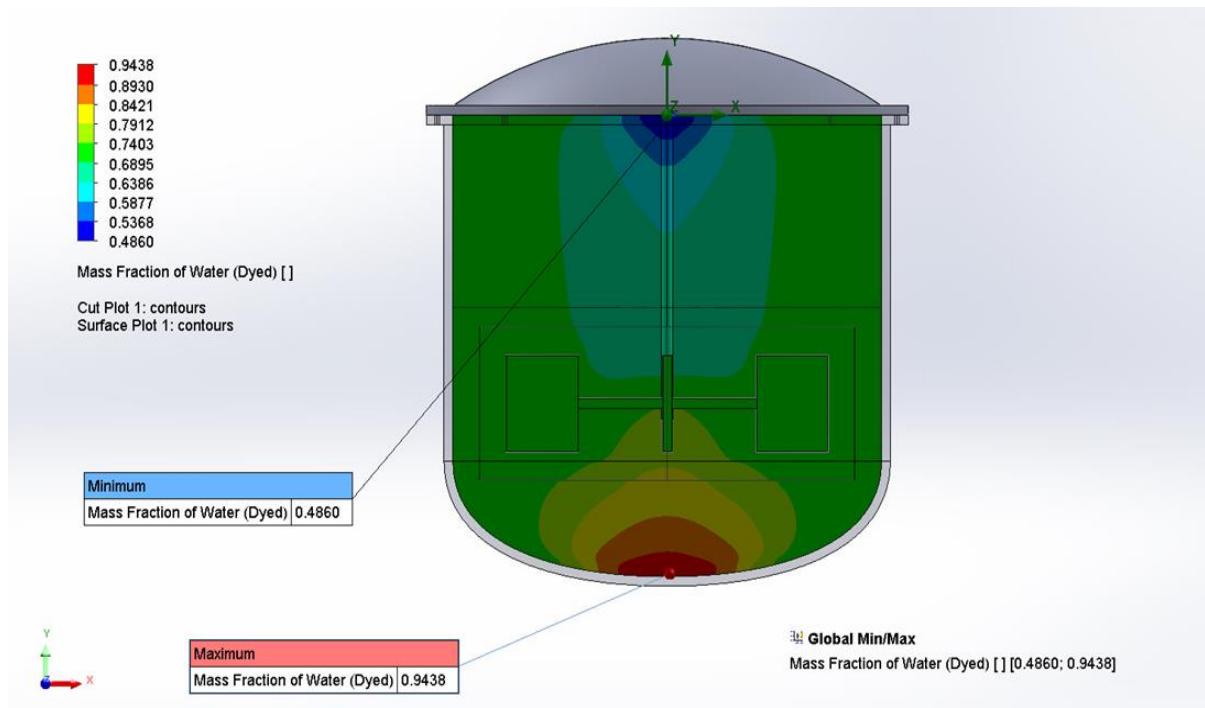


Stirred Tank Mixing Simulation



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1 General Information

Objective of the simulation: This study aims to evaluate the mixing efficiency by examining the dispersion of a dyed tracer within the fluid, providing a clear measure of how effectively the system achieves homogeneity. It also analyzes flow patterns, velocity distribution, and the turbulence generated by the impeller to better understand the underlying mixing mechanisms. The torque acting on the agitator is determined to estimate power consumption, which is essential for assessing energy efficiency. In addition, the analysis identifies potential dead zones or regions of poor mixing that could limit overall performance. The study further demonstrates the capability of SolidWorks Flow Simulation in conducting transient stirred tank analyses. Finally, the results generate valuable data that can be used for impeller design optimization and for making informed scale-up decisions.

1.1 Analysis Environment

Software Product:	Flow Simulation 2025 SP1.0. Build: 6588
CPU Type:	Intel(R) Celeron(R) J4105 CPU @ 1.50GHz
CPU Speed:	1501 MHz
RAM:	12128 MB / 1637 MB
Operating System:	Windows 11 (or higher) (Version 10.0.22631)

1.2 Model Information

Model Name:	StirTank.SLDASM
Project Name:	StirTank

1.3 Project Comments:

Unit System:	SI (m-kg-s)
Analysis Type:	Internal

1.4 Size of Computational Domain

Size

X min	-0.611 m
X max	0.611 m
Y min	-1.220 m
Y max	0.001 m
Z min	-0.611 m
Z max	0.611 m
X size	1.222 m
Y size	1.222 m
Z size	1.222 m

1.5 Simulation Parameters

1.5.1 Mesh Settings

1.5.1.1 Basic Mesh

Fluid Flow Simulation Report

Basic Mesh Dimensions

Number of cells in X	40
Number of cells in Y	40
Number of cells in Z	40

1.5.1.2 Analysis Mesh

Total Cell count:	262871
Fluid Cells:	262871
Solid Cells:	64285
Partial Cells:	36748
Trimmed Cells:	0

1.5.1.3 Additional Physical Calculation Options

Heat Transfer Analysis:	Fluid Flow: On	Conduction: Off
Flow Type:	Laminar and turbulent	
Time-Dependent Analysis:	On	
Gravity:	On	
Radiation:		
Humidity:		
Default Wall Roughness:	0 micrometer	

1.5.2 Material Settings

Material Settings

Fluids

[Water](#)

[Water \(Dyed\)](#)

1.5.3 Initial Conditions

Initial Conditions

Thermodynamic parameters	Static Pressure: 101325.00 Pa Temperature: 293.20 K
Velocity parameters	Velocity vector Velocity in X direction: 0 m/s Velocity in Y direction: 0 m/s Velocity in Z direction: 0 m/s
Concentrations	Substance fraction by mass Water 1.0000 Water (Dyed) 0.5000
Turbulence parameters	Turbulence intensity and length Intensity: 2.00 % Length: 0.014 m

1.5.4 Boundary Conditions

1.5.5 Volumetric Heat Sources

1.5.6 Engineering Goals

Goals

Surface Goals

SG Area (Fluid) 1

Type	Surface Goal
Goal type	Area (Fluid)
Faces	StirTank.STEP<1>/Agitator_1.STEP<1>
Coordinate system	Global Coordinate System
Criteria	1.0000 m^2
Use in convergence	On

SG Torque (Y) 2

Type	Surface Goal
Goal type	Torque (Y)
Faces	StirTank.STEP<1>/Agitator_1.STEP<1>
Coordinate system	Global Coordinate System
Criteria	1.000 N*m
Use in convergence	On

1.6 Analysis Time

Calculation Time: 10604 s

Number of Iterations: 490

Warnings:

2 Results

2.1 Analysis Goals

Goals

Name	Unit	Value	Progress	Criteria	Delta	Use in convergence
SG Area (Fluid) 1	m ²	0.6572	100	6.57200393e-09	0	On
SG Torque (Y) 2	N*m	113.201	78	44.8068907	57.4198606	On

2.2 Global Min-Max-Table

Min/Max Table

Name	Minimum	Maximum
Density (Fluid) [kg/m ³]	997.56	997.56
Mass Fraction of Water []	0.0562	0.5140
Mass Fraction of Water (Dyed) []	0.4860	0.9438
Pressure [Pa]	91834.00	118603.11
Temperature [K]	293.20	293.21
Temperature (Fluid) [K]	293.20	293.21
Velocity [m/s]	0	5.842
Velocity (X) [m/s]	-5.825	5.829
Velocity (Y) [m/s]	-1.357	1.396
Velocity (Z) [m/s]	-5.814	5.801
Volume Fraction of Water []	0.0562	0.5140
Volume Fraction of Water (Dyed) []	0.4860	0.9438
Velocity RRF [m/s]	0	4.701
Velocity RRF (X) [m/s]	-4.643	4.634
Velocity RRF (Y) [m/s]	-1.357	1.396
Velocity RRF (Z) [m/s]	-4.632	4.648
Vorticity [1/s]	0.08	77.40
Relative Pressure [Pa]	-12544.52	14224.59
Shear Stress [Pa]	0	100.20
Bottleneck Number []	9.6266399e-08	1.0000000
Heat Transfer Coefficient [W/m ² /K]	0	0
ShortCut Number []	7.1357017e-08	1.0000000
Surface Heat Flux [W/m ²]	0	0
Surface Heat Flux (Convective) [W/m ²]	0	0
Total Enthalpy Flux [W/m ²]	-6.307e+08	6.307e+08
Acoustic Power [W/m ³]	0	7.366e-14
Acoustic Power Level [dB]	0	0

2.3 Results

The mixing uniformity results show that the mass fraction range of 0.486–0.943 indicates partial mixing at the simulated time step, with persistent low-concentration regions suggesting the presence of dead zones near the bottom or walls, a common challenge in industrial mixing systems. These variations highlight that achieving less than 5% concentration deviation across the tank, which is a typical requirement for quality-critical processes, has not yet been fully attained. Analysis of the flow and turbulence reveals a peak velocity of 5.84 m/s at the impeller blades, generating strong circulation within the tank. The high vorticity value of 77.4 s^{-1} near the impeller confirms effective turbulence generation necessary for dispersion, while regions with low vorticity around 0.08 s^{-1} indicate possible stagnant zones. From a mechanical and energy perspective, the calculated torque of approximately 113 N·m is realistic and provides important input for motor selection and power consumption estimation. The maximum shear stress of about 100 Pa is acceptable for many industrial applications, although it would need to be limited for shear-sensitive processes such as cell cultures or emulsions. Finally, the negligible temperature change throughout the simulation confirms isothermal behavior, and the constant density supports the validity of the incompressible flow assumption.

2.4 Conclusion

This transient CFD study successfully demonstrates the capability of SolidWorks Flow Simulation to model impeller-driven mixing in a stirred tank. The results show strong circulation and turbulence in the region surrounding the agitator, while also revealing the presence of low-mixing or stagnant zones at the current simulation time step. The calculated torque and shear stress values provide practical engineering data that are essential for equipment sizing, motor selection, and ensuring process safety. Overall, the findings confirm that CFD is a powerful and reliable tool for predicting mixing behavior, optimizing impeller design, and reducing the need for costly and time-consuming physical experiments.

3 Appendix

3.1 Material Data

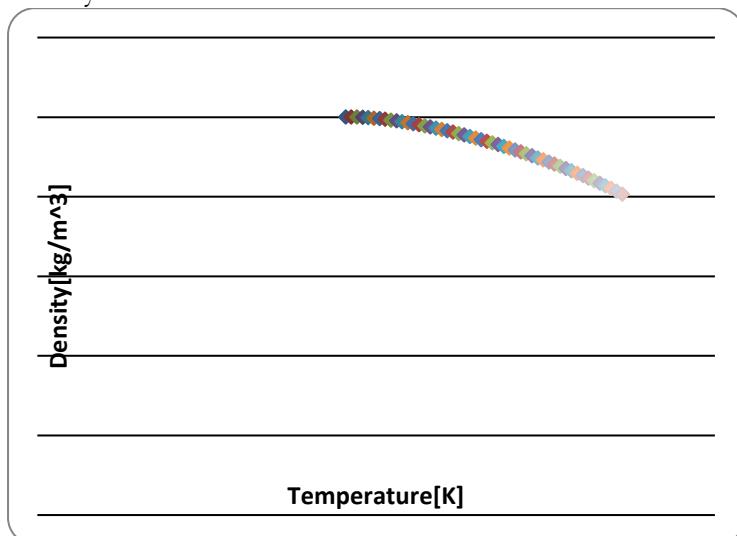
Engineering Database

Liquids

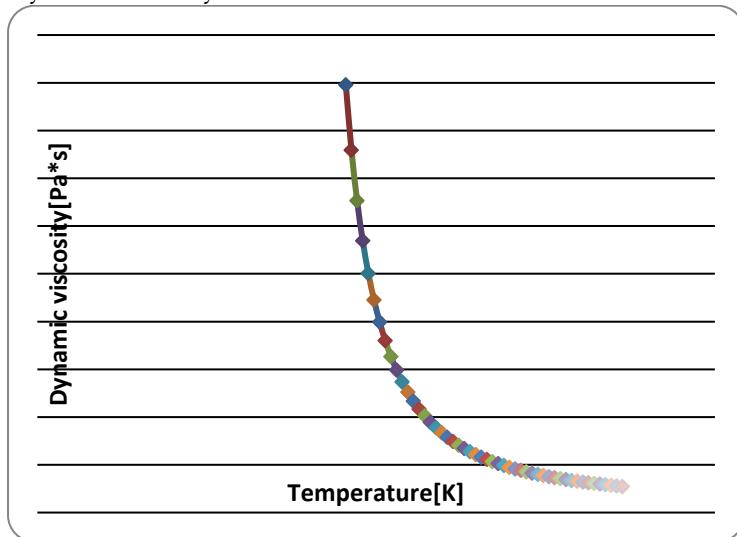
Water

Path: Liquids Pre-Defined

Density

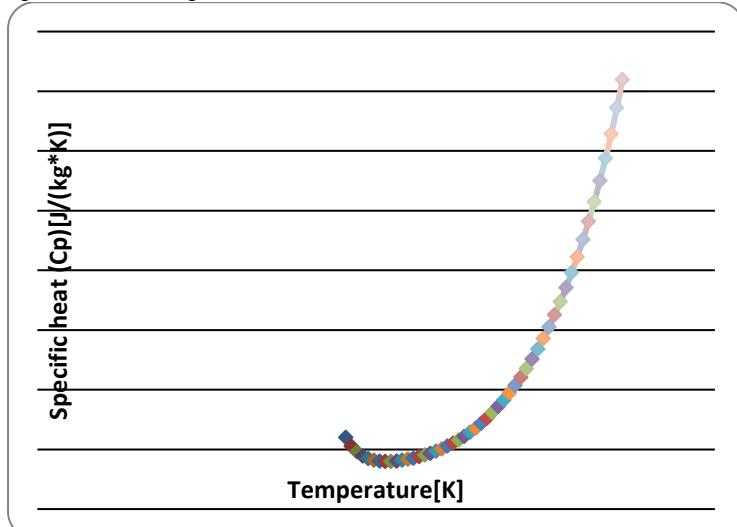


Dynamic viscosity

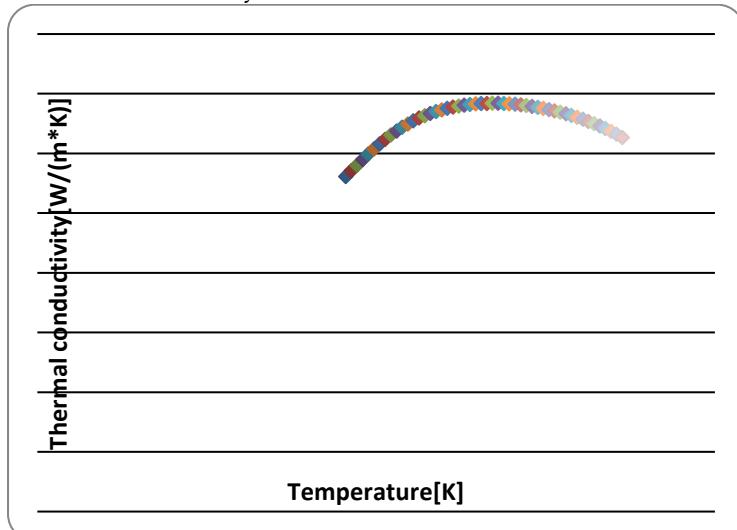


Fluid Flow Simulation Report

Specific heat (C_p)



Thermal conductivity



Cavitation effect: Yes

Temperature: 0 K

Saturation pressure: 0 Pa

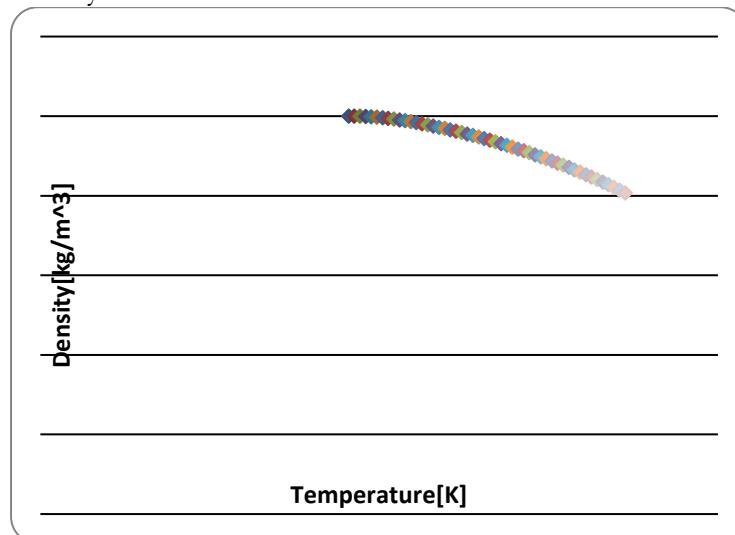
Radiation properties: No

Water (Dyed)

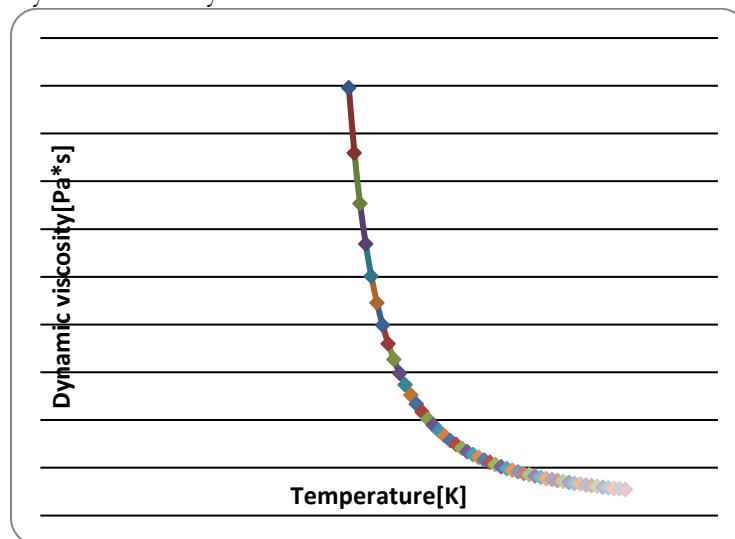
Path: Liquids User Defined

Fluid Flow Simulation Report

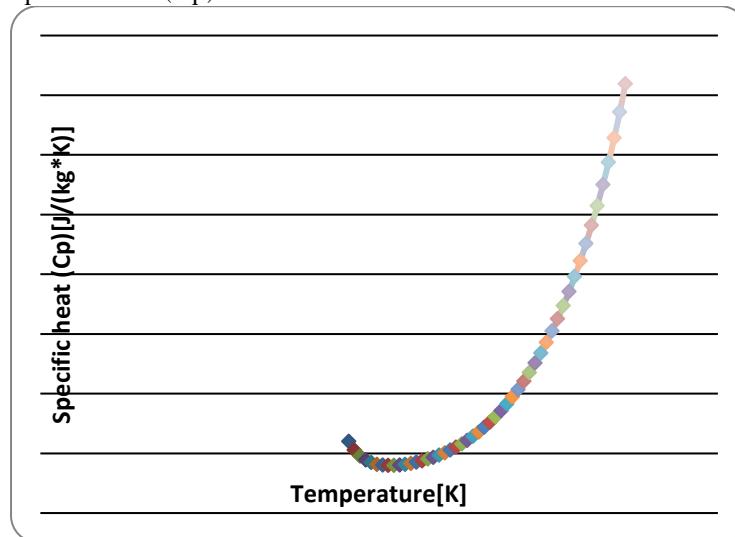
Density



Dynamic viscosity

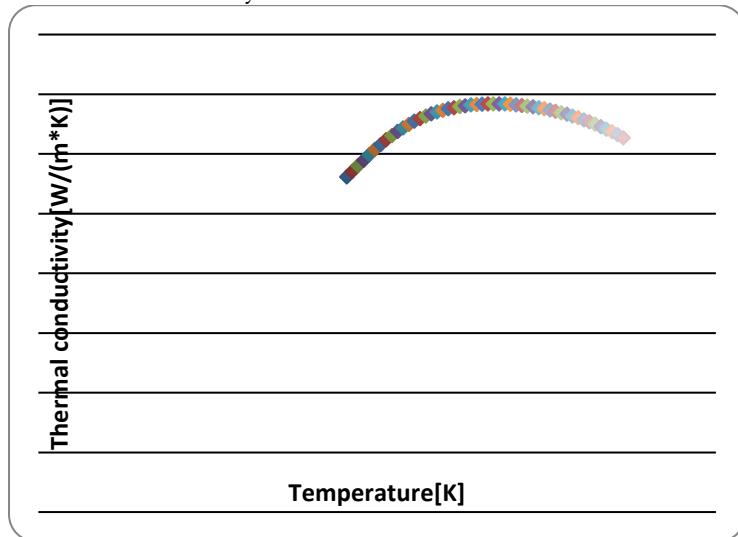


Specific heat (Cp)



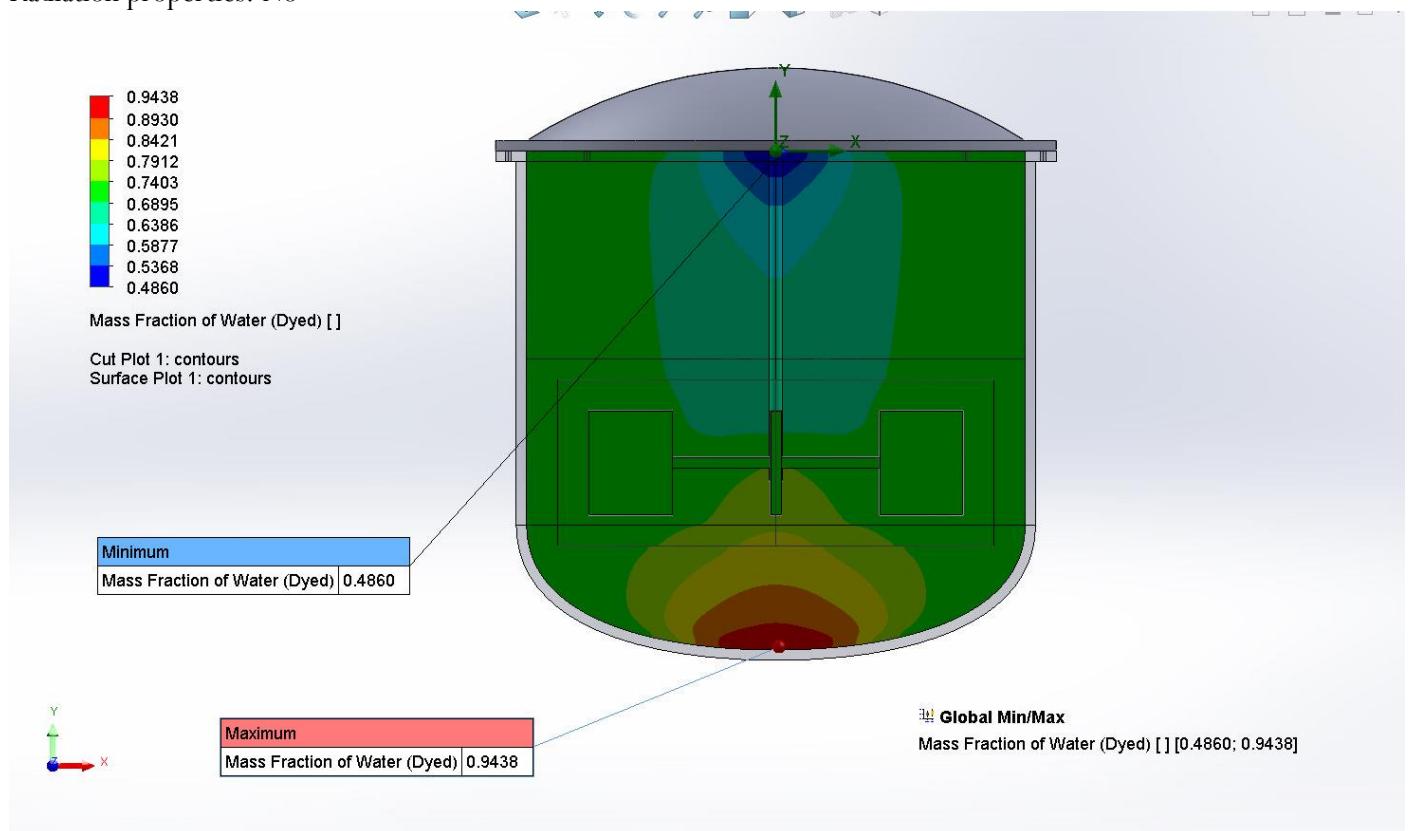
Fluid Flow Simulation Report

Thermal conductivity

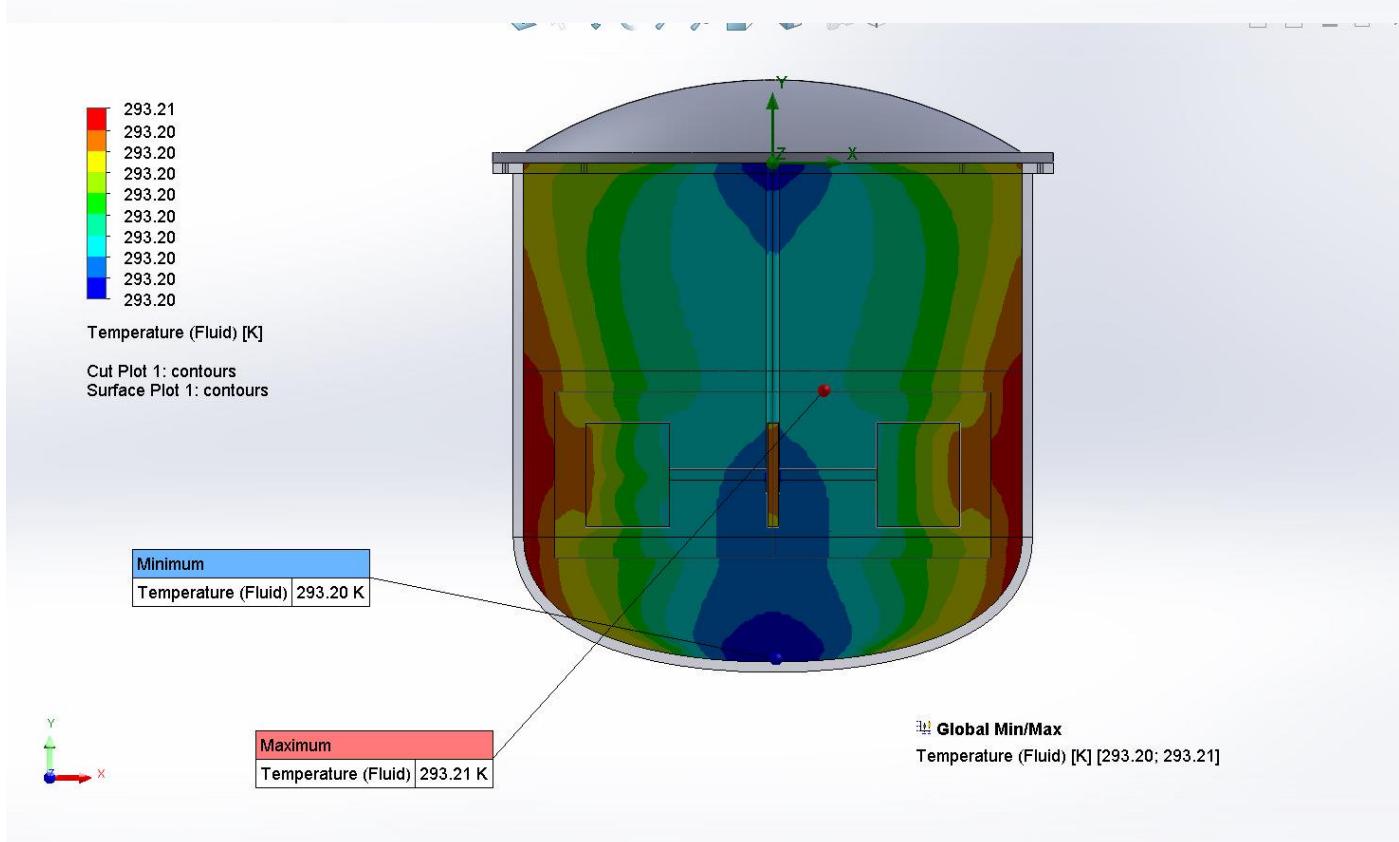
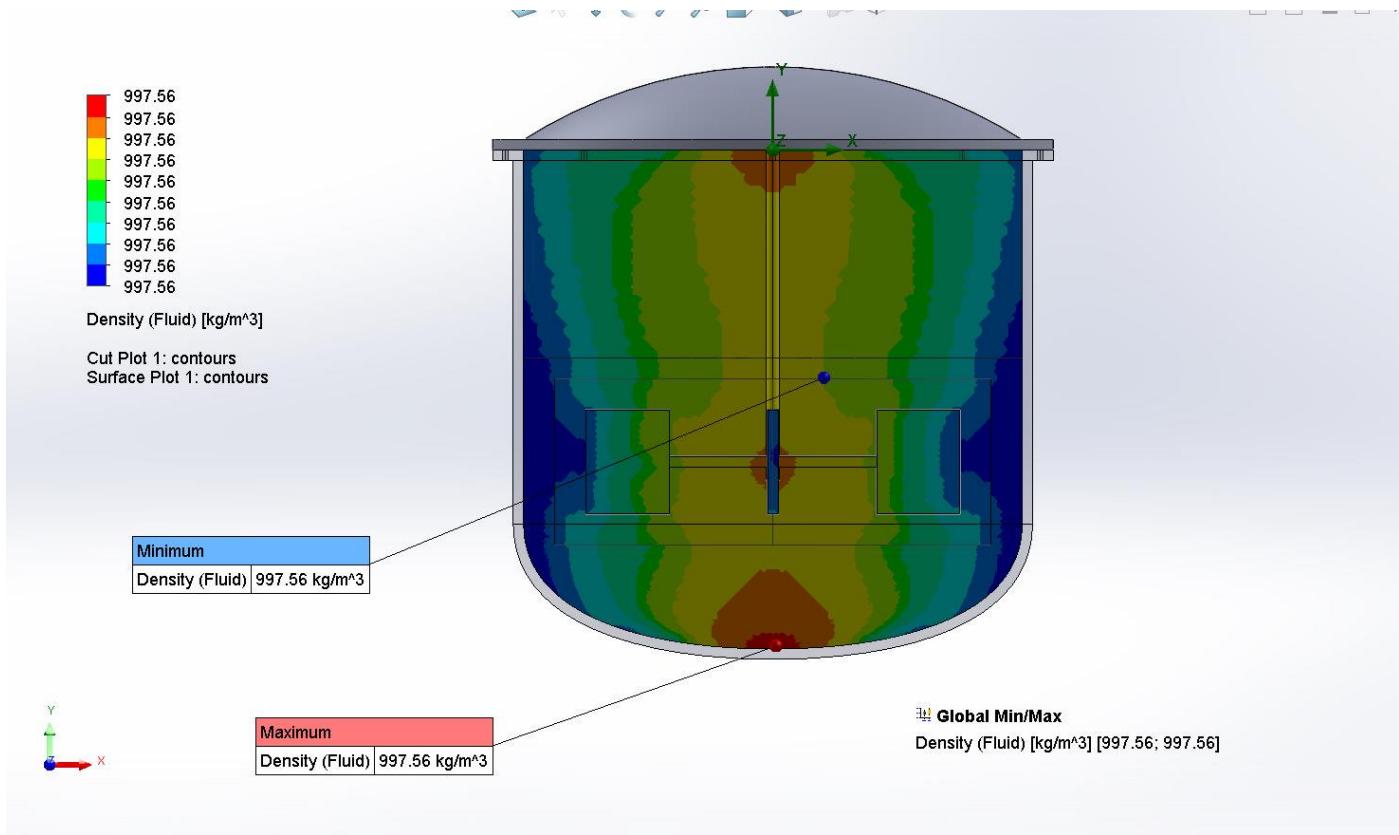


Cavitation effect: No

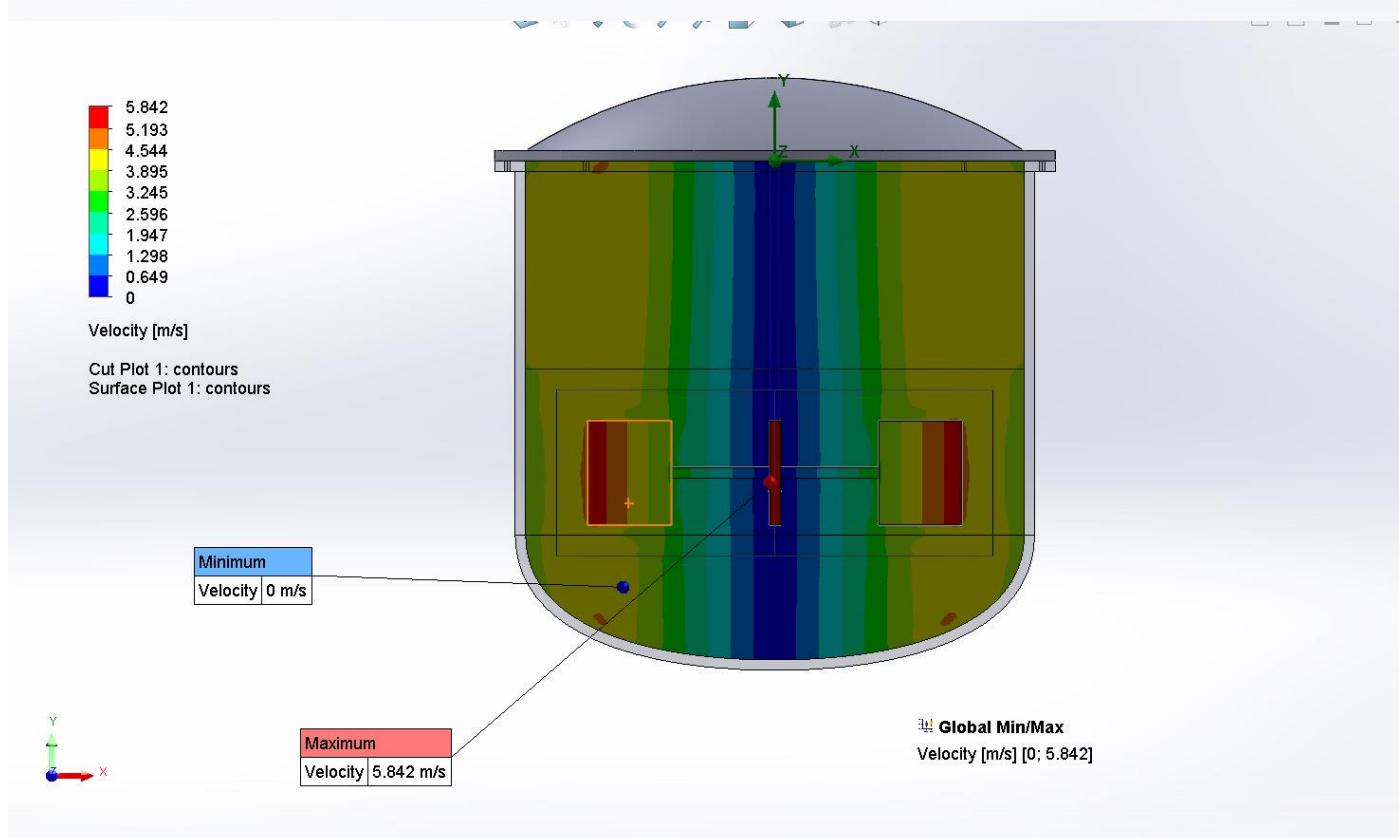
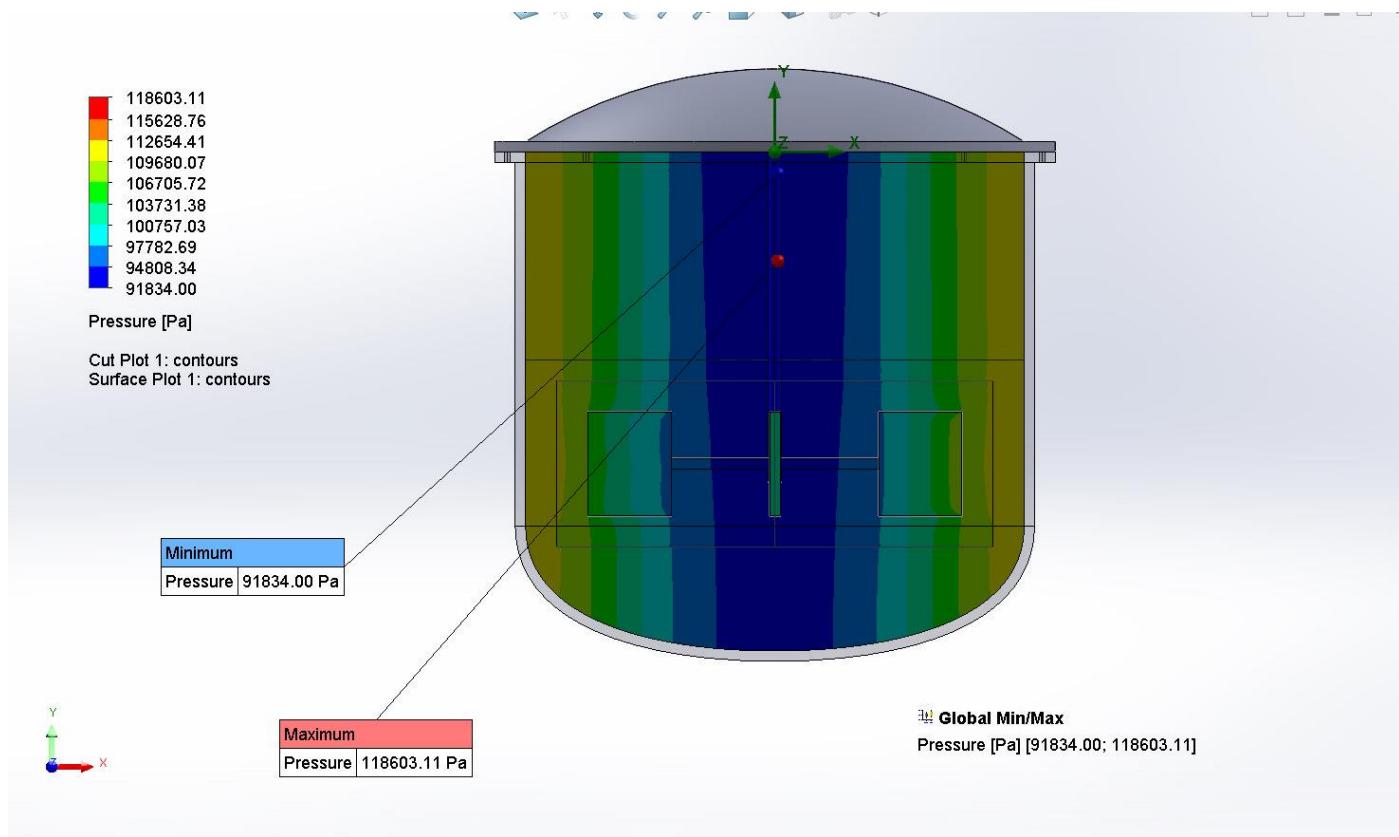
Radiation properties: No



Fluid Flow Simulation Report



Fluid Flow Simulation Report



Fluid Flow Simulation Report

