Using CoolProp

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Evaluating Thermodynamic and Transport Properties - CoolProp

- The National Institute of Standards and Technology (NIST) has a primary function to develop and disseminate Standard Reference Data (SRD) for the thermo-physical properties of fluids and fluid mixtures of interest to the industrial and scientific communities.

- SRD for fluids can be obtained from NIST Reference Fluid Thermodynamic and Transport Properties Database (NIST-REFPROP) – Cover wide range of fluids and mixtures, but fee based.

- NIST SRD for some pure fluids is implemented in CoolProp.

- CoolProp is a C++ library that implements - Pure and pseudo-pure fluid equations of state and transport properties for 122 components (including Helium, Nitrogen, Hydrogen, Methane etc.) Complete list of fluids can be found in –

  http://www.coolprop.org/fluid_properties/PurePseudoPure.html#list-of-fluids

Evaluating Thermodynamic and Transport Properties - CoolProp

- CoolProp at its core is a C++ library, but it can be of interest to use this library from other programming/software environments. For that reason, wrappers have been constructed for most of the programming languages of technical interest to allow users to interface CoolProp.

- In this class, we will be using CoolProp (add-in) with MS-Excel.

- Executable Installer can be downloaded from:

https://sourceforge.net/projects/coolprop/files/CoolProp/6.4.1/Installers/Windows/

Using CoolProp

- MS-Excel function

  =PropsSI(Output, Input_1, Value_1, Input_2, Value_2, Fluid)

- Complete list of fluids can be found in –
  http://www.coolprop.org/fluid_properties/PurePseudoPure.html#list-of-fluids

- For example,

  =PropsSI("T","P",101325,"Q",0,"Helium")

provides the saturation temperature of helium at 1.0 atm (101325 Pa) pressure.

- MS-Excel function

  =Props1SI(Trivial_Output, Fluid)

provides the fluid constants (molar mass, critical parameters etc.)

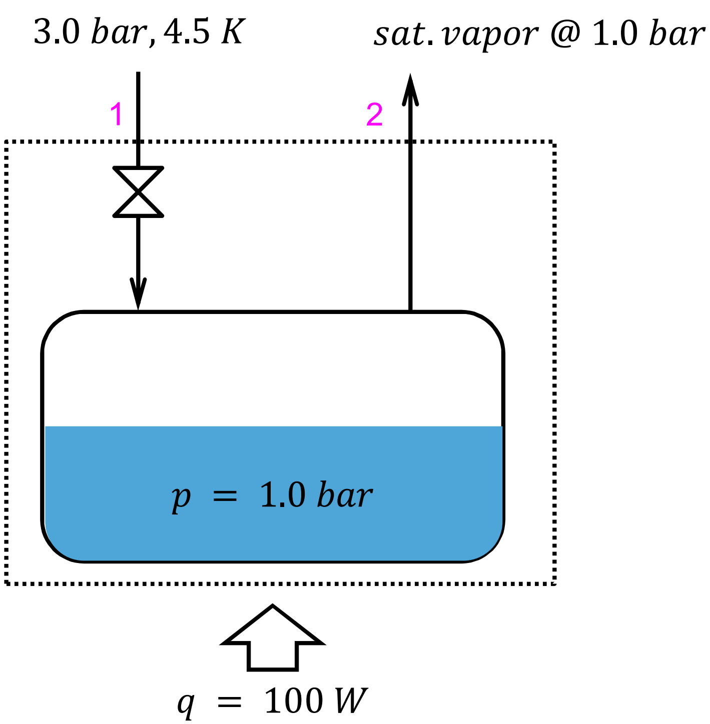
Using CoolProp (Contd.)

Some common parameters

Parameter	Description	Unit
P	Pressure	[Pa]
T	Temperature	[K]
Q	Vapor Quality	[-]
D	Mass Density	[kg/m^3]
S	Mass Specific Entropy	[J/kg-K]
H	Mass Specific Enthalpy	[J/kg]
U	Mass Specific Internal Energy	[J/kg]
C	Mass Specific Constant Pressure Specific Heat	[J/kg-K]
CVMASS	Mass Specific Constant Volume Specific Heat	[J/kg-K]
Z	Compressibility Factor	[-]

- Complete list of parameters (Inputs, Outputs) can be found in – *http://www.coolprop.org/coolprop/HighLevelAPI.html#parameter-table*

Using CoolProp



- Calculate the mass flow required to support the load (q). (*assume balance of mass across the CV*)

From the CV Energy balance –

$$q + \dot{m}h_1 = \dot{m}h_2$$
$$q = \dot{m}(h_2 - h_1)$$

h_2 = PropsSI("H","P",100000,"Q",1,"Helium")
= 20648.05 J/kg

h_1 = PropsSI("H","P",300000,"T",4.5,"Helium")
=1721.68 J/kg

$$\dot{m} = \frac{q}{(h_2 - h_1)} = \frac{100}{20648.05 - 1721.68} = 5.28 \times 10^{-3}\,\frac{kg}{s}$$

	A	B	C	D
1				
2	q	100.00	[W]	
3	h_2	20648.05	[J/kg]	=PropsSI("H","P",100000,"Q",1,"Helium")
4	h_1	1721.68	[J/kg]	=PropsSI("H","P",300000,"T",4.5,"Helium")
5	ṁ	5.28E-03	[kg/s]	=B2/(B3-B4)