

Property Tables and Arrays

Many thermodynamics problems will require the use of a property table. The easiest way to build a property table in EES is to use arrays. Creating an array element in EES is as simple as defining a variable and corresponding element number.

```
{We would like to define a "Pressure" array}  
{The Pressure at State 1 Can Be Defined As.....}  
P[1] = 101.3[kpa]
```

Figure 1: Array Element 1 is defined

```
{We would like to define a "Pressure" array}  
{The Pressure at State 1 Can Be Defined As.....}  
P[1] = 101.3[kpa]
```

```
{There Are 4 States In This System, We Now Need To Define The Other Pressure Array  
Variables}  
P[2] = 160[kPa]  
P[3] = 140[kPa]  
P[4] = 120[kPa]
```

Figure 2: "Pressure Array" is defined (4 states).

One might wonder if there's a quicker way to enter array values in EES. A quick way to enter array values can be seen in the following example. This example shows a temperature and quality array.

```
{We would like to Add Temperatures to Our Property Table}  
{There's A Quick Way of Writing Multiple Array Variables....}  
{Use The Following.....}  
  
T[1..4] = [20,40,35,30] {Temperature Array}  
X[1..4] = [.8, .75,.78,.79] {Quality Array}
```

Figure 3: Quick syntax for arrays.

At this point, a properties table can be created using the known information. Since we aren't solving for any unknowns, the solve button can be pressed, and an "arrays table" will pop up on the screen. The units for each variable can be set by right clicking on the variable at the top of the arrays table, and the different arrays can be organized by dragging and dropping.

Sort	1	2	3	4
	P _i [kpa]	T _i [C]	X _i	
[1]	101.3	20	0.8	
[2]	160	40	0.75	
[3]	140	35	0.78	
[4]	120	30	0.79	

Figure 4: Properties table showing 4 states.

The fluid property functions can use array variables to calculate densities, enthalpies, etc. Since we have the temperature and pressure defined at all states, we can now calculate the density at each state. The density functions and resulting property table can be seen in the following figure.

```

{Fluid Properties Can Use Array Variables To Define a Density Array}
{Since The Temperature and Pressure of The Water Are Defined.....}
{Calculate The Fluid Properties Using Temperature and Pressure Array Variables}
rho[1]=Density(Steam_IAPWS,T=T[1],P=P[1])
rho[2]=Density(Steam_IAPWS,T=T[2],P=P[2])
rho[3]=Density(Steam_IAPWS,T=T[3],P=P[3])
rho[4]=Density(Steam_IAPWS,T=T[4],P=P[4])

```

Sort	1	2	3	4
	P _i [kpa]	T _i [C]	X _i	ρ _i [kg/m ³]
[1]	101.3	20	0.8	998.2
[2]	160	40	0.75	992.2
[3]	140	35	0.78	994.1
[4]	120	30	0.79	995.7

Figure 5: Properties Table Using Density Call-up and Temperature and Pressure Array Variables.

Any array variable can be renamed and pulled into the solutions menu. Let's say that we want to print several values to the solutions screen to build a key variables list. This is also a quick way to present converted units! An example of this is as follows....

```

{Each Element or Array Variable Is Defined As A Number}
{Sometimes It's Beneficial To Bring These Values Into The Solutions Menu}
{Lets Say I Want To Print Several Elements To The Solutions Screen...}
{To Do This.....}
T_1 = T[1] {Temperature At State 1, Pulls Element out And Places On Solutions Screen}
P_1 = P[1] {Pressure At State 1, Brings To Solutions Screen}
rho_1 = rho[1]*convert(kg/m^3,lb_m/ft^3) {Converts Element To Different Units}

```

Unit Settings: SI C kPa kJ mass deg

P₁ = 101.3 [kpa] ρ₁ = 62.32 [lb_m/ft³] T₁ = 20 [C]

Figure 6: Calling array variables into solutions menu.

Duplicate loops are very useful when solving for multiple properties at once. A duplicate loop duplicates as many times as the user specifies. The following example only uses one element (enthalpy) that is duplicated, but any number of other elements can be added and solved for.

Sort	¹ P _i [kpa]	² T _i [C]	³ X _i	⁴ ρ _i [kg/m ³]	⁵ h _i [kJ/kg]
[1]	101.3	20	0.8	998.2	84.01
[2]	160	40	0.75	992.2	167.7
[3]	140	35	0.78	994.1	146.8
[4]	120	30	0.79	995.7	125.8

```

Duplicate i = 1,4 {Duplicates Loop 4 Times}
{NOTE: EACH CHANGING VALUE IN DUPLICATE LOOPS MUST BE DEFINED}
{Since Enthalpy, Temp, and Pressure Are Changing, Each Variable Is Followed By "i"}
{j,k, or other can be used as well, and multiple loops can be used}
h[i]=Enthalpy(Steam_IAPWS,T=T[i],P=P[i]) {Calculates Enthalpy Values}
END {Closes Duplicate Loop}

```

Figure 7: Writing a duplicate loop to add enthalpy to properties table.