3D Convection through an Electronics Box - Physics Setup

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Physics Setup
Update Project
2 🎯 Mesh 🛛 🐔 This
In the Project Schematic window, notice that there is a lightning symbol in the mesh box
need to update the project in order to continue. Press to apply the mesh. The lighting symbol should now be replaced by a green
check mark i i i i i i i i i i i i i i i i i i i
Launch FLUENT
To begin setup, double click Setup To begin setup, double click Setup Control of Processing Options, check the box marked Double Precision, and under Processing Options, select Parallel and change the Number of Processes to 2.
FLUENT Launcher (Setting Edit Only)
FLUENT Launcher
Dimension Options
2D Double Precision 3D Use Job Scheduler
Use Remote Linux Nodes
Display Uptions Visplay Mesh After Reading Processing Options
Embed Graphics Windows O Serial
Workbench Color Scheme O Parallel (Local Machine)
Do not show this panel again Number of Processes
Show More Options
<u>□K</u> <u>Cancel H</u> elp ▼

Once the options are set, press OK to launch FLUENT.

Turn on Energy

The first thing that needs to be done is to tell FLUENT to solve for temperature. To do this, we need to turn on the Energy Equation. Under **Problem Setup**, select *Models*. In the *Models* window, double click *Energy*. The *Energy* window should pop up. Check the box next to *Energy Equation* and press *OK*.

Materials

Next, we will create the materials we are using in the simulation and define their material properties. For reference, the material properties needed for this simulation are included in the table below.

Material	ABS plastic	Copper	Air
Density (kg/m^3)	1080	8800	0.946
Thermal Conductivity (W/mK)	0.188	391	0.0314
Specific Heat (J/kgK)	1260	385	1009

Air

Under Problem Setup, select *Materials*. In the *Materials* window under *Fluid* select *Air*, and press *Create/Edit...*. Define the material properties for air as shown in the table above.

me	Material Type		Order Materials by
ir	fluid	•	Name Chamical Formula
emical Formula	FLUENT Fluid Materials		
	air	•	FLUENT Database
	Mixture		User-Defined Database
	none	~	J
operties			
Density (kg/m3)	constant 💌 Edit	. î	
	.946		
Cp (Specific Heat) (j/kg-k)	constant Tedit		
	1009		
Thermal Conductivity (w/m-k)	constant Tedit	E	
	.0314		
Viscosity (kg/m-s)	constant - Edit		
	1 7894e-05	-	
	1.70542-05	-	

When you are finished entering the material properties of air, press Change/Create and close the window.

Copper

Now, highlight *aluminum* in the *material properties* window and select *Create/Edit...*. We are not using aluminum in this simulation, so we need to change the name and the properties to reflect copper. In the popup window, change the *Name* to Copper, and the *Chemical Formula* to Cu. Also, change the material properties to the values shown in the chart above.

Name	Material Type	Order Materials by
copper	solid	Name
Chemical Formula	ELLIENT Solid Materials	Chemical Formula
cu	aluminum (al)	✓ FLUENT Database
	Mixture	User-Defined Database
	none	*
Properties		
Density (kg/m3)	constant	
	8800	
Cp (Specific Heat) (j/kg-k)	constant	
	385	
Thermal Conductivity (w/m-k)	constant	
	391	
	*	

Now, press Change/Create. You will be asked if you want to overwrite aluminum, press Yes. You may now close the popup window.

ABS Plastic

Now, we need to create a new material. In the *Materials* window, highlight *Solid* and press *Create/Edit...* Notice that the material properties for copper appear in the popup window. This is OK, but we need to remember that we do not want to overwrite the copper data. Rename the new material ABS and for simplicity, also enter the *Chemical Formula* as ABS. Enter the material properties for ABS as shown in the table above.

lame	Material Type	Order Materials by
abs	solid	 Name
Chemical Formula	ELUENT Colid Motorials	Chemical Formula
abs	copper (cu)	FLUENT Database
	Mixture	User-Defined Database.
	none	
roperties		
Density (kg/m3)	constant	
	1080	
Cp (Specific Heat) (j/kg-k)	constant	
	1260	
Thermal Conductivity (w/m-k)	constant	
	.188	
	-	-

When the material properties are entered correctly, press *Change/Create*. The popup will appear asking us if we want to overwrite the material properties for copper. We do not want to overwrite copper, so press *No*. This should create ABS as a new material in the material list.

Materials
Materials Fluid air Solid abs
copper
Create/Edit
Help

Boundary Conditions

Now, we need to enter the boundary conditions for this problem. In the Outline, select Boundary Conditions to bring up the boundary conditions window.

Inlet

In the Boundary Conditions window, select *Inlet*. Check to make sure that the *Type* has correctly defaulted to *Velocity-Inlet* and press *Edit...*. In the *Mome ntum* Tab, we will specify the velocity of the incoming air. Knowing that the inlet feed rate is 35 ft^3/min and that the diameter of the holes is 4.72 inches, we can solve for the inlet speed.

$$flow = 35 \frac{ft^3}{minute} = 1008 \frac{in^3}{s}$$
$$u = \frac{1008 \frac{in^3}{s}}{\left(\frac{4.72}{2}in\right)^2 \pi} = 57.609 \frac{in}{s}$$

Input the speed into the Velocity Magnitude. Please note that the units for the Velocity Magnitude should be in/s and not m/s as in the picture.

velocity inter		
one Name		
inlet		
Momentum Thermal Radiation Species	DPM Multiphase U	DS
Velocity Specification Method	Magnitude, Normal to Bour	dary 🔹
Reference Frame	Absolute	•
Velocity Magnitude (m/s)	57.609	constant 👻
Supersonic/Initial Gauge Pressure (pascal)	0	constant 👻
OK	Cancel Help	

Next, click on the *Thermal Tab*. We need to input the temperature of the incoming air. The ambient air is 114 degrees Fahrenheit. FLUENT only accepts temperatures in Kelvin. 114 degrees Fahrenheit = 318.706 Kelvin. Input the ambient temperature, and press *OK*

Velocity Inlet	x
Zone Name	
Momentum Thermal Radiation Species DPM Multiphase UDS	
Temperature (k) 318.706 constant	
OK Cancel Help	

Outlet

In the Boundary Conditions window, select Outlet. Check to make sure that the Type is set to Pressure-Outlet and press Edit.... In the Momentum tab, the Gauge Pressure (pascal) should be set to 0. Next, click on the Thermal tab. Change the Backflow Total Temperature to 318.706 Kelvin and press OK.

ſ	Pressure Outlet	ſ
	Zone Name	
	outlet	
	Momentum Thermal Radiation Species DPM Multiphase UDS	ľ
	Backflow Total Temperature (k) 318.706 constant	
1		
1		
		l
	OK Cancel Help	

Wall

Next, we need to specify the wall material as ABS plastic. In the *Boundary Conditions* menu, select wall-solid and press Edit.... Select the Thermal tab, and change the Material to ABS.

💶 Wall		×	
Zone Name			
wall-solid			
Adjacent Cell Zone			
solid			
Momentum Therma	Radiation Species DPM Multiphase UDS		
Thermal Conditions			
Heat Flux	Heat Flux (w/m2)	constant 👻	
Convection		Wall Thickness (m)	
 Radiation Mixed 	Heat Generation Rate (w/m3)	constant 👻	
Material Name Shell Conduction			
OK Cancel Help			

Heat Generation

In the Outline window, select Cell Zone Conditions. Under Zones, select HeatGeneration and press Edit. Change the material name to Copper. Check the box next to Source Terms, then select the Source Terms Tab.

Solid EX	
Zone Name	
heatgeneration	
Material Name copper	
Frame Motion 🔽 Source Terms	
Mesh Motion Fixed Values	
Reference Frame Mesh Motion Source Terms Fixed Values	
Energy (w/m3) 0 sources	
OK Cancel Help	

In the Source Terms tab, select *Edit*. Change the number of Energy Sources to 1, then use the pull down menu and select constant. Enter the heat generation as 40682 w/m^3.

Solid	
Zone Name	
heatgeneration	
Material Name copper	▼ Edit
Frame Motion 🔽 Source Terms	
Mesh Motion Fixed Values	
Reference Frame Mesh Motion Sour	ce Terms Fixed Values
Energy (w/m3) 0 sources	Edit Edit Energy (w/m3) sources Number of Energy (w/m3) sources 1. 40682.489442894 constant
	OK Cancel Help

When finished, press OK.

Reference Values

Now that we are done defining the boundary conditions, we need to specify reference values. In the *Outline*, select *Reference Values*. Underneath *Compute From*, select *Inlet*.

Go to Step 5: Numerical Solution

Go to all FLUENT Learning Modules