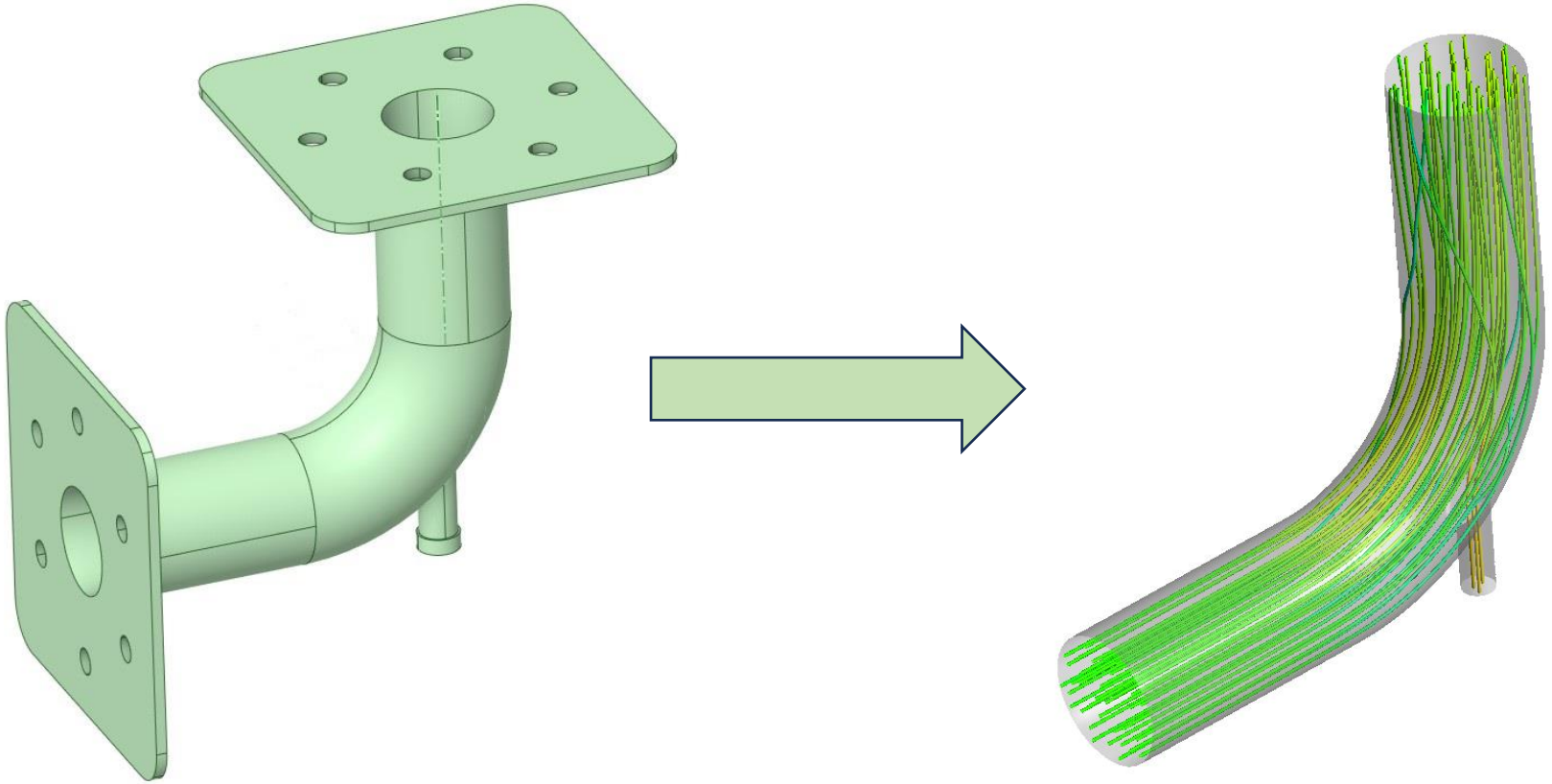
Extracting some meaningful results from an otherwise frantic domain



Objective

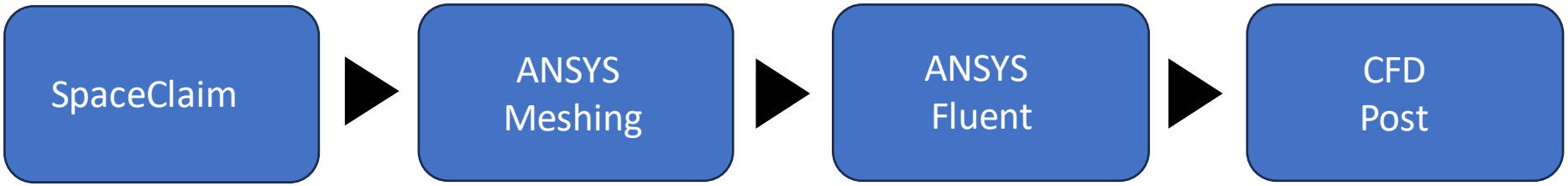
- Objective of this study is to investigate the thermal, velocity and pressure distribution inside a curved pipe with two inlets and a single outlet.

- Additionally, a study is done to check if proper mixing of the fluid is taking place from the two inlets, if vortices are formed etc.

- Finally, the simulation is done to find out the temperature and velocity distribution at the pipe outlet.

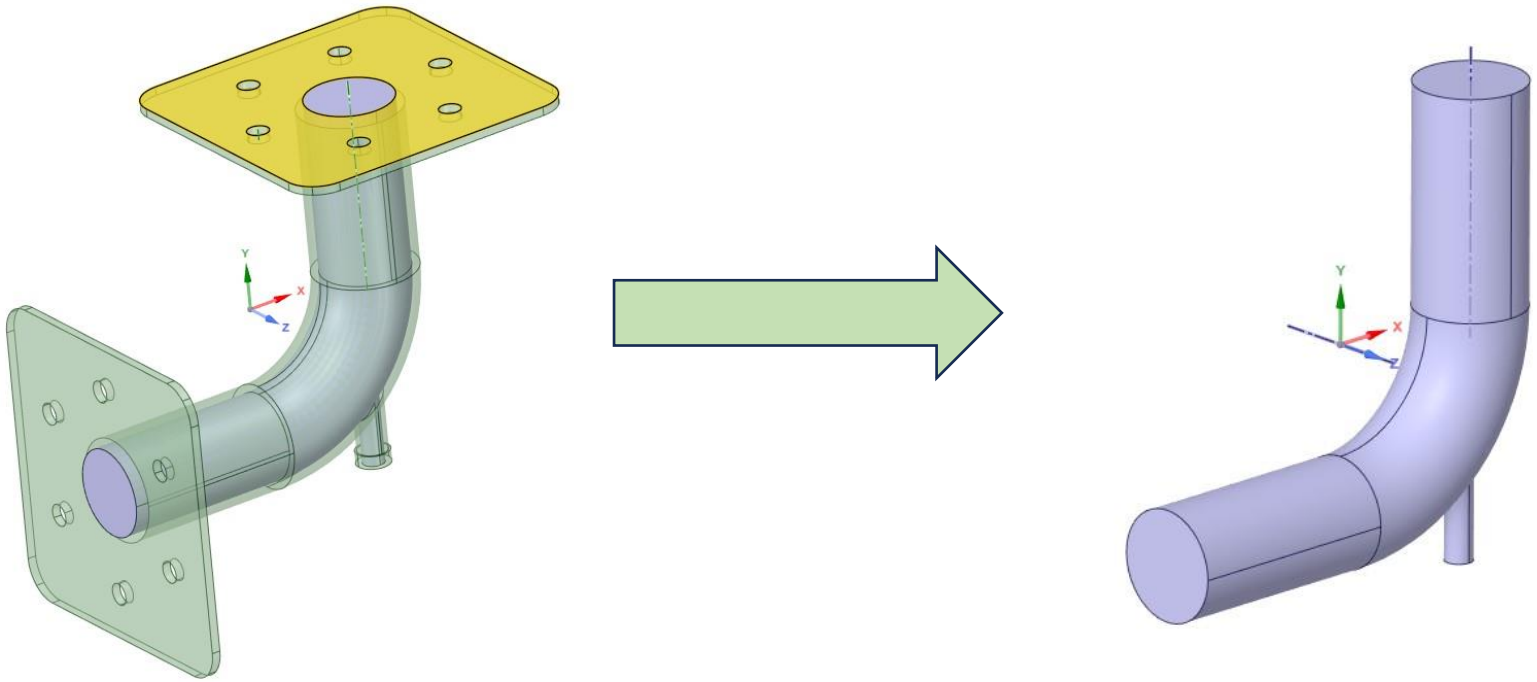
Problem Statement

- The problem can be sub divided into several categories as follows,
  - Geometry preparation using SpaceClaim
  - Meshing of the extracted geometry using ANSYS Mesher
  - Solving the PDEs using ANSYS Fluent solver
  - Post processing using CFD Post



Geometry preparation

- The fluid domain was extracted from the original CAD file using the volume extract feature within SpaceClaim

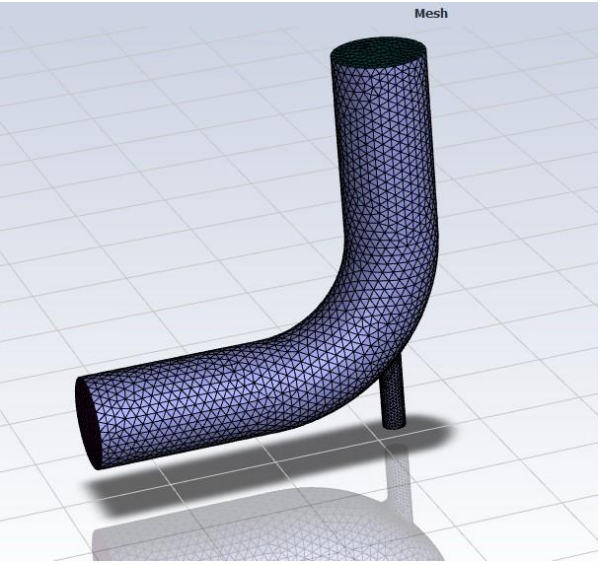


Meshing

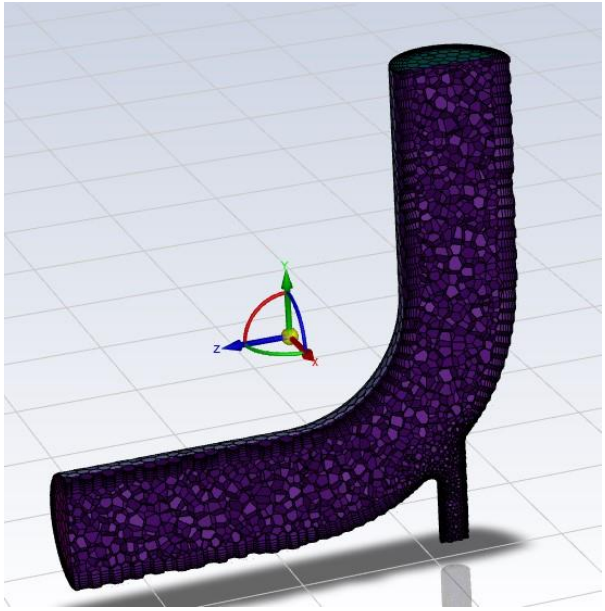
- Software used : Fluent Mesher
- Type of cells used for meshing : Polyhedral
- Boundary layer meshing / prism layer : 6 levels into the fluid domain only on the walls
  - Number of cells : 24669
  - Number of faces : 114907
  - Number of nodes : 70808
  - Number of partitions/cores : 3

Meshing (contd.)

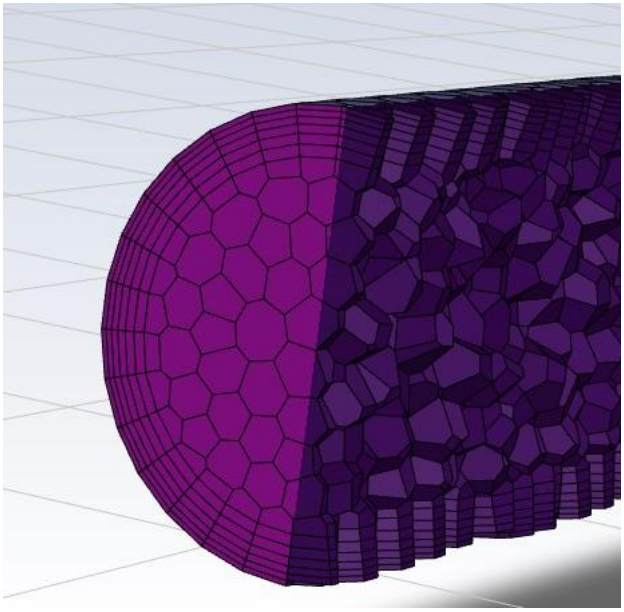
Surface mesh



Internal mesh



Prismatic layers

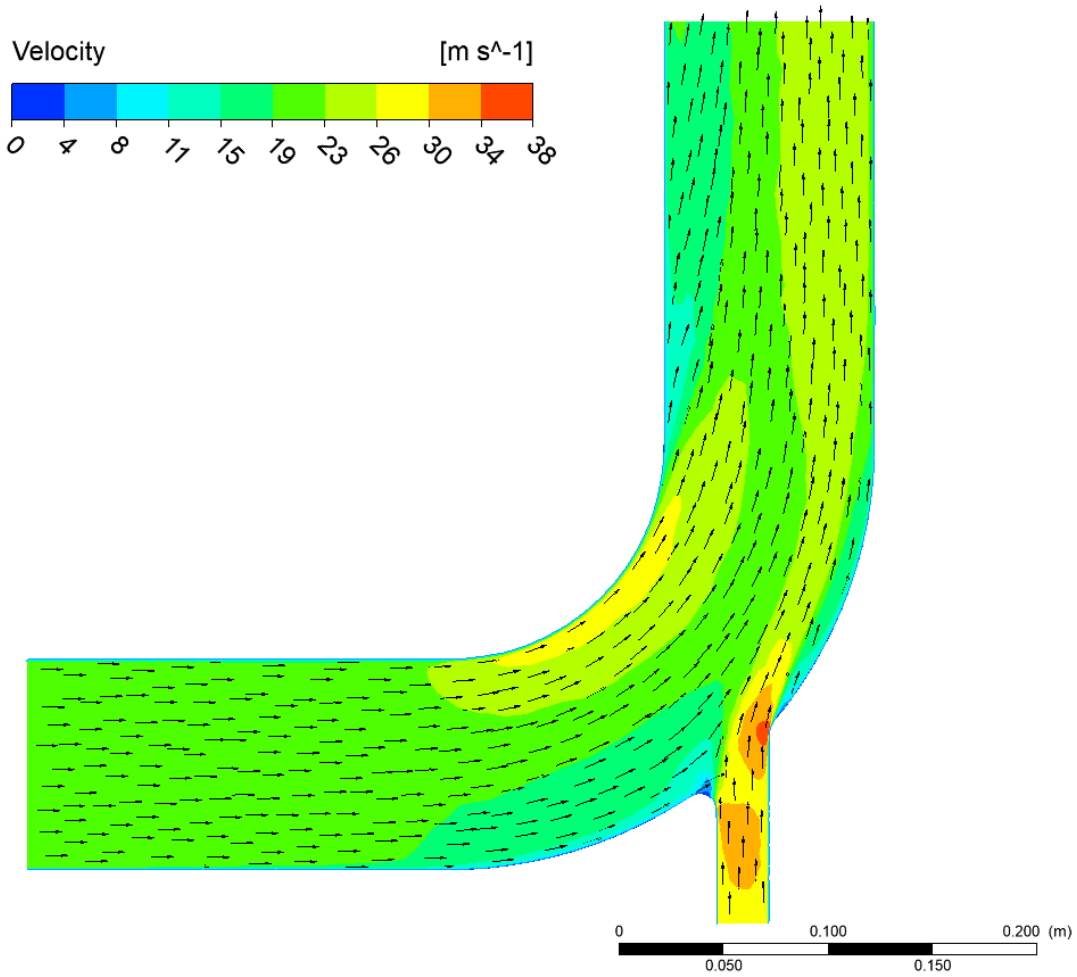


CFD Setting

- Case Setup
  - Solver type : Pressure based
  - Velocity formulation : Absolute
  - Time : Steady
  - Gravity : Not considered
  - Operating Pressure : 1 bar
  - Viscous Model : k – omega SST (2 eqn)
  - Material : Water (liq)
  - Pressure Velocity Coupling : Coupled

- Boundary Condition
  - Big inlet > velocity : 20 ms^-1 ; temperature : 60 C
  - Small inlet > velocity : 30 ms^-1 ; temperature : 100 C
  - Outlet > 1 bar atmospheric pressure

Results (Qualitative)



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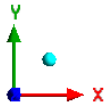
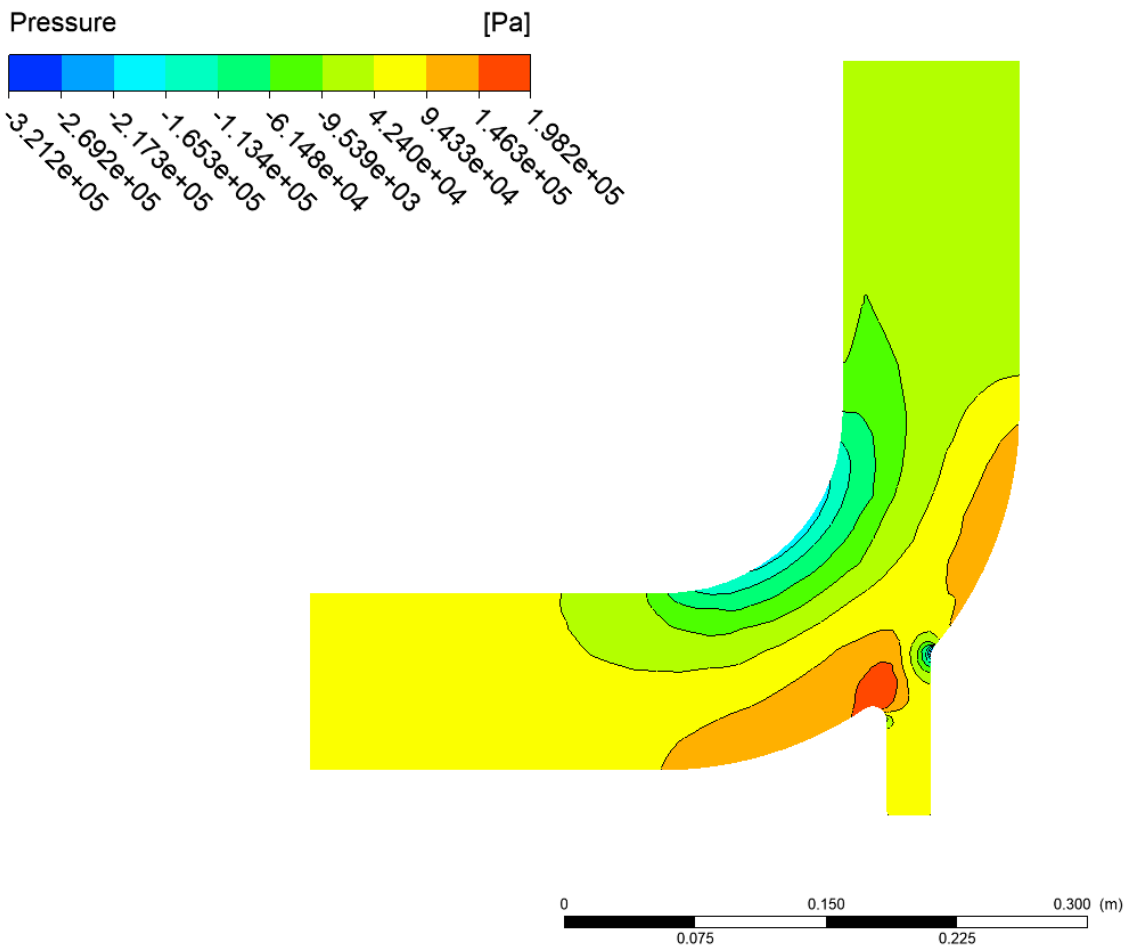
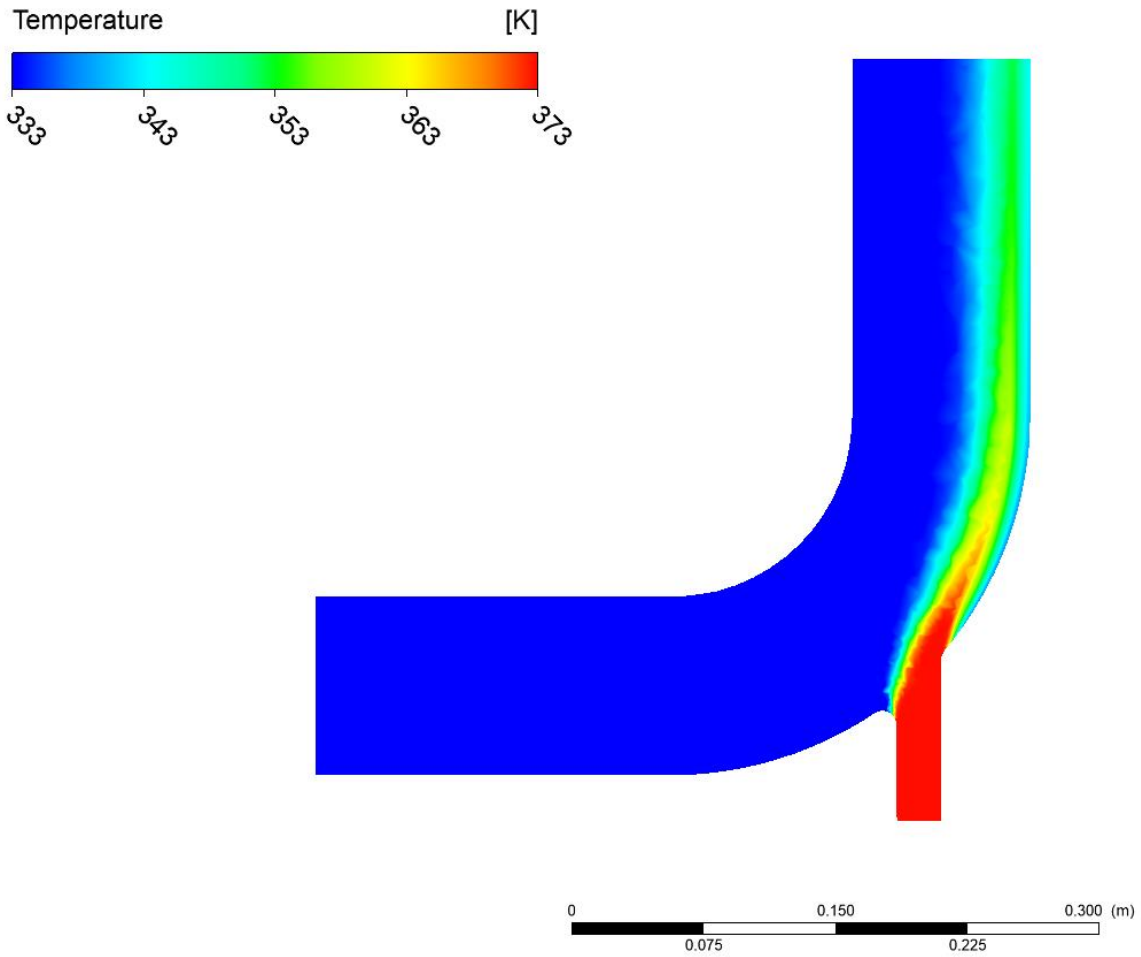


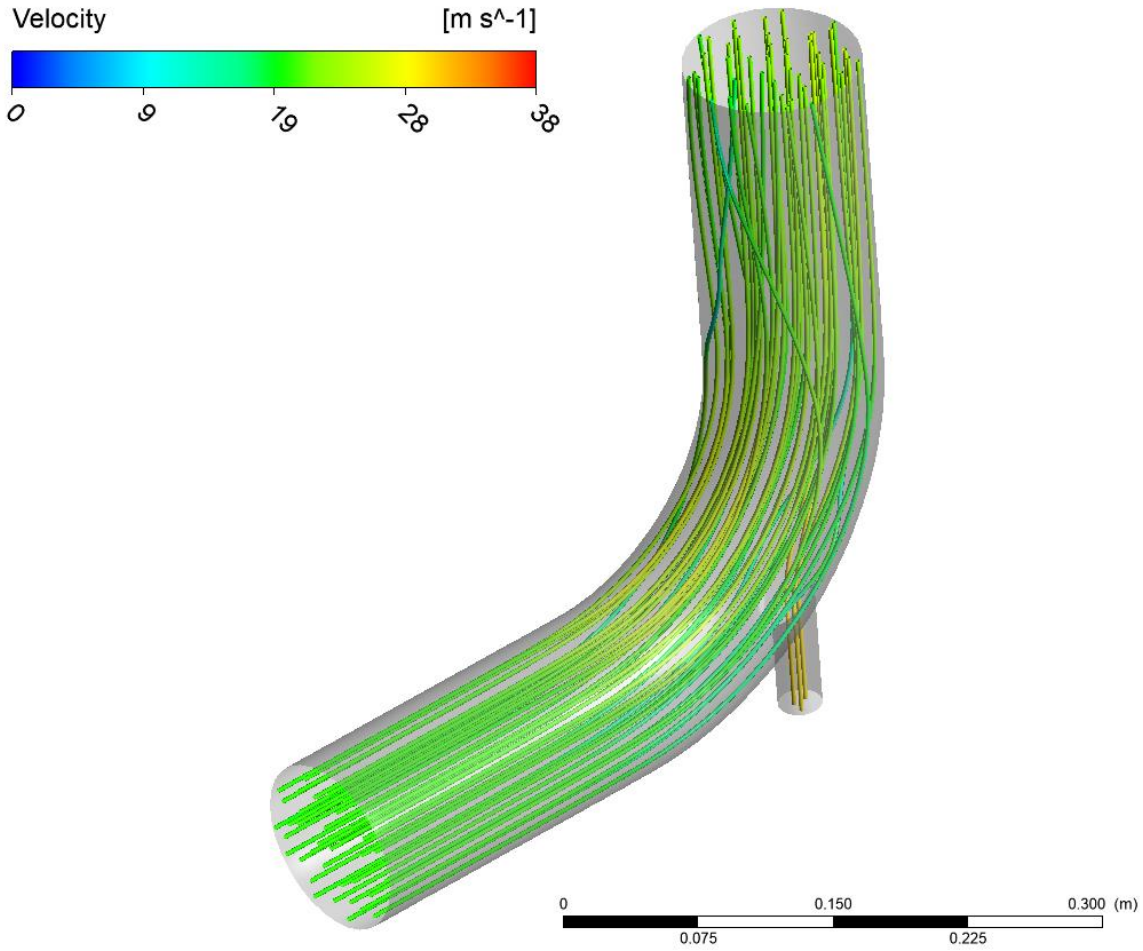
Results (Qualitative)



Results (Qualitative)



Results (Qualitative)



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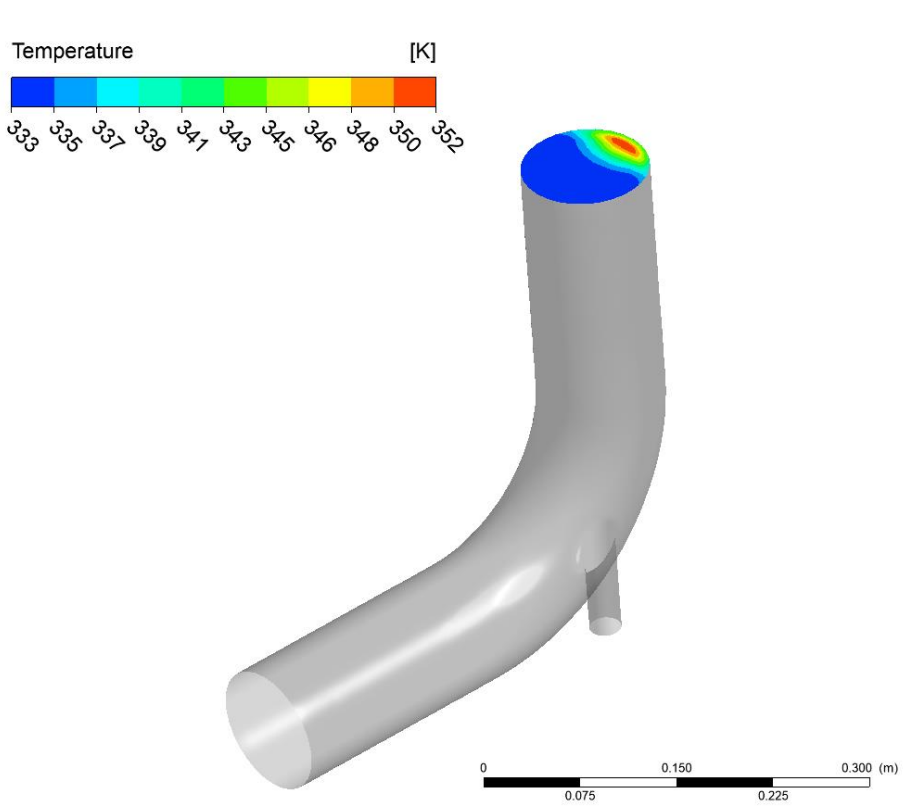
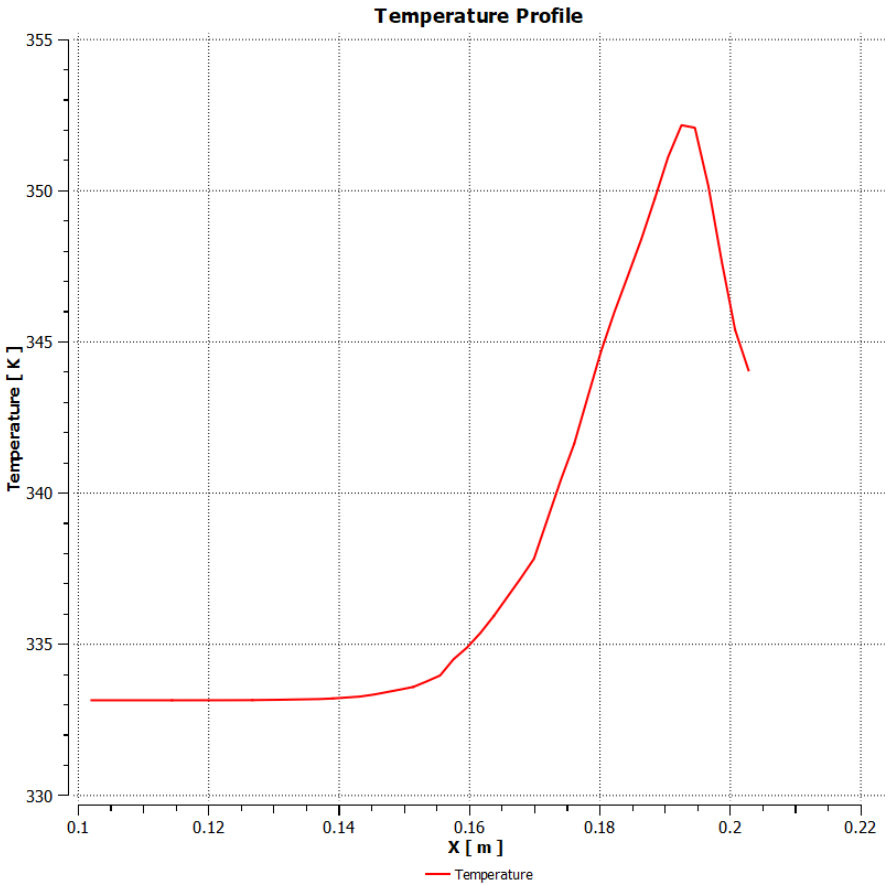
Results (Qualitative)

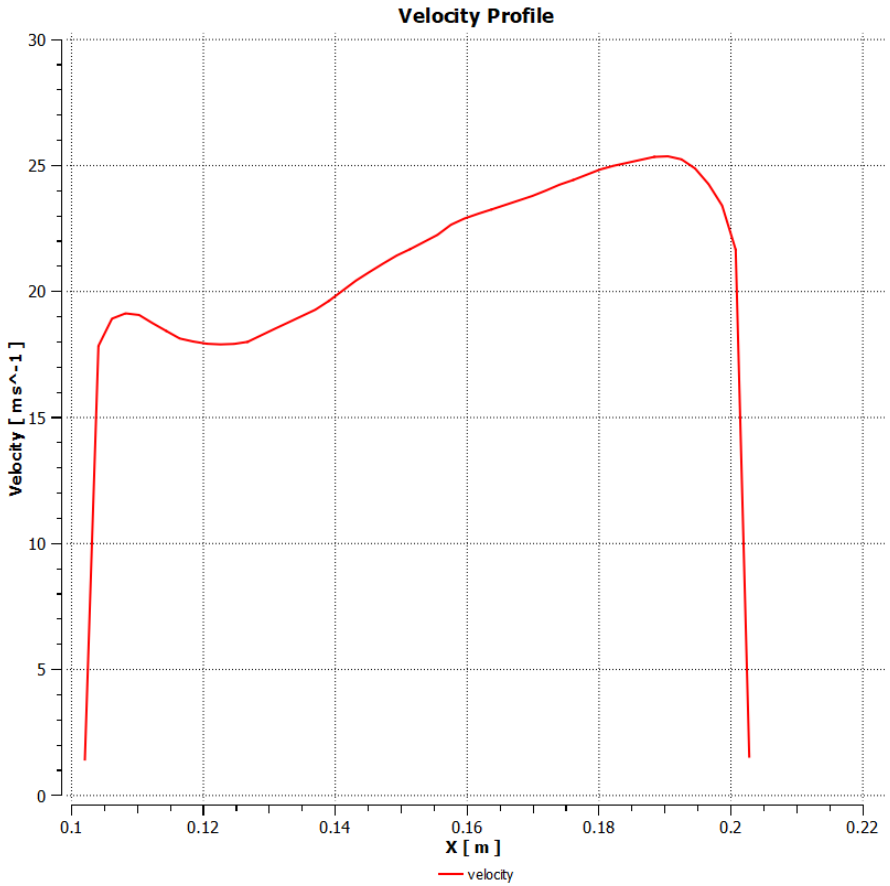
It can be seen that the temperature is not uniformly distributed across the outlet region.



Results (Qualitative)

The temperature and the velocity distribution was extracted across the outlet of the pipe to evaluate the variation





Results (Quantitative)

- Mass flow rate at outlet : -173.477 kgs^-1
- Area weighted avg temperature at outlet : 336 K
- Area weighted avg velocity at outlet : 22 ms^-1

Conclusion

- Mixing from the two inlets is not efficient. It may be improved by placing the small inlet a bit further outwards along the x axis (towards the outlet)

- There is some flow separation around the small inlet region. It could be mitigated by placing the small inlet at an angle facing the fluid flow from the big inlet.