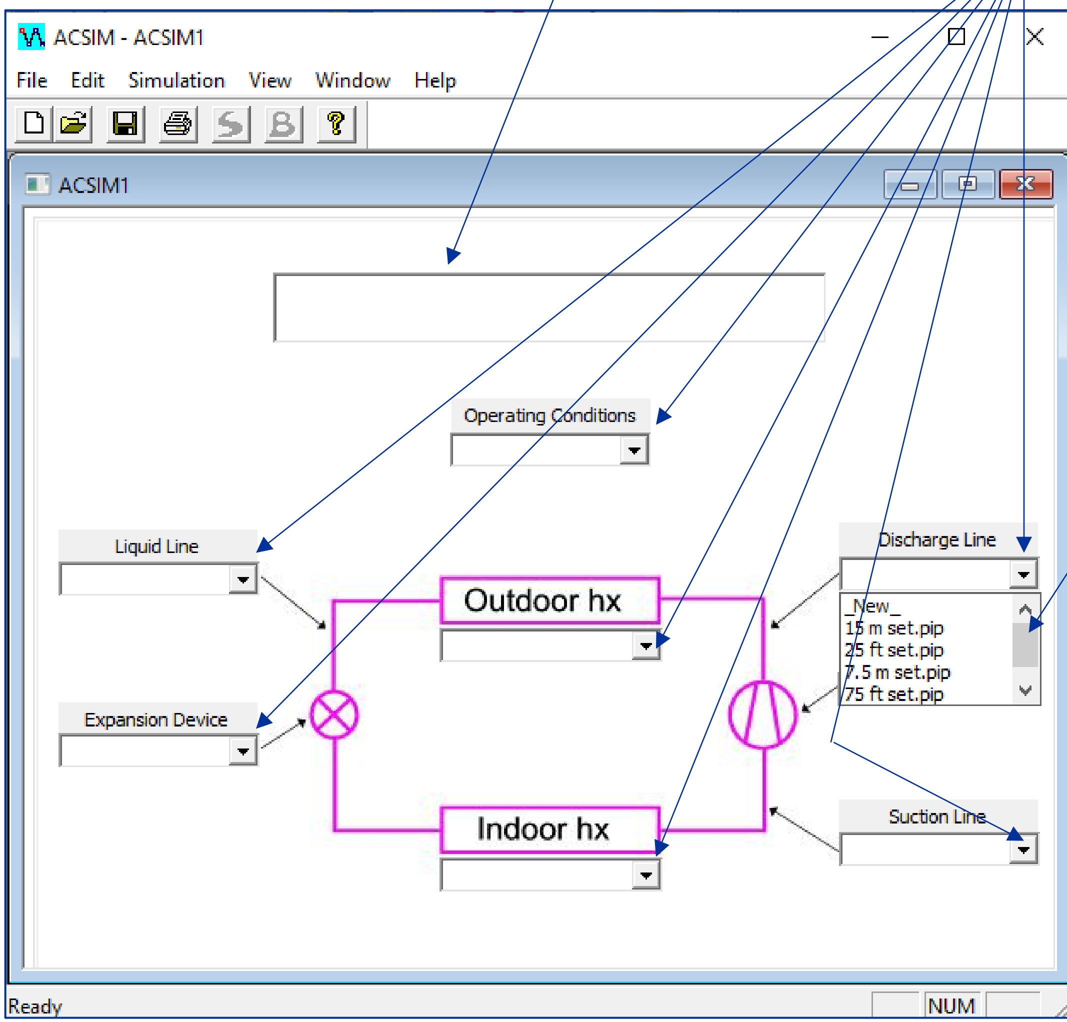
Note: This window also provides an auxiliary path for preparing a data file for a heat exchanger. Data for all other system components and operating conditions shall be entered using the main window with a system schematic shown on the next page.

PREPARE A SYSTEM FILE FROM 'SCRATCH' (cont.)

ACSIM Main Window – Data Input

System description, per user's preference

Pull-down menus for data entry



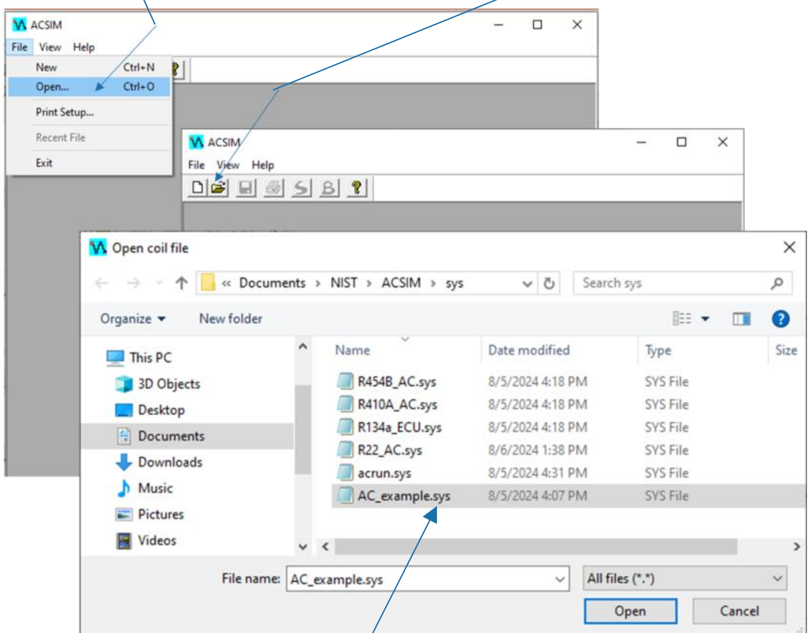
Operating conditions and data for each AC component can be entered using a pull-down menu associated with each entry window.

Here, as an example, you can select any of the existing data files with discharge line information. If "New" is selected, a window will pop-up for data entry (page 28).

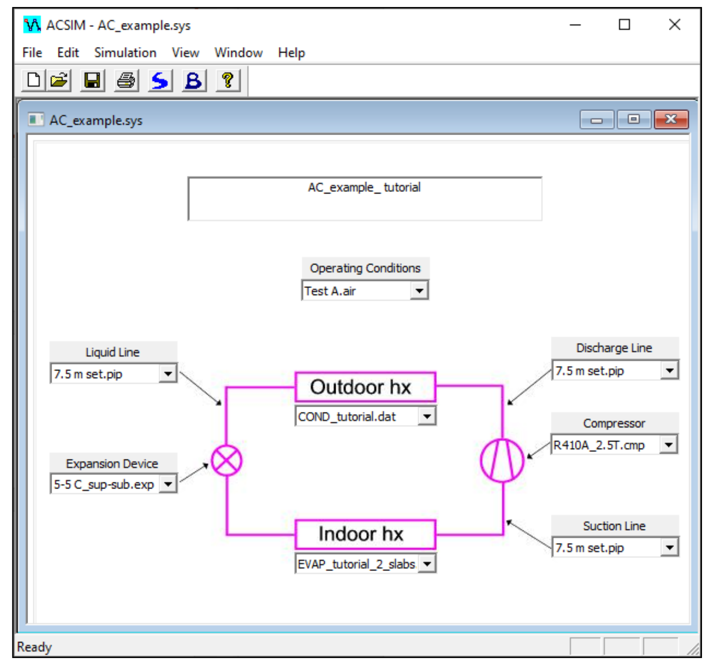
LOAD AN EXISTING SYSTEM FILE

In this tutorial simulation run we will use an existing system file AC_example.sys.

Starting with the empty main window shown on page 8, select "Open" on the "File" pull-down menu or click on the "Open" button on the power bar. Navigate to the folder C: >...Documents > NIST > ACSIM > sys where files with system data are located.

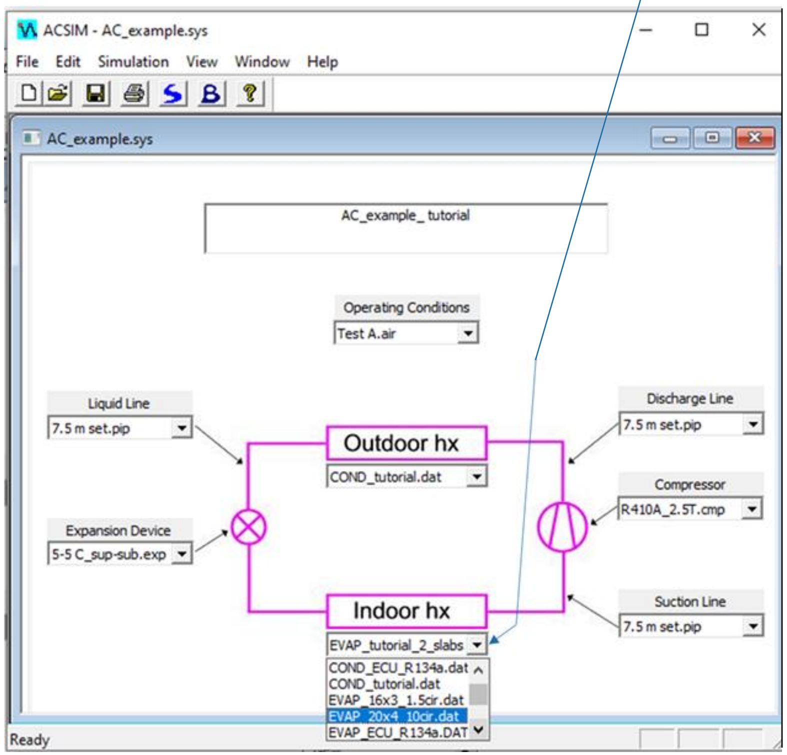


Then select file AC_example.sys, in which an example AC system is specified.
The ACSIM main window will reappear showing file names of the selected components of the system.
We will use this system in the tutorial to follow.



ACSIM MAIN WINDOW – DATA INPUT

You can select a different AC component file via placing the cursor on the pull-down arrow and pressing the left mouse button. A list of existing files will appear allowing you to make the selection.

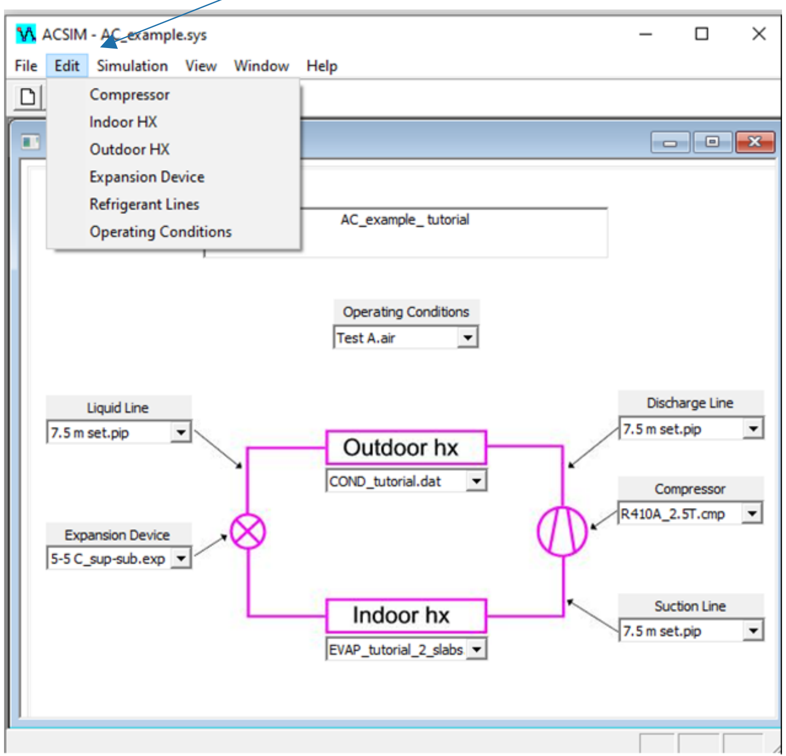


Note: If the above window shows some flaws on your PC, try a different setting for the display resolution. E.g., small screens (laptops) most often require 1366 x 768 or 1600 x 900 display resolution.

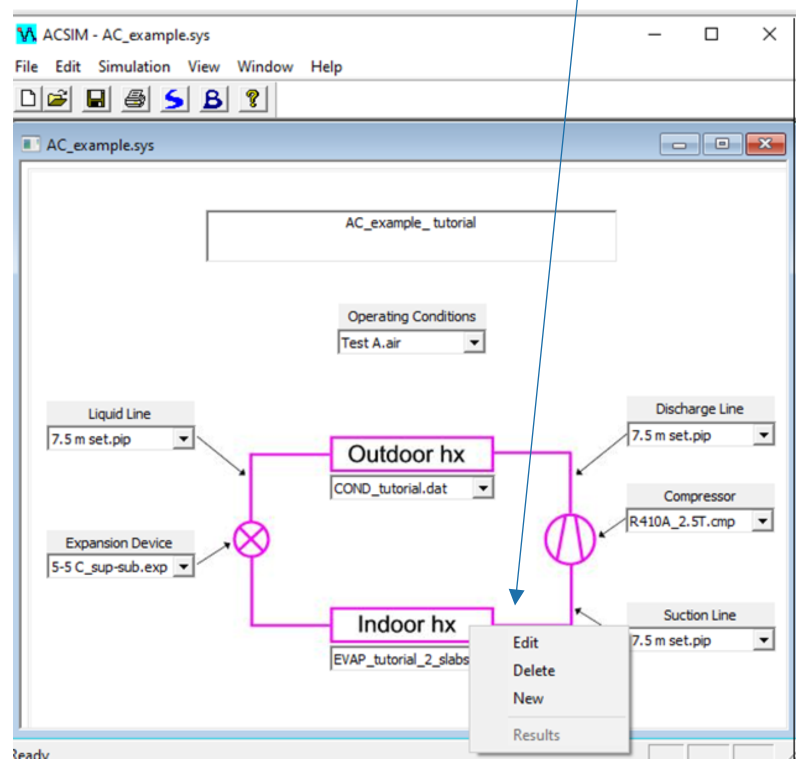
ACSIM MAIN WINDOW – DATA INPUT (cont.)

Once you loaded an existing system file (AC_example.sys in this case), all system components and operating conditions are already specified. Data for system components are contained in separate files. A system file, like AC_example.sys, lists the names of these files so the computer could read them.

You can review and edit any current individual component file by selecting this file using the "Edit" pull-down menu.

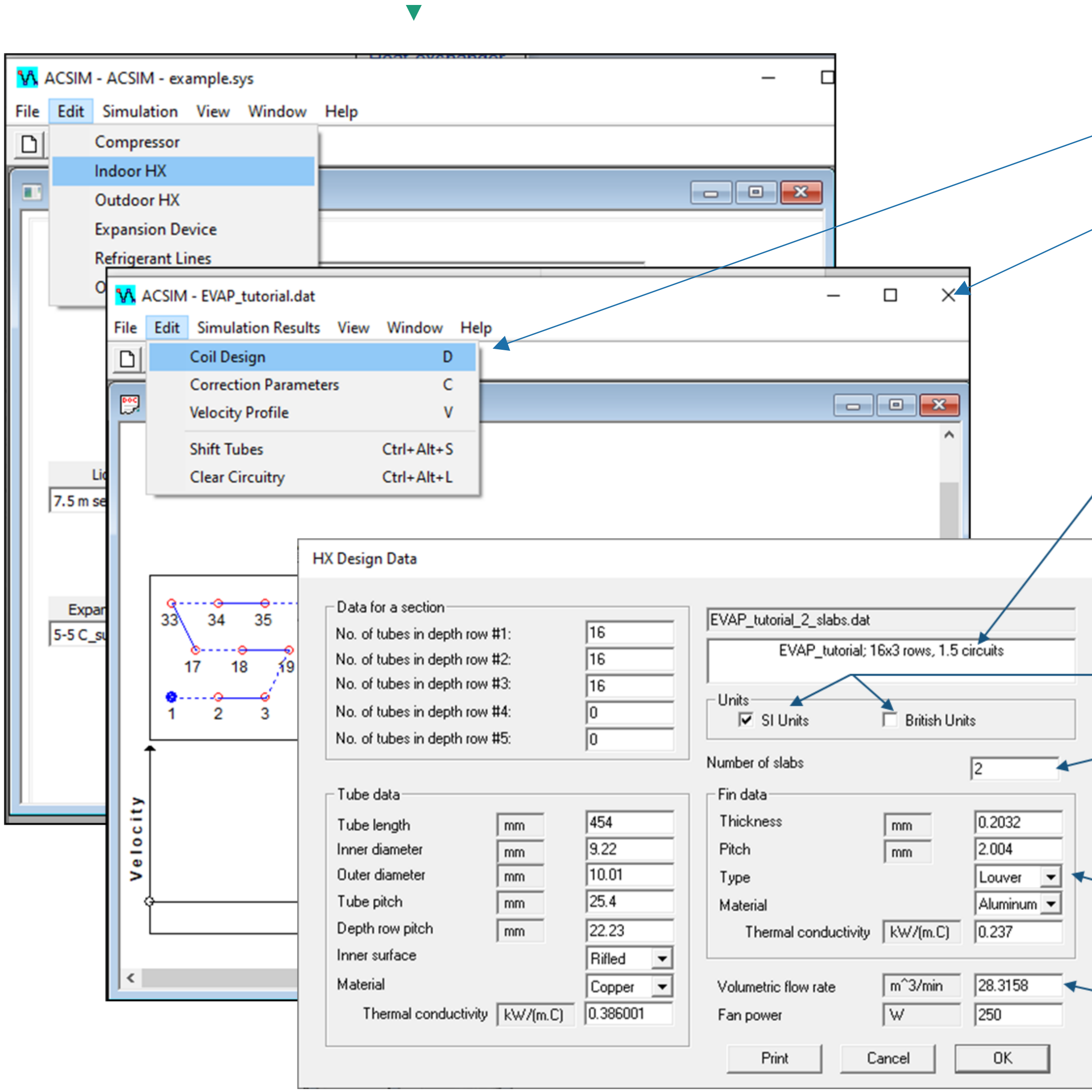


You can also review and edit an individual component file via placing the cursor on a given component ("+" symbol will appear) and then pressing the right mouse button. The options "Edit", "Delete" and "New" will appear.



REVIEW HEAT EXCHANGER DATA

To open the Heat Exchanger Design Data window, select "Indoor HX" or "Outdoor HX" from the "Edit" pull-down menu. Alternatively, you can right-click on the ”Indoor hx” or “Outdoor hx” box on the system schematic view and select "Edit" -> "Coil Design".



To close this window, place the cursor on the “x” and click the left mouse button

Heat exchanger description, per user’s preference.

The system of units for data input and output can be selected here.

Multiple slabs allowed (e.g., V-shaped assemblies)

Flat, wavy, lanced, and louver fins are available.

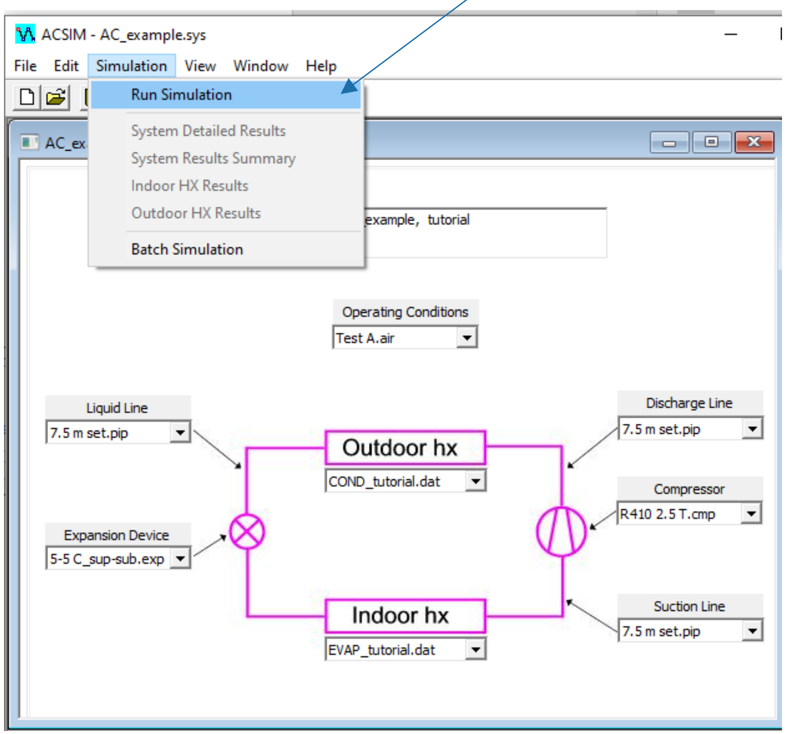
Total flow rate for the coil assembly

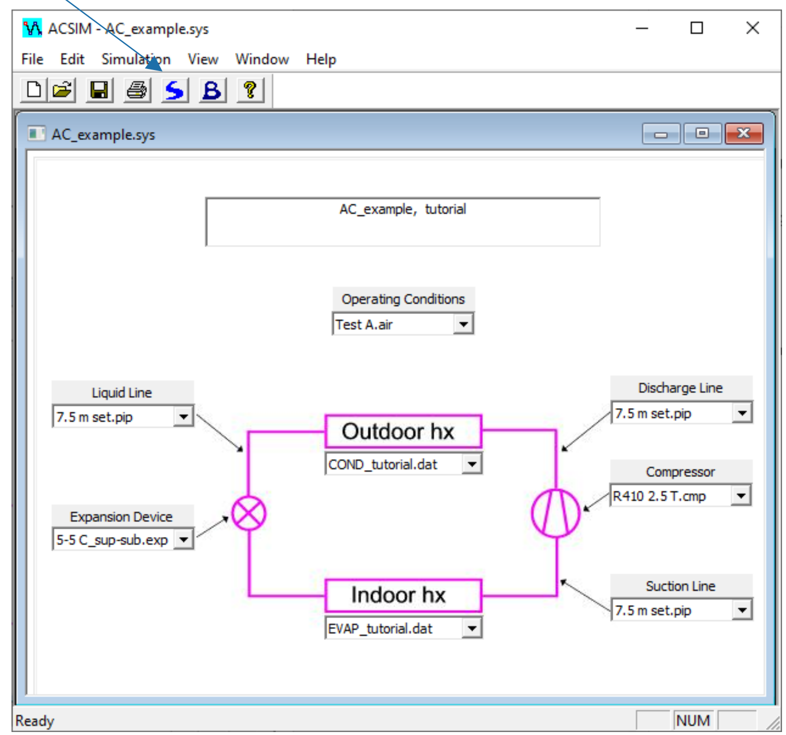
(for all slabs, std. air)

RUN A SIMULATION

Once all files with system component data and operating conditions have been selected, the interface allows you to start a simulation run.

Use the pull-down menu or the “S” key on the power bar to execute ACSIM.

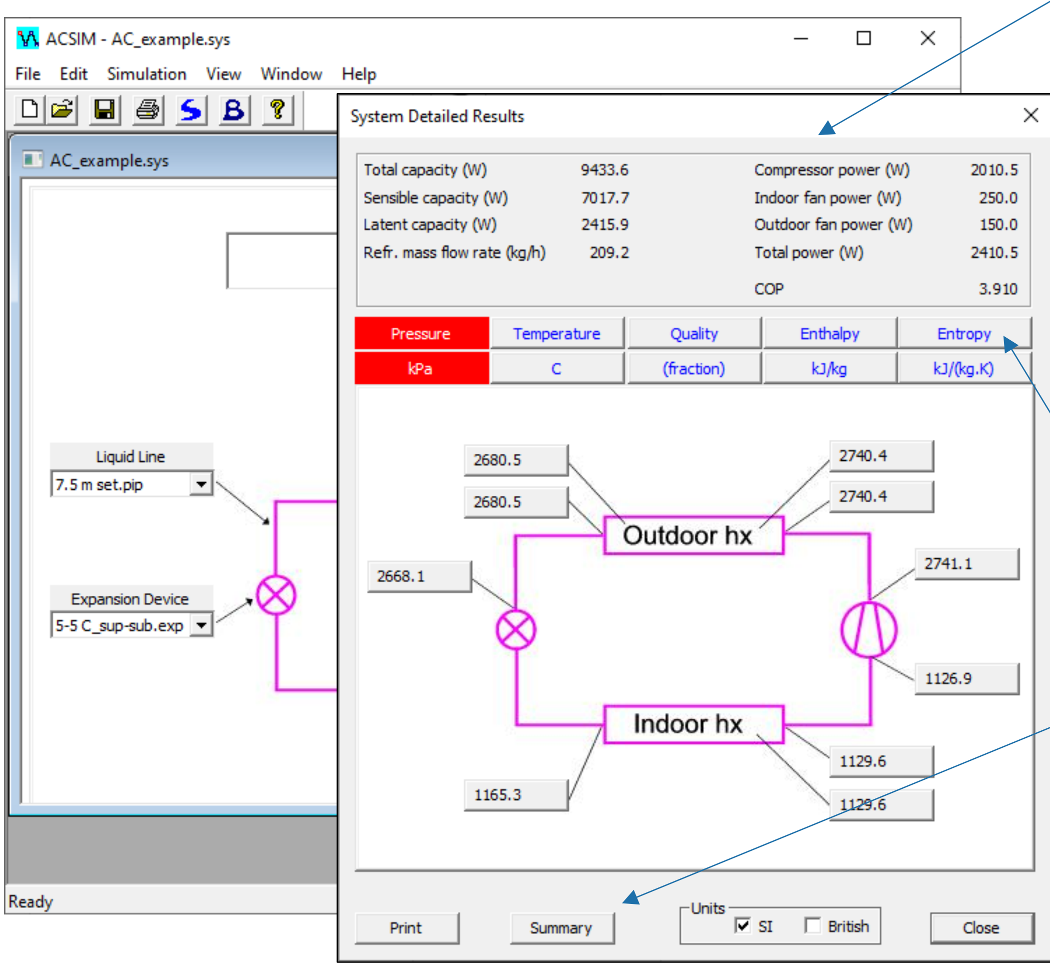




An MS_DOS window will appear showing progression of the simulation.
A window with simulation results will appear upon completion of the simulation run (shown on the next page).

SIMULATION RESULTS

Upon completion of the simulation run a window pops up with global simulation results shown in the upper part of the window.



Refrigerant parameters are displayed on a system schematic for ten key system locations:

- Compressor inlet
- Compressor outlet
- Condenser inlet
- Condenser saturation vapor point
- Condenser saturation liquid point
- Condenser outlet
- Expansion device inlet
- Evaporator inlet
- Evaporator saturation vapor point outlet
- Evaporator outlet

Select pressure, temperature, quality, enthalpy or entropy.

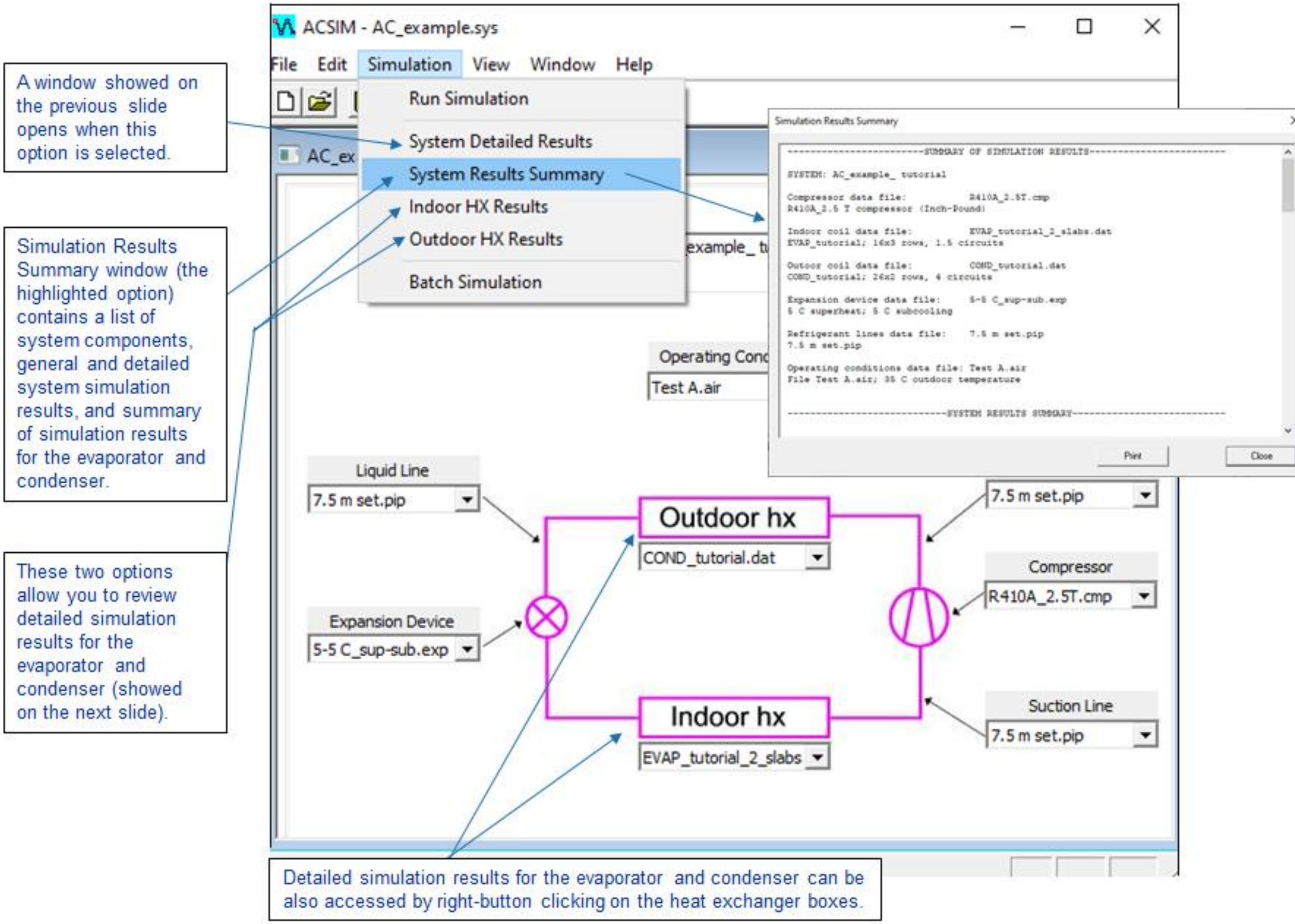
These parameters are included in the “System Results Summary”.

A complete "System Results Summary" can be viewed by clicking the "Summary" button.

You can also view the "System Results Summary" by closing this window and selecting "Simulation" -> "System Results Summary" from the pull-down menu shown on the next page.

Detailed simulation results for heat exchangers can be accessed using the pull-down menu as shown on page 16.

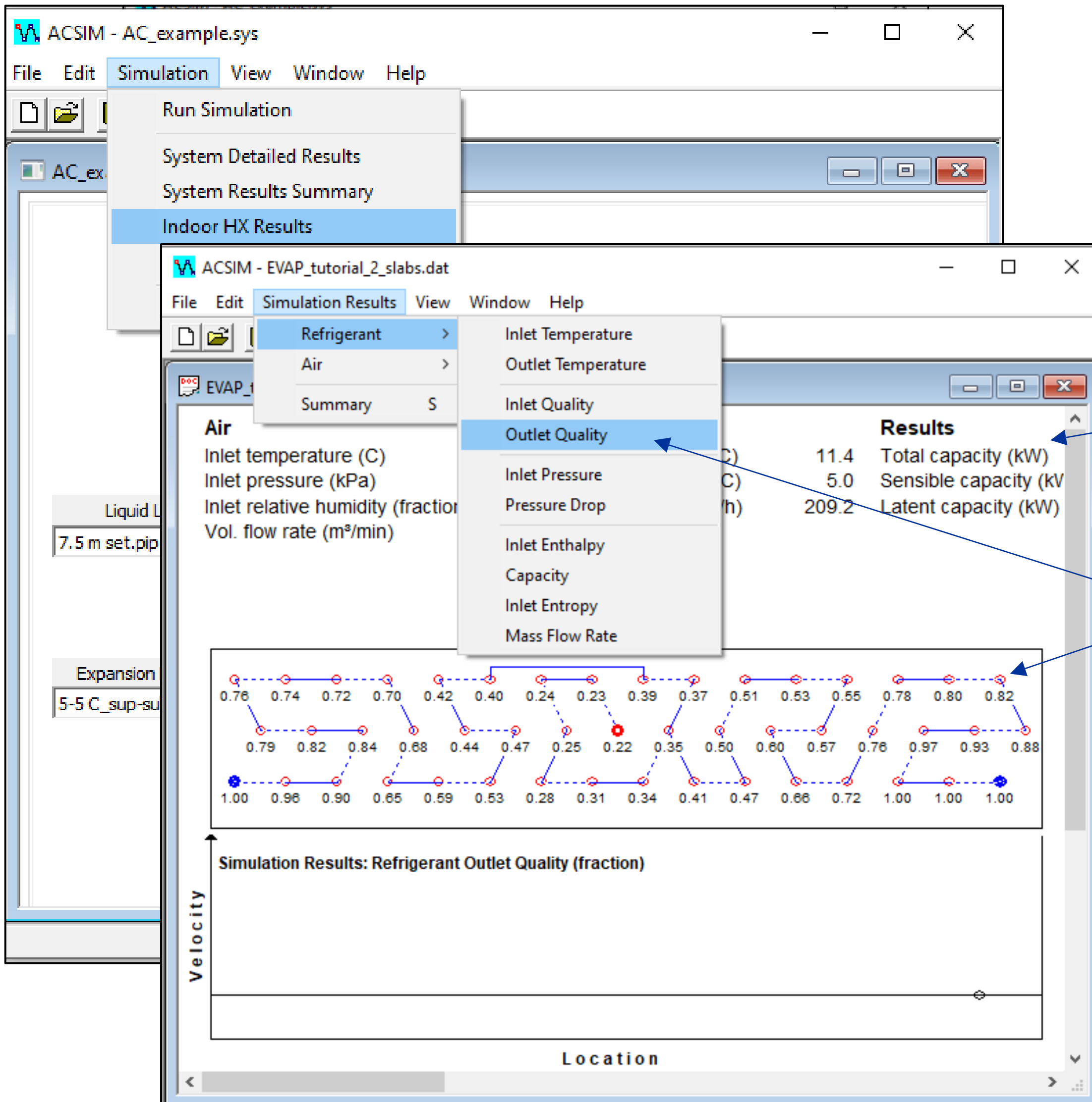
SIMULATION RESULTS (cont.)



All simulation results can also be read directly from *.txt and *.csv files written to C:>...>Documents>NIST>ACSIM>results. Additionally, C:>...>Documents>NIST>ACSIM>results contains a file acsim.txt, with a detailed record of the convergence process the of last simulation run. In case the run encountered convergence problems, a text file diagx.res is also written with diagnostic information.

HEAT EXCHANGER SIMULATIONS RESULTS

Use the “Simulation” pull-down menu, as shown, to access detailed simulation results for heat exchangers.



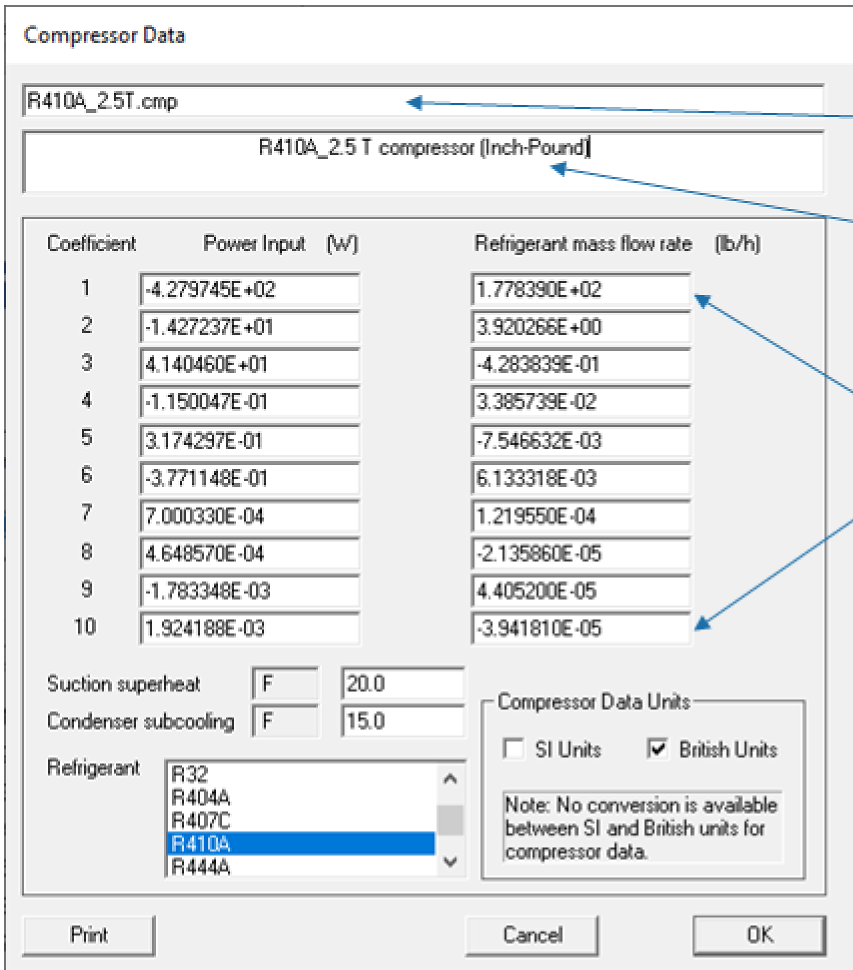
Global heat exchanger simulation results are displayed in the upper part of the window.

Detailed refrigerant and air parameters associated with each tube can be displayed on the refrigerant circuitry schematic. Make the appropriated selection using the pull-down menu.

Note: If the refrigerant circuitry shows some flaws on your PC, try a different setting for the display resolution. E.g., small screens (laptops) most often require 1366 x 768 or 1600 x 900 display resolution.

COMPRESSOR DATA

Compressor representation is based on ANSI/AHRI Standard 540-2020. Files with compressor data are located in the folder C:>...>Documents>NIST>ACSIM>cmp. Use the compressor pull-down menu in the ACSIM main window to review compressor data stored in a given file. If the selection is made to “_New_” from the compressor pulldown menu, the compressor data window would have no data, and new data would have to be entered.



Name of the file with compressor data. The .cmp affix is required.

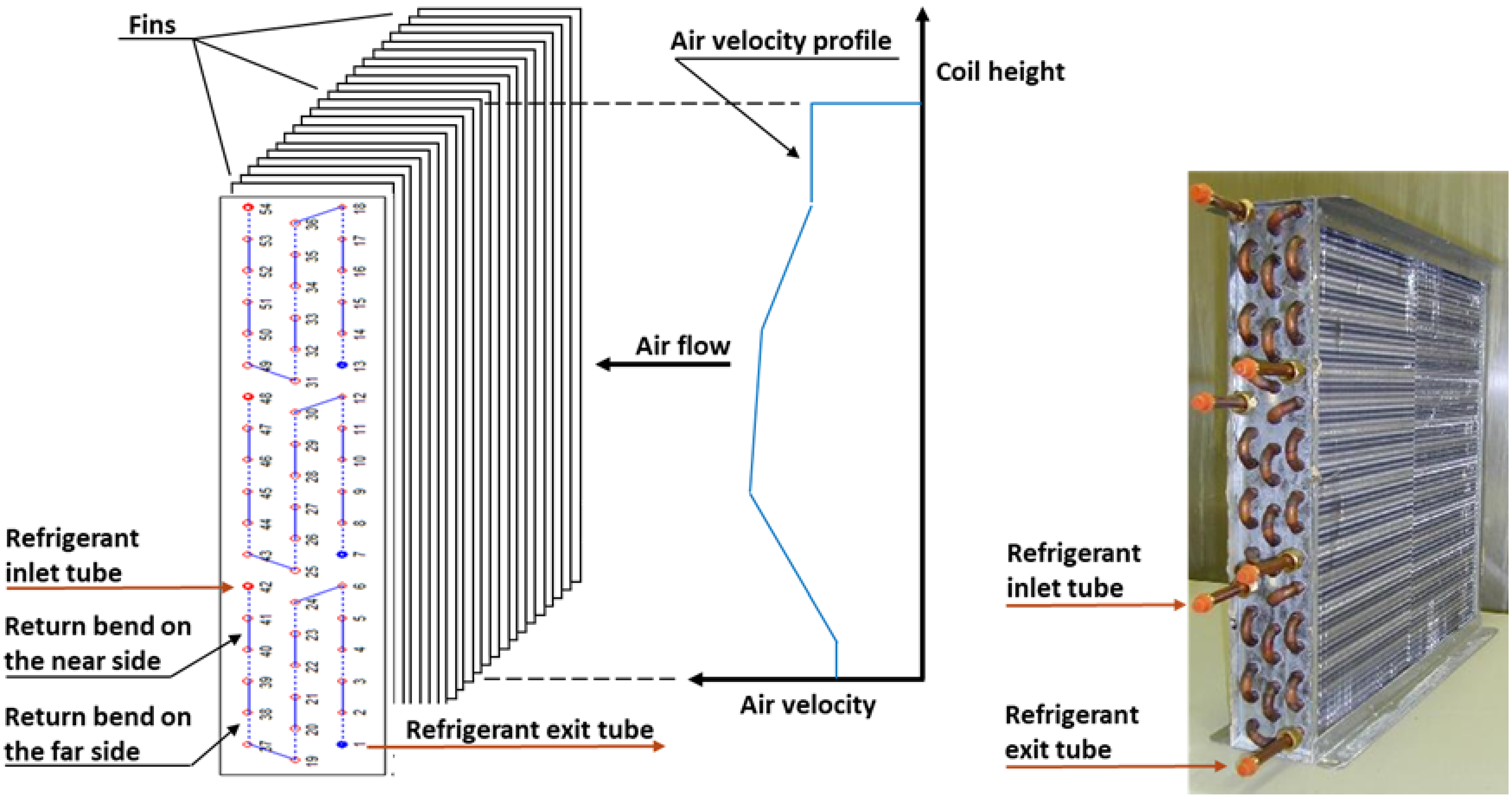
Description of the compressor data file, per user’s preference.

Constants for the compressor map polynomials, per ANSI/AHRI Standard 540-2020.

The selected system of units and refrigerant **must be** those for which the compressor maps were developed.

Note: ACSIM will perform simulations using the refrigerant selected in this window.

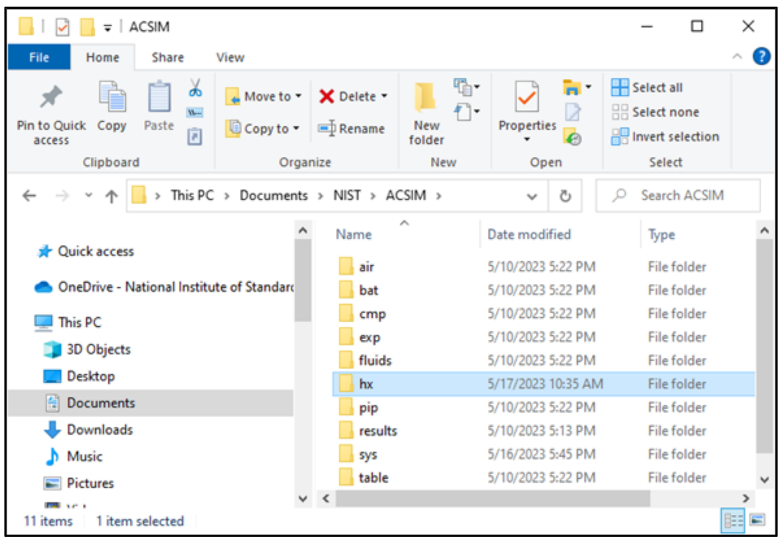
HEAT EXCHANGER REPRESENTATION

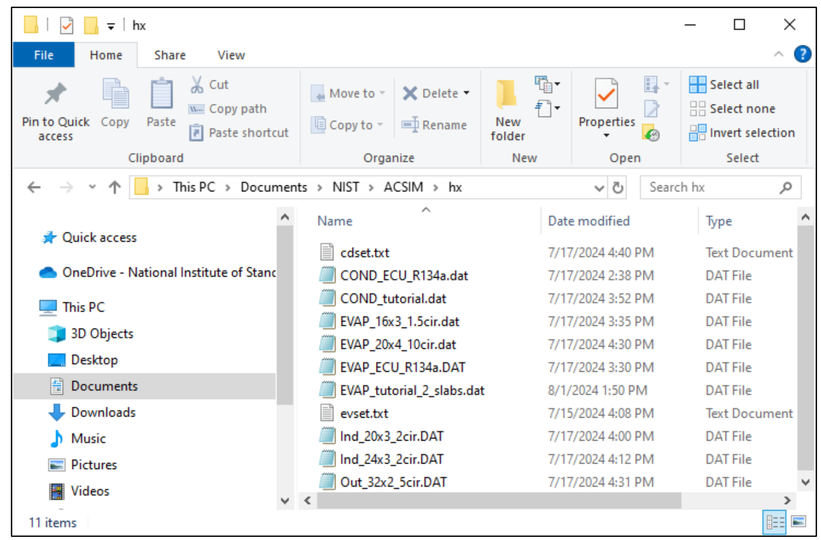


The refrigerant circuitry schematic shows the inlet and outlet tubes (red and blue colors, respectively) as used by the evaporator. The opposite colors and refrigerant flow direction are for the condenser.

PREPARE HEAT EXCHANGER DATA

Evaporator and condenser models used in ACSIM have been imported from the EVAP-COND package (https://www.nist.gov/services-resources/software/evap-cond-version-50). It is strongly recommended to use EVAP-COND to specify new heat exchanger data files. After a new heat exchanger design has been tested by EVAP-COND simulations, the user should copy the new heat exchanger data file (file with the ".dat" affix) from C:>...>Documents>NIST>EVAP-COND>hx to C:>...>Documents>NIST>ACSIM>hx. This way the new heat exchanger file will be available for ACSIM simulations.





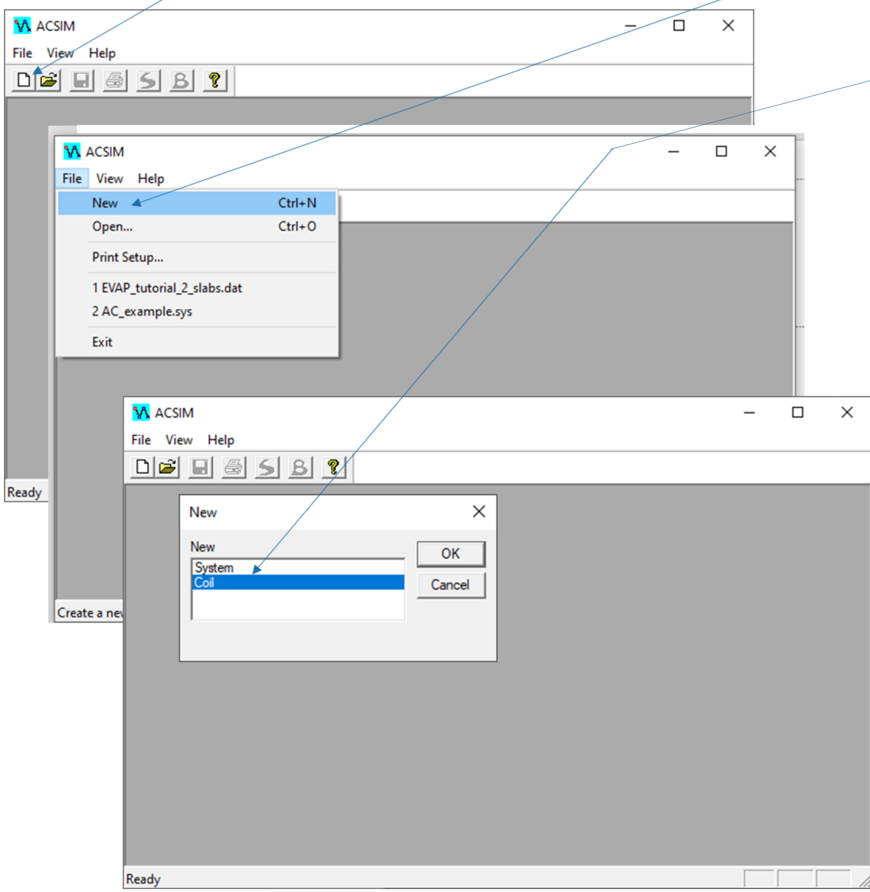
Files containing heat exchanger data have the affix '.dat'.

The text files cdset.txt and evset.txt located in this folder are used to select refrigerant heat-transfer correlations, the number of subsections heat exchanger tubes are to be divided into for heat-transfer simulations, and to select the option for air flow adjustment. To make this selection, use a text editor.

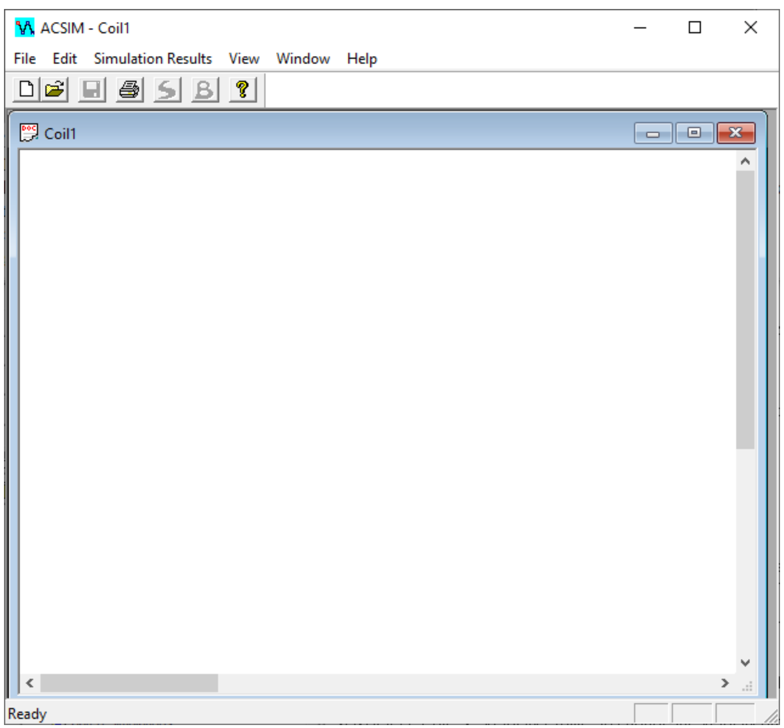
PREPARE HEAT EXCHANGER DATA (cont.)

Below are the steps to be taken if you decide to specify a new heat exchanger within ACSIM.

Step 1. Starting with the ACSIM main window,
use the "New" icon on the power bar or "File" ->New"->"New" pull-down menu and select the "Coil“ option.

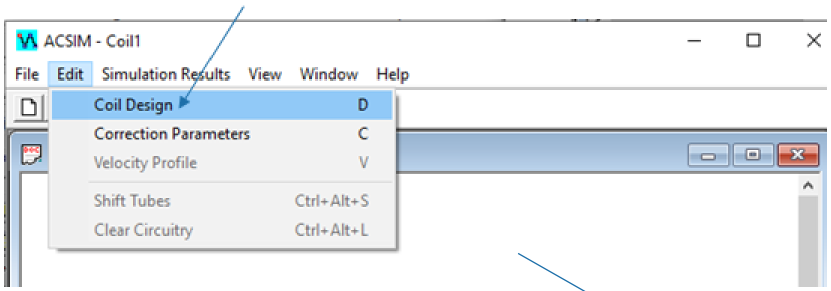


An empty “Coil1” window will open.

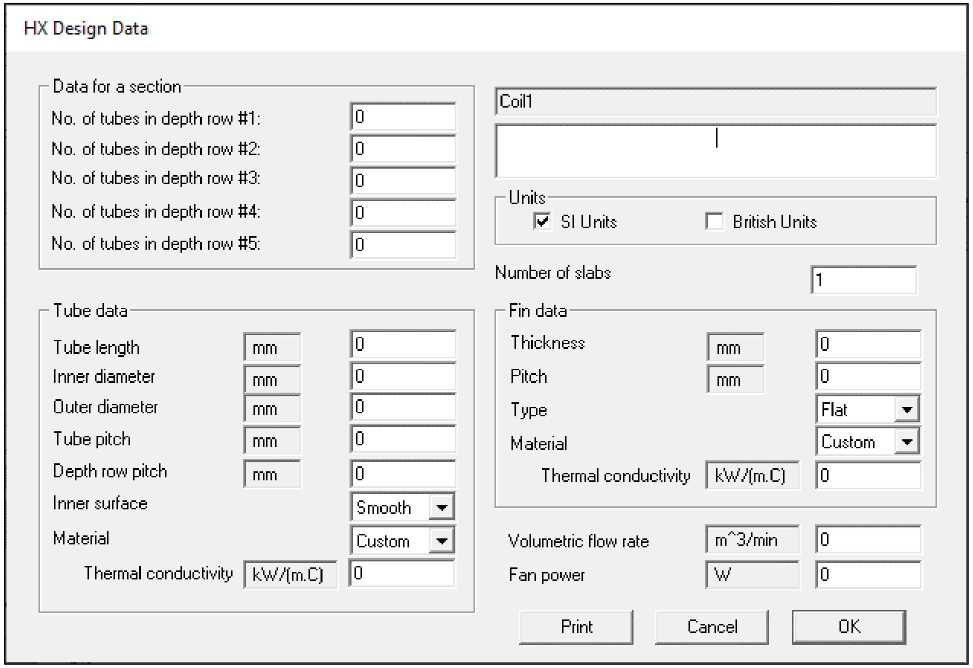


PREPARE HEAT EXCHANGER DATA (cont.)

Step 2. Use the "Edit" -> "Coil Design" pull-down menu to open the HX Design Data window. An empty window will open.



An empty window will open.



PREPARE HEAT EXCHANGER DATA (cont.)

Step 3. Input all information.
Then left-click on the "OK" button to save the data in a file.
The save must be made into folder C:\...\Documents\NIST\ACSIM\hx.

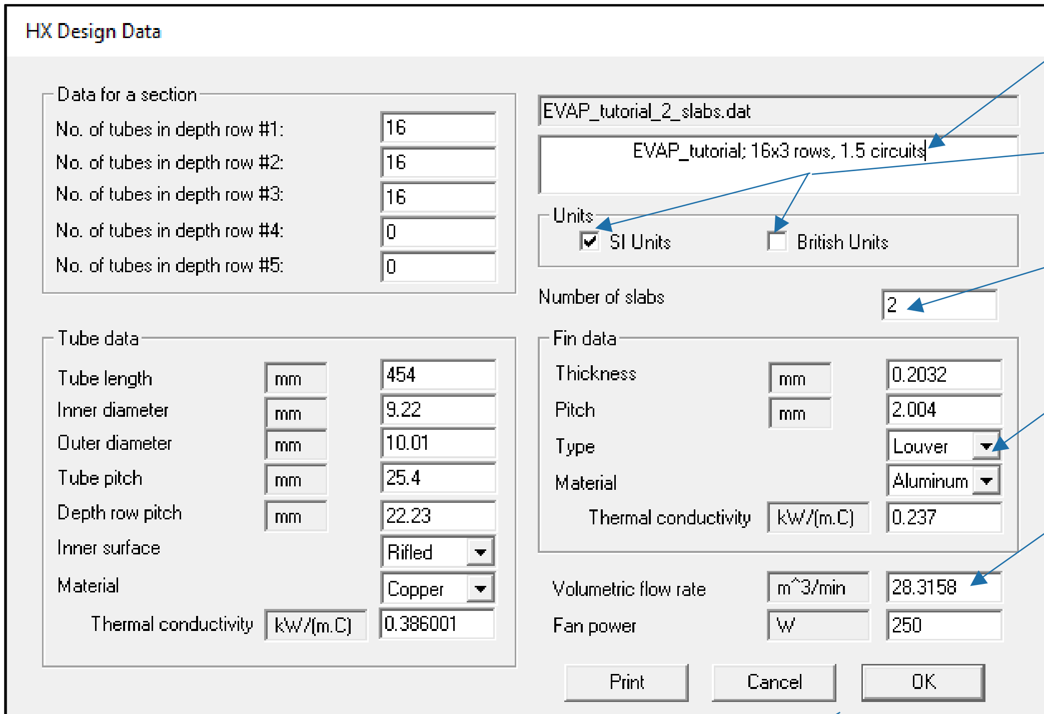
Heat exchanger description, per user's preference

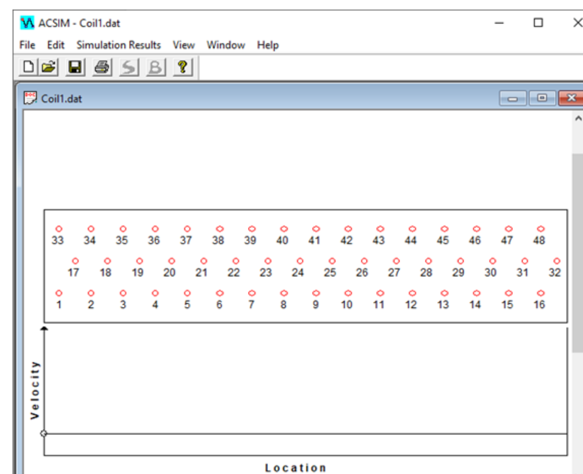
The system of units for data input and output can be selected here

Multiple slabs allowed (e.g., V-shape assemblies)

Flat, wavy, lanced, and louver fins are available

Total flow rate for the coil assembly (for all slabs, std. air)





After a right click on the "OK" button,
a window will appear showing a side view of the coil with refrigerant tubes.

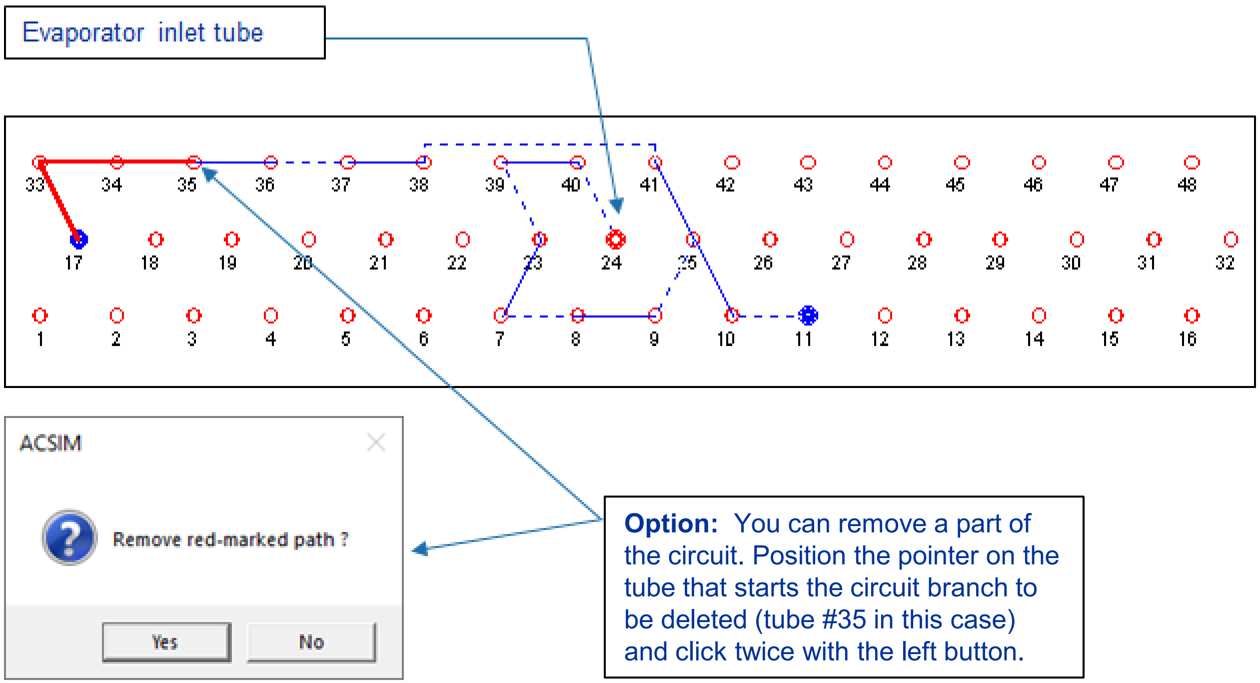
PREPARE HEAT EXCHANGER DATA (cont.)

Step 4. Specify refrigerant circuitry

The refrigerant circuitry was already specified in the example file you loaded for this tutorial. If you had not loaded an existing file and entered coil design data, as shown in the previous page, a rectangle would appear with circles denoting tubes in the coil assembly. Then you would proceed to specify a refrigerant circuitry. Follow the steps below.

If you specify the circuitry for the evaporator, start with the inlet tube and proceed downstream. For the condenser, start with the outlet tube and proceed upstream. The example below is for the evaporator. Start with tube # 24.

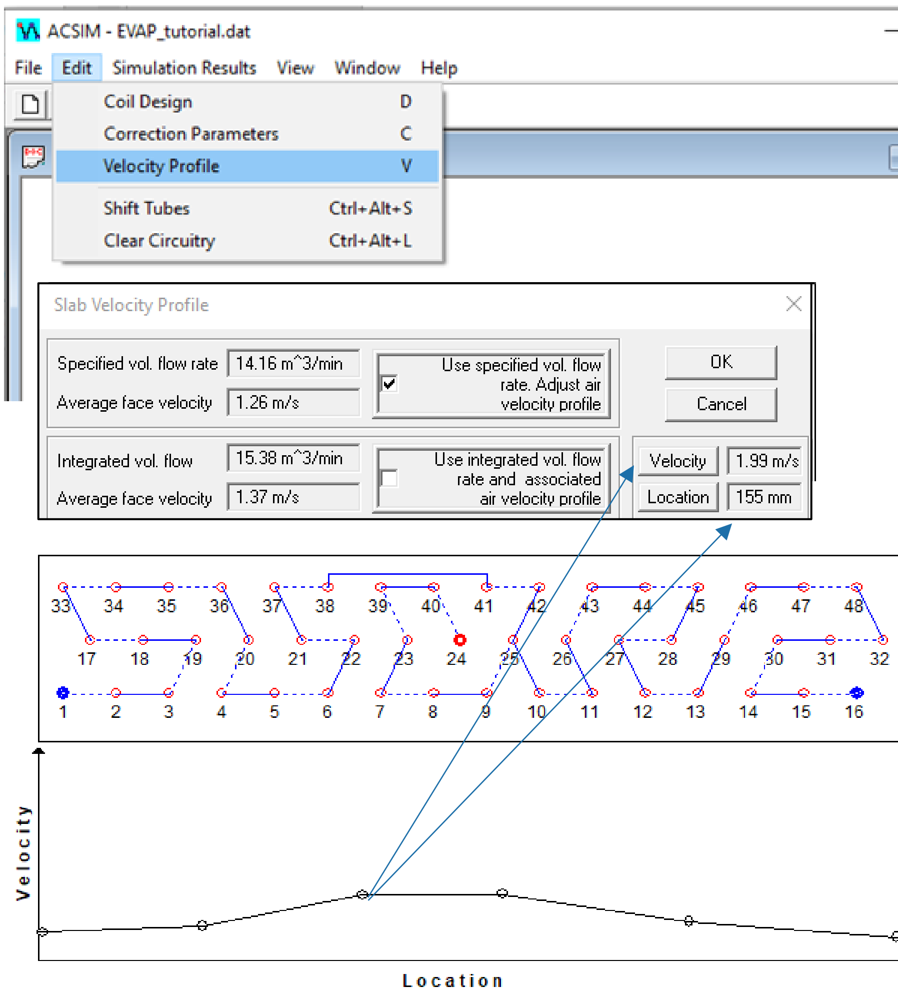
- Place the pointer on the tube.
- Press the left mouse button.
- Drag the pointer to the next tube.
- Release the left button. (A return bend will appear; a broken line for the far side or a solid line for the near side.)



PREPARE HEAT EXCHANGER DATA (cont.)

Step 5. Specify inlet air velocity profile (optional)

ACSIM assumes the uniform inlet air velocity across the coil face based on the specified volumetric flow rate. However, the user has the option to override it by specifying one-dimensional nonuniform air distribution. This can be done by specifying inlet air velocity at selected locations as explained below.



To specify velocity at a given point, place the pointer at that point and left click. The box above shows the coordinates. Up to sixteen velocity points may be specified.

Click on a given point to remove it.

If the heat exchanger consists of more than one slab (3 slabs is the limit), it is assumed that each slab has the same inlet air velocity profile.

Before you leave this window you must decide between two options:

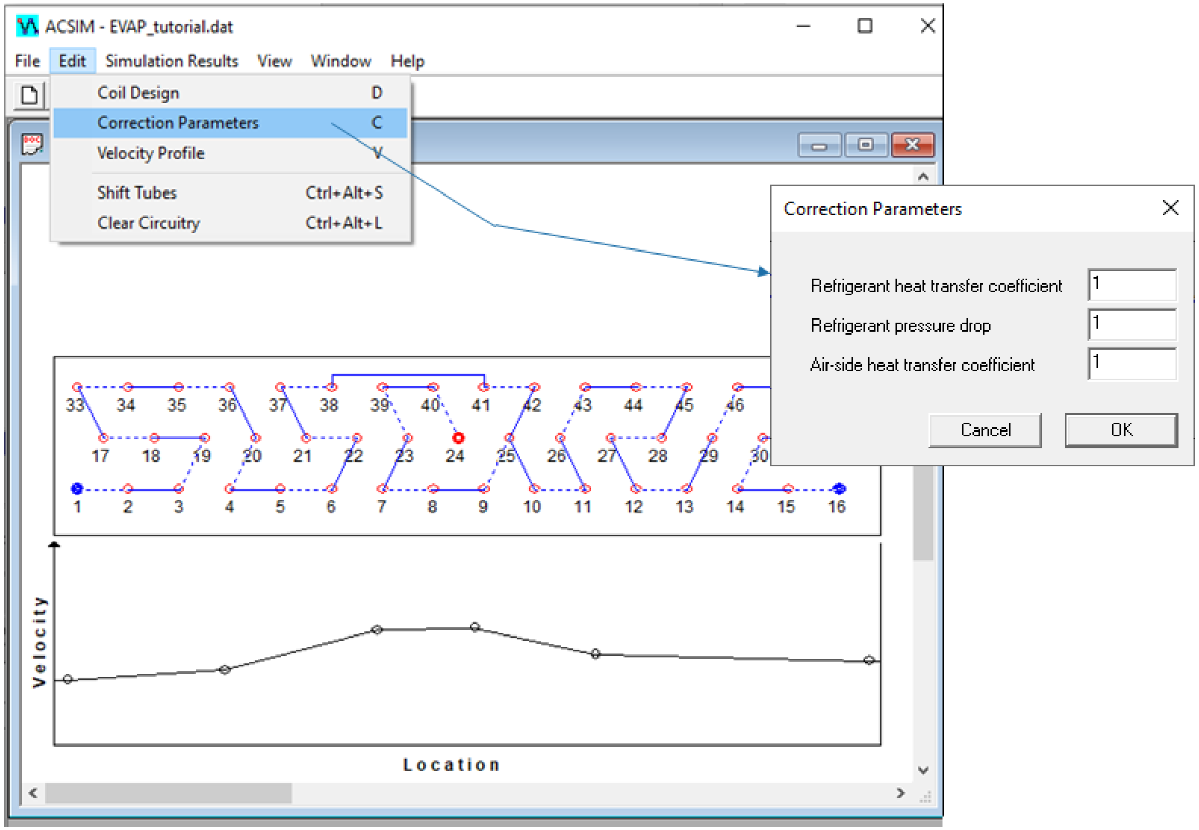
- to use the previously specified volumetric flow rate and have the velocity profile scaled to match that value (recommended)

or

- to override the previously specified volumetric flow rate with the volumetric flow rate calculated from the velocity profile.

HEAT EXCHANGER CORRECTION PARAMETERS

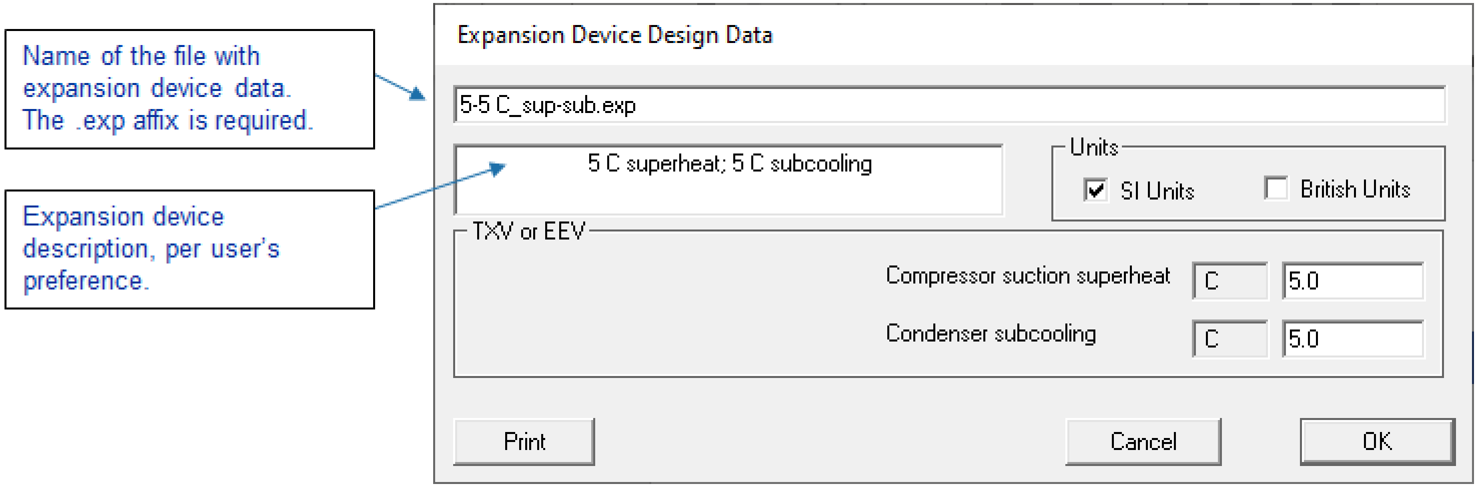
Correction parameters are used as multipliers to the values of heat transfer coefficient or pressure drop calculated by the program. They provide the option of tuning model predictions to laboratory measurements. The default value is 1.0.



There are a few reasons why the use of correction parameters may be needed. The most common reason may be the inadequacy of the air-side correlation to represent the performance of a particular enhanced fin used in the heat exchanger. Also, the heat transfer and pressure drop correlations may have some bias in predicting the refrigerant-side performance for different tubes and refrigerant/lubricant mixtures.

EXPANSION DEVICE DATA

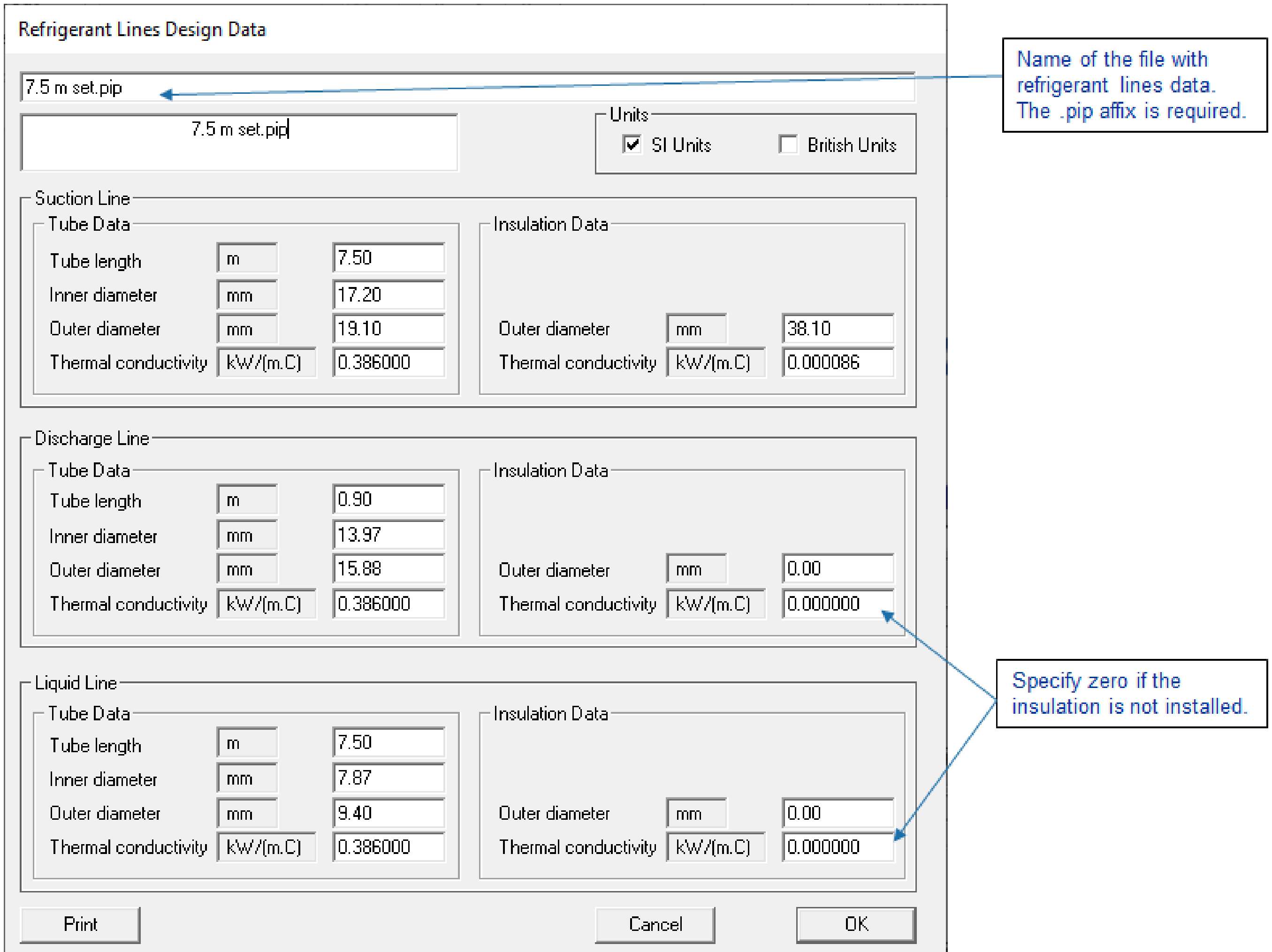
Files with information on expansion devices are saved in the folder C:>...>Documents>NIST>ACSIM>exp.



Note: Only a TXV or EEV maintaining a constant suction superheat is available.

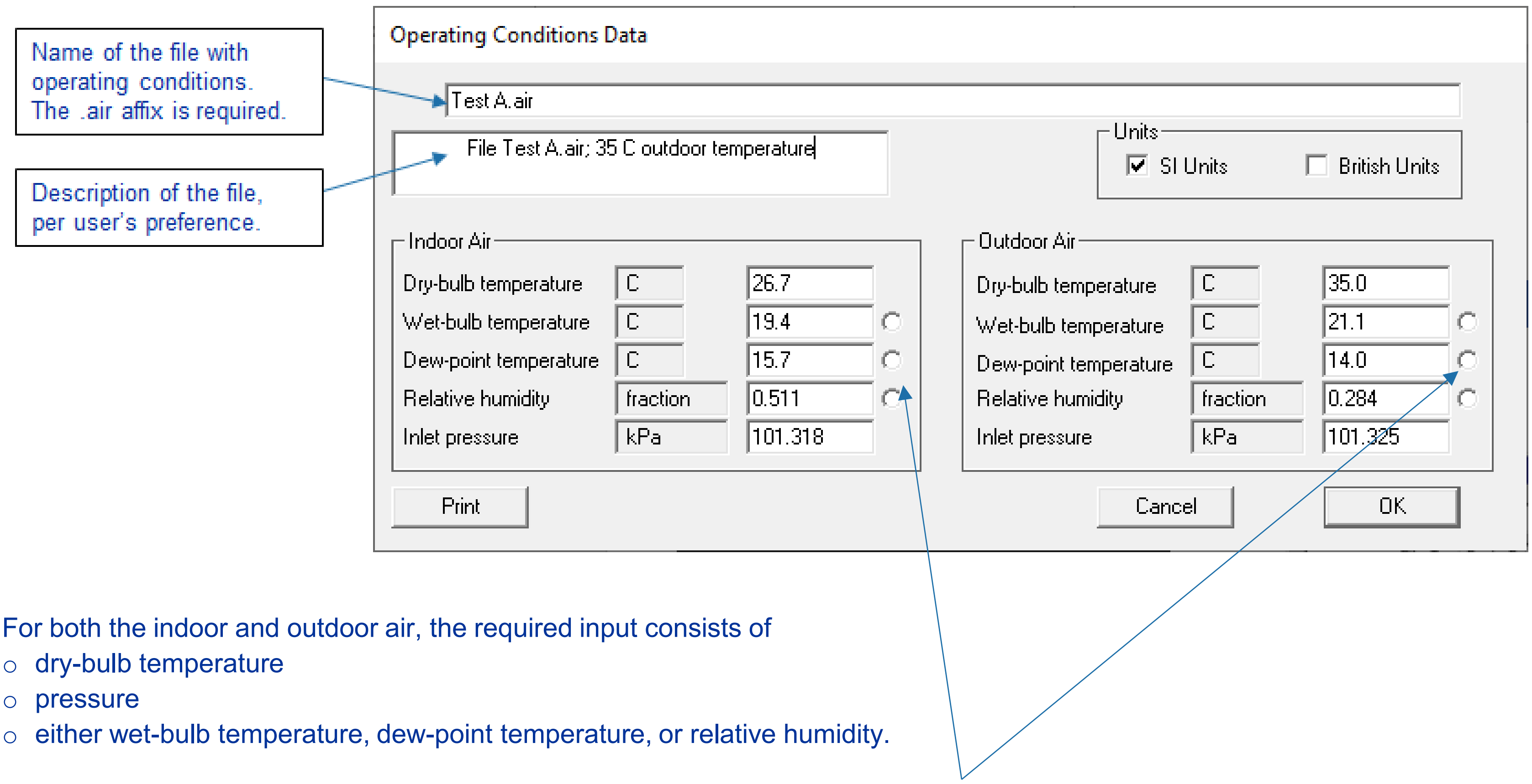
CONNECTING TUBING DATA

This window is for entering design data for the suction line, discharge line, and liquid line. The data for these three lines are saved in one file located in the folder C:>...>Documents>NIST>ACSIM>pip.



OPERATING CONDITIONS

This window is for entering indoor and outdoor air operating conditions. Files with operating conditions are saved in the folder C:>...>Documents>NIST>ACSIM>air.



For both the indoor and outdoor air, the required input consists of

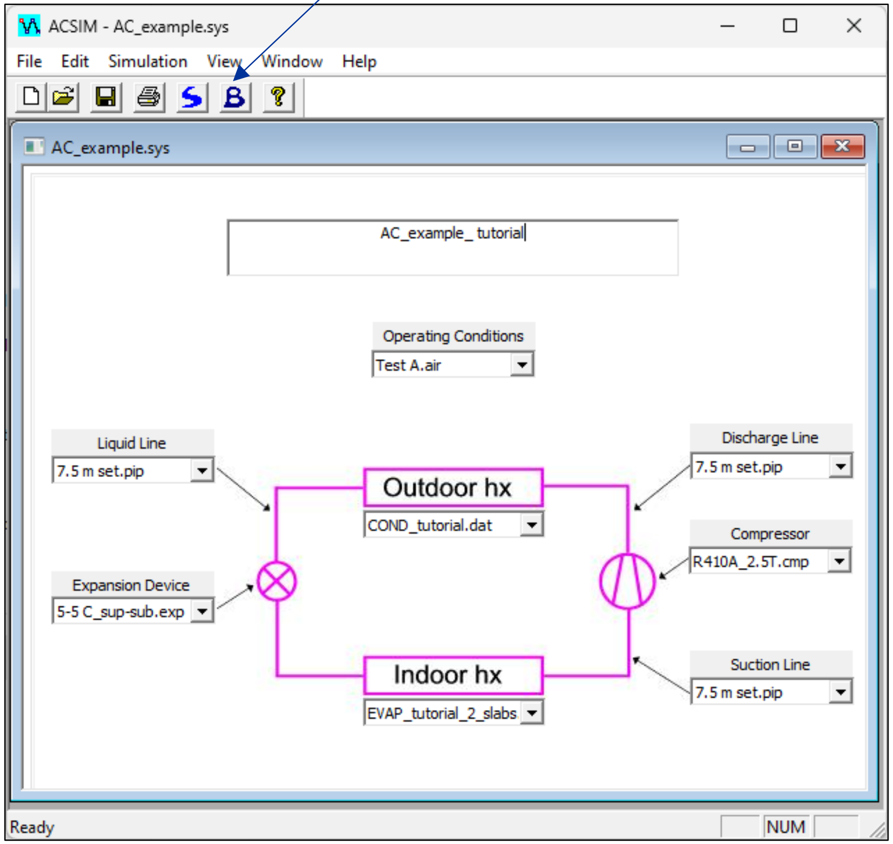
- dry-bulb temperature
- pressure
- either wet-bulb temperature, dew-point temperature, or relative humidity.

After you specified dry-bulb temperature, pressure, and one of the three parameters indicating the moisture content, click with the right button on the entry box of one of the remaining two parameters, and the program will calculate their values.

SET UP A BATCH SIMULATION

The batch simulation option allows executing multiple simulation runs for a given AC system at different operating conditions or for several AC systems that comprise the same outdoor section (compressor, outdoor coil and fan), expansion device, and connecting tubing but use different indoor coils and associated with them indoor fans.

All components for the base system must be selected first in the ACSIM Main Window. Then move to the Batch Simulation window by clicking on the "B" button on the power bar. The Batch Simulation window will open (next page).

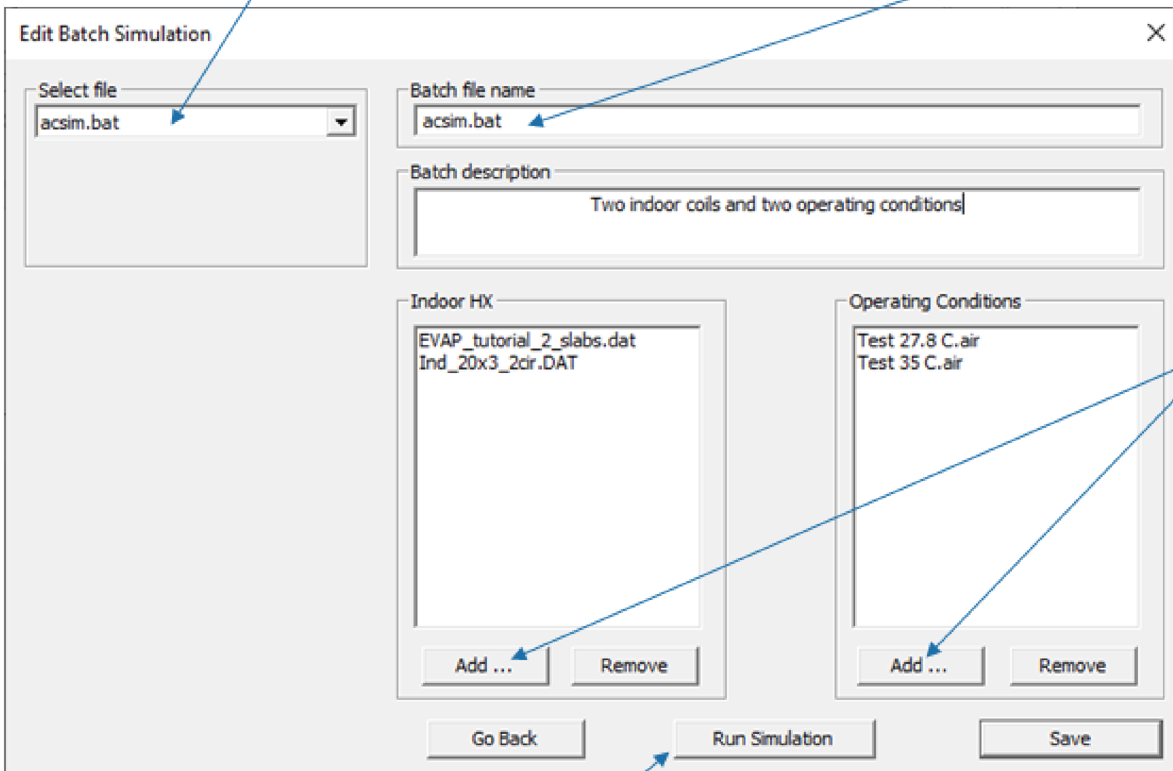


SET UP A BATCH SIMULATION (cont.)

Use sub-windows and buttons for specifying operating conditions and indoor sections; other system components are those that have been specified in the main ACSIM window.

You can select a previously saved batch file and use unchanged or modified

You may store the current batch run information to a file with a name of your choice.

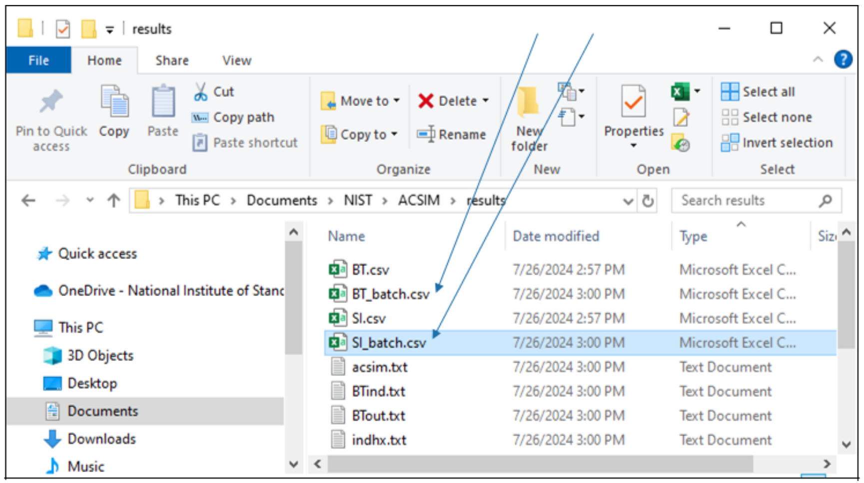


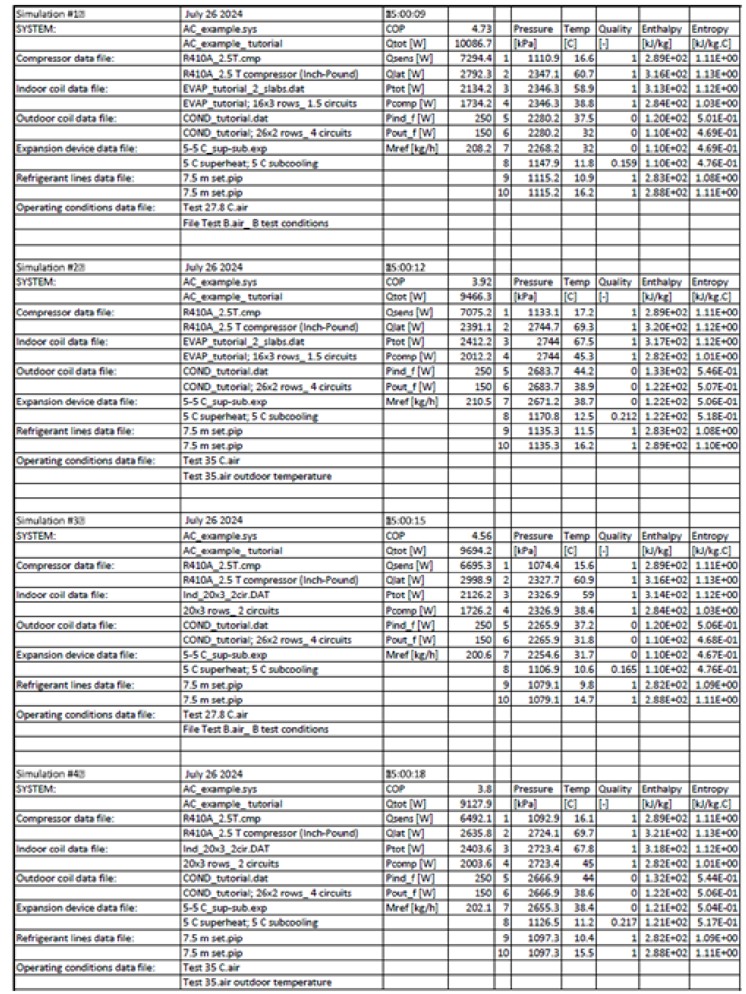
To add an indoor coil or operating condition, click on a respective "Add ..." button. A sub-window will open up showing the list of stored files. Select a file name by clicking on it and then click on the button on the bottom of the sub-window to finalize the selection.

Click on Run Simulation button to start the batch run. Upon completion ACSIM writes simulation results to files SI_batch.csv and BT_batch.csv in the SI and Inch-Pound units, respectively, located in the C:>...> Documents > NIST > ACSIM > results folder.

BATCH SIMULATION RESULTS

Upon completion of a batch simulation run, ACSIM writes SI_batch.csv and BT_batch.csv files with summary of simulation results (for SI and Inch-pound units, respectively) in the folder C:>...>Documents>NIST>ACSIM>results. The user has to move manually to C:>...>Documents>NIST>ACSIM>results to open these files.





Simulation #1	July 26 2024	15:00:09							
SYSTEM:	AC_example.sys	COP	4.73		Pressure	Temp	Quality	Enthalpy	Entropy
	AC_example_ tutorial	Qtot [W]	10086.7		[kPa]	[C]	[-]	[kJ/kg]	[kJ/kg.C]
Compressor data file:	R410A_2.5T.cmp	Qsens [W]	7294.4	1	1110.9	16.6	1	2.89E+02	1.11E+00
	R410A_2.5 T compressor (Inch-Pound)	Qlat [W]	2792.3	2	2347.1	60.7	1	3.16E+02	1.13E+00
Indoor coil data file:	EVAP_tutorial_2_slabs.dat	Ptot [W]	2134.2	3	2346.3	58.9	1	3.13E+02	1.12E+00
	EVAP_tutorial; 16x3 rows_ 1.5 circuits	Pcomp [W]	1734.2	4	2346.3	38.8	1	2.84E+02	1.03E+00
Outdoor coil data file:	COND_tutorial.dat	Pind_f [W]	250	5	2280.2	37.5	0	1.20E+02	5.01E-01
	COND_tutorial; 26x2 rows_ 4 circuits	Pout_f [W]	150	6	2280.2	32	0	1.10E+02	4.69E-01
Expansion device data file:	5-5 C_sup-sub.exp	Mref [kg/h]	208.2	7	2268.2	32	0	1.10E+02	4.69E-01
	5 C superheat; 5 C subcooling			8	1147.9	11.8	0.159	1.10E+02	4.76E-01
Refrigerant lines data file:	7.5 m set.pip			9	1115.2	10.9	1	2.83E+02	1.08E+00
	7.5 m set.pip			10	1115.2	16.2	1	2.88E+02	1.11E+00
Operating conditions data file:	Test 27.8 C.air								
	File Test B.air_ B test conditions								
Simulation #2	July 26 2024	15:00:12							
SYSTEM:	AC_example.sys	COP	3.92		Pressure	Temp	Quality	Enthalpy	Entropy
	AC_example_ tutorial	Qtot [W]	9466.3		[kPa]	[C]	[-]	[kJ/kg]	[kJ/kg.C]
Compressor data file:	R410A_2.5T.cmp	Qsens [W]	7075.2	1	1133.1	17.2	1	2.89E+02	1.11E+00
	R410A_2.5 T compressor (Inch-Pound)	Qlat [W]	2391.1	2	2744.7	69.3	1	3.20E+02	1.12E+00
Indoor coil data file:	EVAP_tutorial_2_slabs.dat	Ptot [W]	2412.2	3	2744	67.5	1	3.17E+02	1.12E+00
	EVAP_tutorial; 16x3 rows_ 1.5 circuits	Pcomp [W]	2012.2	4	2744	45.3	1	2.82E+02	1.01E+00
Outdoor coil data file:	COND_tutorial.dat	Pind_f [W]	250	5	2683.7	44.2	0	1.33E+02	5.46E-01
	COND_tutorial; 26x2 rows_ 4 circuits	Pout_f [W]	150	6	2683.7	38.9	0	1.22E+02	5.07E-01
Expansion device data file:	5-5 C_sup-sub.exp	Mref [kg/h]	210.5	7	2671.2	38.7	0	1.22E+02	5.06E-01
	5 C superheat; 5 C subcooling			8	1170.8	12.5	0.212	1.22E+02	5.18E-01
Refrigerant lines data file:	7.5 m set.pip			9	1135.3	11.5	1	2.83E+02	1.08E+00
	7.5 m set.pip			10	1135.3	16.2	1	2.89E+02	1.10E+00
Operating conditions data file:	Test 35 C.air								
	Test 35.air outdoor temperature								
Simulation #3	July 26 2024	15:00:15							
SYSTEM:	AC_example.sys	COP	4.56		Pressure	Temp	Quality	Enthalpy	Entropy
	AC_example_ tutorial	Qtot [W]	9694.2		[kPa]	[C]	[-]	[kJ/kg]	[kJ/kg.C]
Compressor data file:	R410A_2.5T.cmp	Qsens [W]	6695.3	1	1074.4	15.6	1	2.89E+02	1.11E+00
	R410A_2.5 T compressor (Inch-Pound)	Qlat [W]	2998.9	2	2327.7	60.9	1	3.16E+02	1.13E+00
Indoor coil data file:	Ind_20x3_2cir.DAT	Ptot [W]	2126.2	3	2326.9	59	1	3.14E+02	1.12E+00
	20x3 rows_ 2 circuits	Pcomp [W]	1726.2	4	2326.9	38.4	1	2.84E+02	1.03E+00
Outdoor coil data file:	COND_tutorial.dat	Pind_f [W]	250	5	2265.9	37.2	0	1.20E+02	5.06E-01
	COND_tutorial; 26x2 rows_ 4 circuits	Pout_f [W]	150	6	2265.9	31.8	0	1.10E+02	4.68E-01
Expansion device data file:	5-5 C_sup-sub.exp	Mref [kg/h]	200.6	7	2254.6	31.7	0	1.10E+02	4.67E-01
	5 C superheat; 5 C subcooling			8	1106.9	10.6	0.165	1.10E+02	4.76E-01
Refrigerant lines data file:	7.5 m set.pip			9	1079.1	9.8	1	2.82E+02	1.09E+00
	7.5 m set.pip			10	1079.1	14.7	1	2.88E+02	1.11E+00
Operating conditions data file:	Test 27.8 C.air								
	File Test B.air_ B test conditions								
Simulation #4	July 26 2024	15:00:18							
SYSTEM:	AC_example.sys	COP	3.8		Pressure	Temp	Quality	Enthalpy	Entropy
	AC_example_ tutorial	Qtot [W]	9127.9		[kPa]	[C]	[-]	[kJ/kg]	[kJ/kg.C]
Compressor data file:	R410A_2.5T.cmp	Qsens [W]	6492.1	1	1092.9	16.1	1	2.89E+02	1.11E+00
	R410A_2.5 T compressor (Inch-Pound)	Qlat [W]	2635.8	2	2724.1	69.7	1	3.21E+02	1.13E+00
Indoor coil data file:	Ind_20x3_2cir.DAT	Ptot [W]	2403.6	3	2723.4	67.8	1	3.18E+02	1.12E+00
	20x3 rows_ 2 circuits	Pcomp [W]	2003.6	4	2723.4	45	1	2.82E+02	1.01E+00
Outdoor coil data file:	COND_tutorial.dat	Pind_f [W]	250	5	2666.9	44	0	1.32E+02	5.44E-01
	COND_tutorial; 26x2 rows_ 4 circuits	Pout_f [W]	150	6	2666.9	38.6	0	1.22E+02	5.06E-01
Expansion device data file:	5-5 C_sup-sub.exp	Mref [kg/h]	202.1	7	2655.3	38.4	0	1.21E+02	5.04E-01
	5 C superheat; 5 C subcooling			8	1126.5	11.2	0.217	1.21E+02	5.17E-01
Refrigerant lines data file:	7.5 m set.pip			9	1097.3	10.4	1	2.82E+02	1.09E+00
	7.5 m set.pip			10	1097.3	15.5	1	2.88E+02	1.11E+00
Operating conditions data file:	Test 35 C.air								
	Test 35.air outdoor temperature								

These simulation results were extracted from SI_batch.csv after applying the Excel function Home>Format>AutoFit Column Fit to adjust width of the columns.

REFRIGERANT PROPERTIES

ACSIM uses refrigerant thermophysical properties based on the NIST Standard Reference Data 23; NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 10.0 (https://www.nist.gov/srd/refprop). It can carry out simulations using refrigerant blends with up to six components.

To facilitate fast simulations ACSIM uses refrigerant property look-up tables. They are based on pressure-enthalpy coordinates, can include the supercritical region for high-pressure refrigerants, and cover all thermodynamic and transport properties used in simulations. The look-up scheme includes eight different property routines, which retrieve the desired state or transport property depending on different combinations of available properties identifying the refrigerant's thermodynamic state.

The ACSIM installation module installs files with look-up tables for 16 refrigerants and refrigerant blends: R22, R32, R134a, R290 (propane), R152a, R404A, R407C, R410A, R444A, R450A, R454B, R507A, R513A, R515B, R600a (isobutane) and R1234yf. These files are placed in the folder C:>...>Documents>NIST>ACSIM>table. There are separate files for the evaporator and condenser for each refrigerant covering respective pressure ranges. E.g., for R32, there is a file for the evaporator pressure range, R32.ev, and for the condenser pressure range, R32.cd.

Note: the folder C:>...>Documents>NIST>ACSIM>fluids must be preloaded with REFPROP-compatible files for all fluids used to generate a given look-up table (for a single-component refrigerant or refrigerant blend).

REFRIGERANT-SIDE CORRELATIONS

- Single-phase heat-transfer coefficient, smooth tube: McAdams, described in ASHRAE (2001)
- Evaporation heat-transfer coefficient, smooth tube (selectable in file C:>...>Documents>NIST>ACSIM>hx>evset.txt)
  - 1 - Jung and Didion (1989): up to 80 % quality. For quality range from 80 % to 100 %, linear interpolation between heat transfer coefficient values for 80 % and single-phase saturated vapor.
  - 2 - Thome (2005)
- Evaporation heat-transfer coefficient, rifled tube: The correlation selected for the smooth tube with the 1.9 enhancement multiplier suggested by Schlager et al. (1989).
- Condensation heat-transfer coefficient, smooth tube (selectable in file C:>...>Documents>NIST>ACSIM>hx>cdset.txt)
  - 1 - Travis et al. (1973)
  - 2 - Shah (1979)
- Condensation heat-transfer coefficient, rifled tube: The correlation selected for the smooth tube with a 1.9 enhancement multiplier suggested by Schlager et al. (1989).
- Single-phase pressure drop, smooth tube: Blasius (1911)
- Two-phase pressure drop, smooth tube: Müller-Steinhagen and Heck (1986)
- Return bend pressure drop, single-phase and two-phase, smooth tube: Domanski and Hermes (2008). The length of a return bend depends on the relative locations of the tubes connected by the bend.
- Single-phase and two-phase pressure drops for a rifled tube: smooth tube correlations with a correction accounting for a smaller hydraulic diameter

AIR-SIDE CORRELATIONS

- Heat-transfer coefficient for flat fins: Wang et al. (2000)
- Heat-transfer coefficient for wavy fins: Wang et al. (1999a)
- Heat-transfer coefficient for slit fins: Wang et al. (2001)
- Heat-transfer coefficient for louver fins: Wang et al. (1999b)
- Fin efficiency: Schmidt method, described in McQuiston et al. (1982)

DIAGNOSTIC FILES

Upon completion of a simulation run, the folder C:>...>Documents>NIST>ACSIM>results will contain a text file acsim.txt with a detailed record of the convergence process. In case the run encountered convergence problems, a text file diagx.res will also be written with diagnostic information.

If convergence problems occur in the heat exchangers, they may be eliminated by increasing the number of sections in a tube specified in files C:>...>Documents>NIST>ACSIM>hx>cdset.txt and C:>...>Documents>NIST>ACSIM>hx>evset.txt (accessible by a text editor).

*cdset.txt - Notepad

File Edit Format View Help

```
HTC condensation correlation    ,2          !1=Travis (1973), 2=Shah (1979)
0=No,1=Yes for airflow adjust   ,0          !Adjustment due to temperature change (other than 26.67C)
Number of sections in a tube    ,1          !Tube can be simulated by simulating its smaller sections


File cdset.txt sets control values for the COND
Re: airflow adjustment: It is assumed in the program that air mass flow rate corresponding
to the std. air flow rate was set at the outdoor temperature of 80F (26.67C=299.82K).
No flow adjustment due to temperature is evaluated at Tind=80F.
(Std.Air Condition = temperature is 21.1 C & atm. pressure; see level)
```

Ln 1, Col 51 | 100% | Windows (CRLF) | UTF-8

evset.txt - Notepad

File Edit Format View Help

```
HTC evaporation correlation    ,1          !1=Jung (1989), 2=Thome (2005)
0=N,1=Y for airflow adjustment ,0          !Adjustment due to temperature change and condensate or frost
Number of sections in a tube   ,1          !Tube can be simulated by simulating its smaller sections

File evset.txt sets control values for the EVAP
Re: airflow adjustment: It is assumed in the program that air mass flow rate corresponding
to the std. air flow rate was set in the cooling mode for Tind=80F (26.67C=299.82K).
No flow reduction due to temperature is evaluated at Tind=80F.
(Std.Air Condition = temperature is 21.1 C & atm. pressure; see level)
```

Ln 1, Col 1 | 100% | Windows (CRLF) | UTF-8

LIMITATIONS OF ACSIM

- Expansion devices are limited to thermostatic expansion valves and electric expansion valves maintaining a constant superheat.
- Compressors are limited to those for which ANSI/AHRI Standard 540 compressor maps are available.
- Heat exchanger limitations:
  - Maximum number of tubes in the heat exchanger: 130
  - Maximum number of tubes in a depth row: 50
  - Maximum number of tube depth rows: 5
  - Maximum number of tube merged to (or split from) one tube: 4
  - Maximum difference between the number of tubes in different depth rows: 1
  - No merging refrigerant points in the evaporator circuitry; no split circuitry points in the condenser
  - Maximum number of tube merged to (or split from) one tube: 4
  - Minimum refrigerant temperature in the evaporator: 0 ºC (no frosting)

- ACSIM validation

  Model validation is documented in Domanski et al.(2023), Section 4.7 and Appendix A4, using laboratory tests of an Environmental Control Unit. The test program included four tests prescribed by the indoor condition of 26.7 °C drybulb and 15.8 °C dewpoint and by the outdoor conditions prescribed by 27.8 °C, 35.0 °C, 46.1 °C, and 51.7 °C drybulb temperatures controlled in environmental chambers. Four refrigerants were used: R-134a, R-515B, R-134a/1234yf,1234ze(E) (49.2/33.9/16.9 mass fraction (%)), and R-513A.

  For the above test metrics, the discrepancy between the measured and predicted values for system capacity was in the range from – 5.7 % and 3.8 %. For the coefficient of performance, the discrepancy between the measured and predicted values was in the range from -7.1 % to 6.3 %.

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COMMENTS

SUGGESTIONS

QUESTIONS

?

Please submit your comments on ACSIM to:

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