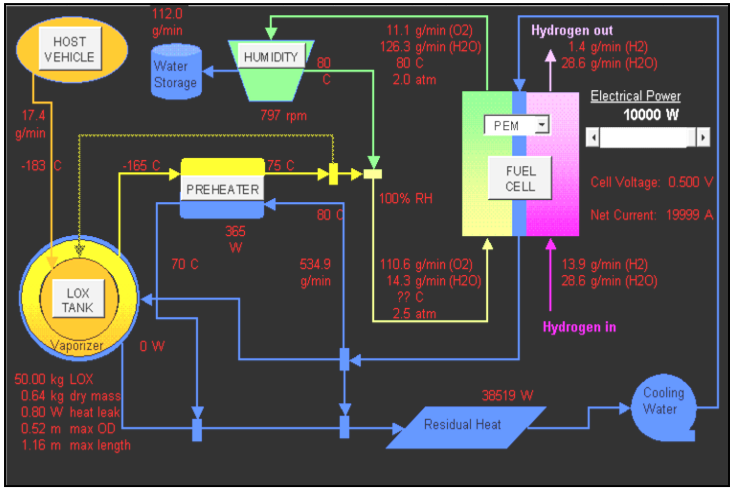
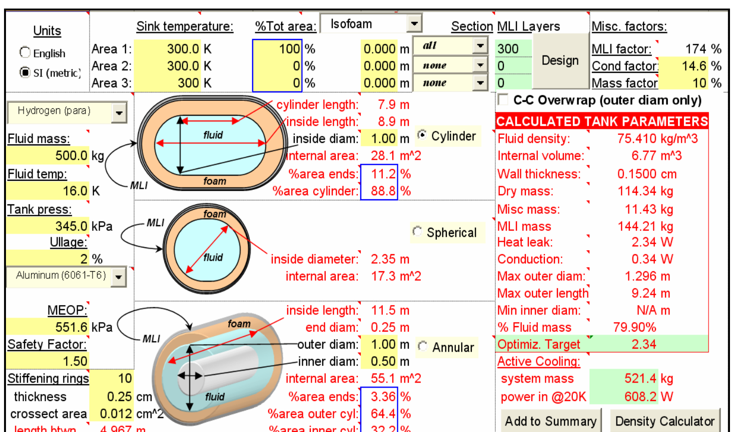
Isotherm Technologies
(isothermtech.com)

Test Your Excel VBA Skills: 8 Engineering Exercises





These course exercises and application examples are from the 2-day short course "Engineering Analysis & Modeling with Excel-VBA". The complete set of notes are available in paperback and kindle formats on Amazon. In-depth details are presented on principles, practices, and implementation of Excel and its integrated programming environment, Visual Basic for Applications (VBA), for analysis and creating engineering models.

The exercise problems in each section build upon the previous exercises to demonstrate new techniques. To obtain completed exercises and other helpful Excel-VBA resources, visit: www.isothermtech.com

 excerpts from: Engineering Analysis & Modeling with Excel-VBA: Course Notes

Isotherm Technologies
(isothermtech.com)

Exercise 1: Convection Sheet

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)

E10 =IF(Reynolds_number<2300,"Laminar","Turbulent")

DESCRIPTION:
Forced convection heat transfer for internal fully developed turbulent flow

ASSUMPTIONS:
1. Fully developed turbulent flow
2. Smooth pipe walls
3. Constant properties at the bulk temp.

REFERENCE:
Lienhard, A Heat Tranfer Text, 3rd ed., 2006, p360

EQUATIONS:

$$Nu = \frac{hD}{k} = \frac{(f/8)(\mathrm{Re}-1000)\,\mathrm{Pr}}{1+12.7\sqrt{f/8}\,(\mathrm{Pr}^{2/3}-1)}$$

for

$$2300 \le \mathrm{Re} \le 5x10^6$$

$$f = \frac{1}{(1.82\log_{10}\mathrm{Re}-1.64)^2}$$

$$\mathrm{Re} = \frac{uD}{\nu}$$

INPUTS			
D	Pipe diameter	0.05	m
T_b	Bulk temp	40	C
k	Fluid conductivity	0.633	W/m-C
Pr	Prandtl number	4.3	
u	Fluid velocity	1	m/s
ν	Kinematic viscosity	6.58E-07	m^2/s

OUTPUTS			
Re	Reynolds number	7.60E+04	Turbulent
Nu	Nusselt number		
h	Heat transfer coeff		W/m^2-C

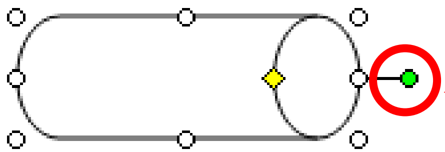
Pipe Heat Transfer

1. Draw the graphics
2. Add the sheet name, description, assumptions, & reference
3. Set up the inputs & outputs (I/O) as shown and define the cell names
4. Use standard cell equation and the built-in "IF" function to check flow regime
5. Format the cells (fill, border, etc.)
6. Start documenting the equations

Isotherm Technologies (isothermtech.com)

Exercise 1: Convection Sheet - Hints

- Resize the "A" column by dragging the separator line to make room for the graphics



- Use the cylinder ("can") from the menu and use the green edit circle to rotate it (optional: add black "hole" at pipe end)
- Use the arrow icon to add flow arrows
- Experiment with the Equation Editor:
  - Fraction notation
  - Subscript & superscripts

EQUATIONS:

$$Nu = \frac{hD}{k} = \frac{(f/8)(\mathrm{Re}-1000)\,\mathrm{Pr}}{1+12.7\sqrt{f/8}(\mathrm{Pr}^{2/3}-1)}$$

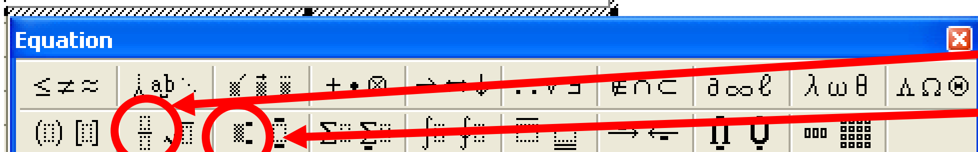
for

$$2300 \le \mathrm{Re} \le 5x10^6$$

where

$$f = \frac{1}{(1.82\log_{10}\mathrm{Re}-1.64)^2}$$

$$\mathrm{Re} = \frac{uD}{\nu}$$



Exercise 2: Convection VBA

```
Dim Veloc As Single 'Fluid velocity
Dim Diam As Single 'Pipe diameter
Dim Kvisc As Single 'Kinematic viscosity
Dim Prandtl As Double 'Prandtl number
Dim Cond As Double 'Thermal conductivity
Dim FFactor As Double 'Friction factor
```

```
'CALCULATE REYNOLDS NUMBER
Function Reynolds(Veloc, Diam, Kvisc)
    Reynolds = Veloc * Diam / Kvisc
End Function
```

```
'CALCULATE FRICTION FACTOR
Function Friction(Reynolds)
    Friction = 1 / ((1.82 * Application. _
        WorksheetFunction.Log10(Reynolds)) _
        - 1.64) ^ 2
End Function
```

```
'CALCULATE NUSSELT NUMBER
Function Nusselt(Reynolds, Prandtl)
    FFactor = Friction(Reynolds) 'Call to a function
    Nusselt = FFactor / 8 * (Reynolds - 1000) * _
        Prandtl / (1 + 12.7 * Sqr(FFactor / 8) * _
        (Prandtl ^ (2 / 3) - 1))
End Function
```

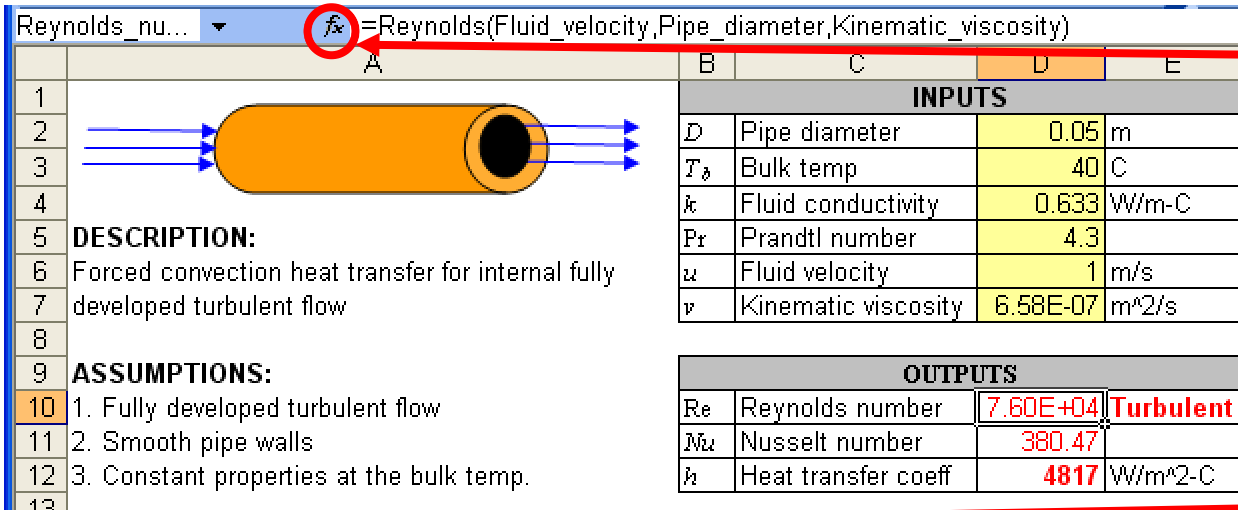
```
'CALCULATE HEAT TRANSFER COEFFICIENT
Function HTcoeff(Nusselt, Diam, Cond)
    HTcoeff = Nusselt * Cond / Diam
End Function
```

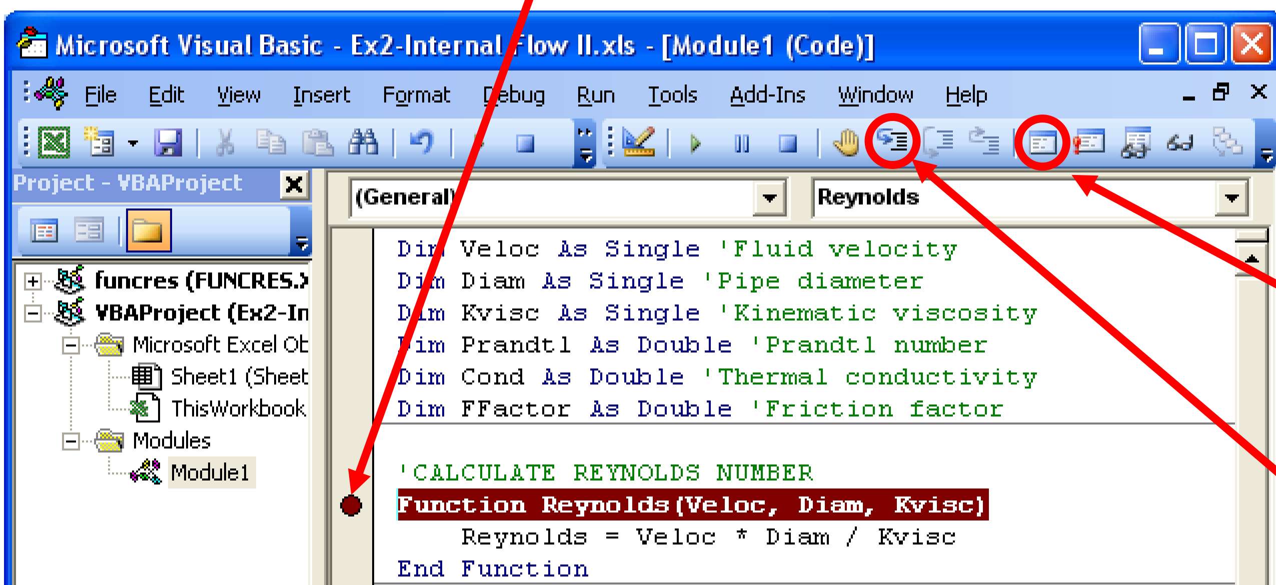
1. Insert a module
2. Declare the variables using “Dim”
3. Add the functions shown to calculate the outputs, and call them from the worksheet
4. Include a friction factor function called by the Nusselt function
5. Use the debugger and locals window to try out the procedures
6. Optional: Use the macro recorder to change the fill color of a cell, then edit the macro & interpret it using VBA Help

Exercise 2: Convection VBA - Hints

Isotherm Technologies (isothermtech.com)

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)





- Select the target cell, and use the "fx" icon and the "user defined" category to find your created functions
- Click in front of any line of code to create a toggle breakpoint for debugging
- Open the locals window to watch variables
- Step into the code to observe execution

Isotherm Technologies (isothermtech.com)

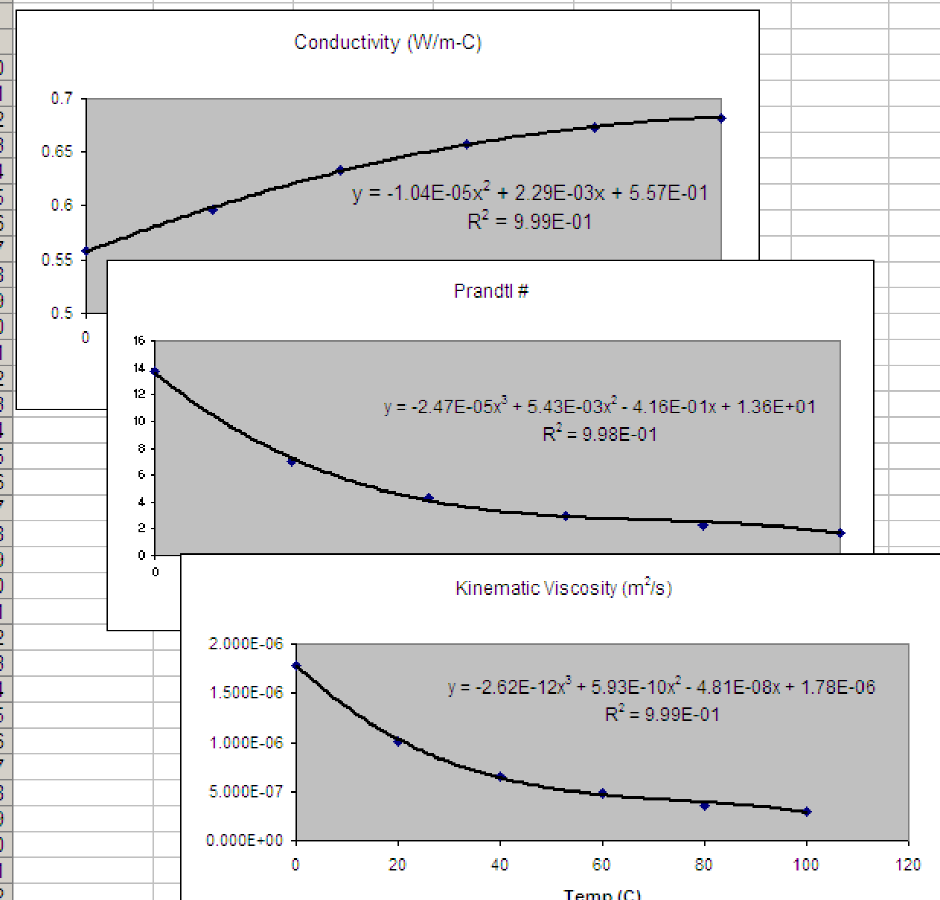
Exercise 3: Fluid Properties

1. Add a new sheet called “Fluid Properties”
2. Fill in the property data shown
3. Create plots for all the properties vs temperature
4. Add trendlines (curve fits) for each property
5. Create a function that calculates the properties using the curve fit equations & try it out from the worksheet

```
'DETERMINE FLUID PROPERTIES FROM CURVE FITS
Function Property(Prop As String, Temp As Single)
    Select Case Prop
    Case "Conductivity"
        Property = -1.04 * 10 ^ -5 * Temp ^ 2 + _
            0.00229 * Temp + 0.557
    Case "Prandtl"
        Property = -2.47 * 10 ^ -5 * Temp ^ 3 + _
            0.00543 * Temp ^ 2 - 0.4159 * Temp + 13.
    Case "Viscosity"
        Property = -2.62 * 10 ^ -12 * Temp ^ 3 + _
            5.93 * 10 ^ -10 * Temp ^ 2 - 4.81 * _
            10 ^ -8 * Temp + 1.78 * 10 ^ -6
    End Select
End Function
```

G4 =Property(F4,G3)

Temperature (°C)	Conductivity (W/m-C)	Prandtl #	Kinematic Viscosity (m^2/s)	Pressure			
0	0.558	13.7	1.789E-06	saturation	Property Calculator		
20	0.597	7.00	1.006E-06	saturation	Temperature	40	C
40	0.633	4.30	6.580E-07	saturation	Conductivity	0.632	W/m-C
60	0.658	3.00	4.780E-07	saturation	Prandtl	4.08	
80	0.673	2.25	3.640E-07	saturation	Viscosity	6.37E-07	m^2/s
100	0.682	1.75	2.940E-07	saturation			

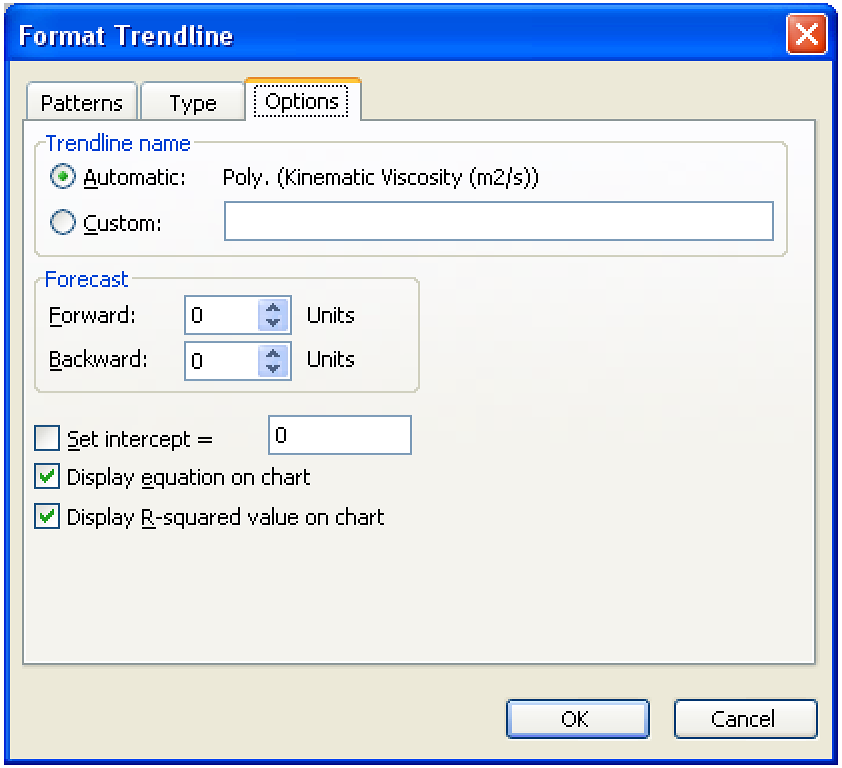


Fluid Properties | Pipe Heat Transfer

Isotherm Technologies
(isothermtech.com)

Exercise 3: Fluid Properties - Hints

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)



Note: Curve fitting of properties in this exercise is for illustrative purposes only. Better approaches include: NIST Refprop (or online webbook), equations of state, or interpolation of high fidelity tabular data

- Right click any cell to access formatting options (or use menu/ribbon)
  - Select wrap text to auto-size the cell to fit the text
  - The font of individual characters can be made superscripts
- Make a scatter plot of the data
  - For noncontiguous data, use the "ctrl" key while selecting the cells
  - Right click on chart axis to change the scale
- Add a trendline by right clicking on a data point & choosing settings
  - Right click the curve fit equation to format as scientific with 2 digits after the decimal (in ≤2003, double click curve fit equation to set format)

Isotherm Technologies
(isothermtech.com)

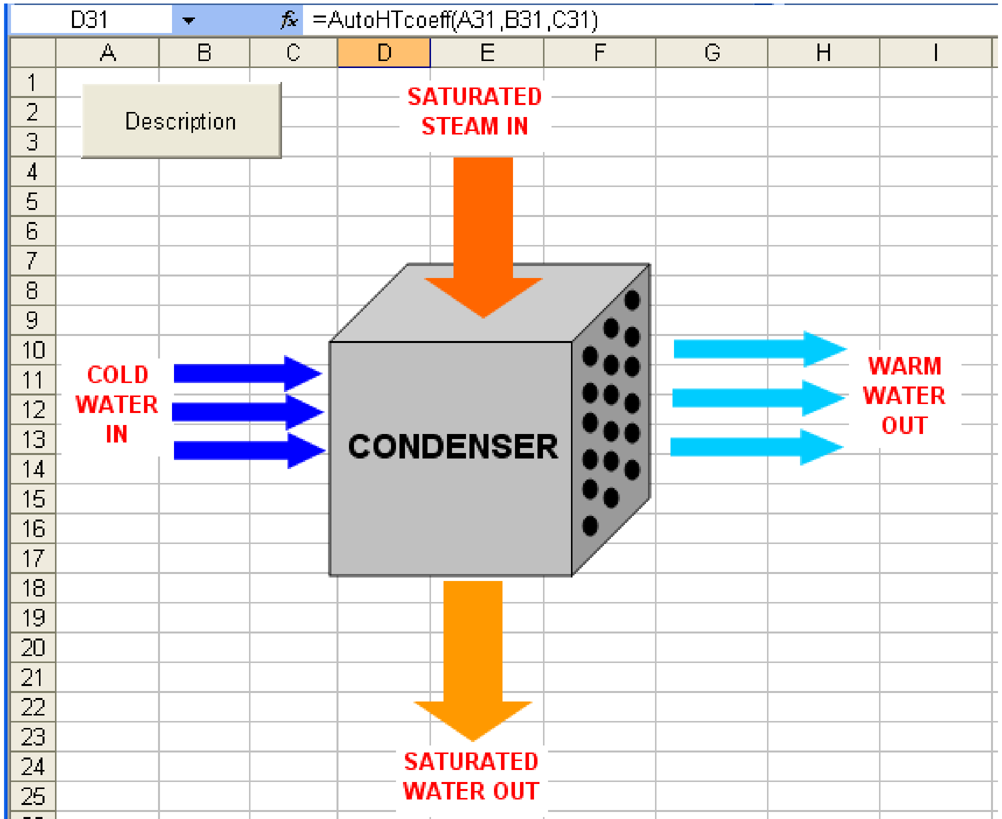
Exercise 4: Condenser

1. Add a “Condenser” sheet & create a condenser sketch as shown
2. Make a button to open a message
3. Add the data for pipe diameter, water velocity, and water bulk temp
4. Create a new function in “Module 1” that calls the existing functions to calculate film heat transfer coeff’s
5. Call the new function from the sheet
6. Create a scatter plot of film coeff vs pipe diameter (change temperature to 30… what happens to the plot?)

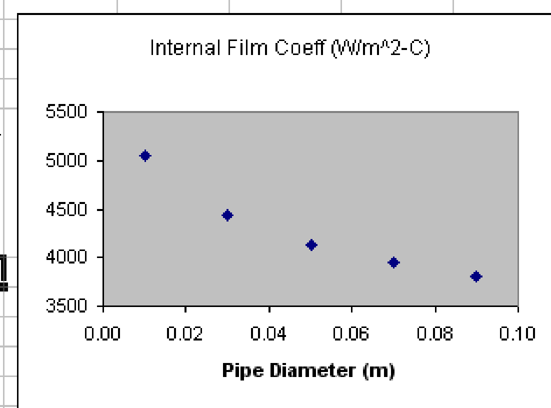
```
Private Sub CommandButton1_Click()
    MsgBox ("This is a steam condensor")
End Sub
```

```
'CALCULATION OF HT COEFF DIRECTLY FOR DATA TABLE
Function AutoHTcoeff(Diam As Single, Veloc As _
    Single, Temp As Single)
'Multiple function calls set equal to variables
    Cond = Property("Conductivity", Temp)
    Kvisc = Property("Viscosity", Temp)
    Pr = Property("Prandtl", Temp)
    Re = Reynolds(Veloc, Diam, Kvisc)
    Nu = Nusselt(Re, Pr)
    AutoHTcoeff = Nu * Cond / Diam
End Function
```

D31 =AutoHTcoeff(A31,B31,C31)



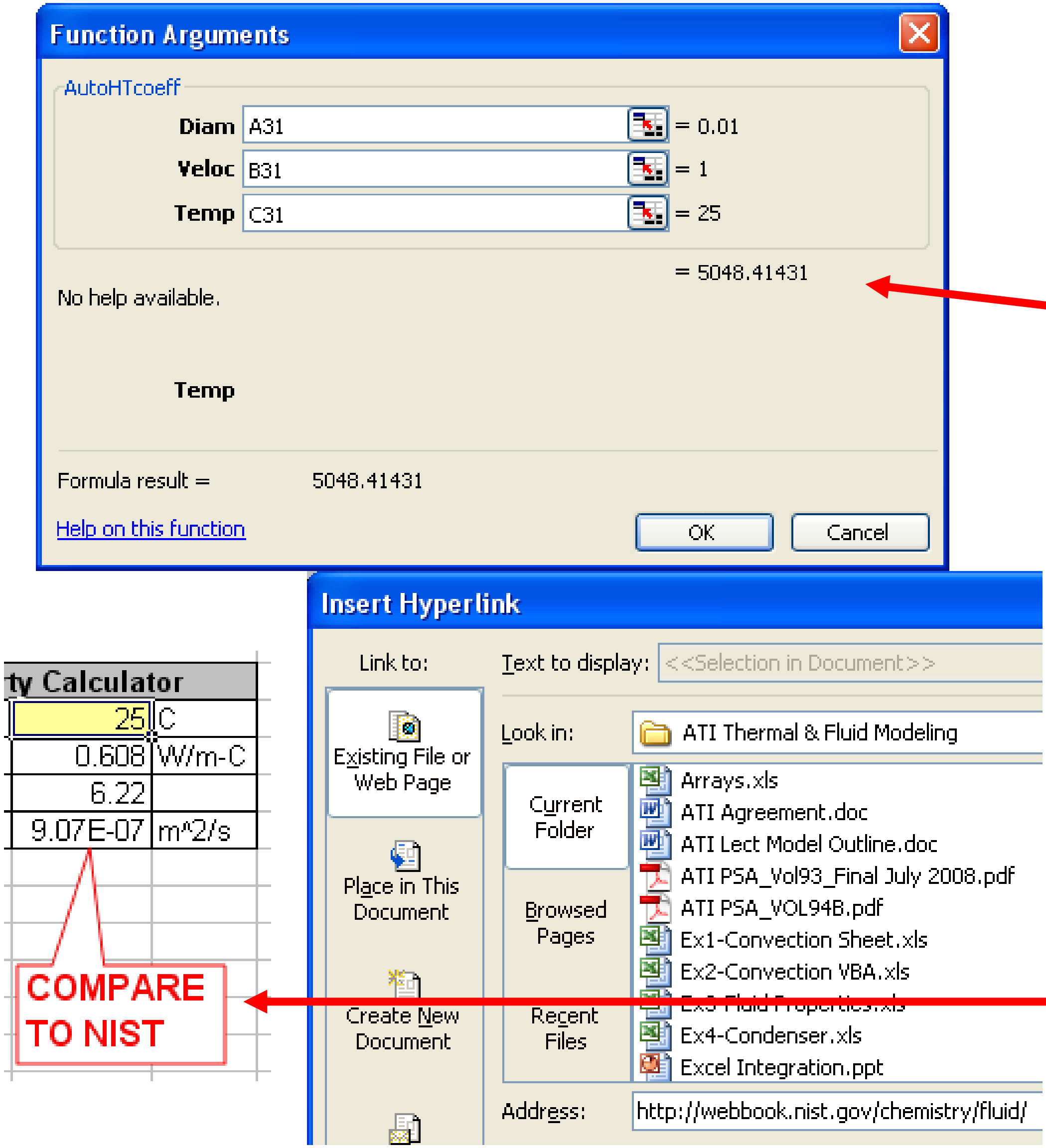
	Water Pipe Diameter (m)	Water Velocity (m/s)	Water Bulk Temp (°C)	Internal Film Coeff (W/m^2-C)
31	0.01	1.00	25	5048
32	0.03	1.00	25	4439
33	0.05	1.00	25	4138
34	0.07	1.00	25	3948
35	0.09	1.00	25	3812



(isothermtech.com)

Exercise 4: Condenser - Hints

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)

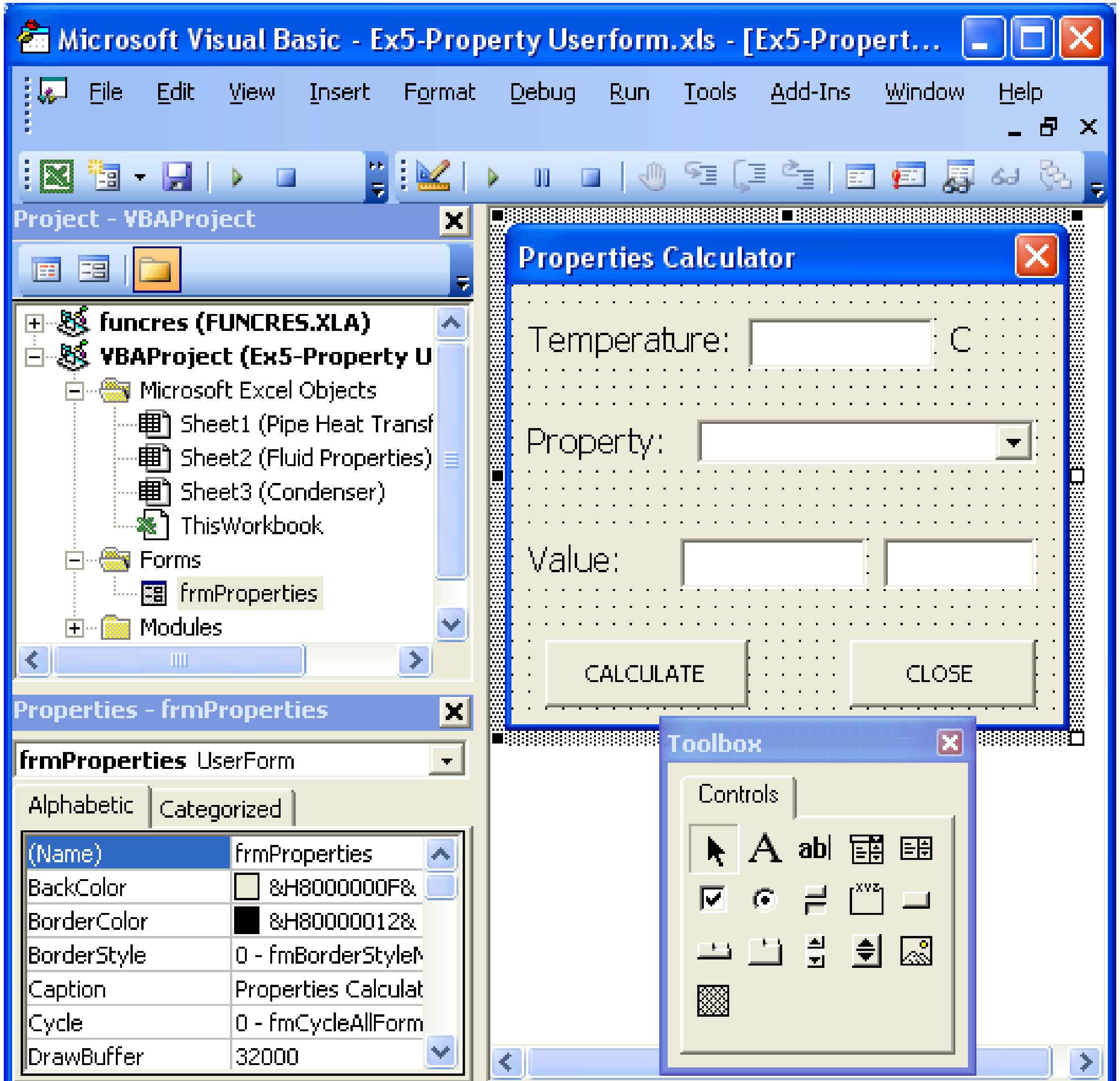


- **Use the "ctrl-D" keys together to duplicate selected graphics**
- **Right click the button to add code**
- **Call the new "AutoHTcoeff" function from the first cell in the film coeff column**
  - **Use the "knuckle" to drag the first cell down to the remaining cells**
  - **Since this equation uses the default relative cell reference, the function call is updated with the appropriate inputs**
- **Optional: add link to the "Fluid Properties" sheet for NIST data source**

Isotherm Technologies
(isothermtech.com)

Exercise 5: Properties Userform

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)



1. Insert a userform in the VBA Editor
2. Name the form "frmProperties" and change the caption to "Properties Calculator"
3. Use Label, TextBox, ComboBox and CommandButton controls to build the userform shown
4. Name the controls using the prefix nomenclature:
   - lblTemp
   - txtTemp
   - lblProp
   - cboProp
   - lblValue
   - txtValue
   - txtUnits
   - cmdCalculate
   - cmdClose

Exercise 5: Properties Userform (cont)

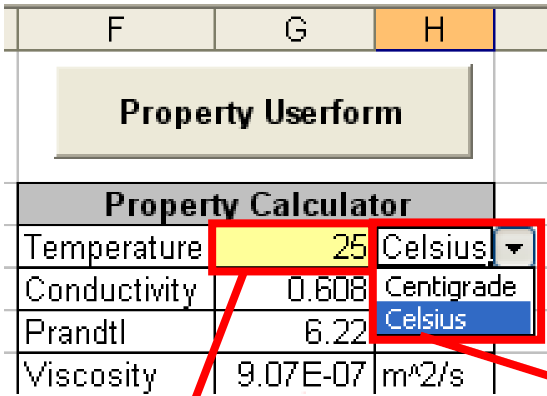
```
Dim Temp As Single
Dim PropType As String
Dim Result As String
Dim Units As String

Private Sub cmdCalculate_Click()
'Collect input data from the userform
Temp = frmProperties.txtTemp.Value
PropType = frmProperties.cboProp.Value

'Call property function
Result = Property(PropType, Temp)

'Display result in value textbox
frmProperties.txtValue.Value = Result

'Display correct units in units textbox
Select Case PropType
Case "Conductivity"
    frmProperties.txtUnits.Value = "W/m-C"
Case "Prandtl"
    frmProperties.txtUnits.Value = "#"
Case "Viscosity"
    frmProperties.txtUnits.Value = "m^2/s"
End Select
End Sub

Private Sub cmdClose_Click()
'Unload & hide the form
Unload frmProperties
frmProperties.Hide
End Sub
```

5. Right click on the cmdCalculate userform button and add the code shown
6. Right click on the cmdClose userform button and add the code shown
7. Go to the “Fluid Properties” sheet, add a button, change the caption to “Property Userform”, right click on the button and add the code shown

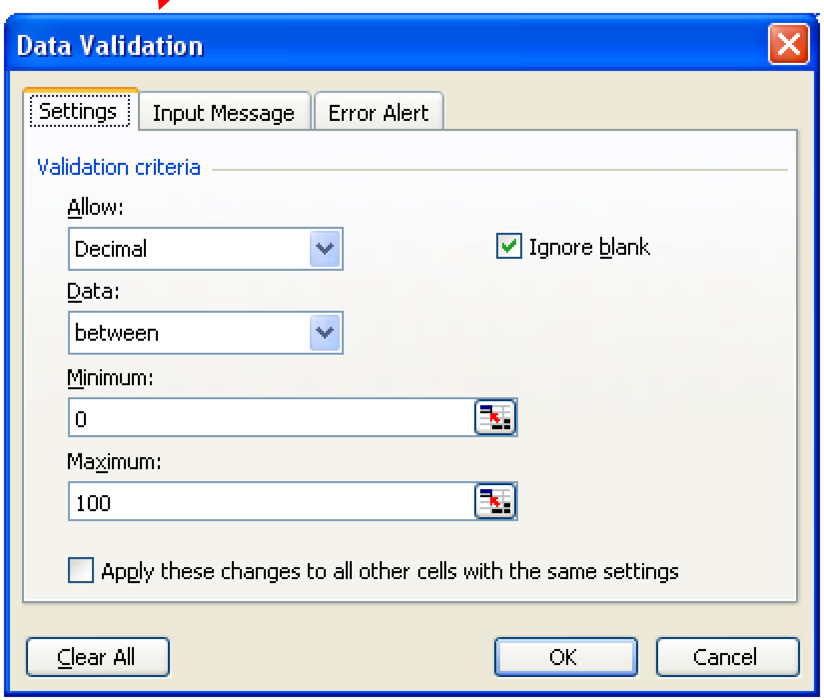
Property Calculator		
Temperature	25	C
Conductivity	0.608	W/m-C
Prandtl	6.22	
Viscosity	9.07E-07	m^2/s

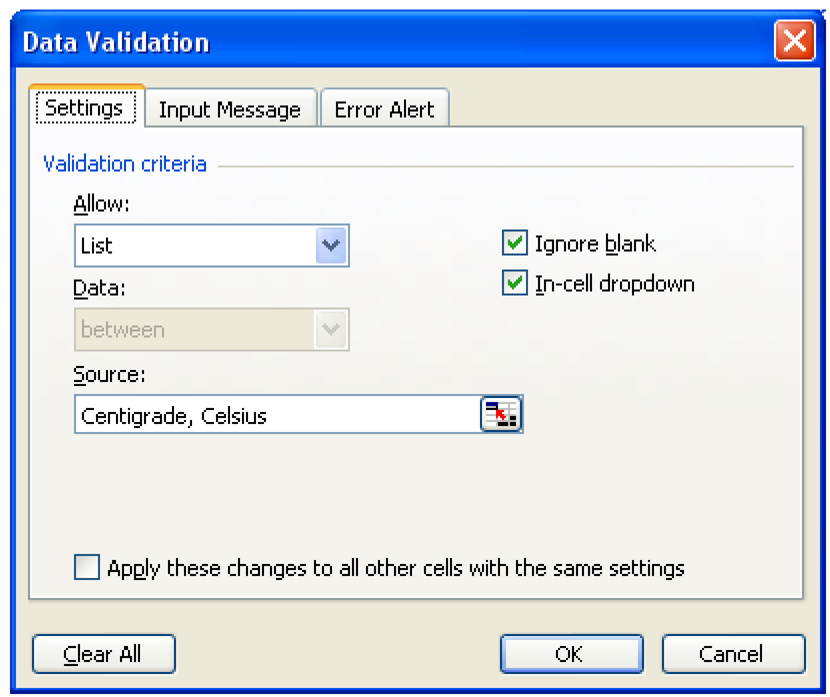
```
Private Sub CommandButton1_Click()
'Load userform into memory
Load frmProperties
'Populate the userform's combobox
frmProperties.cboProp.AddItem "Conductivity"
frmProperties.cboProp.AddItem "Prandtl"
frmProperties.cboProp.AddItem "Viscosity"
'Make the userform visible
frmProperties.Show
End Sub
```


Exercise 5: Properties Userform - Hints



- To name controls, make sure the properties window is open, select the control, and edit the “(Name)” property (the “Caption” property is accessed the same way)
- Optional: try setting up validation for the temperature cell of the worksheet property calculator, and drop down selection for the units cell, using data validation

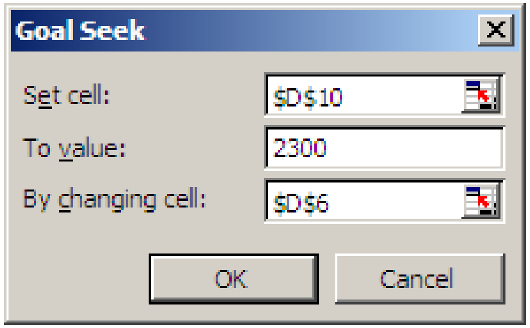




Isotherm Technologies
(isothermtech.com)

Exercise 6: Pipe Design

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)



	INPUTS		
D	Pipe diameter	0.01	m
T_b	Bulk temp	25	C
k	Fluid conductivity	0.608	W/m-C
Pr	Prandtl number	6.22	
u	Fluid velocity	0.20861	m/s
ν	Kinematic viscosity	9.07E-07	m^2/s

	OUTPUTS		
Re	Reynolds number	2.30E+03	Turbulent

	B	C	D	E	F	G	H	I	J
1		INPUTS				D (m)	u (m/s)	Tb (C)	h (W/m-C)
2	*D*	Pipe diameter	0.01	m		0.01	1	25	5048
3	T_b	Bulk temp	25	C		0.02	1	25	4681
4	*k*	Fluid conductivity	0.608	W/m-C		0.03	1	25	4439
5	Pr	Prandtl number	6.22			0.04	1	25	4269
6	*u*	Fluid velocity	1	m/s		0.05	1	25	4138
7	*ν*	Kinematic viscosity	9.07E-07	m^2/s		0.06	1	25	4034
8						0.07	1	25	3948
9		OUTPUTS				0.08	1	25	3875
10	Re	Reynolds number	1.10E+04	Turbulent		0.09	1	25	3812
11	*Nu*	Nusselt number	83.07						
12	*h*	Heat transfer coeff	5048	W/m^2-C		D (m)	u (m/s)	Tb (C)	h (W/m-C)
13						0.01	0.21	25	904
14						0.02	0.21	25	1076
15		Diameter Trade		Echo Data		0.03	0.21	25	1083
16						0.04	0.21	25	1068

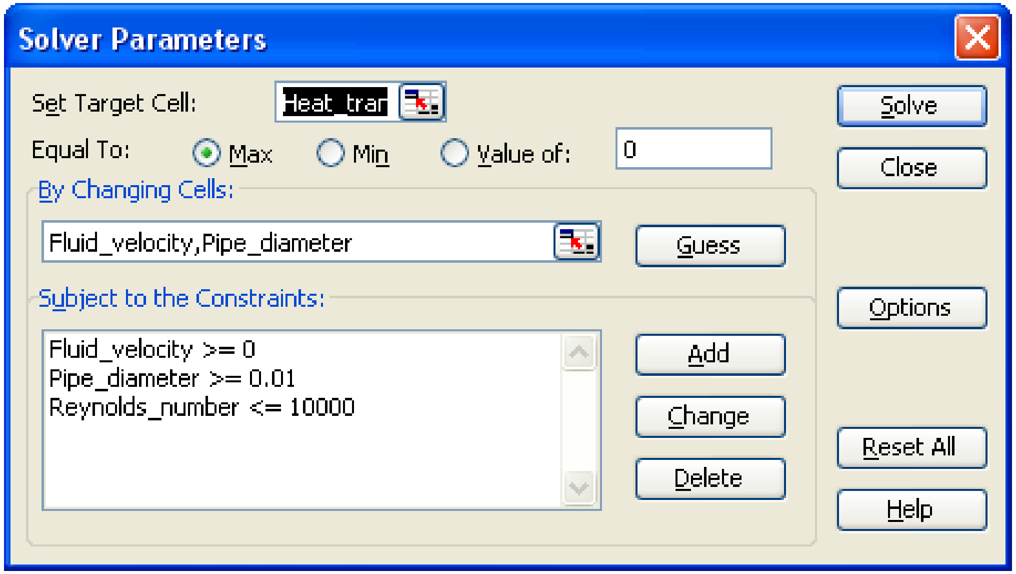
1. Use Goal Seek to find out what velocity gives a Reynolds number of 2300 for a pipe diameter of 0.01 m and bulk temp of 25 C
2. Create a Diameter Trade button on the Pipe HT sheet, and add the code shown on the next slide
3. Create an Echo Data button & add the code shown on the next slide
4. Try changing the velocity value to 1 in the input cell, then run the Diameter Trade again

Exercise 6: Pipe Design - Hints

```
Dim Velocity As Single
Dim Temp As Single
Dim Diam As Single
Dim HTcoeff As Single
Dim i As Integer

Private Sub CommandButton1_Click()
'Read in velocity & temp data from sheet
Velocity = Cells(6, 4).Value
Temp = Cells(3, 4).Value
'Write out headers to sheet
Cells(1, 7).Value = "D (m)"
Cells(1, 8).Value = "u (m/s)"
Cells(1, 9).Value = "Tb (C)"
Cells(1, 10).Value = "h (W/m-C)"
For i = 1 To 9
    'Call the HT function & set equal to coeff variable
    Diam = i / 100
    HTcoeff = AutoHTcoeff(Diam, Velocity, Temp)
    'Write out results to sheet one cell at a time
    Cells(1 + i, 7).Value = Format(Diam, "0.00")
    Cells(1 + i, 8).Value = Format(Velocity, "0.00")
    Cells(1 + i, 9).Value = Format(Temp, "###")
    Cells(1 + i, 10).Value = Format(HTcoeff, "####")
Next i
End Sub

Private Sub CommandButton2_Click()
'Read pipe diameter trade data & echo back to sheet
Echo = Range("G1", "J10").Value
Range("G12", "J21") = Echo
End Sub
```

- **Right click on the buttons to change the captions & create the associated code**
- **Remember the syntax is "Cells(Row#,Col#)", not the other way around as is typical in cell references on the worksheet side (i.e. cell "D2" would be referenced as "Cell(2,4)" in VBA)**
- **In this exercise, the Cells and Range objects can be accessed without specifying parent objects (e.g. Worksheet) since all the "action" is occuring on one active sheet**

Exercise 7: Optimize Pipe



Target Cell (Max)

Cell	Name	Original Value	Final Value
D12	Heat_transfer_coeff	904	4616

Adjustable Cells

Cell	Name	Original Value	Final Value
D6	Fluid_velocity	0.20861	0.907
D2	Pipe_diameter	0.01	0.01

Constraints

Cell	Name	Cell Value	Formula	Status	Slack
D10	Reynolds_number	1.00E+04	D10<=10000	Binding	0
D2	Pipe_diameter	0.01	D2>=0.01	Binding	0
D6	Fluid_velocity	0.907	D6>=0	Not Binding	0.907

Condenser | Answer Report 1 | Pipe Hea

SOLVER MODEL
4616
2
TRUE
TRUE
FALSE
100

1. Use Solver on the Pipe HT sheet to find the maximum heat transfer coeff given the constraints shown
2. Select the Answer report and diagnose which variables the solution "bumped up against"
3. Save the Solver model on the Pipe HT sheet
4. Add code to the Property function that returns an "Out of Range" message if the temp is not 0-100 C

Exercise 7: Optimize Pipe - Hints

Isotherm Technologies (isothermtech.com)

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)

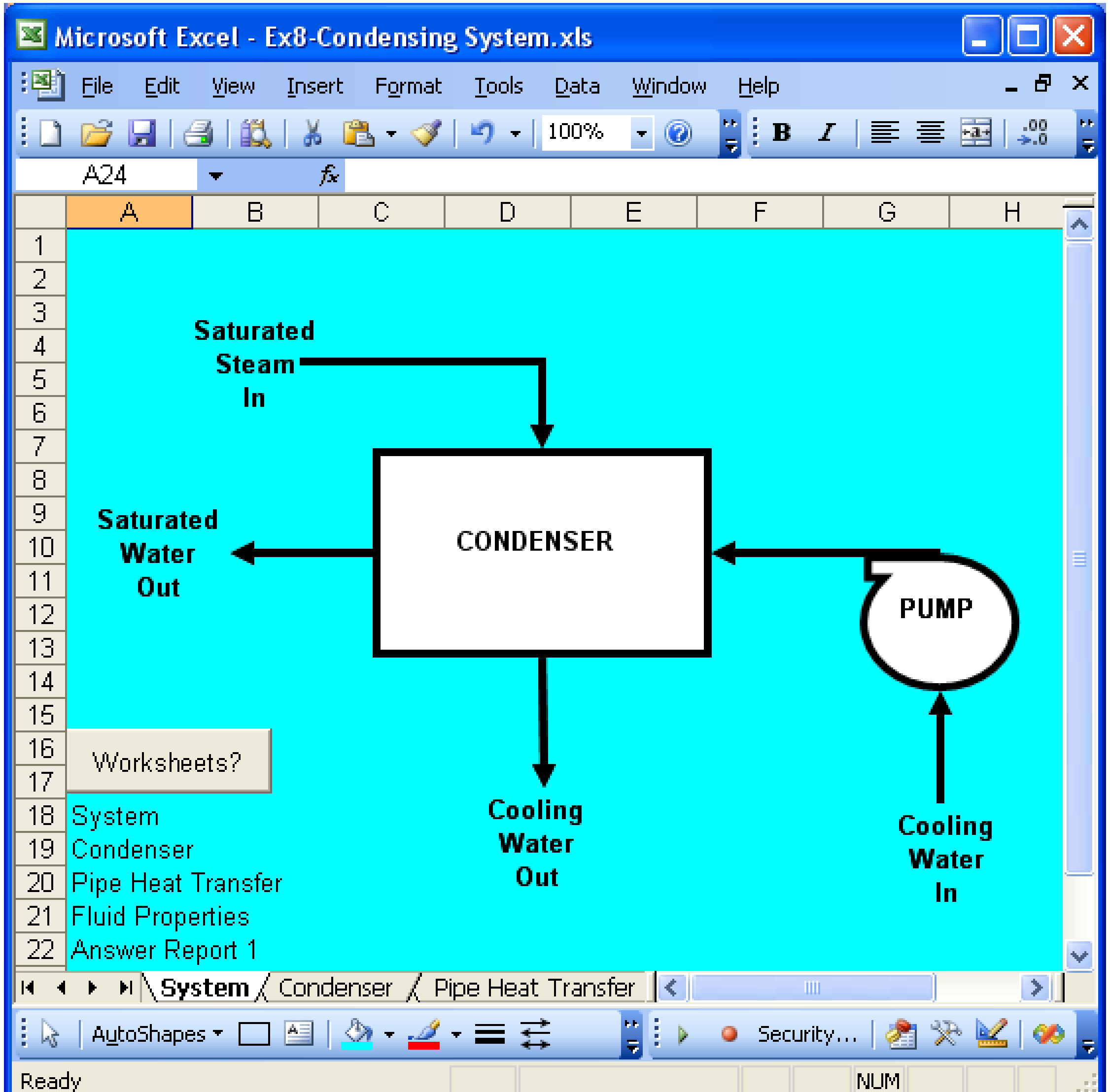
```
'DETERMINE FLUID PROPERTIES FROM CURVE FITS
Function Property(Prop As String, Temp As Single)
    If Temp < 0 Then
        Property = "Out of Range"
    ElseIf Temp > 100 Then
        Property = "Out of Range"
    Else
    Select Case Prop
    Case "Conductivity"
        Property = -1.04 * 10 ^ -5 * Temp ^ 2 + _
            0.00229 * Temp + 0.557
    Case "Prandtl"
        Property = -2.47 * 10 ^ -5 * Temp ^ 3 + _
            0.00543 * Temp ^ 2 - 0.4159 * Temp + 13.613
    Case "Viscosity"
        Property = -2.62 * 10 ^ -12 * Temp ^ 3 + _
            5.93 * 10 ^ -10 * Temp ^ 2 - 4.81 * _
            10 ^ -8 * Temp + 1.78 * 10 ^ -6
    End Select
    End If
End Function
```

- You can select cells for Solver by clicking on them
- Solver may initially show cell references instead of defined names when setting it up for the first run
- Use the “Options” button in the Solver window to save the model, and select a location on the sheet with empty vertical cells

Exercise 8: System Sheet

Isotherm Technologies (isothermtech.com)

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)



1. Add a system sheet and create the graphics shown
2. Make a hyperlink from the Condenser box that goes to the Condenser sheet
3. Select the input cells on the Pipe HT sheet change the format protection to unlock the cells (do the same with columns G - J)
4. Protect the sheet with a blank (null) password (now try modifying cells)
5. Hide the Answer sheet
6. Add a “Worksheets?” button on the System sheet and create the code shown on the next slide to count and list names of the sheets (how does it handle the hidden sheet?)

Exercise 8: System Sheet - Hints

Isotherm Technologies (isothermtech.com)

(To obtain completed exercises, an electronic version of the notes, and other helpful Excel-VBA resources, visit: isothermtech.com)

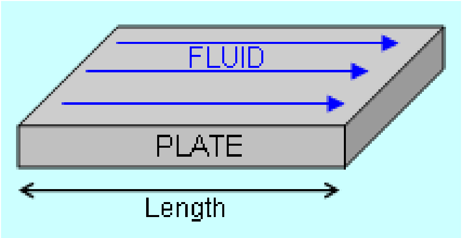
```
Dim TotalSheets As String
Dim i As Integer
Dim SheetArray()
Private Sub CommandButton1_Click()
'Count the sheets & put in a message
TotalSheets = Worksheets.Count
MsgBox ("This Workbook has " & TotalSheets & " Sheets")
'Create an array of the sheet names
ReDim SheetArray(1 To TotalSheets)
Do While i < TotalSheets
    i = i + 1
    SheetArray(i) = Worksheets.Item(i).Name
Loop
'Place the sheet names on the System sheet
For i = 1 To TotalSheets
    Cells(i + 17, 1).Value = SheetArray(i)
Next i
End Sub
```

- Hyperlink the condenser by right clicking on the object and choosing the Condenser sheet
- Be sure to unlock input cells before protecting the sheet
- Optional: Try getting rid of the column & row headings and the gridlines on the Condenser sheet

Isotherm Technologies
(isothermtech.com)

Application: Simple Calc Sheet

FORCED CONVECTION: FLAT PLATE



Description:
Forced convection over a flat plate where bulk fluid is flowing parallel to the plate.

Assumptions:
Fluid properties evaluated at film temp (avg of plate & fluid temps)

INPUTS			
L	Plate Length	10	ft
T_p	Plate Temp	97	F
V	Fluid velocity	0.6	ft/s
T_f	Fluid Temp	72	F
Pr	Fluid Prandtl Number	0.71	
ν	Fluid Kinematic Viscosity	1.60E-05	m^2/s
k	Fluid Thermal Conductivity	0.025	W/m-C

OUTPUTS			
T_m	Film Temp	**29.16666667**	C
Re	Reynolds Number	**34838.64**	(Laminar)
Nu	Nusselt Number	**110.5651159**	
h	Heat Transfer Coeff	**0.159715764**	Btu/hr-ft^2-F
q	Heat Flux	**3.995356895**	Btu/hr-ft^2

Equations:

$$Nu = \frac{hL}{k} = 0.664\,\mathrm{Re}^{1/2}\,\mathrm{Pr}^{1/3} \quad for\ \mathrm{Re} < 5\times 10^5$$

$$Nu = \frac{hL}{k} = 0.036\,\mathrm{Pr}^{1/3}\left(\mathrm{Re}^{0.8} - 23{,}200\right) \quad for\ \mathrm{Re} > 5\times 10^5$$

$$\mathrm{Re} = \frac{VL}{\nu}$$

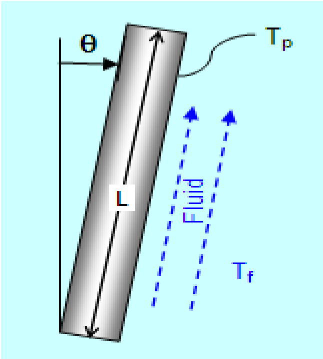
$$q = h\left(T_p - T_f\right)$$

References: Kreith & Black, Basic Heat Transfer, 1980, pp248-249

Isotherm Technologies (isothermtech.com)

Application: Another Calc Sheet

NATURAL (FREE) CONVECTION: VERTICAL PLANE



INPUTS

L	Plate Length	0.0254	m
θ	Plate Angle from Vertical	0	degrees
T_p	Plate/Cylinder Temp	80	C
T_f	Fluid Temp	25	C
Pr	Fluid Prandtl Number	0.71	
$\beta g/\nu$^2	Buoyancy Factor	1.17E+08	1/C-m^3
ν	Fluid Kinematic Viscosity	1.67E-05	m^2/s
k	Fluid Thermal Conductivity	0.026	W/m-C

OUTPUTS

T_m	Film Temp	52.5	C
Gr	Grashof Number	1.05E+05	
Nu	Nusselt Number	9	
h	Heat Transfer Coeff	9.4	W/m^2-C
q	Heat Flux	516.9	W/m^2

Description:

Natural (free) convection along a vertical cylinder or plate (small inclination allowed)

Assumptions:

1 Fluid properties evaluated at film temp (avg of plane & fluid temps)

2 Isothermal surface temp, or uniform heat flux with temp taken at plate midpoint

Equations:

$$Nu = \frac{hL}{k} = C\,(Gr\ \Pr)^n$$

$$Gr = \frac{\beta g}{\nu^2}(T_p - T_f)L^3$$

$$\beta = \frac{\rho_f - \rho_p}{\rho_p (T_p - T_f)}$$

$$q = h(T_p - T_f)$$

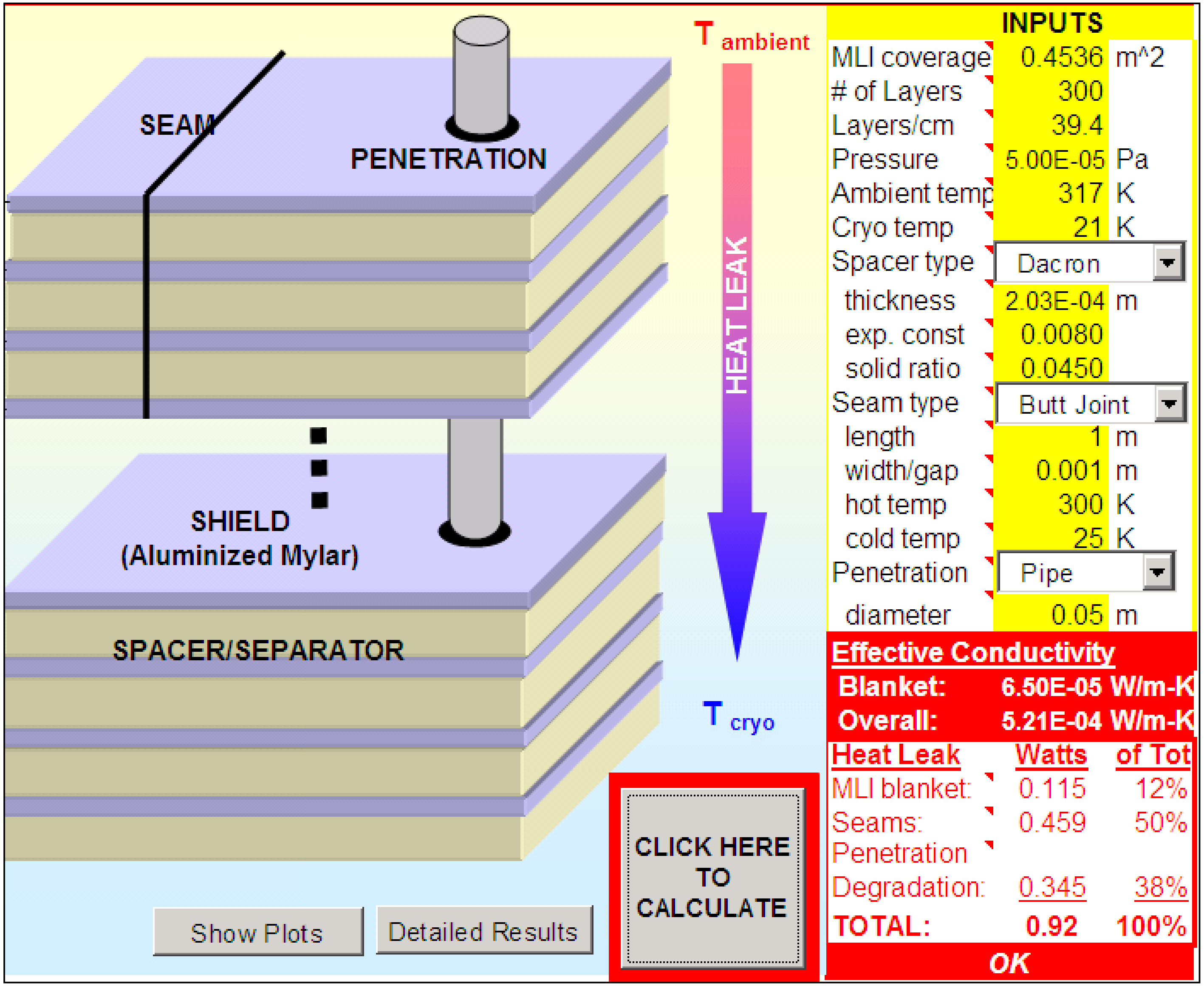
Ref	GrPr	C	n
3*	$< 10^4$	0.555	0.25
2	10^4 - 10^9	0.59	0.25
4	10^9 - 10^{13}	0.021	0.4
3*	$> 10^{13}$	0.021	0.4

** Out of range of experimental data; values extrapolated from reference 3 (Gebhart) figure.*

References:

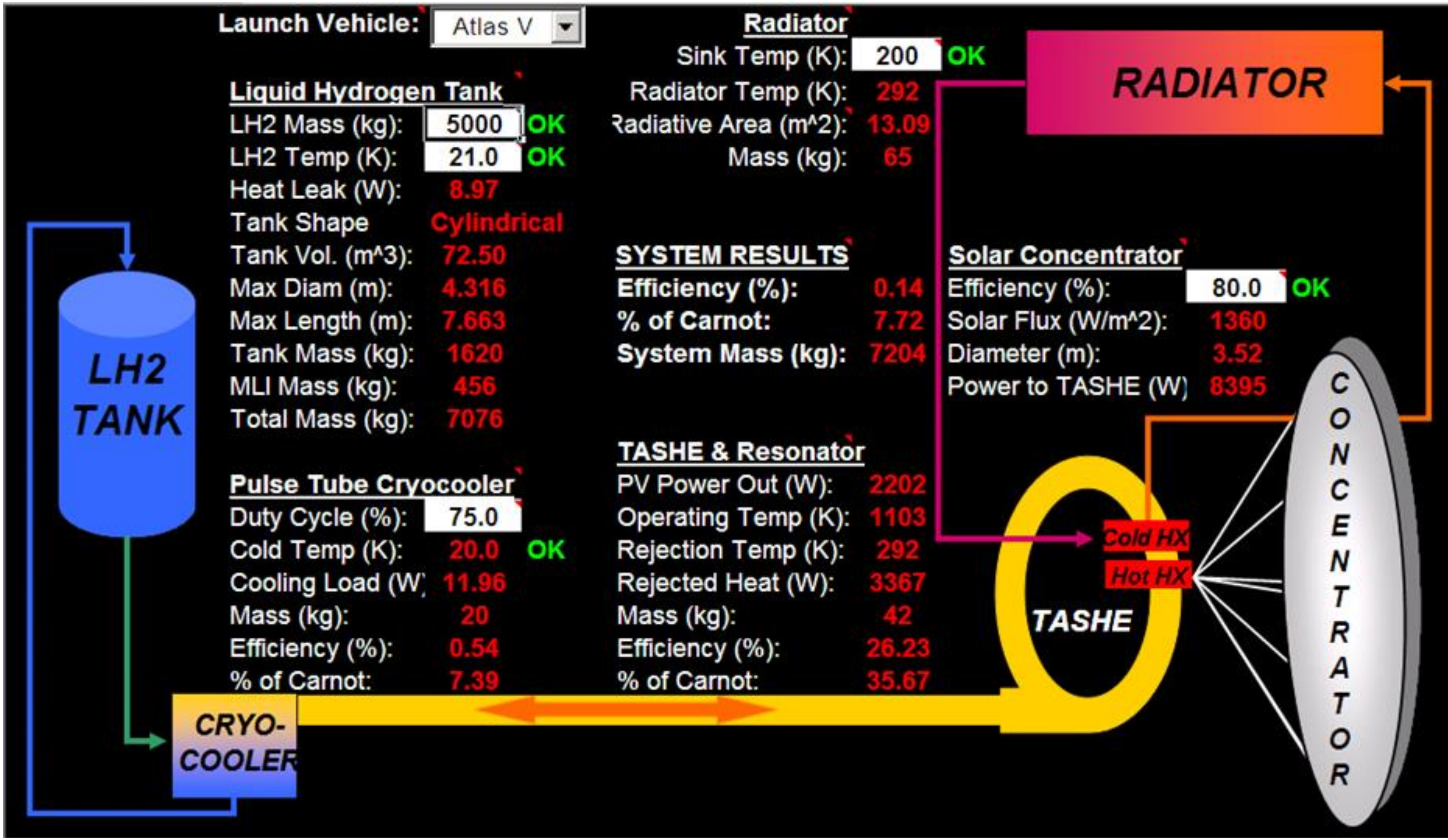
1 Kreith & Black, Basic Heat Transfer, 1980, pp257-261
2 McAdams, Heat Transmission, 3rd ed., 1954
3 Gebhart, Heat Transfer, 2nd ed., 1970
4 Eckert & Jackson, "Analysis of Turbulent Free Convection Boundary Layer on a Flat Plate", NACA Rept. 1015, 1951

Application: Multilayer Insulation (cont)



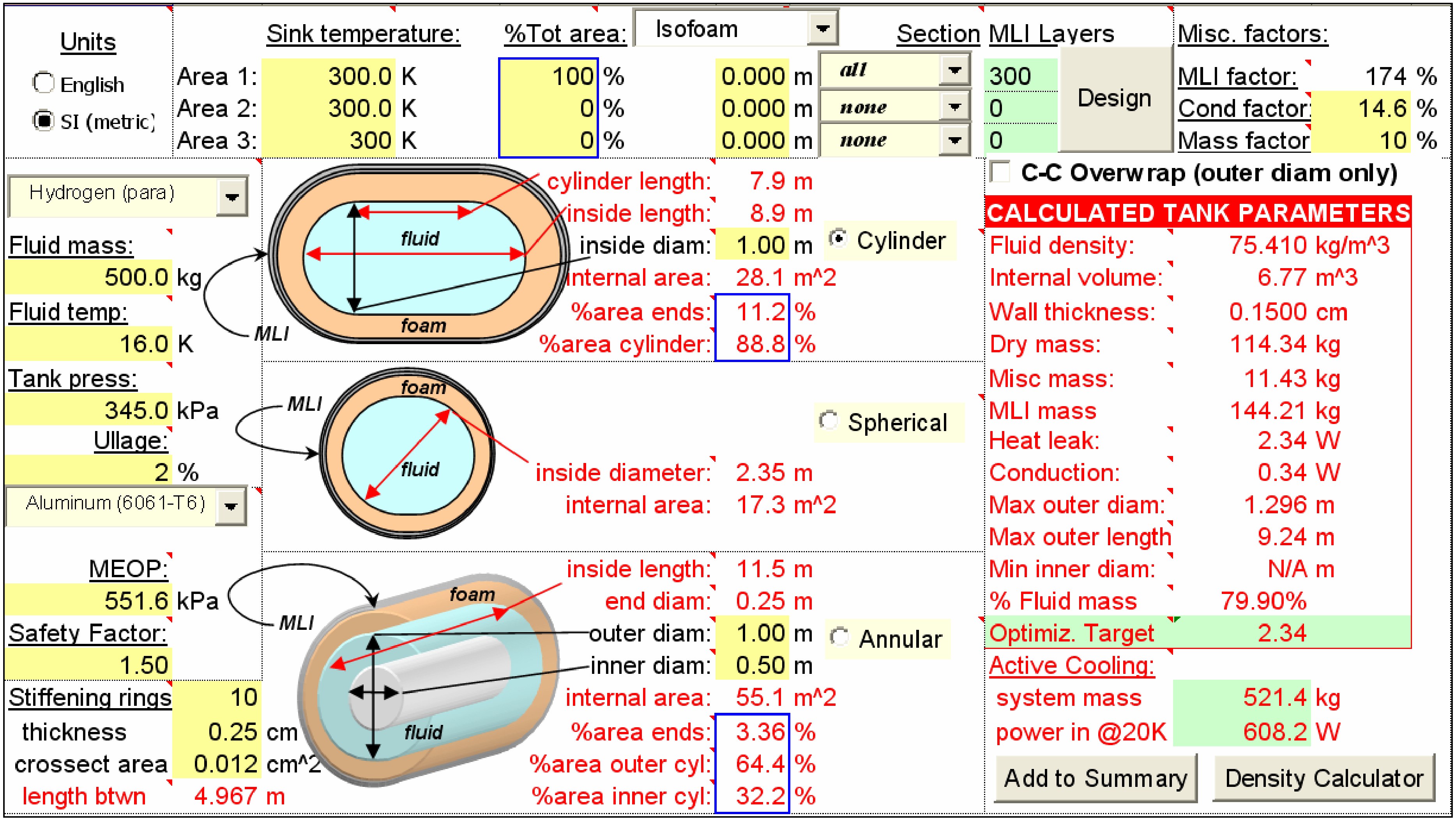
Isotherm Technologies
(isothermtech.com)

Application: SOTV Spacecraft (cont)



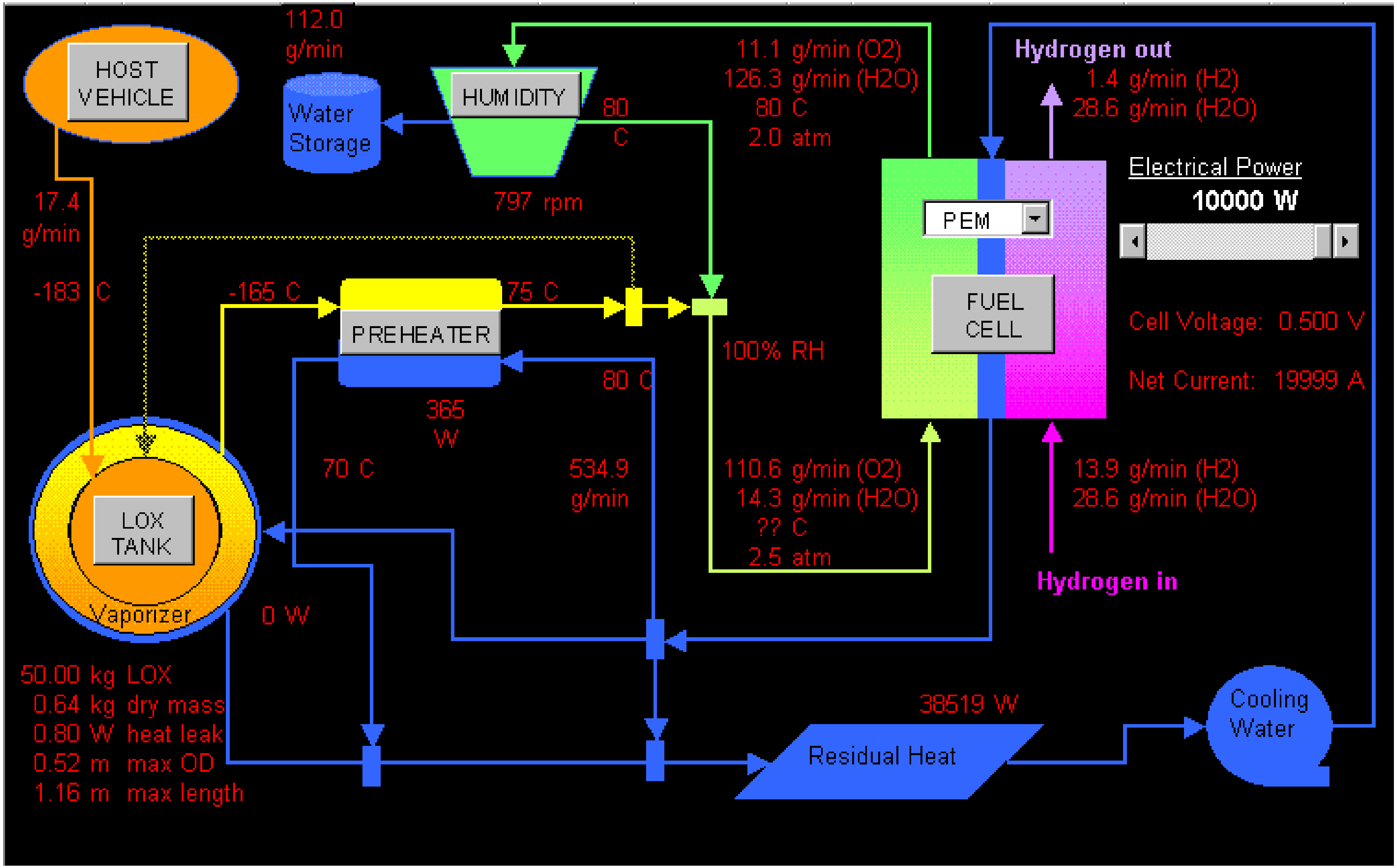
Isotherm Technologies
(isothermtech.com)

Application: Cryo Tank Design



Isotherm Technologies
(isothermtech.com)

Application: Fuel Cell (cont)

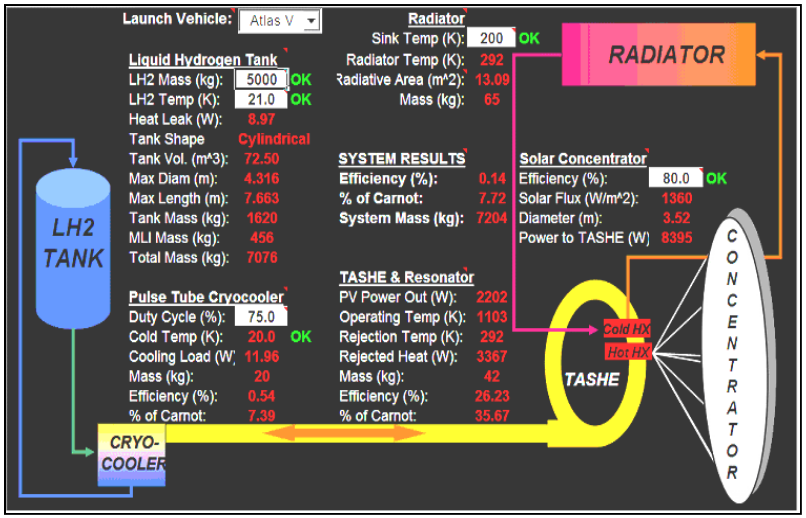


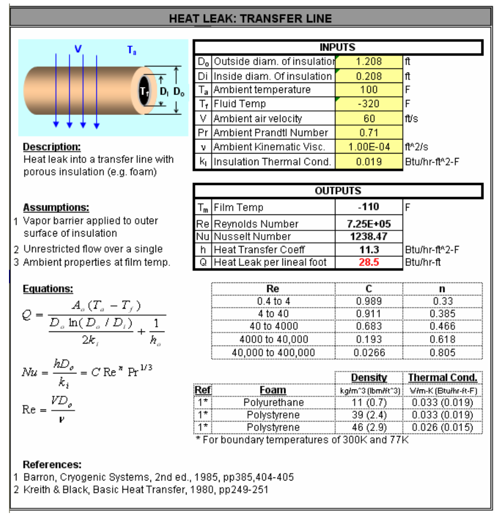
 excerpts from: Engineering Analysis & Modeling with Excel-VBA: Course Notes

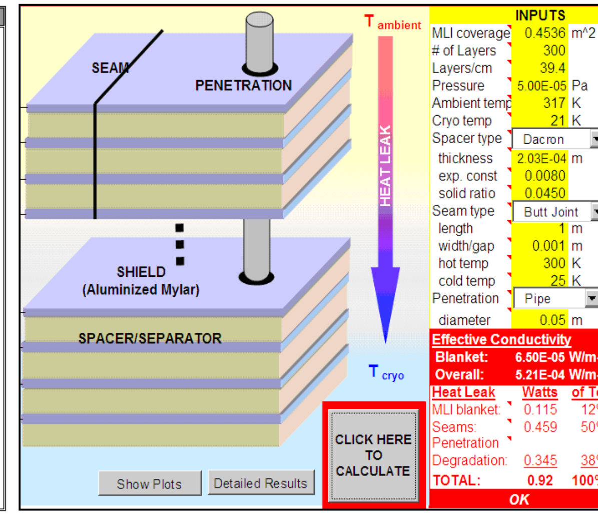
Isotherm Technologies LLC (www.isothermtech.com)

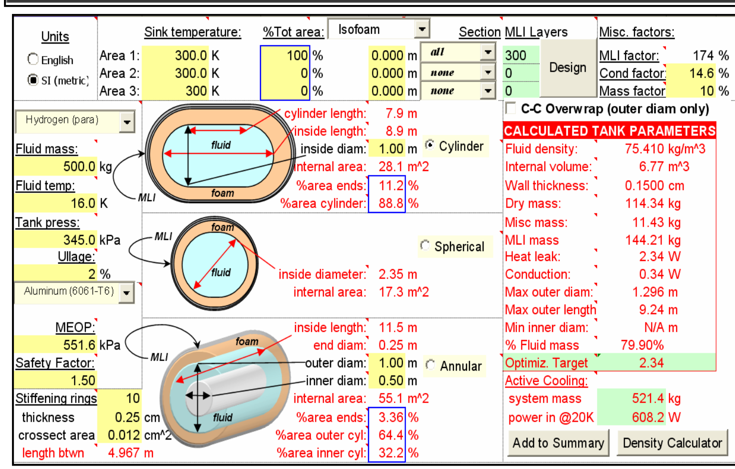
Engineering Analysis & Modeling with Excel-VBA

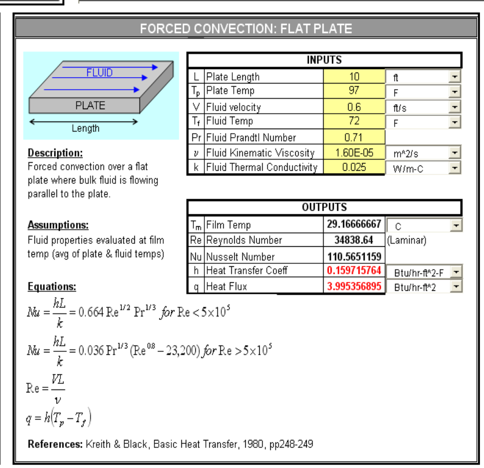
Version 8.0

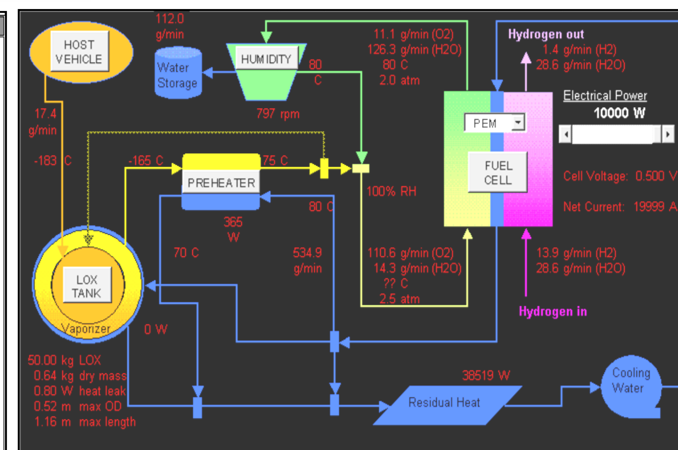












excerpts from: ***Engineering Analysis & Modeling with Excel-VBA: Course Notes***

Isotherm Technologies
(isothermtech.com)

Table of Contents

 excerpts from: ***Engineering Analysis & Modeling with Excel-VBA: Course Notes***

Isotherm Technologies
(isothermtech.com)

Table of Contents (cont)

Isotherm Technologies
(isothermtech.com)

Table of Contents (cont)

Isotherm Technologies
(isothermtech.com)

Table of Contents (cont)

Course Description

These course notes (available in paperback and kindle formats) are from the 2-day short course entitled "Engineering Analysis & Modeling with Excel-VBA". In-depth details are presented on principles, practices, and implementation of Excel and its integrated programing language – Visual Basic for Applications (VBA) – for analysis and engineering model creation.

The exercise problems in each section build upon the previous exercises to demonstrate new techniques. To obtain completed exercises and other helpful Excel VBA resources, visit: www.isothermtech.com.

FEEDBACK ON SELF-STUDY USING THE COURSE NOTES

"I worked through the course materials of 'Engineering Analysis & Modeling w/Excel/VBA' and would highly recommend it to other engineers.", Maury DuPont, University of Cincinnati

"...the exercises were very easy to understand... followed extremely well after the learning slides that came before them. The instructions were detailed enough to understand, but still left enough leeway for individual learning", Monica Guzik, Rose-Hulman Institute of Technology

Course Feedback

"Great material, great presentation", *William J. Armiger, Naval Research Laboratory*

"Lots of useful information, and a good combination of lecture and hands-on", *Brent Warner, Goddard Space Flight Center*

"Excellent course documentation... excellent communicator", *Linda Hornsby, Jacobs ESTS Group*

"Very knowledgeable... presented clearly and answered all questions", *Marc Wilson, Johns Hopkins University Applied Physics Laboratory*

"Great detail… informative and responsive to questions. Offered lots of useful info to use beyond the class", *Sheleen Spencer, Naval Research Laboratory*

"Excellent… Good overview of VBA programming…", *John Yocom, General Dynamics*

"Really enjoyed how much info was passed along in such a short and easily understandable method", *Will Rehlich, Noren Products*

"Good introduction and quick functioning using VBA was enabled by this course", *Michael R. Palis, Hybricon Corp.*

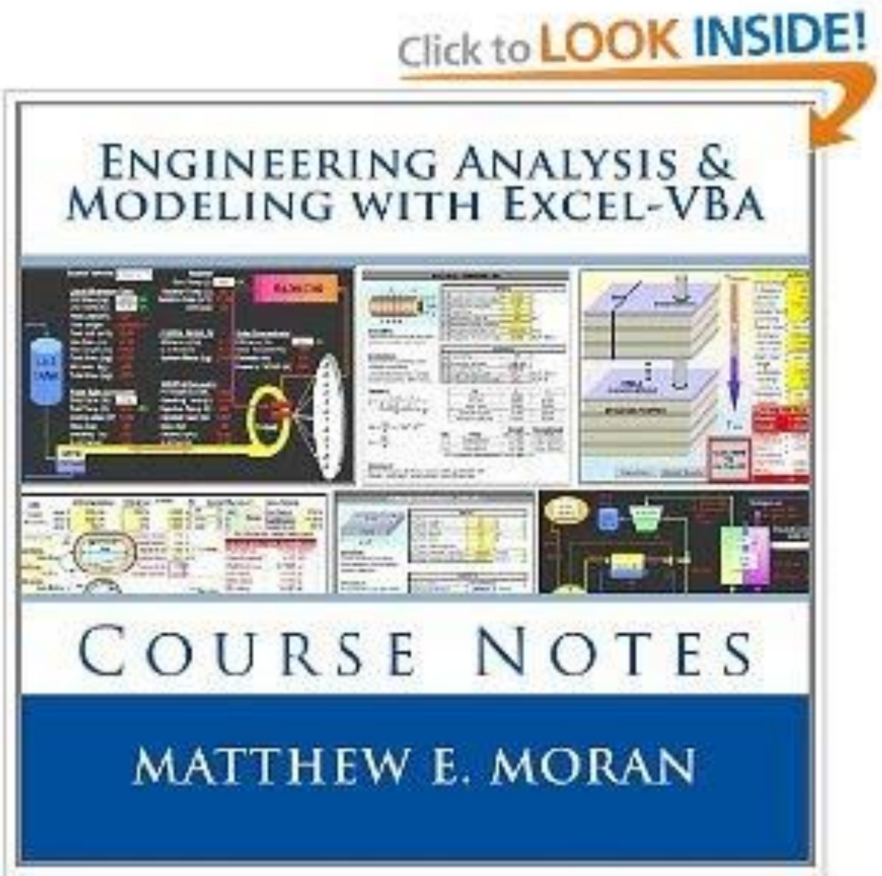
"I've been looking for a course like this for years! Matt was very knowledgeable and personable and walked his talk", *James McDonald, Crown Solutions*

"Gave me a lot to work with. Very helpful and hands on. [My favorite parts?]... It was all good", *Dale Folsom, Battelle*

"Matt was extremely knowledgeable and a great instructor", *Jennifer Snelling, Barrios Technology*

Isotherm Technologies
(isothermtech.com)

Course Materials



Visit www.isothermtech.com to get a variety of course materials and resources:

- ***Course notes in paperback and kindle formats***
- ***Excel files containing worked-out copies of all the course exercises***
- ***Helpful reports and online resources***
- ***Sample slides and exercises***
- ***Training course videos***
- ***Upcoming course offerings***

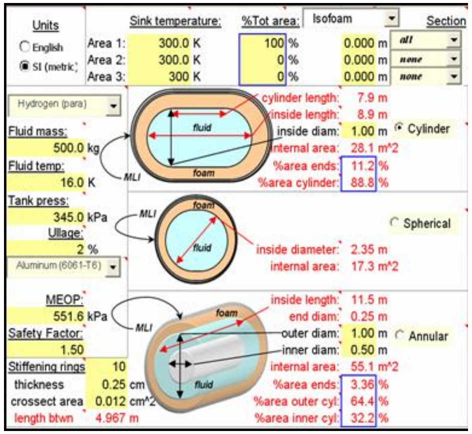
Intended Audience & Usage

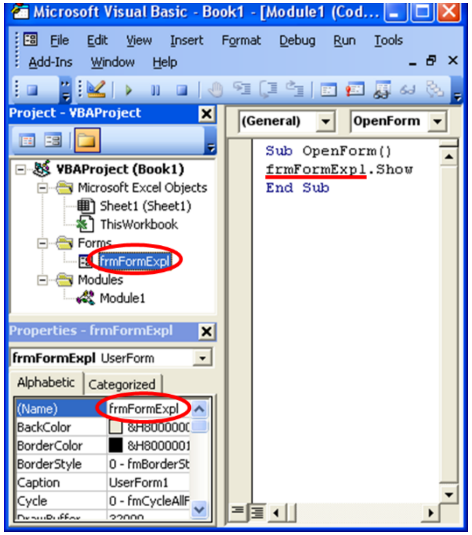
These course notes are intended for practicing engineers, scientists and others with an interest in analysis and modeling. It is targeted toward intermediate to advanced Excel users, although no prior experience with VBA is assumed. If you are new to Excel, you should consider supplementing these notes with an introductory course or book.

You may occasionally hear or read the opinion that Excel is not an appropriate tool for engineers. This is nonsense. The instructor has used many engineering software tools for more than three decades (e.g. general math, finite difference, FEA, CFD, CAE, DAQ, system simulation, custom codes, etc.), and they all have their place. Excel has a rich set of features for calculation, visual display and user interaction that makes it a very good general tool for many engineering and other technical computations. With its built-in VBA programming environment, and the associated techniques taught in these course notes, it becomes a highly versatile platform. Nonetheless, there is no substitute for good professional judgment in choosing the right tool for the job. There are certainly applications where Excel isn't the best choice - or even a viable option in some cases.

It's important to remember that the quality of all analytical results are dependent on a user's skills, knowledge, experience, discipline, and work quality. *Any* software tool will provide poor results if used improperly, although some tools hide it better with a polished display! In addition, verification and validation are always critical, and should be part of any analysis or model regardless of the tools and methods used. With that in mind, this course teaches principles and practices with Excel VBA that facilitate quality results.

How to Use These Course Notes





<u>Ways to use the course notes</u>:*

- Self study (paperback or kindle versions)
- Video training (with paperback or kindle version)**
- Course offering (public or hosted)**

<u>Each section uses a sequential teaching methodology</u>:

1) Real world application to illustrate the topics to be covered
2) Introduction to the learning topics and step-by-step details on how to implement them in Excel VBA
3) Integrated hands on exercise to solidify the topics learned

<u>General format & conventions</u>:

- Screen shots are predominantly used to facilitate immediate experimentation and rapid learning
- Notes, tips, and step-by-step instructions throughout
- Detailed text limited to topics needing more explanation
- Valuable supplemental info included in the appendices

** Visit www.isothermtech.com for information on video training and upcoming courses*

*** Video & course offerings can be applied toward PE continuing education requirements (check with your state or other licensing entity to confirm what types of training qualify)*

Instructor Bio

(Dec, 2013)

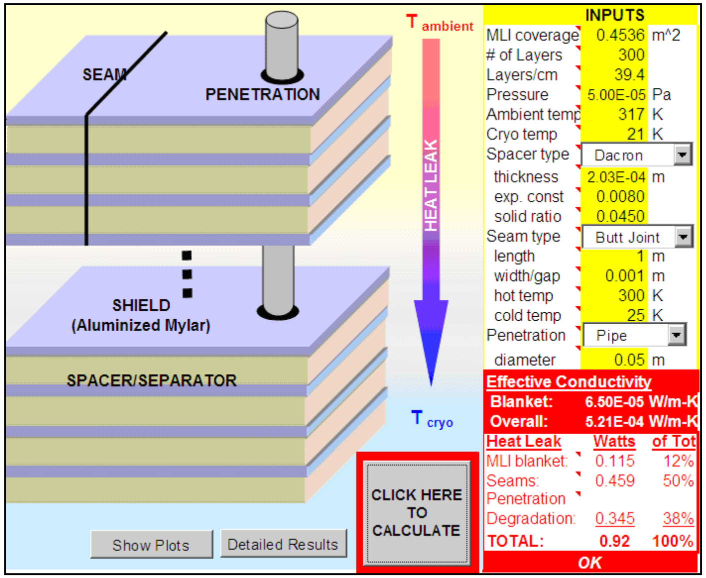
Matt Moran is the owner of Isotherm Technologies LLC. He is also a sector manager and senior engineer at NASA. Matt teaches engineering analysis seminars throughout the U.S., and has been adjunct faculty at the graduate school at Walsh University and other colleges. He has been a co-founder or key contributor to the start up of five high tech businesses, and has worked with hundreds of organizations of varying size, type and industry sector.

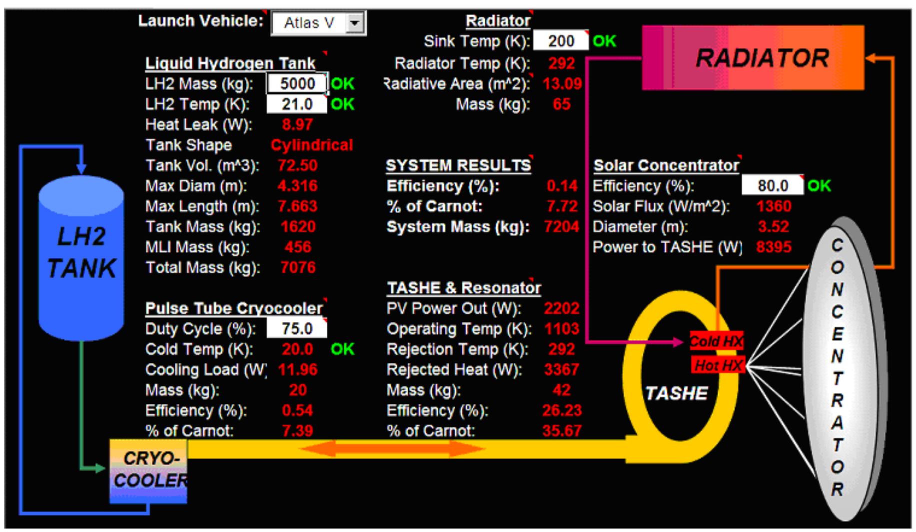
Matt has 32 years experience developing products and systems for aerospace, electronics, military, and power generation applications. He has used many software tools for analysis and modeling. Matt has created Excel VBA engineering system models for DARPA, Air Force, Office of Naval Research, Missile Defense Agency, NASA and various commercial organizations.

Matt is a Professional Engineer (Ohio), with a B.S. & graduate work in Mechanical Engineering, and an MBA in Systems Management. He has published 44 papers and a book; and has 3 US patents.

Isotherm Technologies
(isothermtech.com)

Course Summary





This course will provide the knowledge and methods to create custom engineering models for…

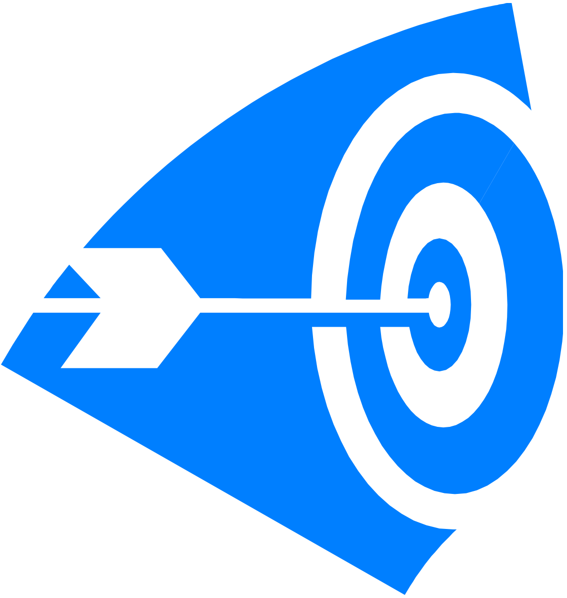
- ***Analyzing conceptual designs***
- ***Creating system trades***
- ***Simulating operation***
- ***Optimizing performance***

…with Excel VBA.

The instructor has been using spreadsheets for engineering computations since the early 1980s; and VBA since 1996 (shortly after its integration with Excel). He has taught these methods to hundreds of course participants since 2007.

(isothermtech.com)

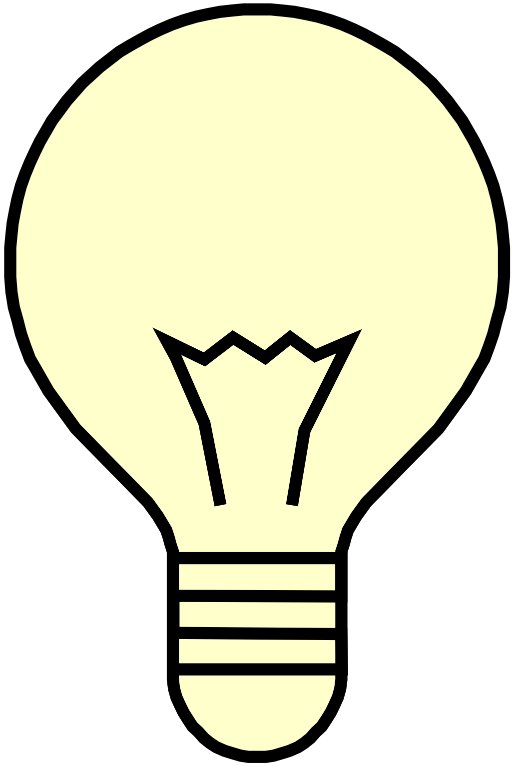
Learning Objectives



- Exploit the full power of Excel for building engineering models
- Master the built-in VBA programming language
- Implement advanced data I/O, manipulation, analysis, and display
- Create full featured graphical interfaces and interactive content
- Optimize performance for multi-parameter systems and designs
- Integrate interdisciplinary capabilities into engineering models

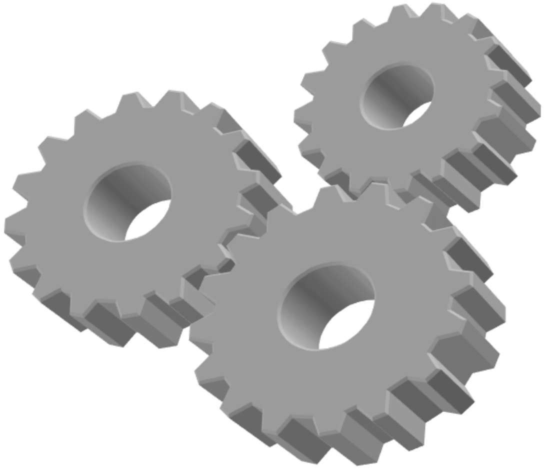
Isotherm Technologies
(isothermtech.com)

Topics: Design & Build



1. Excel VBA Review
2. Identifying Scope & Capabilities
3. Quick Prototyping
4. Defining Model Structure
5. Designing Graphical User Interfaces
6. Building & Tuning the VBA Engine
7. Customizing Output Results
8. Exploiting Built-in Excel Functions

Topics: Refine & Optimize



9. Integrating External Data
10. Adding Interdisciplinary Capabilities
11. Unleashing GoalSeek & Solver
12. Incorporating Scenarios
13. Documentation, References, & Links
14. Formatting & Protection
15. Flexibility, Standardization, & Configuration Control
16. Other Useful Tips & Tricks
17. Application Topics

