# Air-Water-Foam Mix Chamber for Fire Protection of Fossil Fuel Containers: Modeling and Optimization

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**Introduction**:

1. Geometry Generation and meshing the Foam Chamber Geometry.

2. Modeling and understanding the physical interaction between the multi-phase fluid Water-Foam Concentrate-Air mixture and the process in the chamber.

3. Optimizing the chamber geometry in order to get better quality of the final mixture.

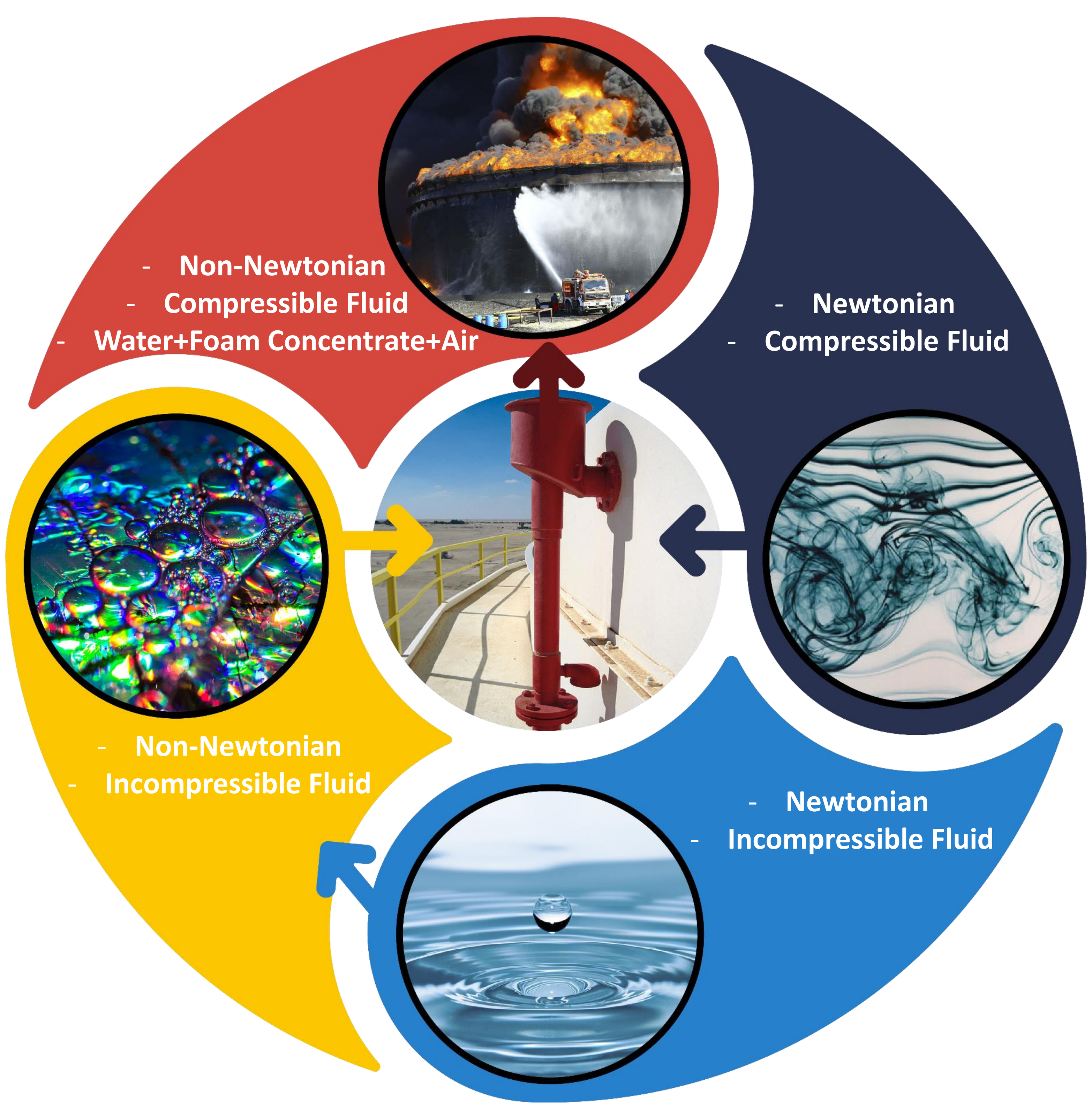


**Figure 1**. Fire Foam Mixture Process

**Research Methodology**:

1. Create & import the Foam Chamber CAD model to Comsol Multiphysics®.
2. Define material properties: Water, Foam Concentrate and Air.
3. Select proper physical model for phase-to-phase interactions.
4. Test meshing techniques to find a proper mesh and corresponding multi-phase flow modeling.
5. Apply proper constitutive models for each of the fluid phases, i.e., water-foam concentrate-air.
6. Optimize chamber geometry in terms of foam-solution quality rate and volume.

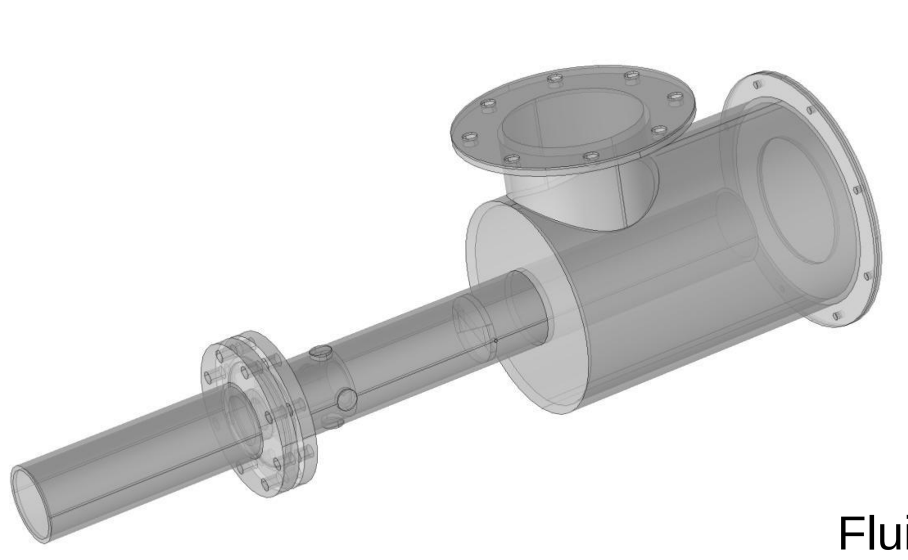

**Figure 2**. Foam Chamber CAD Model

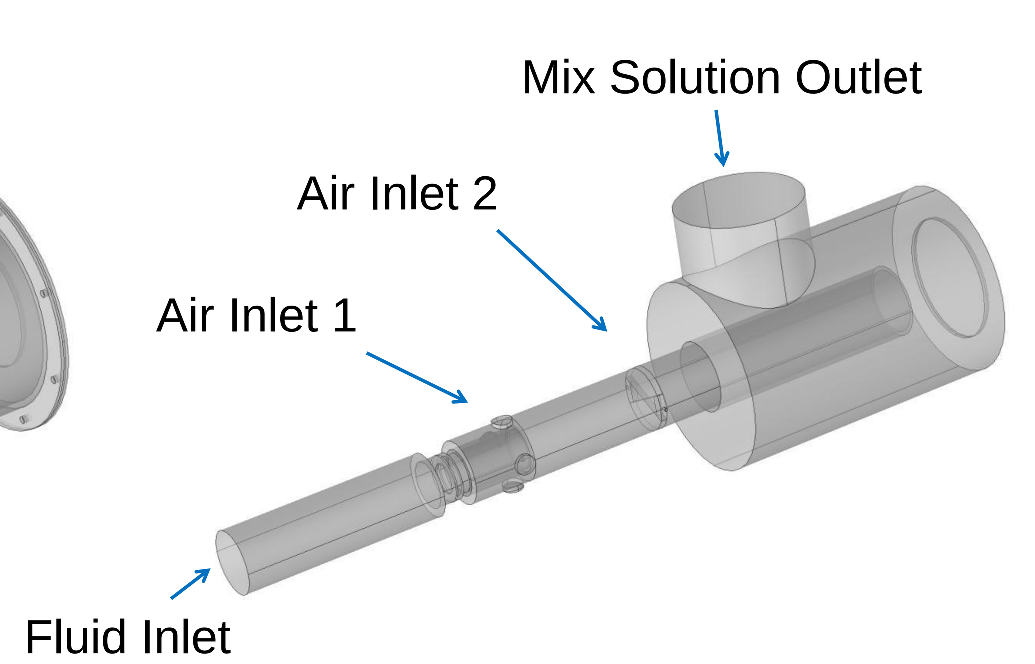


**Figure 3**. Foam Chamber Fluid Domain

**Results**:

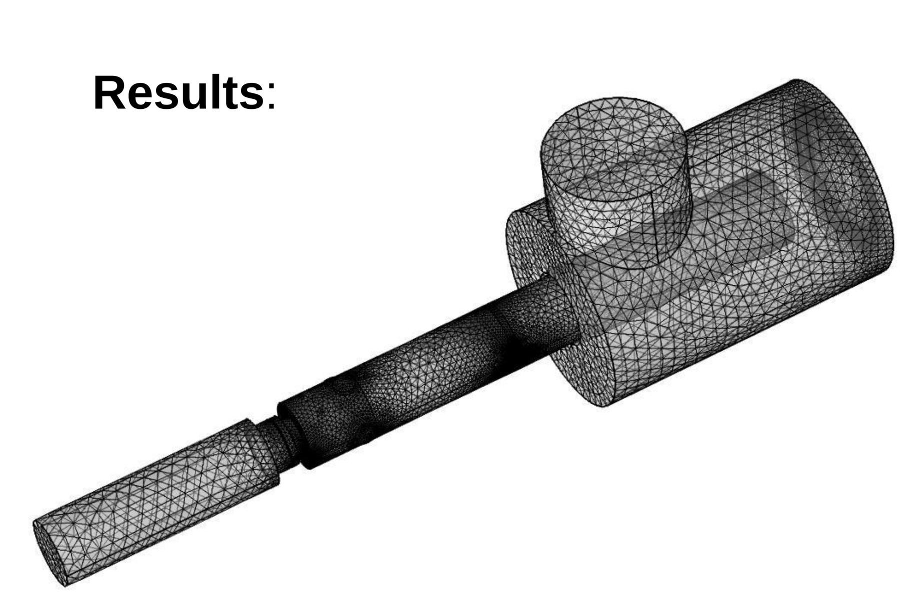

**Figure 4**. Fluid Domain Mesh

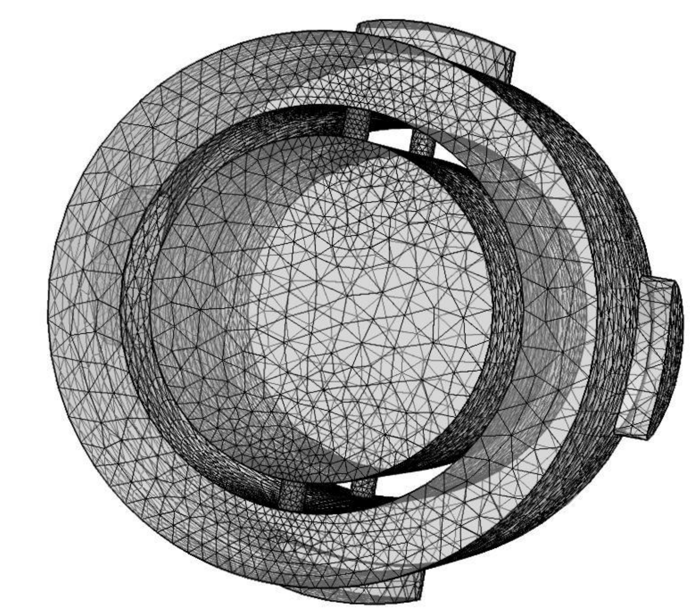

**Figure 5**. Mesh Air Inlet 1

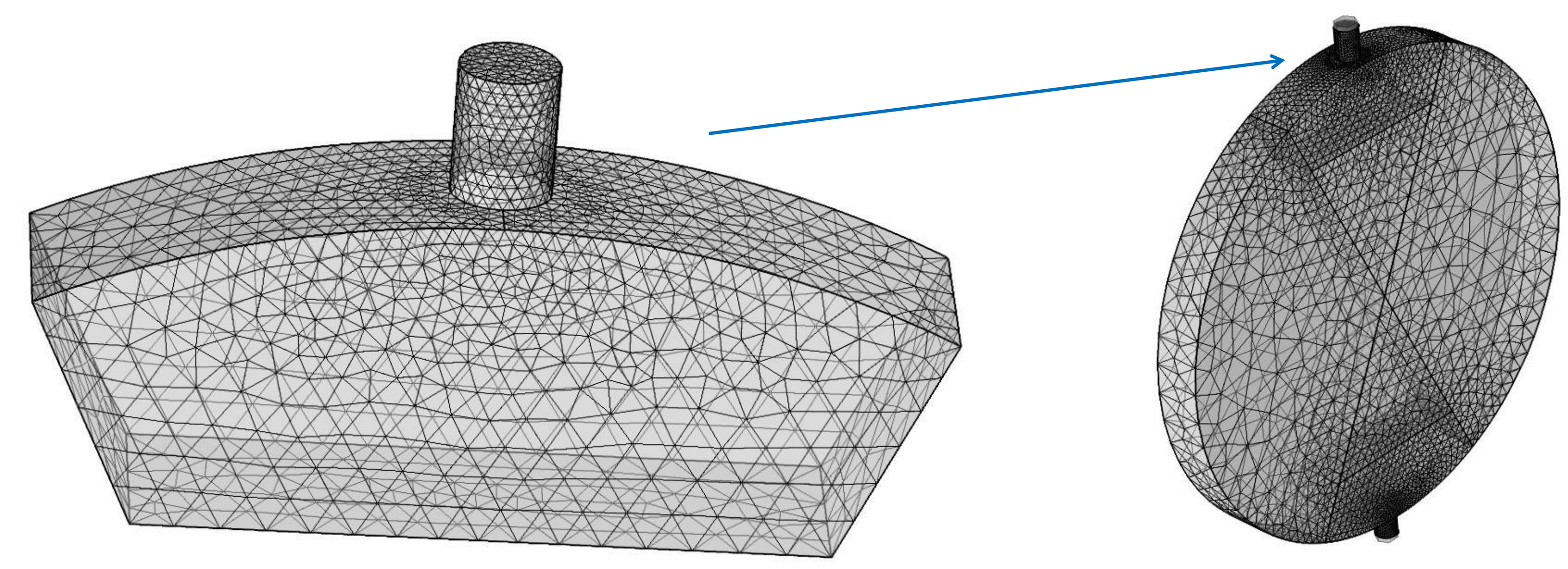

**Figure 6**. Mesh Zoom Air Inlet 2

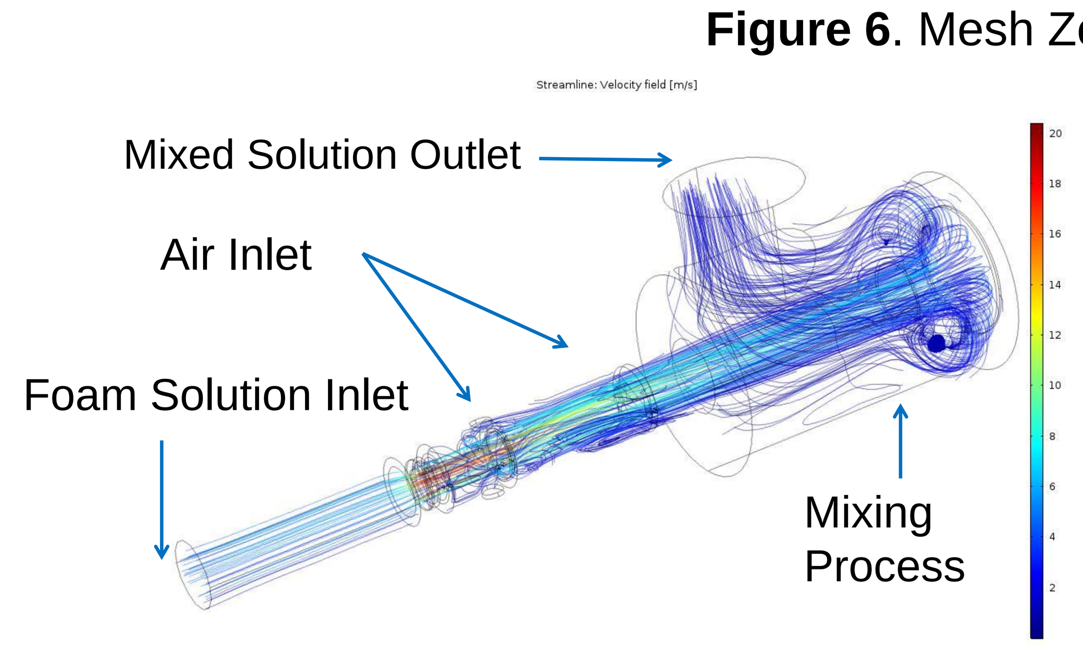


**Figure 8**. Streamlines Velocity Field

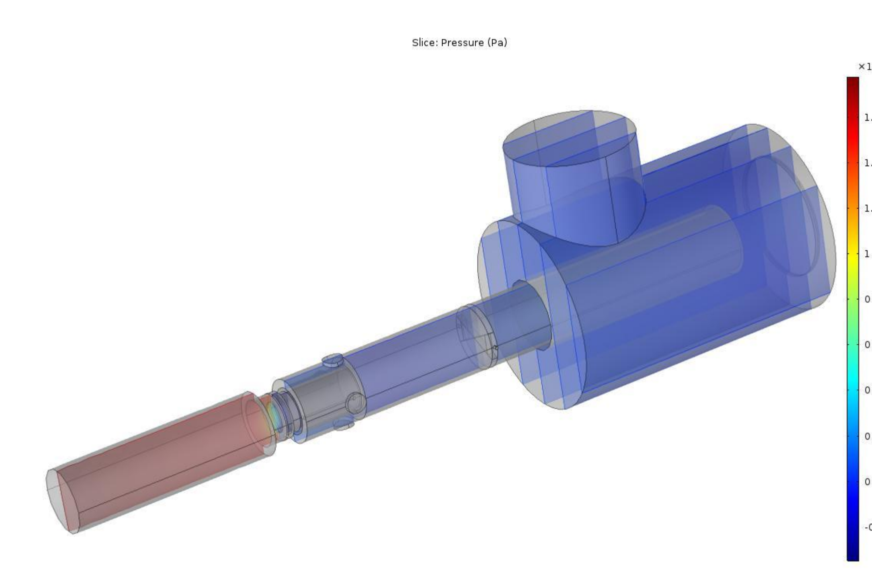

**Figure 7**. Slice Magnitude Pressure

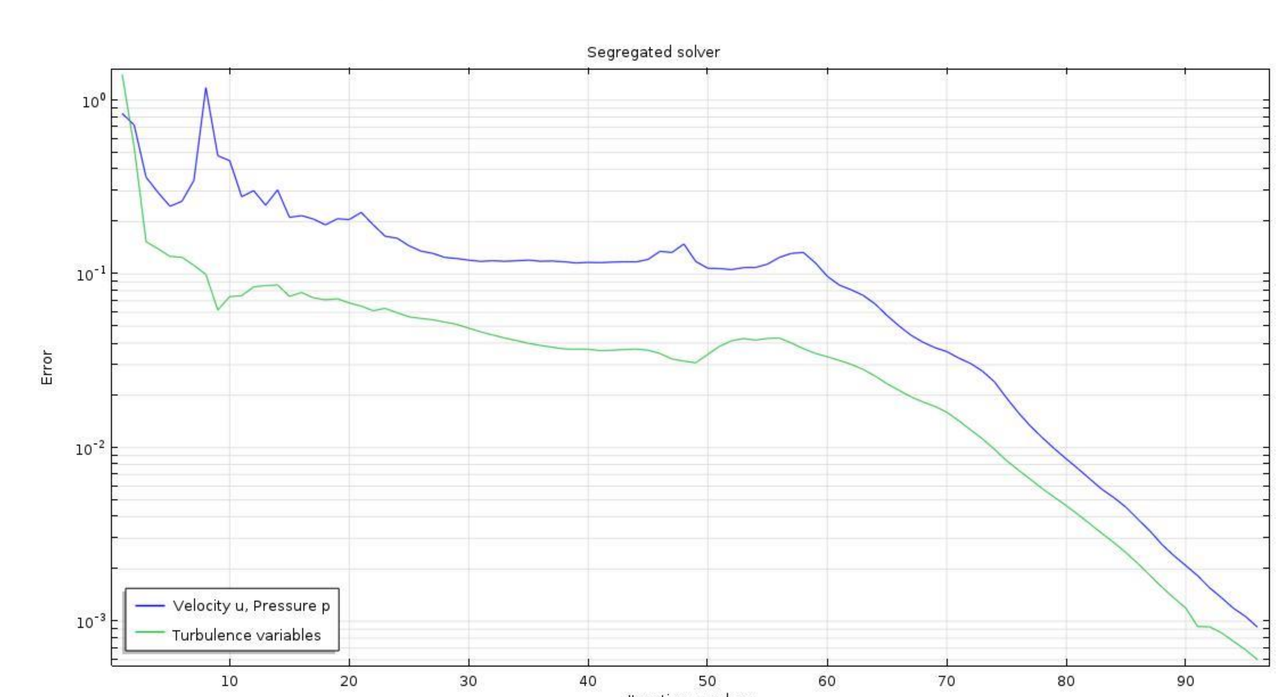


**Figure 9**. Velocity, Pressure and Turbulence Variables Convergence Plot

$$\tau = \frac{\eta_0 \gamma}{1 + \left|\frac{\tau}{\tau_{1/2}}\right|^{\alpha - 1}}$$

$\eta_0 =$ *viscosity at zero shear rate*
$\tau_{1/2} =$ *characteristic stress*
$\alpha$ *is a constant*
$\gamma =$ *wall shear rate*

**Conclusions**:

- CAD model accuracy is extremely important (complex geometry).
- Creating the proper mesh:
  - Domain partitioning advanced technique.
  - Equations convergence.
  - Saving computational resources and time.
- Obtained results using turbulent flow constitutive model:
  - Algebraic yPlus physics module.
  - Tolerance error: $1x10^{-3}$.
  - Fluid: water.
  - Computational time: 43 min 33 s.

**References**:
1. X. O. Olivella, Mechanics of Continuous Media for Engineers, UPC Edition, pg, 303, (2000)
2. C. Miller, Predicting Non-Newtonian Flow Behavior in Ducts, Vol. 11, pg, 526, (1972)

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