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).

and thermophysical Prop	erty Look-up Table Gene	rator for EVA	P-CON	ND 5.0 (Last Updated:	2020-11-19)		-	×
📲 started at: 2020-11-1	9 17:49:38							×
Look-up Table Gene	erator v.2							
Selection		Informat	tion —					
Single-(<u>E</u>	Compound [luid	Selecte	d:	Propane				
Predefi	ned <u>B</u> lend							
<u>D</u> efine I	New Blend							
	Pressure Limits				-Number of Lev	els		
	High Pressure	2000	kPa		Pressure	50 🗘		
	Low Pressure	200	kPa		Enthalpy	50 🜩		
	Save Table Paramete	rs		<u>G</u> enerate Table		<u>E</u> xit		

Figure 1. TableGen2.exe main window

• <u>Select refrigerant</u>

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).

	3	elected blend components	
Ammonia Butane Carbon dioxide Dichloroethane Dimethyl ether isobutane Pentane Propylene R11 R1123 R113 R114 R115 R114 R115 R124 R126 R1224yd(Z) R123 R1233zd(E) R1234yf R1234ze(E)	<u>A</u> dd> < <u>R</u> emove	R134a Propane	

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.

📲 Sp	Specify Blend Composition								
Blend Name: R134a-Propane									
Components and composition									
Su	Sum: 1 Mole Fraction ~								
	Component MoleFraction MassFraction								
	R134a	0.500	0.698						
	Propane 0.500 0.302								
	<u>S</u> tore	<u>0</u> K	<u>C</u> ancel						

Figure 3. 'Specify Blend Composition' window

• <u>Store the blend for future simulations</u> (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).

ave As						×
$\leftrightarrow \rightarrow \uparrow \uparrow$	« Table_Generator_2	> UserDefinedMixture	~	Q, O	Search User	DefinedMixture
Organize 🔻 Ne	w folder					· · · · · · · · · · · · · · · · · · ·
Documents	^	Name	Da	te modified	Тур	be
 Downloads Music Pictures Videos 	_	R32R1234yf.mix	12,	/4/2020 4:53	PM ME	X File
Local Disk (C:	·)	<				3
File name:	propaneR134a77					~
Save as type:	(*.mix)					~
∧ Hide Folders					Save	Cancel

Figure 4. 'Save As' window

Thermophysical Property Look-up Ti	able Generator for EVAP-CC)ND 5.0 (I	ast Updated: 202.	0-11-19)		_	×
📲 started at: 2020-12-04 16:42:10							×
Look-up Table Generator v.2							
Selection	Information						
Single-Compound <u>F</u> luid	Selected: Blend comp	position	propaneR134a7	77			
	Comp	onent	MoleFraction	MassFracti	on		
Predefined <u>B</u> lend	R13	4a	0.500	0.472			
	R12	54yı	0.500	0.526			
Define New Blend							
Pressure Lin	nits		N	lumber of Level	S		
High Pres	sure 2000 kPa			Pressure	50 ≑		
Low Press	sure 200 kPa			Enthalpy	50		
<u>S</u> ave Table F	arameters	<u>G</u> ener	ate Table		<u>E</u> xit		

Figure 5. Main window after blend selection

• <u>Specify table parameters</u>

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 $^{\circ}$ 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.

- <u>Save Table Parameters</u> 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).

C:\Users\pad\Document	s\NIST\Table Genera	tor/Table_Generator_2\gen-table.exe -	- 🗆	×
Pressure level:	0.10449E+04	kPa		^
Pressure level:	0.10816E+04	kPa		
Pressure level:	0.11184E+04	kPa		
Pressure level:	0.11551E+04	kPa		
Pressure level:	0.11918E+04	kPa		
Pressure level:	0.12286E+04	kPa		
Pressure level:	0.12653E+04	kPa		
Pressure level:	0.13020E+04	kPa		
Pressure level:	0.13388E+04	kPa		
Pressure level:	0.13755E+04	kPa		
Pressure level:	0.14122E+04	kPa		
Pressure level:	0.14490E+04	kPa		
Pressure level:	0.14857E+04	kPa		
Pressure level:	0.15224E+04	kPa		
Pressure level:	0.15592E+04	kPa		
Pressure level:	0.15959E+04	kPa		
Pressure level:	0.16327E+04	kPa		
Pressure level:	0.16694E+04	kPa		
Pressure level:	0.17061E+04	kPa		
Pressure level:	0.17429E+04	kPa		
Pressure level:	0.17796E+04	kPa		
Pressure level:	0.18163E+04	kPa		
Pressure level:	0.18531E+04	kPa		
Pressure level:	0.18898E+04	kPa		
Pressure level:	0.19265E+04	kPa		
Pressure level:	0.19633E+04	kPa		
Pressure level:	0.20000E+04	kPa		
Press 'Enter' key t	o exit			~

Figure 6. DOS window showing progress of table generation

📙 🛛 🛃 🔻 🗌 Table	_Generator_2					- 🗆	×
File Home	Share View						^ ?
Pin to Quick Copy access	Cut A Cut M Copy path Paste Paste shortcut	Move Copy to * Copy	New item ▼ ↑ New folder	Properties	Open → S Edit :: S History :: In	elect all elect none nvert selection	
CI	ipboard	Organize	New	Open		Select	
← → × ↑ 📙 > This PC > Documents > NIST > Table Generator > Table_Generator_2 v 👌 🔎 Search Table_Generat							nerato
	^	Name ^	Date modifie	ed T	ype	Size	^
 Quick access Desktop Downloads 	A A	FLUIDS MIXTURES UserDefinedMixture	11/9/2020 1:. 11/9/2020 1:. 4/28/2020 5:.	21 PM F 22 PM F 29 PM F	ile folder ile folder ile folder		
Documents	*	📧 gen-table.exe	10/29/2020 1	0:37 PM A	pplication	3,147	KB
Pictures	*	Last(LtG2).xml	11/17/2020 9	:23 PM X	ML Document	9	KB
HX		propaneR134a77.txt	11/17/2020 9	:23 PM T	ext Document	1,531	KB
HX		StartupPreferences.xml	11/6/2020 2:	54 PM X	ML Document	2	KB
 Monitoring	and Reporting	ableGen2.exe	11/9/2020 3:	57 PM A	pplication	1,138	KB
	ration	TableInfo.txt	11/17/2020 9	:23 PM T	ext Document	1	КВ
10 items	V V	🗋 Unit.xml	9/1/2017 2:27	1 PM X	MI Document	5	KB ×

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.