Alexander McGregor
Project 1
9/28/17

Table 1

Name of collaborator (write clearly): Andrew Leaton	
Specific task(s) on which a collaboration occurred, and my contribution:	
Task # and (if applicable) specific portion of the question that was solved by the team together	My contribution (in %) to the specific collaborative effort as stated in the left column
Task1: Compared ANSYS Fluent settings setup	50%
Task 4: Compared ANSYS Fluent settings setup	50%

Task 1:

Settings:

Gravity: -9.8 m/s^2 in y direction

Models:

Energy: on

Viscous: Realizable K-e, standard wall

Water properties:

Density (Boussinesq equation)= 990

C_p= 4182

Thermal Conductivity= .6

Viscosity= .00103

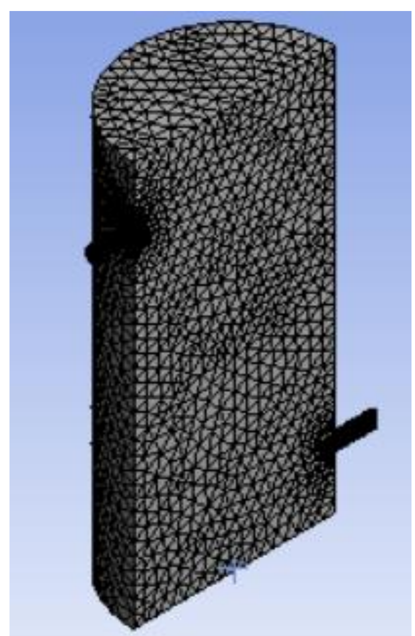
Thermal Expansion Coefficient= .000426

Operating Conditions:

Temp= 318K

Density= 990

Boundary Conditions:



Alexander McGregor
Project 1
9/28/17

Inlet:

Z-velocity= -.05

Turbulent Intensity= 5%

Hydraulic Diameter= .04

Base:

Temp: 333K

Mesh settings:

Size function: Curvature

Relevancy Center: Medium

Use automatic Inflation: Program control

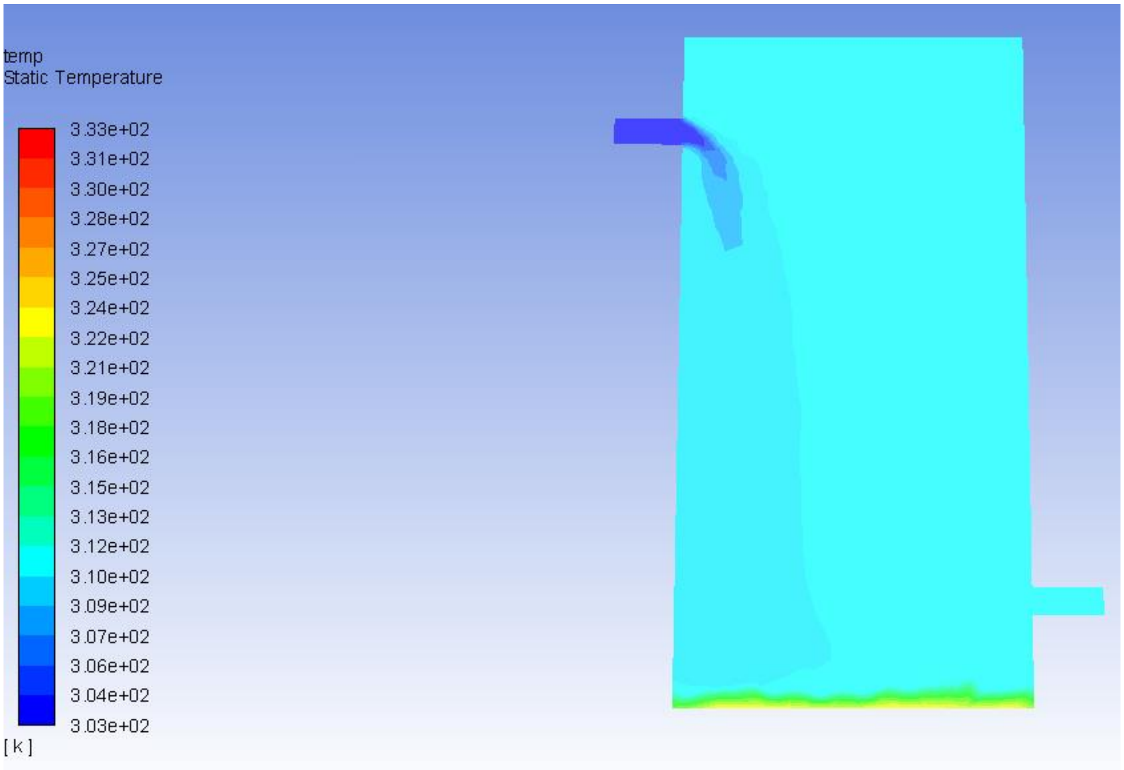
The calculation was ran for 1000 iterations and resulted in the following output temperature, temperature contour, velocity contour and velocity streamline.

1. Value of T_{out}:

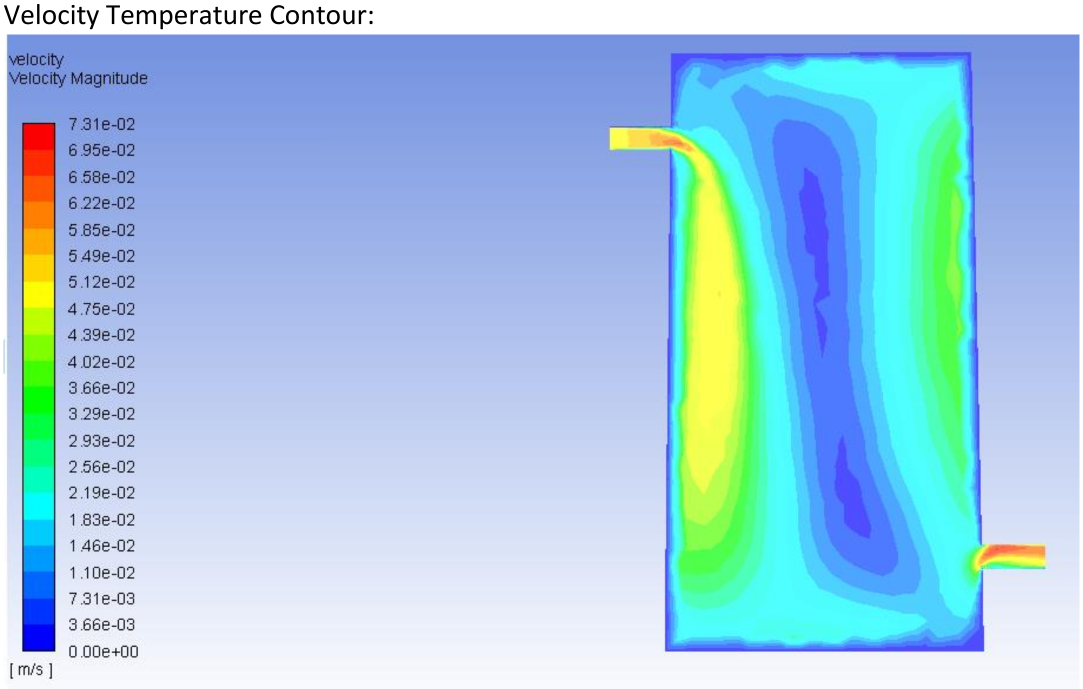
```
   Integral
      t_out
----------- --------------------
    outflow         -0.009548591

   Integral
 Z Velocity            (m/s)(m2)
----------- --------------------
    outflow       -3.0684691e-05
```

T_out top	Velo in Z	Outflow Temp
-0.00955	-3.07E-05	311.18

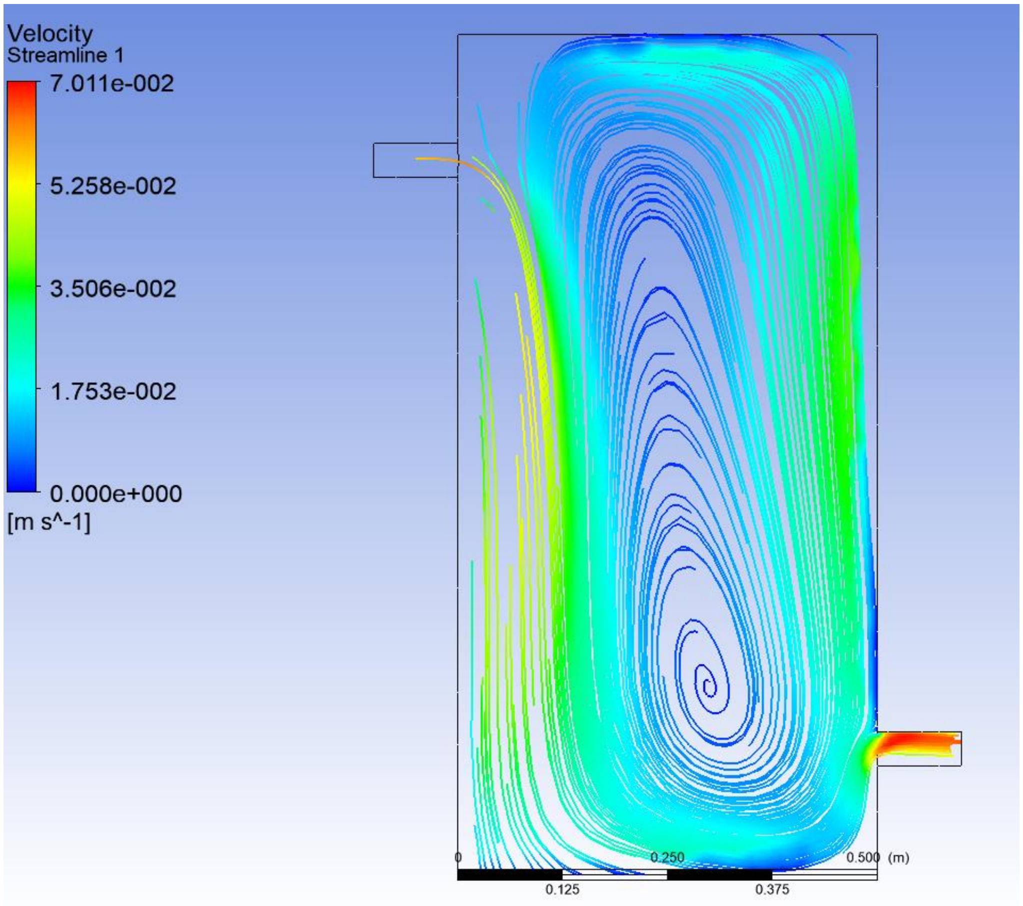
2. Temperature Contour:



3. Velocity Temperature Contour:



4. Stream Lines:



Task 2:

The settings for task two are the same as task one just with the gravity, -9.8 m/s^2, moved into the z direction. The calculation was ran for 1000 iterations and resulted in the following output temperature, temperature contour, velocity contour and velocity streamline.

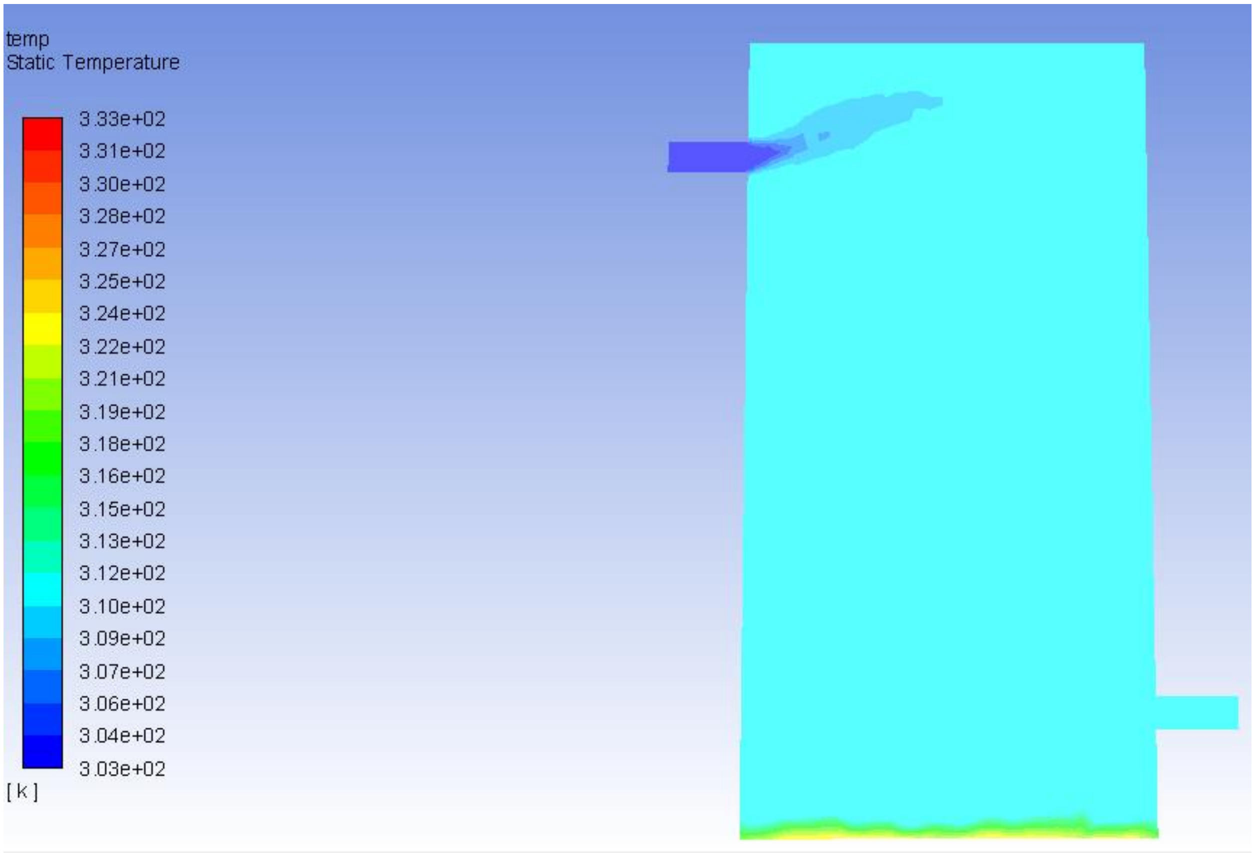
1. T_{out} calculation:

```
        Integral
           t_out
--------------- --------------------
         outflow        -0.0096750438

        Integral
      Z Velocity            (m/s)(m2)
--------------- --------------------
         outflow       -3.1241402e-05
```

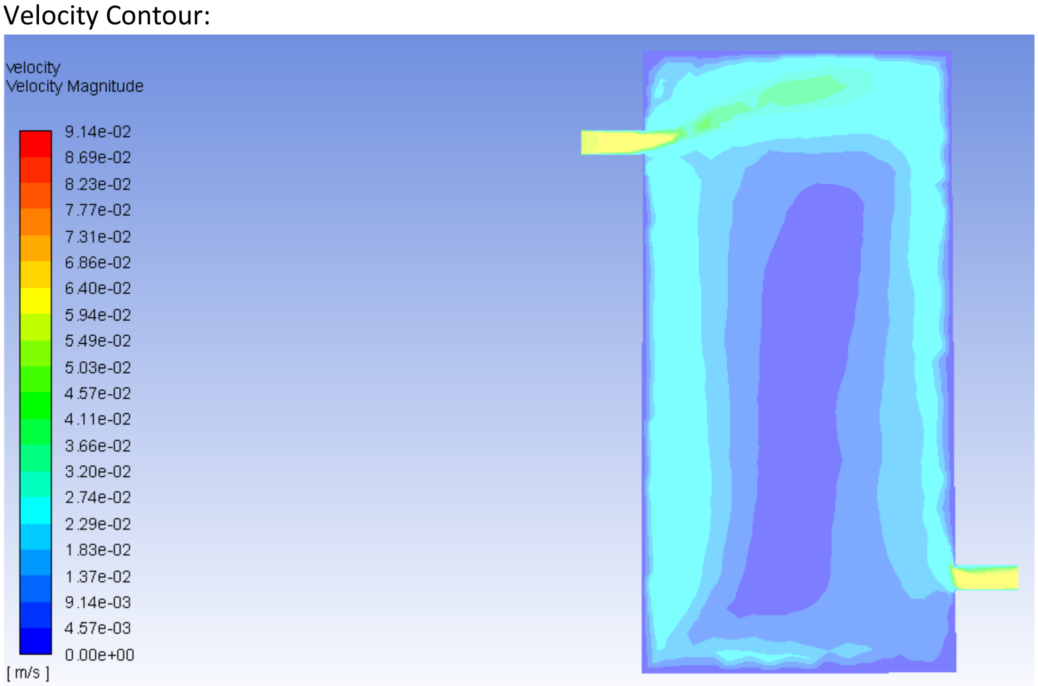
T_out top	Velo in Z	Outflow Temp
-0.00968	-3.12E-05	309.69

Alexander McGregor

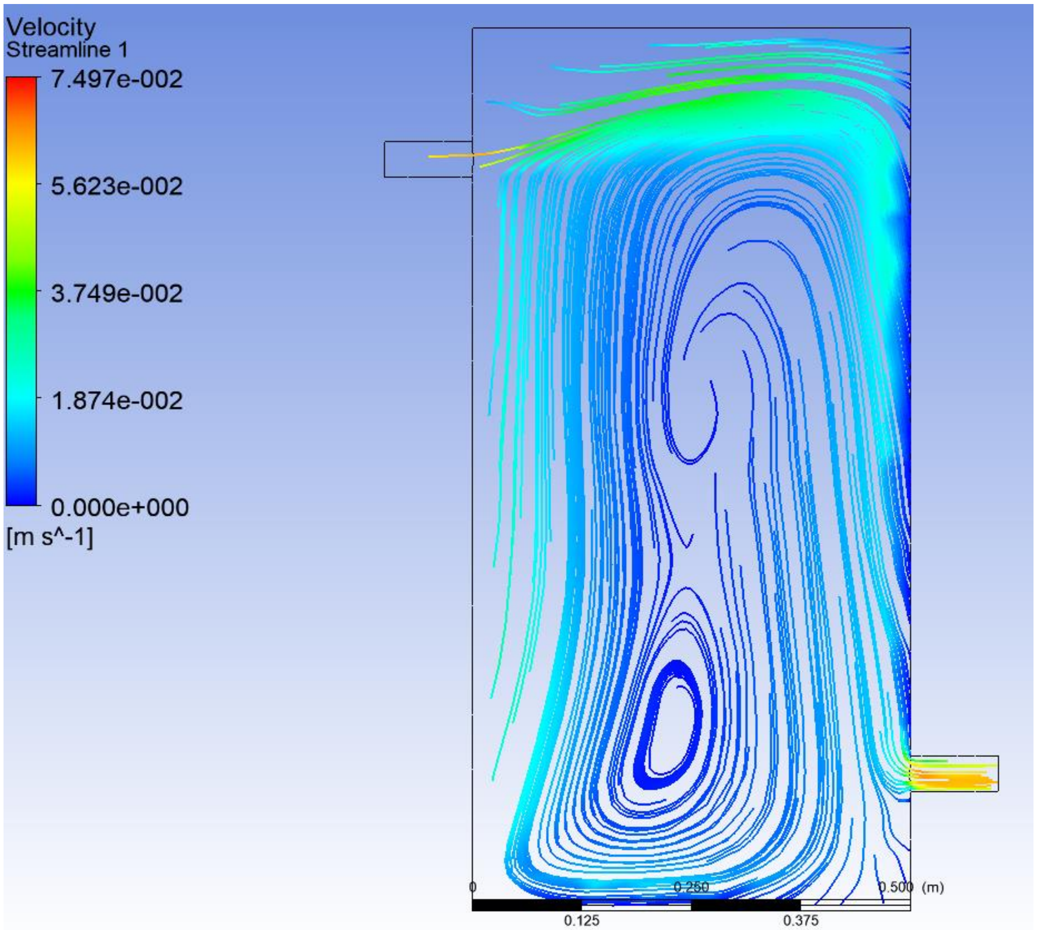
2. Temperature Contour:



3. Velocity Contour:



4. Streamlines:



Task 3:

The settings for task three are the same as task one just without gravity. The calculation was ran for 1200 iterations and resulted in the following output temperature, temperature contour, velocity contour and velocity streamline.

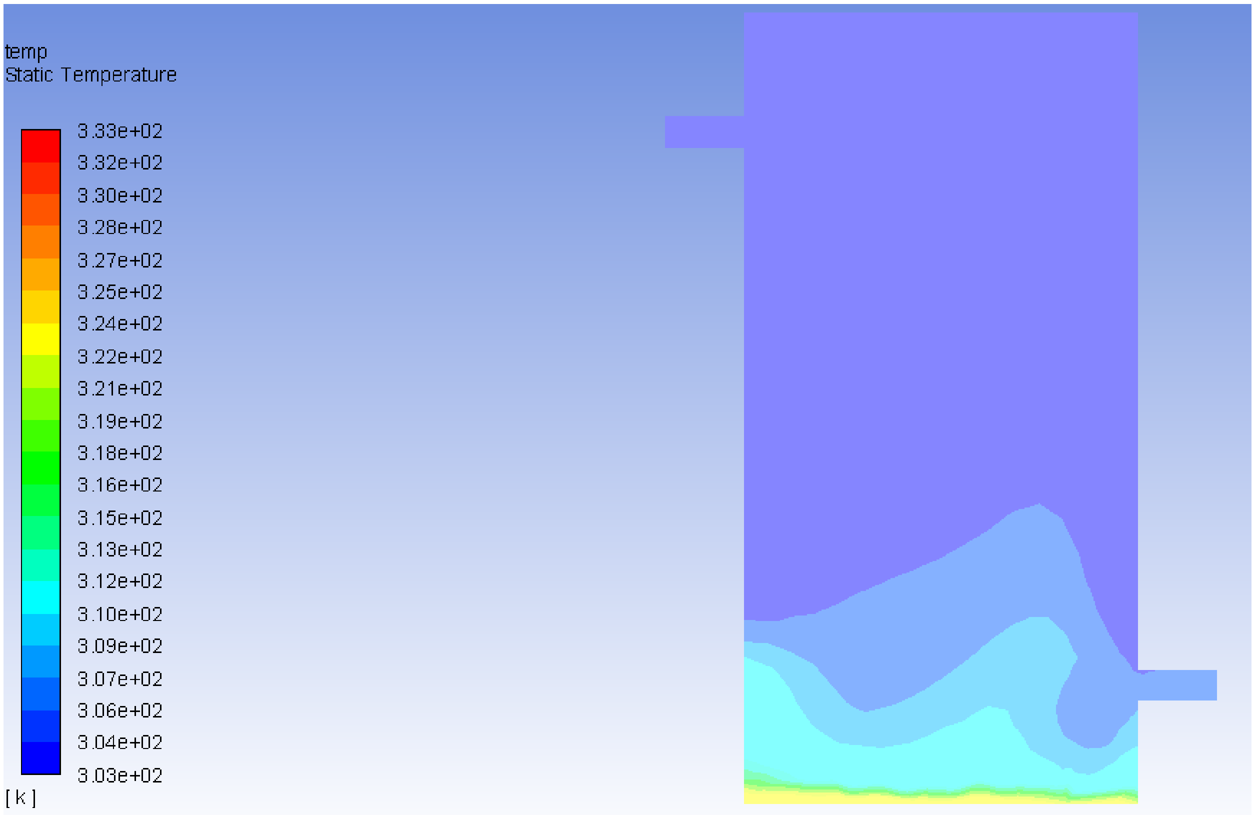
1. T_{out} calculation:

```
   Integral
      t_out
----------- --------------------
    outflow        -0.0093256073

   Integral
 Z Velocity              (m/s)(m2)
----------- --------------------
    outflow       -3.0603622e-05
```

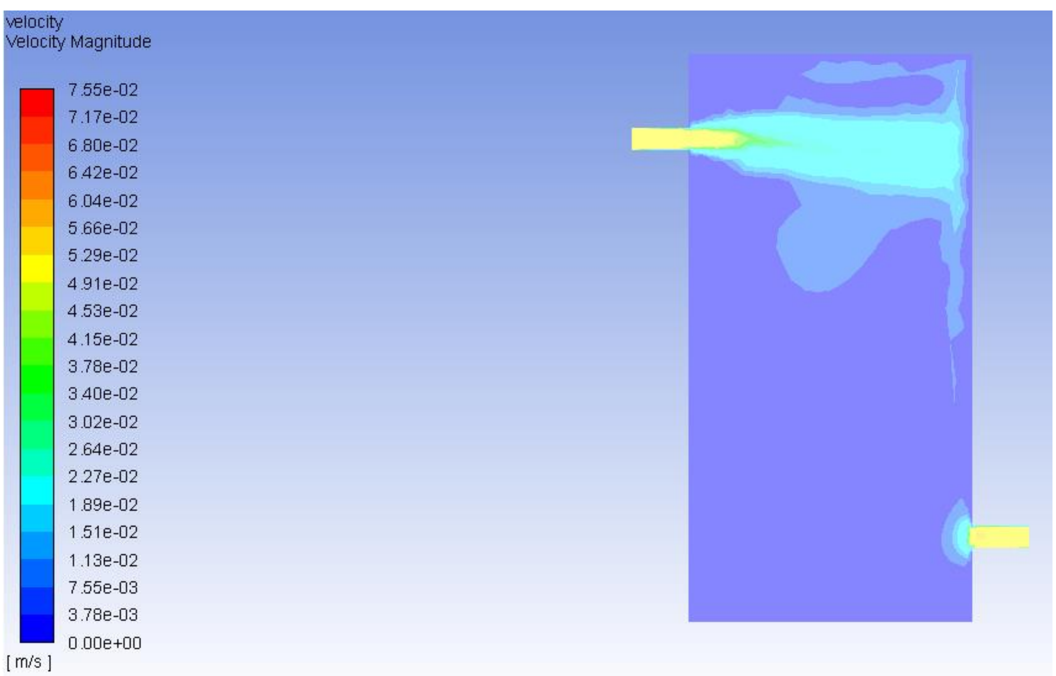
T_out top	Velo in Z	Outflow Temp
-0.00933	-3.06E-05	304.72

Alexander McGregor
Project 1
9/28/17

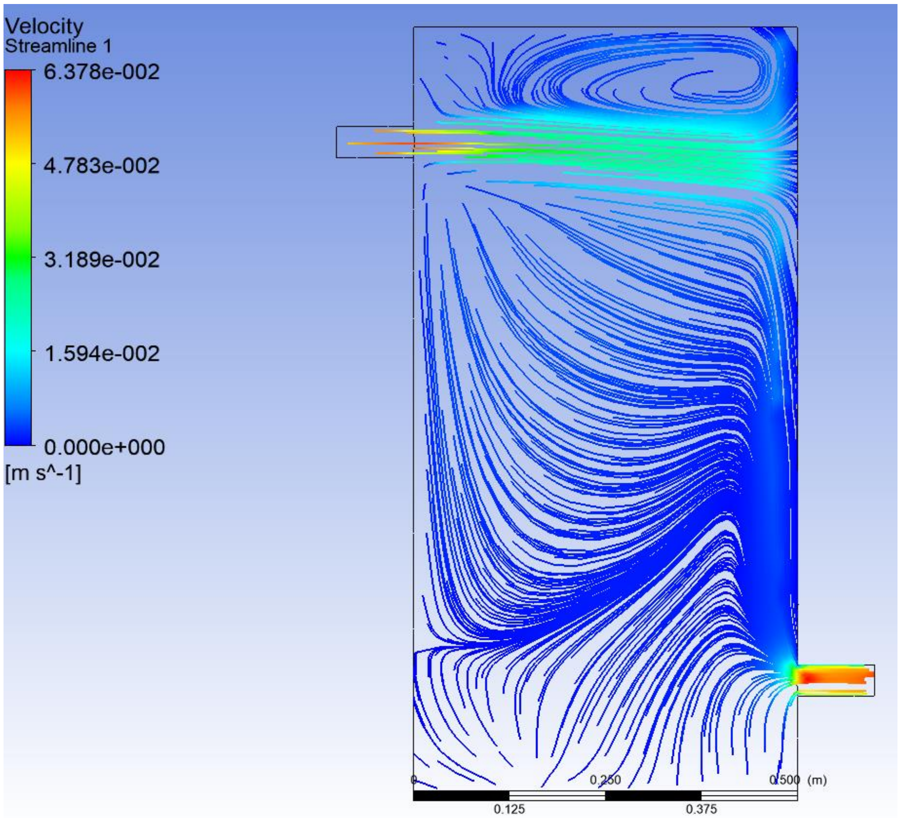
2. Temperature contour:



3. Velocity contour:



4. Stream Lines:



5. Explanation:

Task 1, 2, and 3 all have different temperature contours, velocity contours, and streamlines. Task 1, which has gravity normal to the top of the tank, has a temperature output of 311.2 K. The temperature contour shows the input water falling down with gravity and cool the water closest to the wall of the input. The velocity contour shows the water leaving the input and having a slight initial increase in speed as it begins to feel the effects of gravity. The velocity of the water then slows down as it reaches the base until it exits back out the outflow. The streamline shows the water moving from the output, along with the direction of gravity and moving towards the output and fluid that does not go out the outflow then moves back to the top of the tank causing a circular movement of the water.

Task 2, which has gravity normal to the input, has an output temperature of 309.7K. The temperature contour shows the cool water from the input being pushed to the top of the tank from the view of the screenshot. This can be understood by looking at the streamline plot which shows water being brought up from the bottom of the tank that did not make it out the output. After it hits the base, it is pushed to the left side of the tank and on it's way back up the input. The velocity contour shows the fluid moving parallel to the direction of gravity, like that in task 2. However, the velocity is faster in task 2 than in task 1 because gravity is in the same direction as velocity in task 2.

Alexander McGregor
Project 1
9/28/17

Task 3 has zero gravity and results in an output temperature of 304.7 K. This is much lower than the two tasks before. The temperature plot shows almost very variation throughout the body except for the bottom of the tank. The velocity plot shows the fluid coming straight out of the input. The constraints of the walls are what push the fluid down to the bottom and out the outflow as shown in the streamline contour.

The differences in temperature are all dependent on gravity. The scenario in task one result in the highest temperature because gravity is perpendicular to the hot plate. This shows that gravity compresses liquid against the hot plate. Scenario two has gravity parallel to the hot plate, resulting in a lower temperature output. The velocity and streamline contours show that in task two the fluid exits the tank before coming in direct contact with the hot plate, explaining why the output temperature is less than task one. Task one results in the least output temperature because this is no force compressing or pushing the fluid to make contact with the hot plate. The velocity and streamline plots show the fluid arriving at the output after hitting the walls. Since there is no gravity force pushing the fluid to the hot plate, the output temperature is much lower than in task one and two.

Task 4

Settings:

Transient

Time step: 90 seconds

Number of time steps: 60

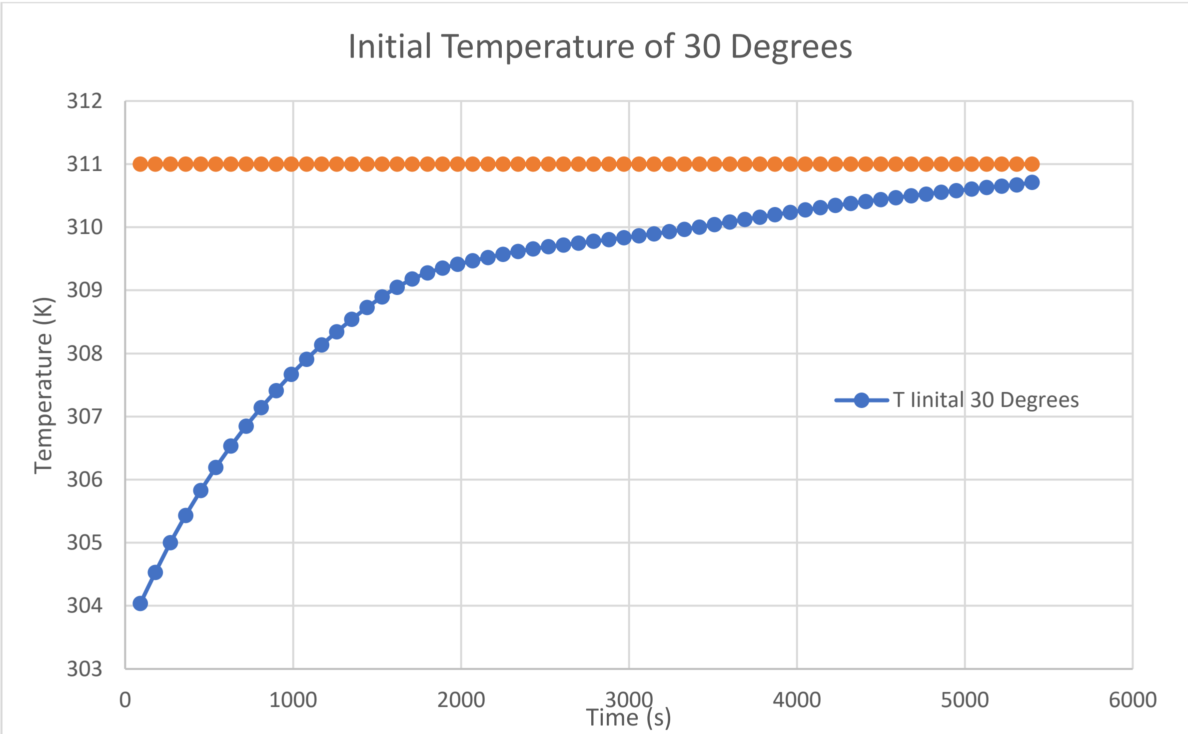
Total Time: 5,400 seconds (1.5 hours)

Introduction:

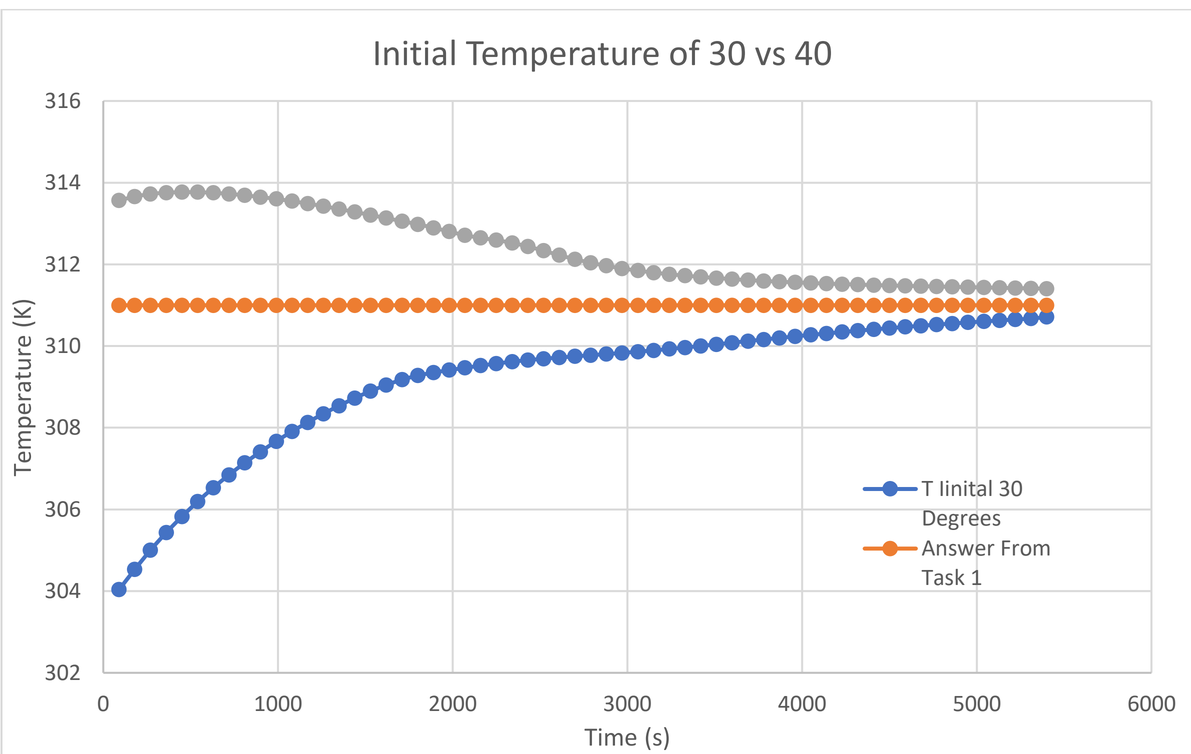
In task four, we were asked to run a trainset calculation that had the tank fluid with the initial temperatures of 30^{o} C and 40^{o} C. 30^{o} C is below the output temperature from in task one, so we can expect the fluid to heat up over time and converge to the temperature found in task one. 40^{o} C is hotter than the output temperature found in task one, so we can expect the water to cool down and converge to the output temperature found in task one.

Alexander McGregor
Project 1
9/28/17

Part a)



Part b)



Alexander McGregor
Project 1
9/28/17

Explanation:

The figure in part b show the convergence paths from the initial temperatures of 30° C and 40° C. after 5400 seconds, they have both converged to the outflow temperature from task one. At this time, when the tank starts from an initial temperatures of 30° C, it is within .3° C while the initial temperature of 40° C is not. One interesting trend shows when the initial temperature is 40° C, the output temperature initially increases then starts to decrease. This is because the cool temperature from the inlet has not reached the output when the output temperature peaks at about 400 seconds. This puts into perspective how long the fluid takes to move around the tank.

Task 5:

I switched to a geometry to full tank so I reran the simulation to make sure everything was the same as task 1. Below is what the solution produced:

```
    Integral
       t_out
------------ --------------------
     outflow         -0.018997622

    Integral
  Z Velocity              (m/s)(m2)
------------ --------------------
     outflow        -6.0913604e-05
```

T_out_top	T_out_b	Temp (k)
-0.019	-6.09E-05	311.8781

a) Heat Transfer rate:

```
   Total Heat Transfer Rate                  (w)
---------------------------- --------------------
                        base            2273.3723
            ---------------- --------------------
                         Net            2273.3723
```

Heat Flux	Base Area	Flux/area
2273.372	0.19635	11578.19

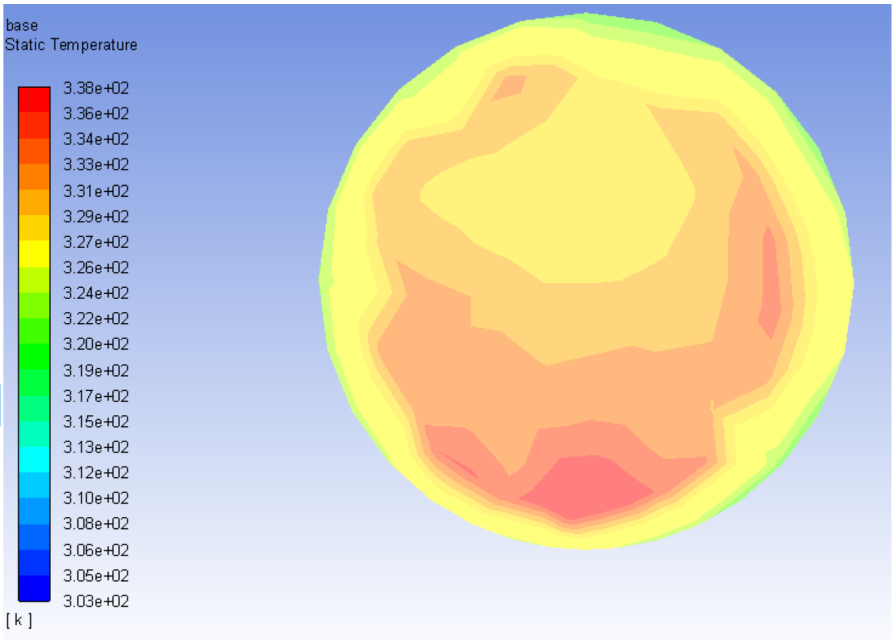
b) Output temperature using heat flux:

```
   Integral
      t_out
----------- --------------------
    outflow         -0.019001642

   Integral
 Z Velocity            (m/s)(m2)
----------- --------------------
    outflow       -6.0942446e-05
```

T_out_top	T_out_b	Temp (k)
-0.019	-6.09E-05	311.7965

This temperature found in part b is very close to that as part a. This is what we would expect because the heat flux we calculated was from the temperature. Therefore, applying the heat flux instead of a temperature should not change the output temperature. This shows that the heat flux and temperature are directly related and can be used interchangeably.

c) Contour Plot



This contour plot is interesting because it does not show a constant temperature. This is significant because in tasks 1-3 when we used a constant temperature for the heat plate, this contour plot would all be the same color. This contour plot proves that even if the temperature is not constant across the plate, as long as it is a corresponding heat flux to a constant temperature, they will affect the fluid in the same manner.