FLUENT - Compressible Flow in a Nozzle- Step 6

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Step 6: Results

Useful Information

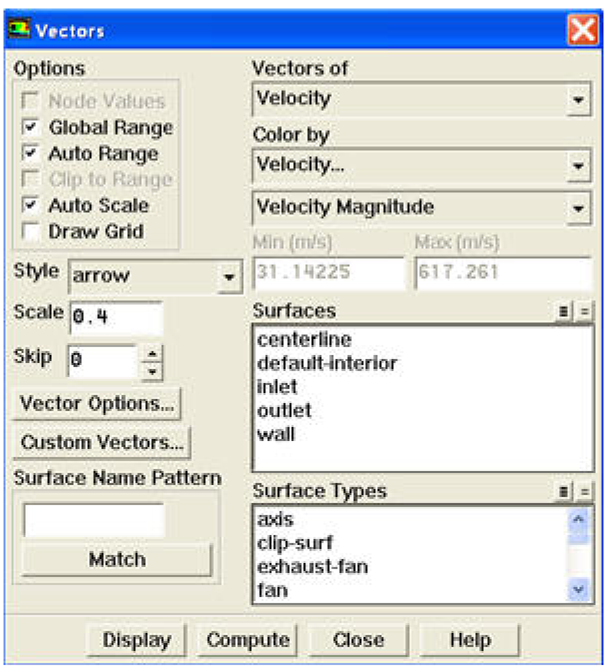
These instructions are for FLUENT 6.3.26. Click here for instructions for FLUENT 12.

Velocity Vector

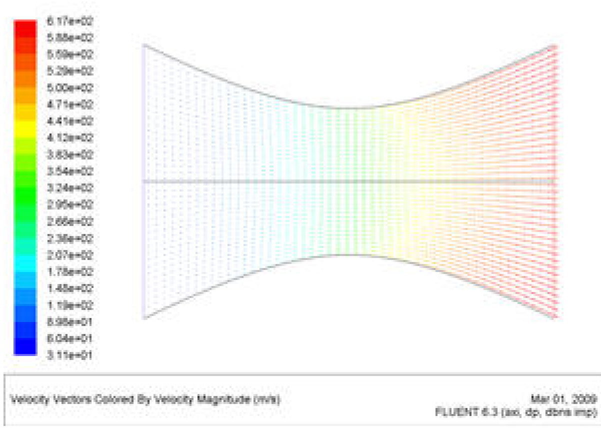
Let's first look at the velocity **vector** in the nozzle.

Display > Vectors...

Select ***Velocity*** under ***Vectors of*** and ***Velocity...*** under ***Color by***. Set ***Scale*** to 0.4



Click ***Display***.



Higher Resolution Image

We see that the flow is smoothly accelerating from subsonic to supersonic.

To include the lower half of nozzle, do the following:

Display > Views...
Select ***centerline*** and click ***Apply***

White Background on Graphics Window

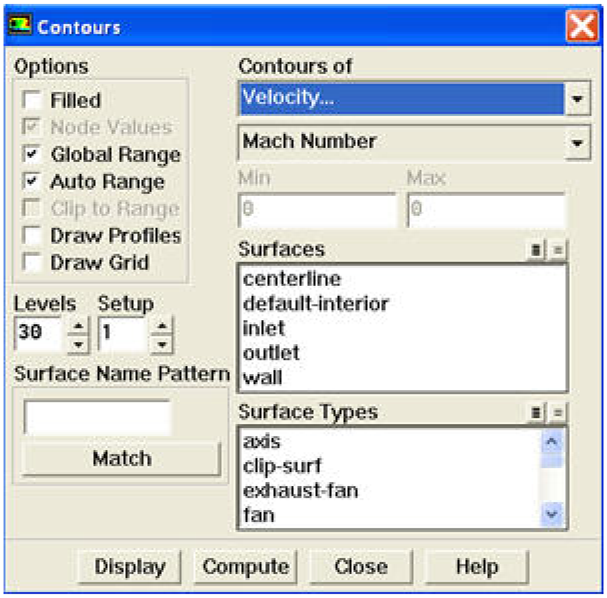
To get white background go to:
Main Menu > File > Hardcopy
Make sure that ***Reverse Foreground/Background*** is checked and select ***Color*** in ***Coloring*** section. Click ***Preview***. Click ***No*** when prompted "*Reset graphics window?*"

Mach Number Contour

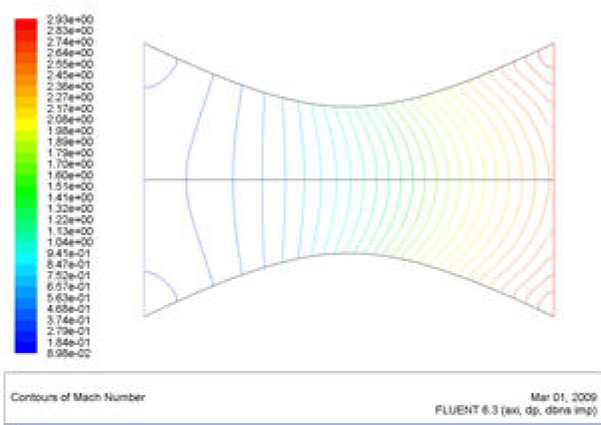
Let's now look at the Mach number

Display > Contours

Select ***Velocity...*** under ***Contours of*** and select ***Mach Number***. Set ***Levels*** to 30.



Click ***Display***.



Higher Resolution Image

For 1D case, mach number is a function of x position. For 1D case, we are supposed to see vertical contour of mach numbers that are parallel to each other.

For 2D case, we are seeing curving contour of mach number. The deviation from vertical indicates the 2D effect.

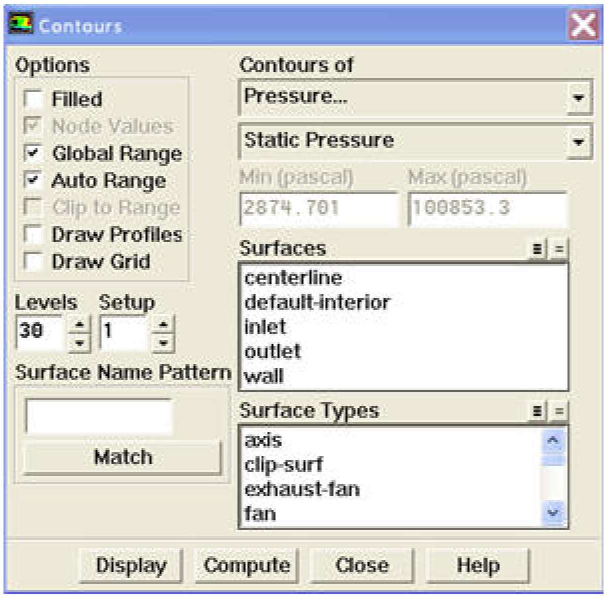
Do note that 1D approximation is fairly accurate around the centerline of nozzle.

Pressure Contour Plot

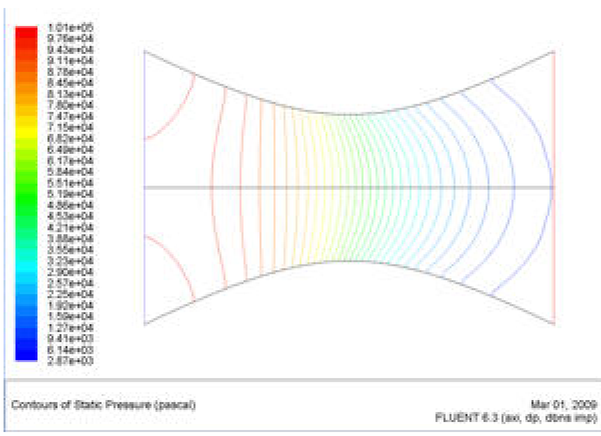
Let's look at how pressure changes in the nozzle.

Display > Contours...

Select ***Pressure...*** and ***Static Pressure*** under ***Contours of***. Use ***Levels*** of 30



Click **Display**.



Higher Resolution Image

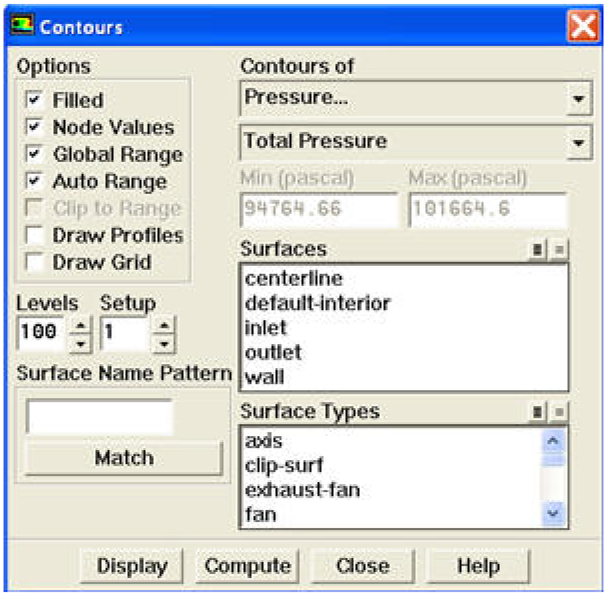
Notice that the pressure decreases as it flows to the right.

Total Pressure Contour Plot

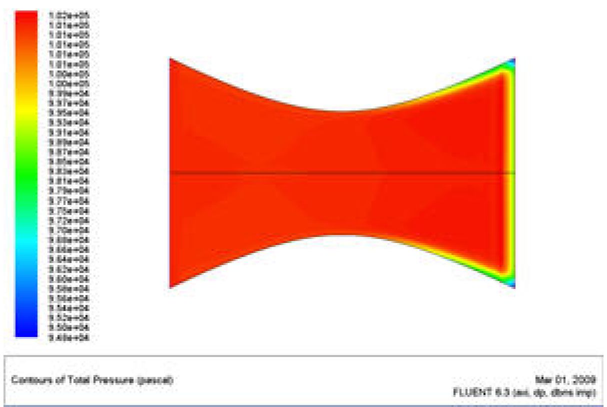
Let's look at the total pressure in the nozzle

Display > Contours...

Select ***Pressure...*** and ***Total Pressure*** under ***Contours of***. Select ***Filled***. Use ***Levels*** of 100.



Click ***Display***.



Higher Resolution Image

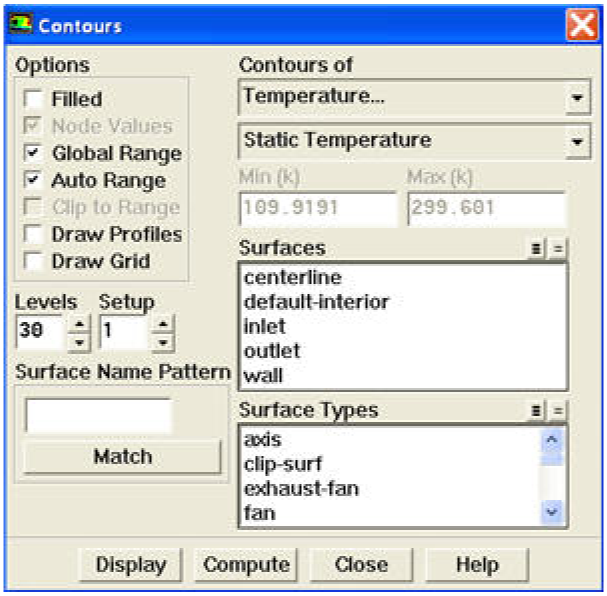
Around the nozzle outlet, we see that there is a pressure loss because of the numerical dissipation.

Temperature Contour Plot

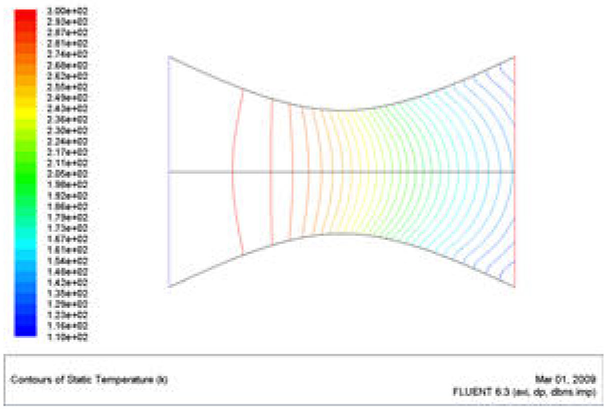
Let's investigate or verify the temperature properties in the nozzle.

Display > Contours...

Select ***Temperature...*** and ***Static Temperature*** under ***Contours of***. Use ***Levels*** of 30.



Click ***Display***.



Higher Resolution Image

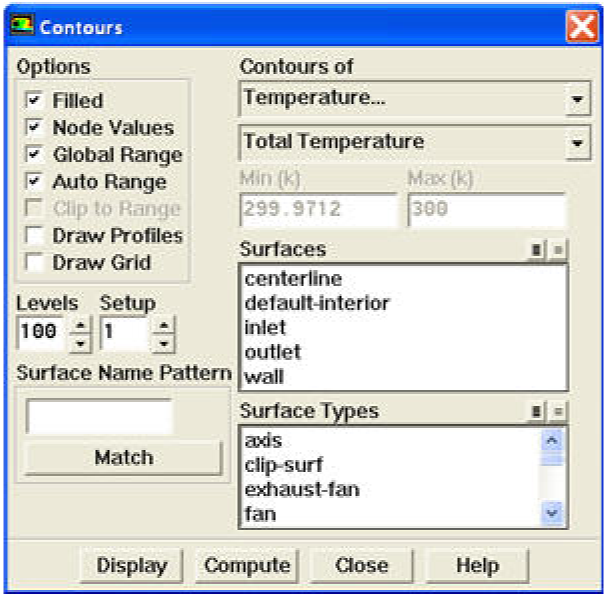
As we can see, the temperature decreases from left to right in the nozzle, indicating a transfer of internal energy to kinetic energy as the fluid speeds up.

Total Temperature Contour Plot

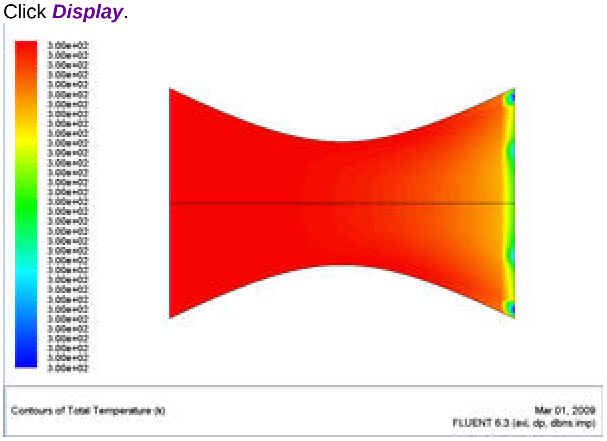
Let's look at the total pressure in the nozzle

Display > Contours...

Select ***Temperature...*** and ***Total Temperature*** under ***Contours of***. Select ***Filled***. Use ***Levels*** of 100.



Click ***Display***.

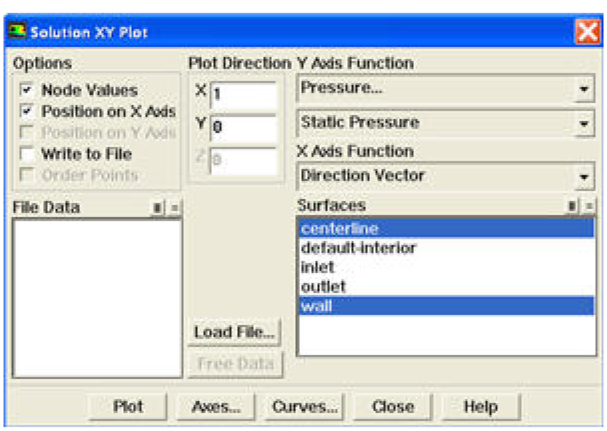


Higher Resolution Image

Looking at the scale, we see that the total temperature is uniform 300 K throughout the nozzle. The contour abnormality at the outlet of the nozzle is due to the round off errors.

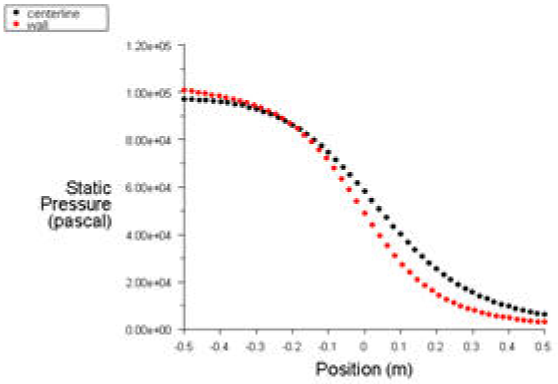
Pressure Plot

Let's look at the pressure along the centerline and the wall.



Plot > XY Plot

Make sure that under ***Y-Axis Function***, you see ***Pressure...*** and ***Static Pressure***. Under ***Surfaces***, select ***centerline*** and ***wall***. Click ***Plot***.



Higher Resolution Image

It is good to write the data into a file to have greater flexibility on how to present the result in the report. At the same XY Plot windows, select ***Write to File***. Then click ***Write...*** Name the file "p.xy" in the directory that you prefer.

Open "p.xy" file with notepad or other word processing software. At the top, we see:

```
(title "Static Pressure")

(labels "Position" "Static Pressure")
```

First line tells us the properties we are comparing. For our case, we are looking at Static Pressure.
Second line tells us about the x and y label.

There is a header at the beginning of each the data sets so that we can differentiate which data sets we are looking at. For our case, we have "centerline" and "wall" data sets.

Following is an example of two data sets (centerline and wall).

```
((xy/key/label "centerline")

-0.5    97015.3

-0.48    96949.9


.


.


.


0.5    6012.92

)



((xy/key/label "wall")

-0.5    100853

-0.480911    100496


.


.


.


0.5    2874.7

)
```

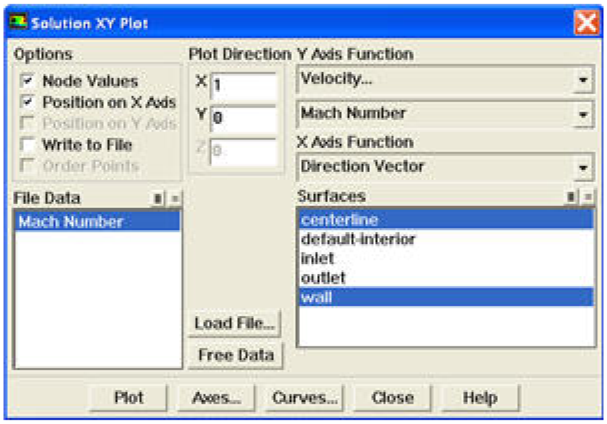
Try copy the appropriate data sets to excel and plot the results.

Mach Number Plot

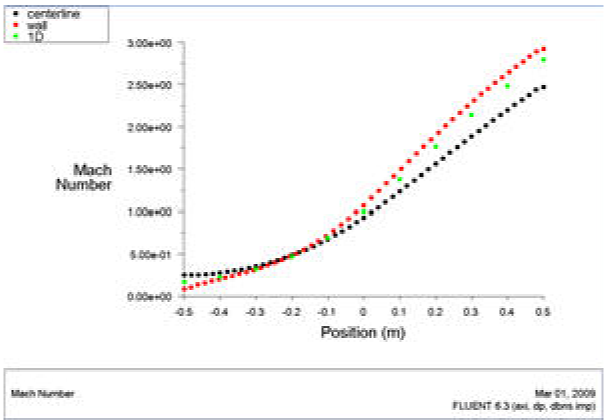
Let's plot the variation of Mach number in the axial direction at the axis and wall. In addition, we will plot the corresponding variation from 1D theory. You can download the file here: mach_1D.xy.***Plot > XY Plot***Under the ***Y Axis Function***, select ***Velocity...*** and ***Mach Number***.

Also, since we are going to plot this number at both the wall and axis, select ***centerline*** and ***wall*** under ***Surfaces***.

Then, load the mach_1D.xy by clicking on ***Load File....***



Click ***Plot***.



Higher Resolution Image

How does the FLUENT solution compare with the 1D solution?

Is the comparison better at the wall or at the axis? Can you explain this?

Save this plot as `machplot.xy` by checking ***Write to File*** and clicking ***Write...***.

Go to Step 7: Verification & Validation

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