December 4, 2020

Instructions for generating and implementing look-up tables with refrigerant thermophysical properties in EVAP-COND Ver. 5.0

EVAP-COND uses refrigerant property look-up tables to facilitate fast simulations. The tables provide all thermodynamic and transport properties. The look-up scheme includes eight different property routines to retrieve the desired state or transport property depending on the properties identifying the refrigerant's thermodynamic state. The tables are based on pressure-enthalpy coordinates and can cover the supercritical region for high-pressure refrigerants. The tables for 23 refrigerants included in the EVAP-COND installation package were generated using TableGen2.exe, a stand-alone program, which is based on property routines contained in REFPROP (Lemmon et al., 2018).

EVAP-COND uses separate look-up tables with different low- and high-pressure limits for EVAP (evaporator model) and COND (condenser model). Except for R744 (carbon dioxide), the evaporator property look-up tables cover the -32 °C to +28 °C (-25.6 °F to 84.2 °F) range of bubble-point temperatures. For condenser simulations, the temperature range is approximately 10 °C to 70 °C (50 °F to 158 °F) for all fluids except R507A (10 °C to 68.5 °C; 50 °F to 155.3 °F) and R32, R404A, R410A and R744, for which the table extends to the supercritical region. If EVAP or COND calls for a refrigerant property that is outside the bounds of the look-up table, this property is calculated by REFPROP routines.

To expand the list of refrigerants available in EVAP-COND, you need to generate separate look-up tables for EVAP and COND and copy them to four EVAP-COND folders.

Steps to generate a loop-up table

- Execute TableGen2.exe
  Locate TableGen2.exe in the folder and execute it is by clicking on it with the left mouse key. The main screen of the table generator will open (Figure 1).

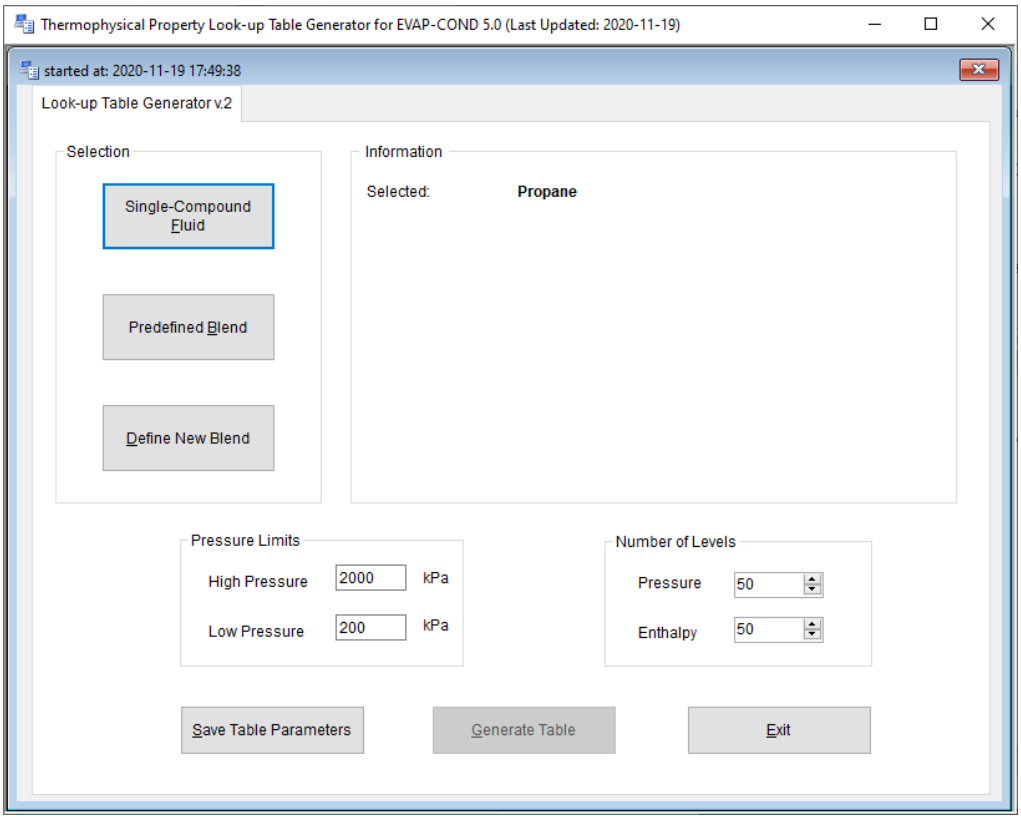

Figure 1. TableGen2.exe main window

- Select refrigerant
  A selected refrigerant can be a single-compound fluid, predefined mixture, or a mixture the user wants to define. In this example, we will select this last option. After clicking on the 'Define New Blend' button, a new window will open for selecting blend components (Figure 2). Select each component by clicking on it with the left mouse key and follow by clicking on the 'Add' button. Up to six components can be selected. Click on the 'OK' button when all components have been selected and appeared on the right-side window. A 'Specify Blend Composition' window will open (Figure 3).

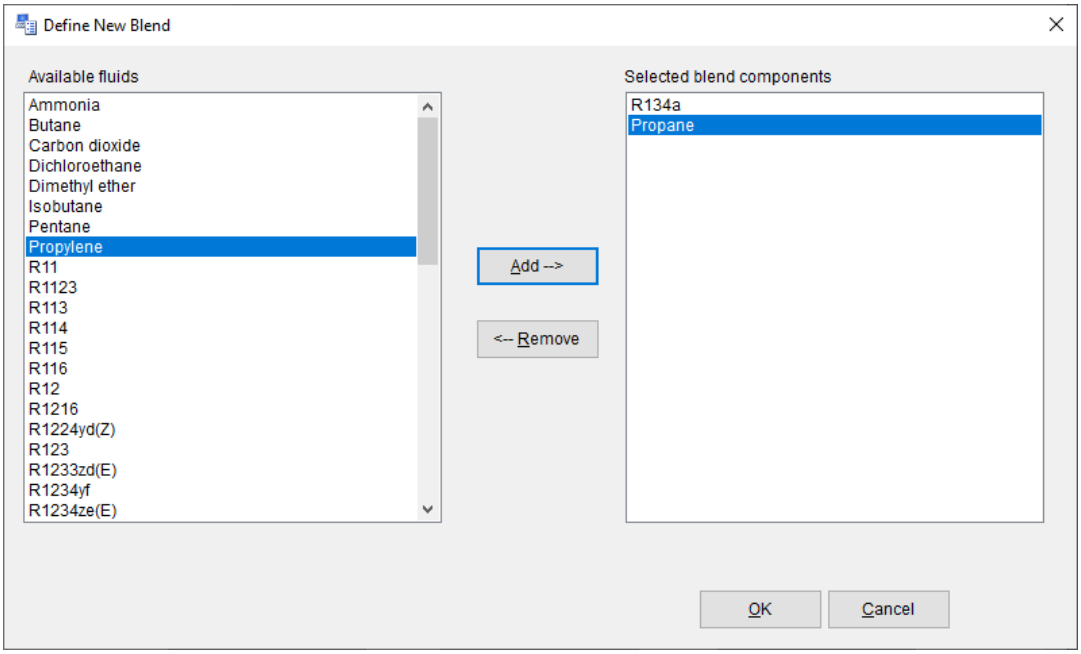

Figure 2. 'Define New Blend' window

- Specify blend composition
  Adjust the mass or molar fraction by placing the cursor in a proper box and entering the desired value.

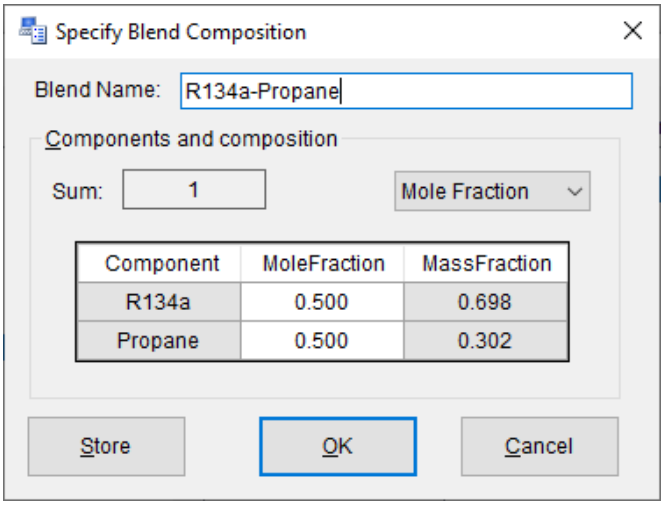

Figure 3. 'Specify Blend Composition' window

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- Store the blend for future simulations (optional).
  After clicking on the 'Store' button, a generic 'Save As' window will open (Figure 4). Enter the name for the new blend. You can specify any name with up to 20 characters, letters and numbers only (no special characters). After clicking on the 'Save' button, the program will return to the main window (Figure 5).

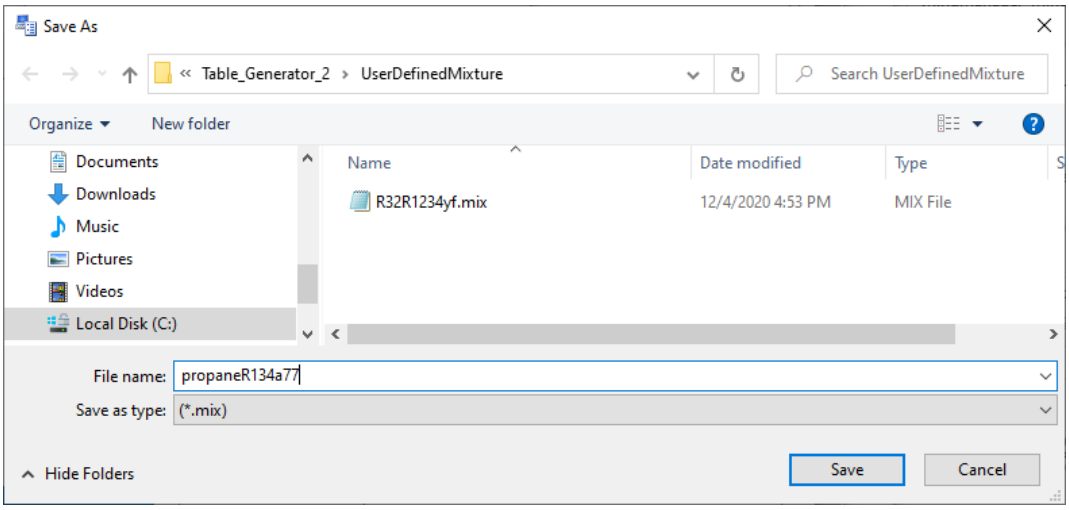

Figure 4. 'Save As' window

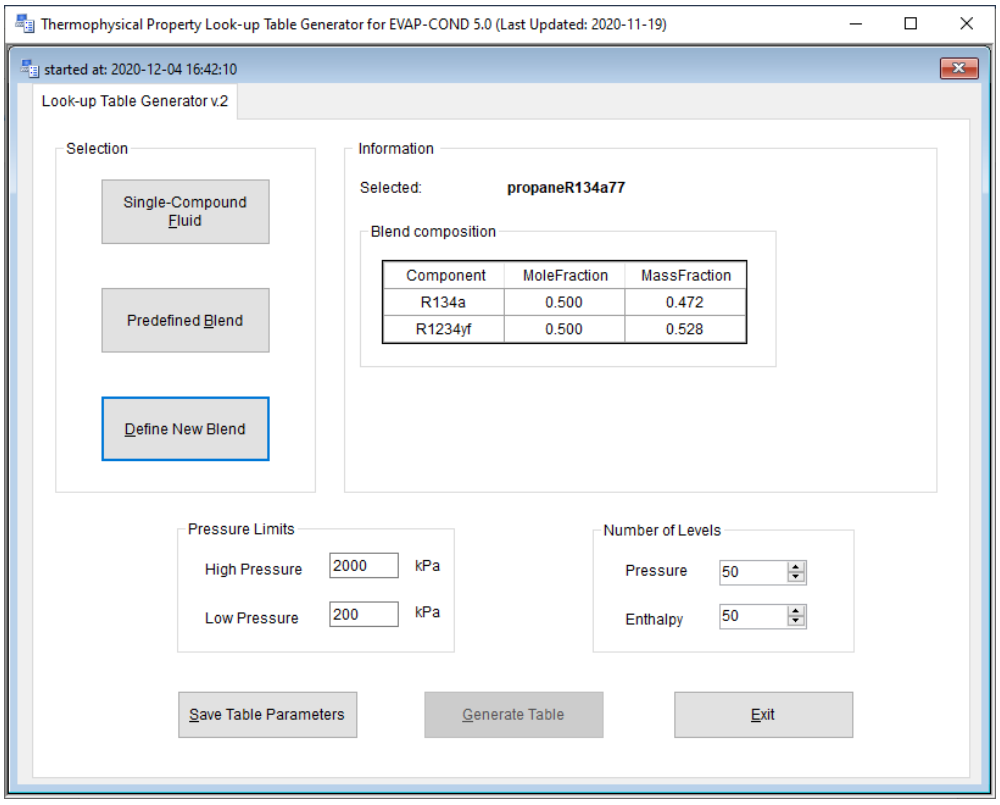

Figure 5. Main window after blend selection

- Specify table parameters
  a) Pressure limits
  Enter values for high- and low-pressure limits in respective boxes.

Note: The pressure limits used for blends included in the EVAP-COND package were selected to cover the operating regime considered to be suitable for broad applications. A user may be interested in other operating conditions and may prefer different pressure limits. In such a case, the user may generate a new table and replace the one provided in the EVAP-COND package.

b) Number of pressure and enthalpy levels
The granularity of table grid is determined by the number of pressure levels and enthalpy levels. Enter the values in respective boxes. The maximum number of pressure levels is 150, and the maximum number of enthalpy levels is 100.

To limit the size of EVAP-COND installation package, the look-up tables included in the package were generated with the following entries:

Pressure levels:
- 50 for look-up tables with properties under the critical point
- 75 for condenser look-up tables extending above the critical point (R32, R404A, R410A and R744).

Enthalpy levels:
- 50 for all single-compound fluids, azeotropic blends and zeotropic blends with a two-phase temperature glide below 1 K (1.8 °F) at the normal boiling point
- 75 for zeotropic blends with a two-phase temperature glide greater than 1 K (1.8 °F) at the normal boiling point.

An EVAP-COND user may choose to use higher numbers for pressure and enthalpy levels for refrigerants of particular interest.

- Save Table Parameters
  Click on the 'Save Table Parameters' button.

- Generate Table
  Click on the 'Generate Table' button. A DOS window will open showing the progress of calculations (Figure 6). Follow the command "Press 'Enter' key to exit…".
  The table has been generated and written to propaneR134a77.txt file located in the default folder, where 'propaneR134a77' is the name we gave to the blend earlier in this example (Figure 7).

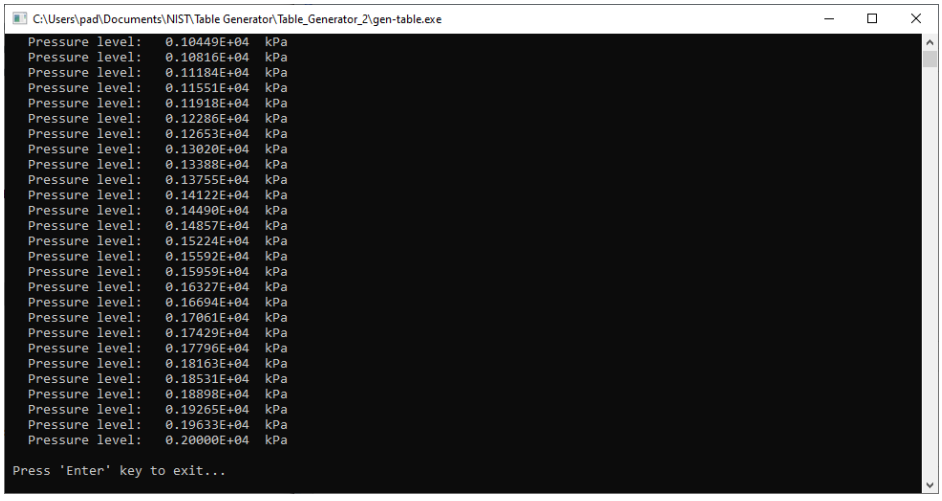

Figure 6. DOS window showing progress of table generation

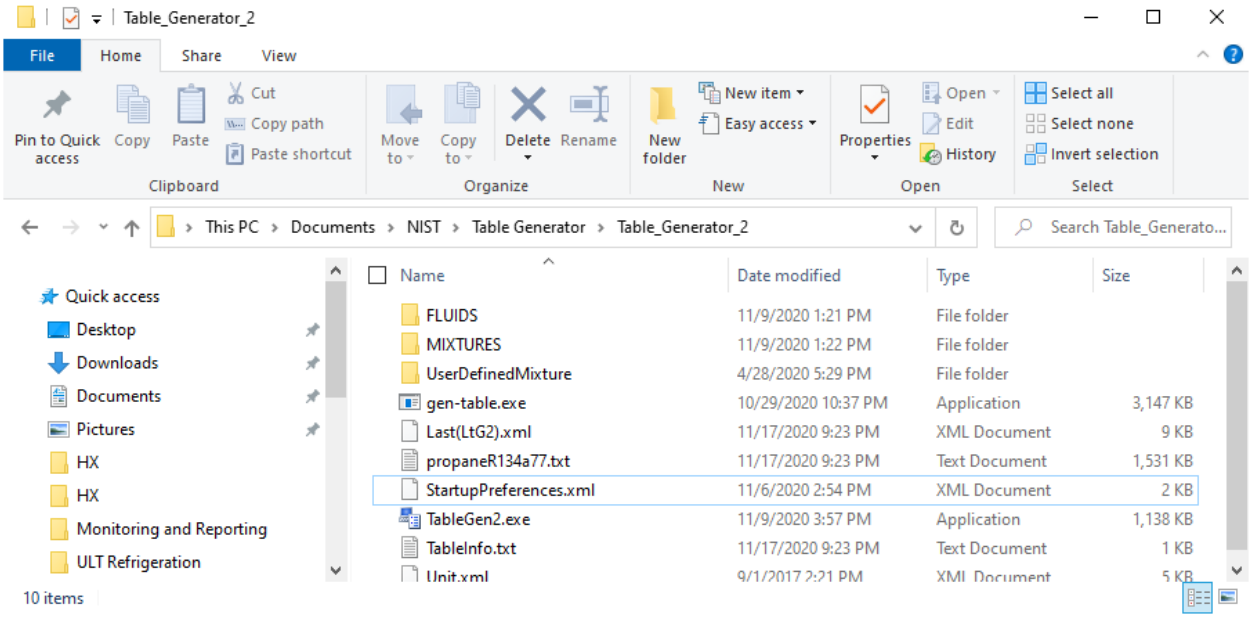

Figure 7. TableGen2 folder with a generated look-up table propaneR134a77.txt

EVAP-COND's name convention requires loop-up table files to have extensions 'ev' and 'cd' for EVAP and COND, respectively. If the table is intended for use by EVAP, you need to change manually the 'txt' extension to 'ev'; in this example the name of the file will be propaneR134a77.ev. For use by COND, the name of the file would be propaneR134a77.cd.

Implementation of look-up tables in EVAP-COND

To add a new refrigerant or refrigerant blend to EVAP-COND, you need to generate look-up tables for both the evaporator and condenser and copy these files to three TABLE folders. Figure 8 shows the location of these folders in the EVAP-COND folder structure. EVAP-COND must not be running during the copying process. Names of the look-up table files must conform to the EVAP-COND convention stated above. On the program start up after the copying is complete, EVAP-COND may take 15 seconds to update itself to a new content of TABLE folders.

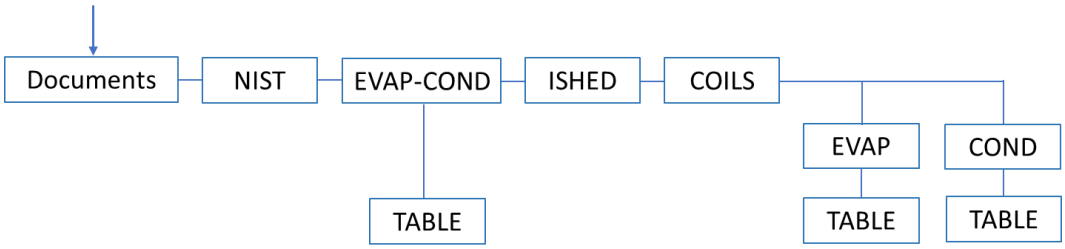

Figure 8. EVAP-COND folder structure

Reference

Lemmon, E. W., Bell, I.H., Huber, M. L., McLinden, M. O., 2018. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties – REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, Maryland, U.S.A.