Rylie Lodes MAE 494: Applied CFD Professor HP Huang Homework 1 Report

1. Contour plots of velocity and temperature in the plane of symmetry, as well as a contour plot of temperature over the circular opening of the outlet.

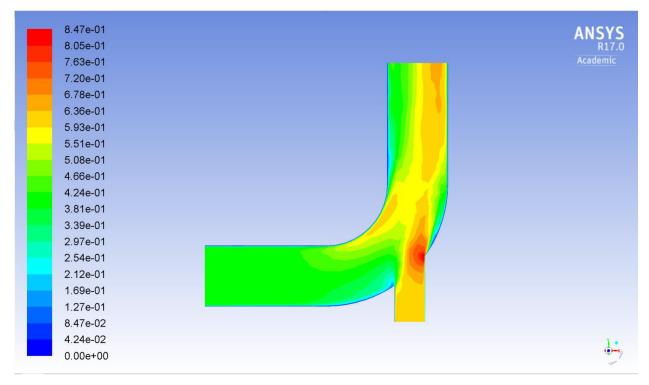


Figure 1: Velocity on plane of symmetry for the R=1in. inlet pipe, R=2in large inlet, and an inlet velocity for the small inlet of 0.6m/s.

3.13e+02 3.12e+02 3.11e+02 3.09e+02 3.09e+02 3.07e+02 3.06e+02 3.05e+02 3.05e+02 3.04e+02 3.03e+02 3.02e+02 3.01e+02 3.01e+02 3.00e+02 2.99e+02 2.98e+02 2.98e+02	ANSYS R17.0 Academic
2.95e+02 2.94e+02 2.93e+02	<b>b</b> -,

Figure 2: Temperature distribution on the plane of symmetry.

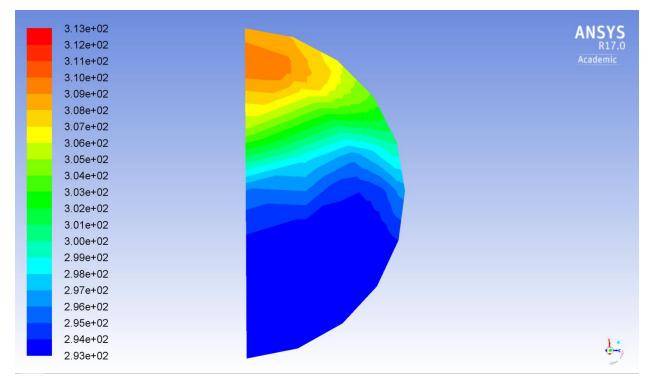


Figure 3: Temperature profile for the outlet.

2. Line plots of temperature and velocity along the line AB, with comparisons of profiles with their counterparts from the standard case in Task 0 (R=0.5in and V\_inlet = 1.2m/s).

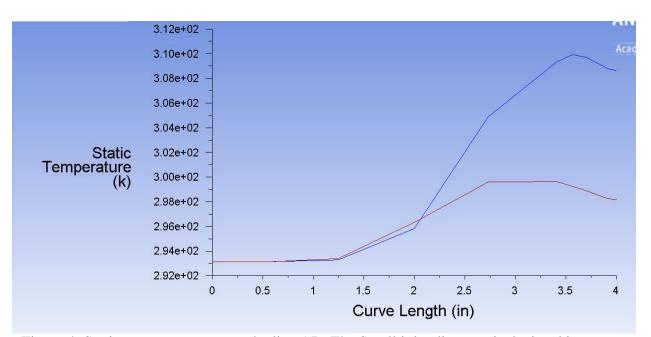


Figure 4: Static temperature across the line AB. The Small inlet diameter is depicted in red, while the Large inlet diameter is depicted in blue.

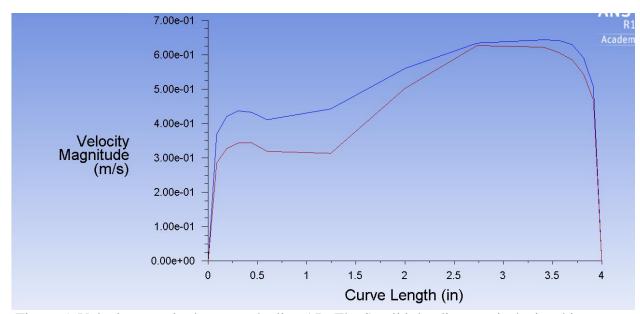


Figure 5: Velocity magnitude across the line AB. The Small inlet diameter is depicted in red, while the Large inlet diameter is depicted in blue.

3. Check the energy balance and mass balance of the system. Calculate the three values of H and three values of M to show the requirements of energy and mass balance are satisfied.

In order to perform the surface integrals, custom field functions were defined for heat flux and mass flux; one for the large inlet and one for the two outlets (both have velocity vectors in the y direction). The general solution steps are as follows, with figures to visually show the windows and equations:

Field Function Definitions	×		
Definition			
Vx * density * specific-heat-cp * temperature			
Field Functions   heat-flux-large-inlet   heat-flux-inletsmall-outlet   large-inlet-mfr	Name heat-flux-large-inlet		
mfr-inletsmall-outlet	ID 0		
Rename Delete Save	Load Close Help		

Figure 6: Custom Field Function for calculating surface integrals for heat flux (large inlet depicted)

Field Function Definitions	×
Definition	
Vx * density	
Field Functions	Name
heat-flux-large-inlet	large-inlet-mfr
heat-flux-inletsmall-outlet	
large-inlet-mfr	
mfr-inletsmall-outlet	
	ID
	2
Ren	ame Delete Save Load Close Help

Figure 7: Custom Field Function for calculating surface integrals for mass flux (large inlet depicted)

## Surface Integrals

Report Type	Field Variable	
Integral 👻	Custom Field Functions 🝷	
Custom Vectors	large-inlet-mfr 🔹	
Vectors of	Surfaces [1/8] 🗉 🔳 =	
Custom Vectors	interior-solid line-7	
Surface Types [0/31]	line-ab pressure-outlet	
axis 🔨		
clip-surf	velocity-inlet-large	
exhaust-fan	velocity-inlet-small	
fan 🗸	wall-solid	
Surface Name Pattern		
Match		
materi	Highlight Surfaces	
Save Output Parameter	Integral	
	1.594912	
Compute W	/rite Close Help	

Figure 8: Using Surface Integrals to compute large inlet mass flux

Field Variable				
Custom Field	Custom Field Functions 🝷			
heat-flux-large-inlet 🔹				
Surfaces	[1/8]	: = =		
interior-solid line-7 line-ab pressure-out symmetry <u>velocity-inlet</u> velocity-inlet wall-solid	let :-large			
Highlight Surfaces				
Integral				
1971184				

Figure 9: Surface Integral for large inlet heat flux

 $\times$ 

Field Variable			
Custom Field	functions	-	
heat-flux-inl	etsmall-outlet	•	
Surfaces	[1/8]	3 2 =	
interior-solid	ł		
line-7			
line-ab			
pressure-out	tlet		
symmetry			
velocity-inlet-large			
velocity-inlet-small			
wall-solid			
Highlight Surfaces			
Integral			
789624.9			

Figure 10: Surface Integral for small inlet heat flux

Field Variable			
Custom Field Functions 🔻			
heat-flux-inl	etsmall-outlet	-	
Surfaces	[1/8]	<b>) = =</b>	
interior-solid line-7 line-ab pressure-ou symmetry velocity-inle velocity-inle wall-solid	tlet :t-large		
Highlight Integral	Surfaces		
2760810			

Figure 11: Surface Integral for outlet heat flux

Field Variable				
Custom Field Functions 🝷				
large-inlet-m	fr	-		
Surfaces	[1/8]	<b>= =</b>		
interior-solid	I			
line-7				
line-ab				
pressure-out	let			
symmetry	symmetry			
velocity-inle	t-large			
velocity-inlet-small				
wall-solid				
Highlight :	Surfaces			
Integral				
1.594912				

Figure 12: Surface Integral for large inlet mass flux

Field Variable				
Custom Field Functions 🝷				
mfr-inletsmall-outlet				
Surfaces	[1/8]	3 2 =		
interior-solid	1			
line-7				
line-ab				
pressure-out	tlet			
symmetry	symmetry			
velocity-inlet-large				
velocity-inlet-small				
wall-solid				
Highlight Surfaces				
Integral				
0.5980917				

Figure 13: Surface Integral for small inlet mass flux

Field Variable			
mfr-inletsmal		•	
Surfaces	[1/8]	<b>&gt; =</b> =	
interior-solid line-7 line-ab pressure-out symmetry velocity-inlet velocity-inlet wall-solid	let t-large		
Highlight Surfaces			
Integral			
2.193004			

Figure 14: Surface Integral for pressure outlet mass flux

 $M = 1.594912 + 0.5980917 - 2.193004 = -0.0000003 \ kg/s$  $H = 1971184 + 789624.9 - 2760810 = -1.1W \ (w/\ constants)$ 

Mass was conserved within 0.00003% which is a very good approximation from the software. The difference in Heat with the constants of Cp and density included results in a difference of 1.1W, which is nearly negligible considering the order of magnitude of the fluxes (~ e+06).