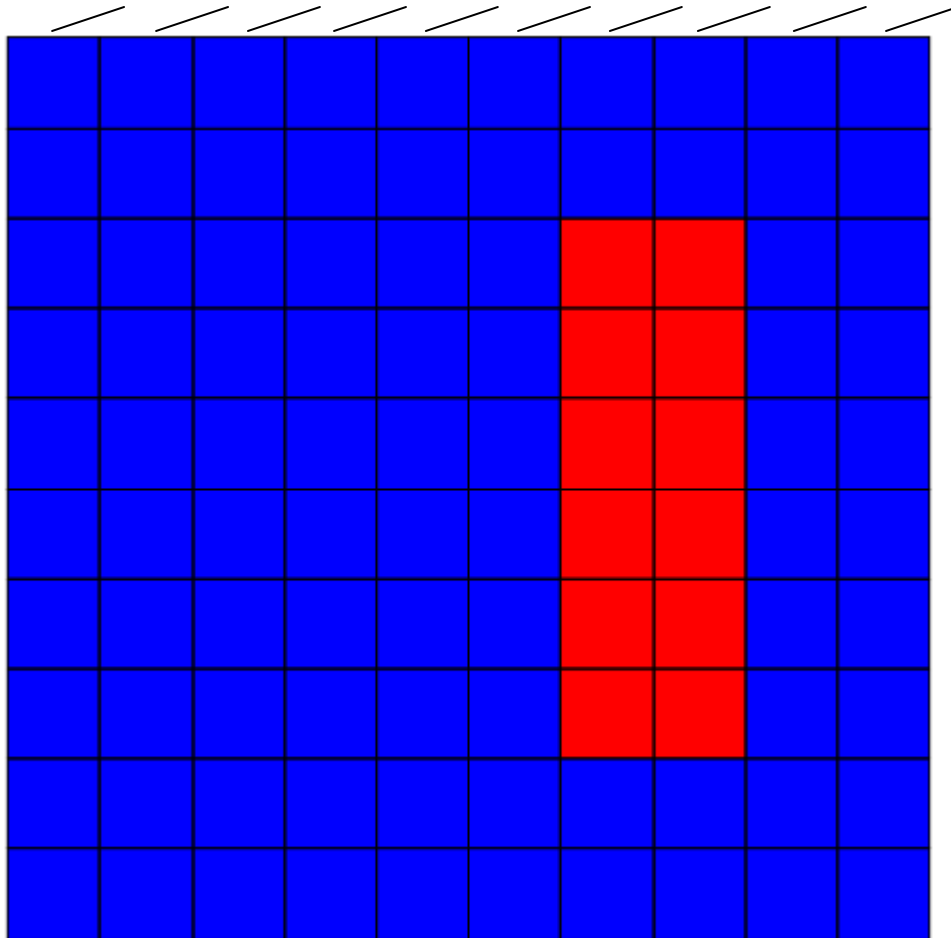


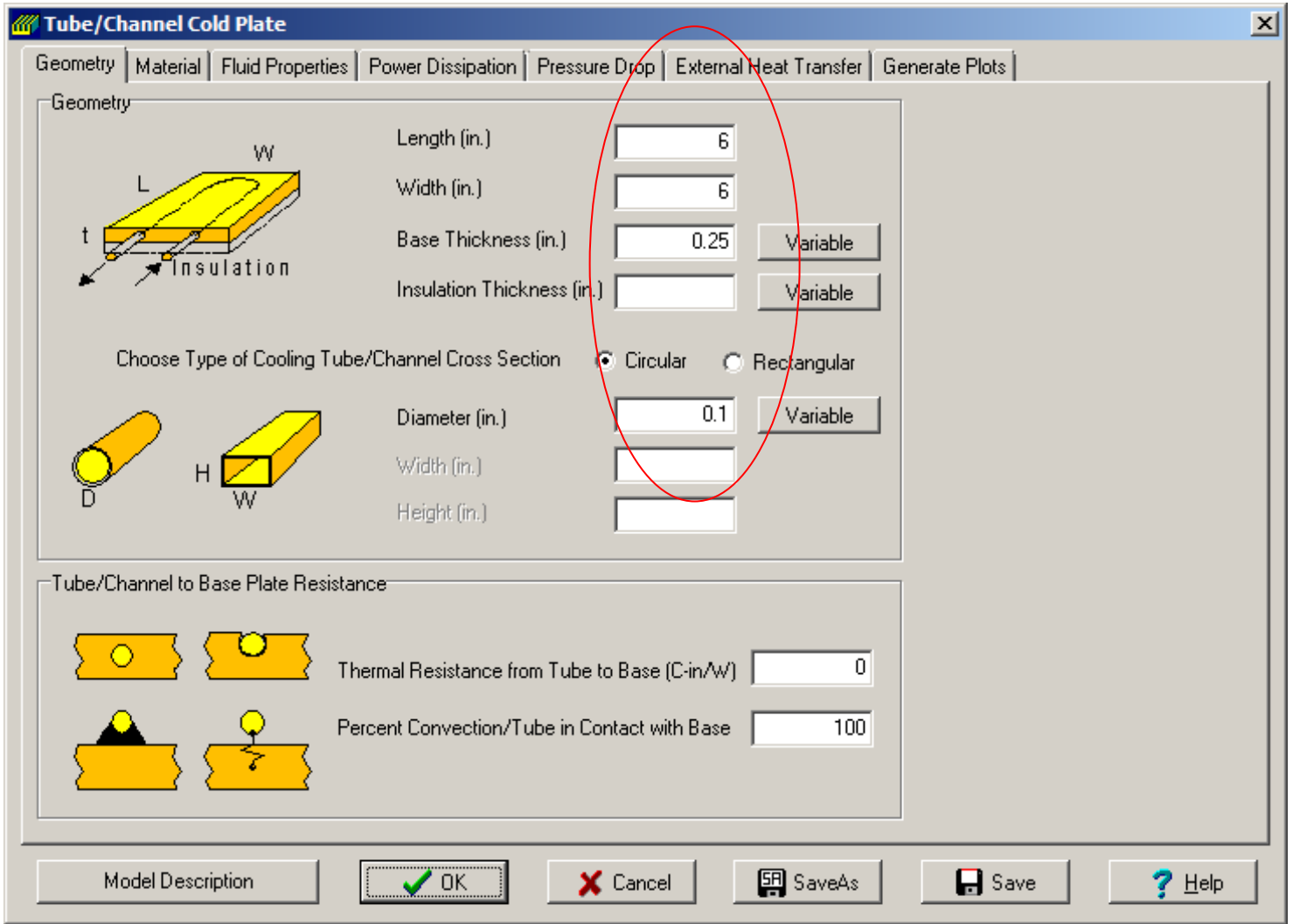
Copper Plate Example Model

Here's a demonstration of modeling a plate that is cooled by conduction to sink on one side, but without active fluid cooling through fins or a cooling tube. Assume the design parameters listed below:

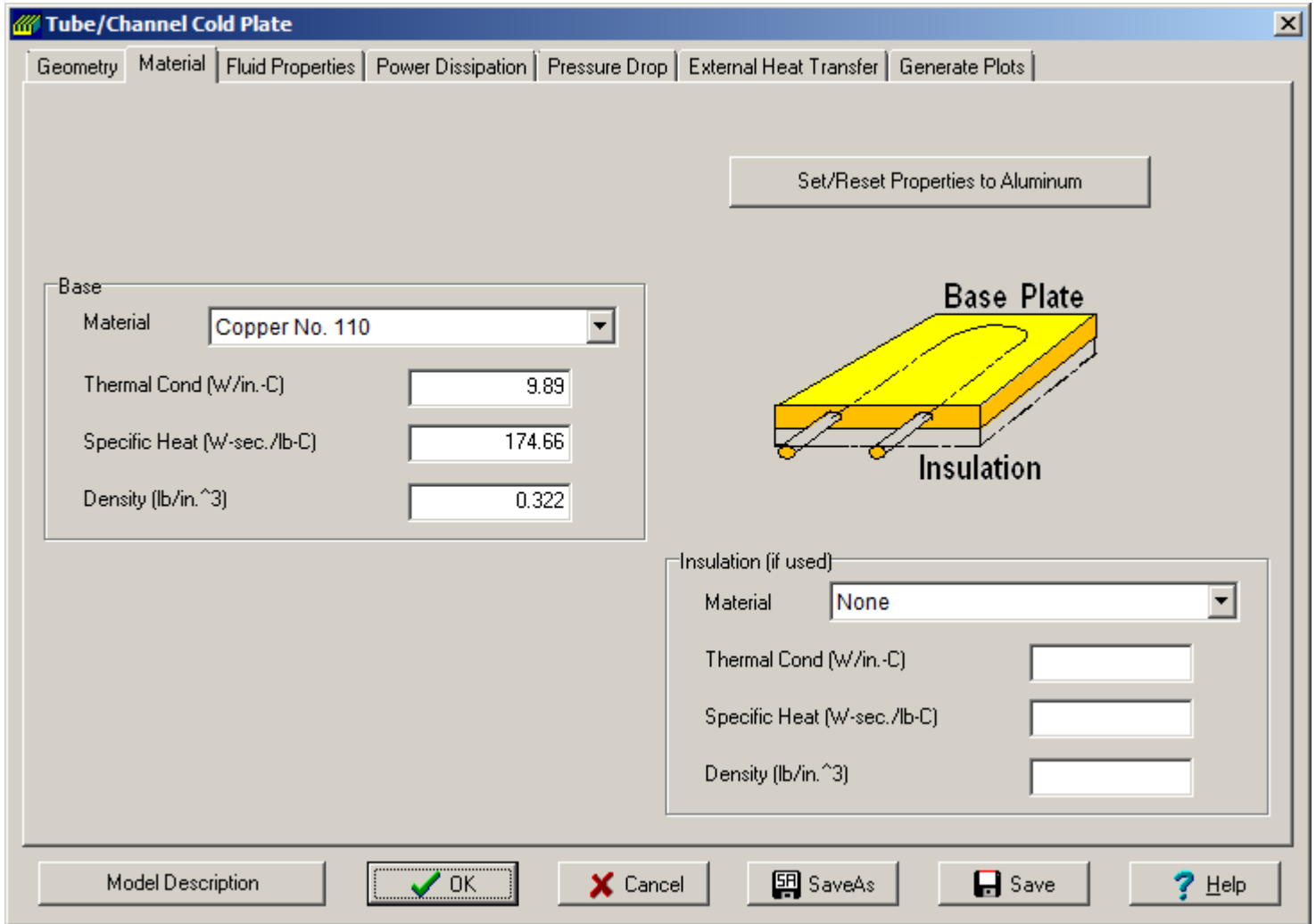
- Length L is 6 inches
- Width W is 6 inches
- Base plate is .25 inches thick
- The plate is attached to a 20C boundary along its top edge as shown below
- The thermal resistance from the plate edge to the sink is .10 C/W
- The plate is made of copper
- Assume a 10 node by 10 node model with the power dissipation as shown below with .80 Watt on each blue node and 10 Watts on each red node for a total power of 190.4 Watts.



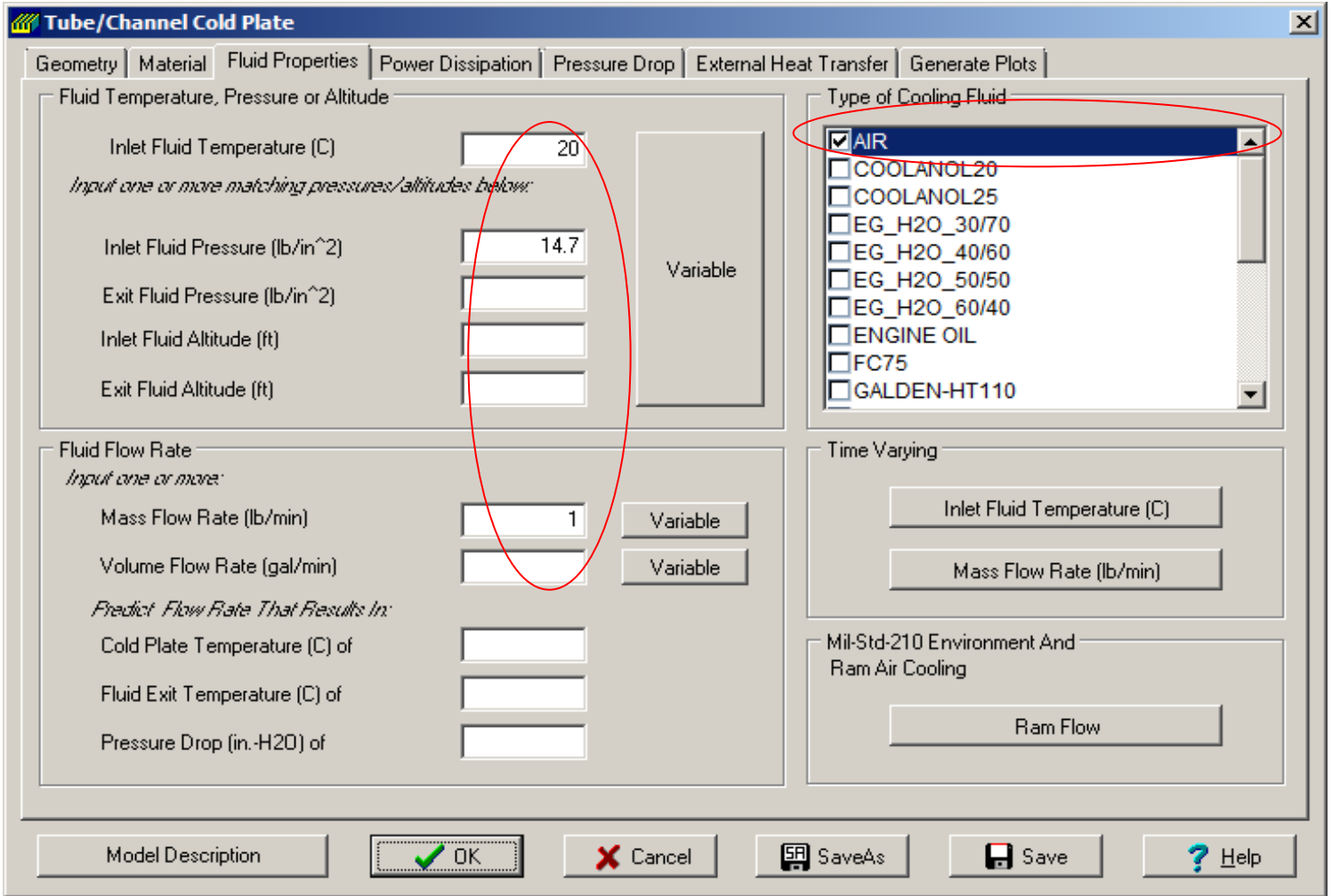
The trick to setting up this type of model is to assume that it is a tube flow cold plate but with the fluid flow turned off. In the non-isothermal part of the analysis we will tell the program that there is no flow. Of course in doing this we need to make sure that we have connected the cold plate to some type of boundary or run a transient analysis. The plate geometry is defined as shown below. We have specified a tube diameter of .1 inch, its value doesn't matter since it won't be used, and we just have to be sure to input a value.



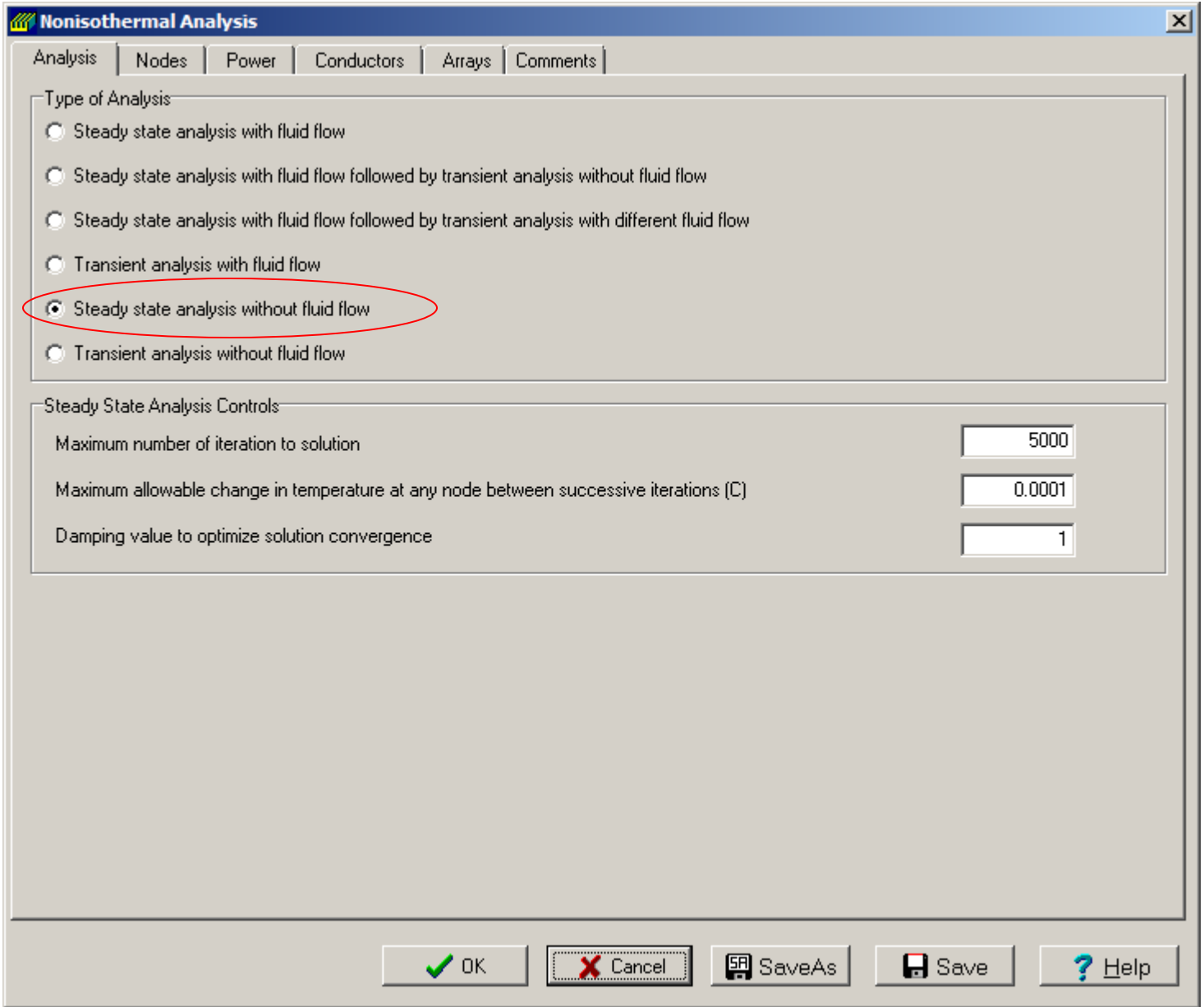
Select copper as the base plate material on the Material tab sheet.



On the Fluid Properties tab sheet we again assume that this is a fluid cooled model, its values other than its temperature are ignored. The temperature will be the conduction boundary temperature that the plate is connected to. The fluid inlet node is always node 5001; this will be used later when connecting the plate to it.



On the Nonisothermal Analysis form, select the “Steady state analysis without fluid flow” radio button to tell the program there is no fluid flow.



On the Nodes tab, input 10 nodes along the width and 10 nodes along the long. (The model is not restricted to these values.) Then select the “Connect Coolant Tube/Channel to Base” button and change one of the Node Row Numbers from No to Yes. It doesn’t matter which one, just as long as at least one of them is connect, the connection will not be used in the analysis.

Nonisothermal Analysis

Analysis Nodes Power Conductors Arrays Comments

Cold Plate Nodes

Number of nodes along width: 10

Number of nodes along length: 10

Connect Coolant Tube/Channel to Base

Example: 5 Nodes along Length, 4 Nodes along Width

		Length					
		4	8	12	16	20	Width
Flow Direction	4	4	8	12	16	20	
	3	3	7	11	15	19	
	2	2	6	10	14	18	
	1	1	5	9	13	17	
	1	1	5	9	13	17	

List of Extra Nodes

Node Number	Initial Temperature (C)	Thermal Mass (W-sec./C)	Comment Number
1			
2			
3			
4			
5			
6			

Groups of Extra Nodes

Number of Nodes	Starting Node Number	Initial Temperature (C)
1		
2		
3		
4		
5		
6		

Thermal Mass: D = Density

Tube/Channel Connection and Design

Select Tube/Channel Design

- Extended Serpentine Design
- Unextended Serpentine Design
- Parallel Tubes Design
- Custom Layout Design

Define Tube Connections

Node Row Number	Connected? (Yes or No)
1	Yes
2	No
3	No
4	No
5	No
6	No
7	No
8	No
9	No
10	No

Example - Tube Connection Scheme

OK Cancel Help

The power is input by selecting the Power tab sheet then the "Power Layout" button. On the power assignment table first select the "Uniformly" radio button, input 80 Watts (.8 Watts per node) then select the "Update Table" to uniform apply the 80 Watts. Next, select the "Discretely" radio button and then apply 10 Watts each to nodes 27,28,37,38,47,48,57,58,67,68,77,78. That takes care of the power assignment.

Nonisothermal Analysis

Analysis | Nodes | Power | Conductors | Arrays | Comments

Use "Uniform" power
 Constant power (Lists or Layout)
 Power

Uniformly Uniform Power (Watts)

Discretely

Uniformly
 Discretely Total Power is 190.40

Apply Power Uniformly: (then Discretely, if Desired)

	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9	Row 10
	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000
	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000
	N21	N22	N23	N24	N25	N26	N27	N28	N29	N30
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	10	10	0.8000	0.8000
	N31	N32	N33	N34	N35	N36	N37	N38	N39	N40
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	10	10	0.8000	0.8000
	N41	N42	N43	N44	N45	N46	N47	N48	N49	N50
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	10	10	0.8000	0.8000
	N51	N52	N53	N54	N55	N56	N57	N58	N59	N60
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	10	10	0.8000	0.8000
	N61	N62	N63	N64	N65	N66	N67	N68	N69	N70
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	10	10	0.8000	0.8000
	N71	N72	N73	N74	N75	N76	N77	N78	N79	N80
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	10	10	0.8000	0.8000
	N81	N82	N83	N84	N85	N86	N87	N88	N89	N90
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000
	N91	N92	N93	N94	N95	N96	N97	N98	N99	N100
Power	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000	0.8000

All that is left now is to tie the plate to boundary node number 5001 (the fluid inlet). As stated in the model input parameters, the total thermal resistance is .10 C/Watt. Since there are 10 nodes along the top, the resistance from each node to the boundary node is 1.0 C/Watt. But conductor values are the reciprocal of resistance, so the conductance is 1.0 Watt/C. The 10 conductors are input on a single line of input as shown below. For reference, the node numbering scheme used by COLDPLATE is shown on the Nodes tab sheet.

Nonisothermal Analysis

Analysis **Nodes** Power Conductors Arrays Comments

Constant conductance Conductance versus time Conductance versus temperature

List of Extra Conductors

	"From" Node	"To" Node	Constant Conductance	Time Array No.	Temperature Array No.	Cond. Type	Comment Number
1						C	
2						C	
3						C	
4						C	
5						C	
6						C	
7						C	
8						C	

Conductor Types:
C - conduction
F - fluid flow
R - radiation

Conductor Units:
C, F - Watt/C
R - Watt/C^4

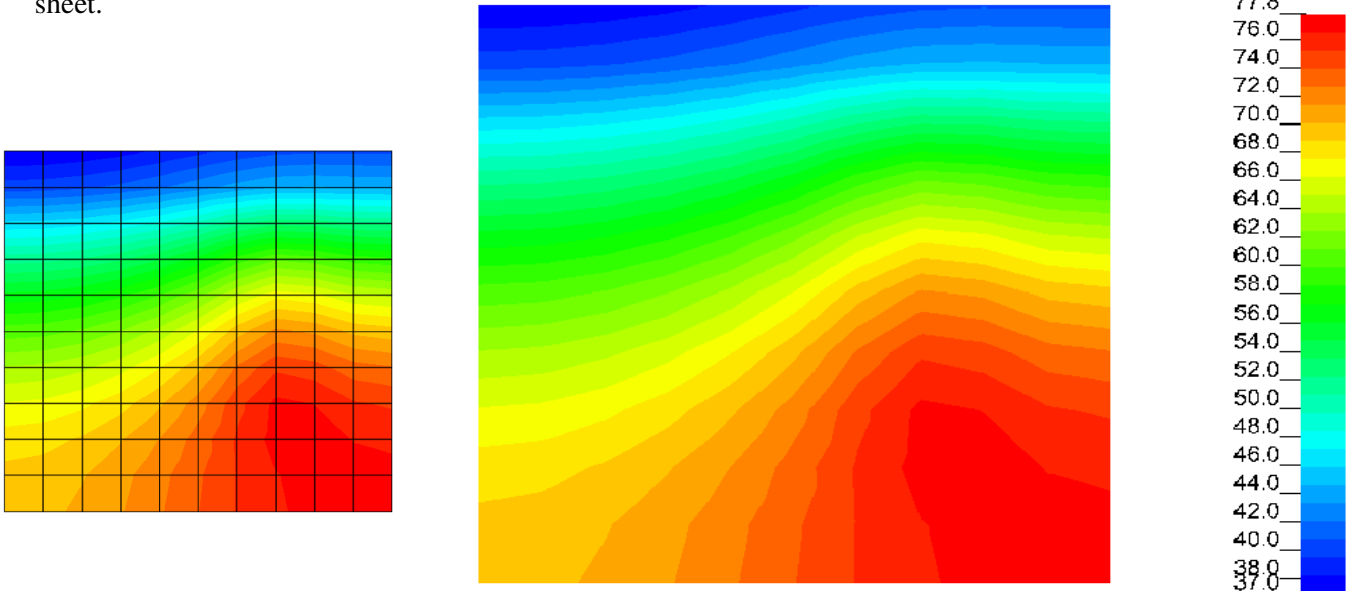
Duplicate Conductors
 Over-write
 Add in parallel

Groups of Extra Conductors

	No. of Conductors	Starting "From" Node	Increment Value	Starting "To" Node	Increment Value	Constant Conductance	Time Array No.	Temp. Array No.	Cond. Type	Comment Number
1	10	1	1	5001	0	1			C	
2									C	
3									C	
4									C	
5									C	
6									C	
7									C	
8									C	

OK Cancel SaveAs Save Help

The results are shown below. Note that we also could have added both convection and radiation to the model by inputting the ambient and/or wall temperatures on the “External Heat Transfer” tab sheet and then specifying the external convection (node 5002) and radiation (node 5003) parameters on the same sheet.



37.0	37.2	37.6	38.1	38.8	39.6	40.3	40.7	40.6	40.6
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 1	N 2	N 3	N 4	N 5	N 6	N 7	N 8	N 9	N 10
43.4	43.6	44.2	44.9	46.0	47.3	48.6	49.0	48.7	48.5
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 11	N 12	N 13	N 14	N 15	N 16	N 17	N 18	N 19	N 20
49.2	49.5	50.2	51.2	52.6	54.6	57.3	57.9	56.5	55.8
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 21	N 22	N 23	N 24	N 25	N 26	N 27	N 28	N 29	N 30
54.3	54.7	55.5	56.7	58.5	60.8	64.1	64.8	63.0	62.2
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 31	N 32	N 33	N 34	N 35	N 36	N 37	N 38	N 39	N 40
58.7	59.2	60.0	61.4	63.3	65.9	69.4	70.2	68.3	67.4
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 41	N 42	N 43	N 44	N 45	N 46	N 47	N 48	N 49	N 50
62.4	62.9	63.8	65.2	67.1	69.8	73.3	74.1	72.3	71.4
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 51	N 52	N 53	N 54	N 55	N 56	N 57	N 58	N 59	N 60
65.4	65.8	66.7	68.0	69.9	72.5	75.9	76.7	75.0	74.2
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 61	N 62	N 63	N 64	N 65	N 66	N 67	N 68	N 69	N 70
67.5	67.9	68.8	70.0	71.8	74.0	77.0	77.8	76.5	75.9
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	10.00W	10.00W	0.80W	0.80W
N 71	N 72	N 73	N 74	N 75	N 76	N 77	N 78	N 79	N 80
68.9	69.3	70.1	71.3	72.8	74.5	76.2	77.0	76.9	76.7
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 81	N 82	N 83	N 84	N 85	N 86	N 87	N 88	N 89	N 90
69.7	70.0	70.8	71.9	73.2	74.7	76.0	76.8	77.0	77.0
(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)	(-----)
0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W	0.80W
N 91	N 92	N 93	N 94	N 95	N 96	N 97	N 98	N 99	N 100