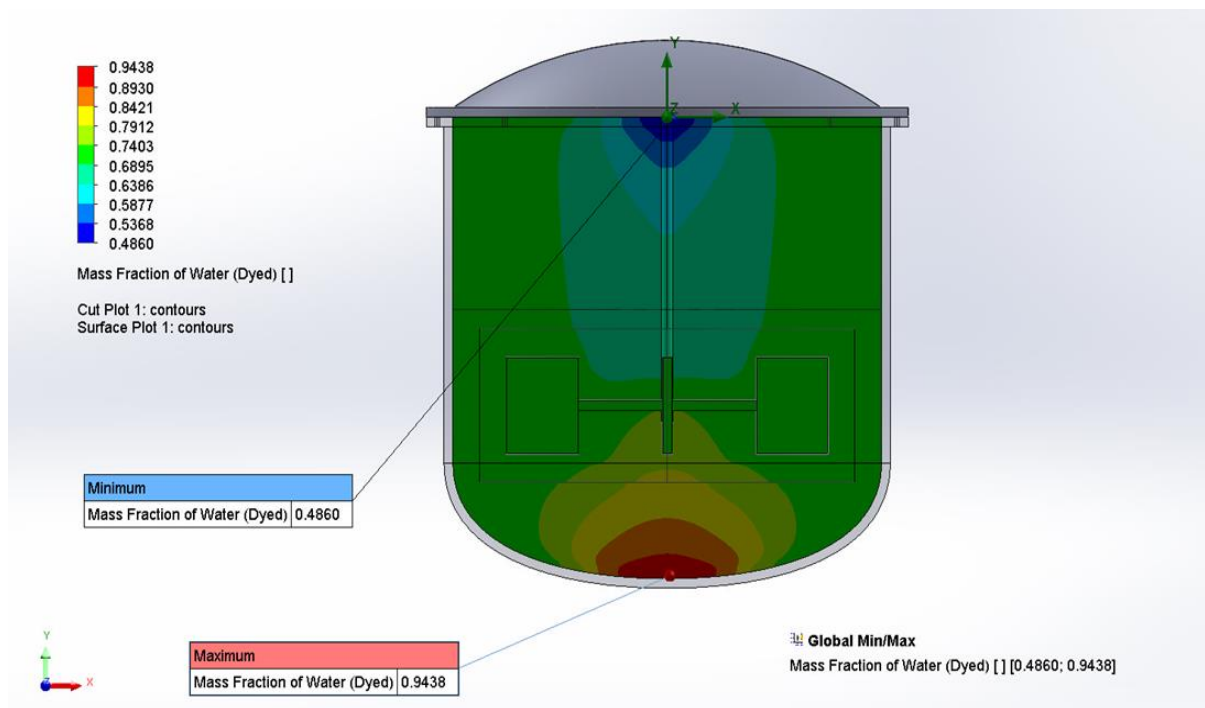




Stirred Tank Mixing Simulation



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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: OnConduction: 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

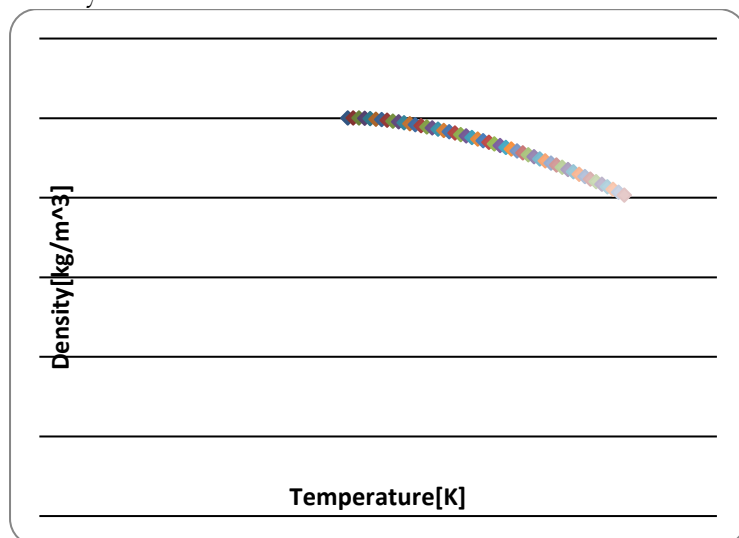
Engineering Database

Liquids

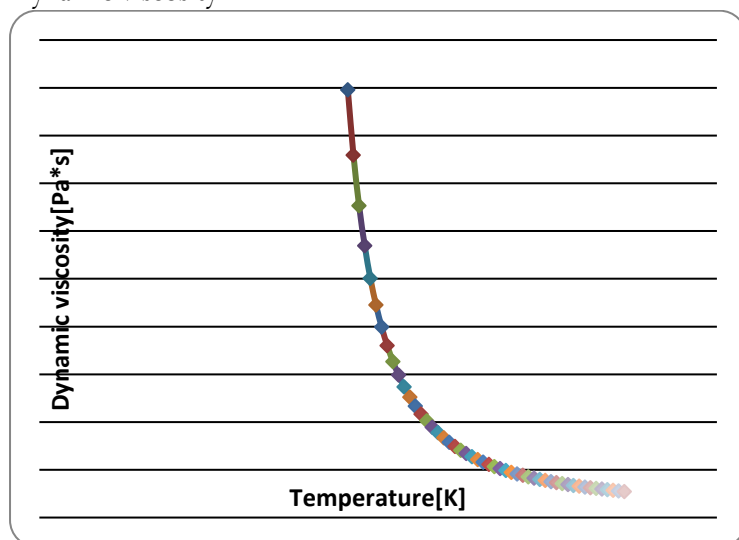
Water

Path: Liquids Pre-Defined

Density

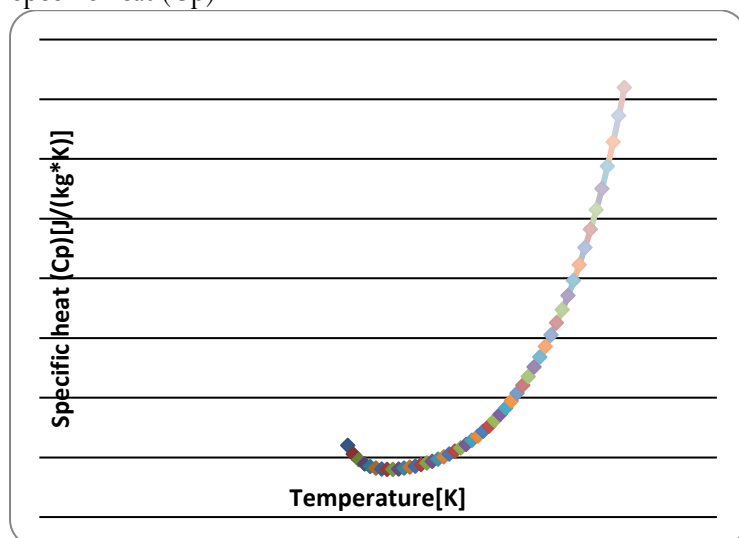


Dynamic viscosity

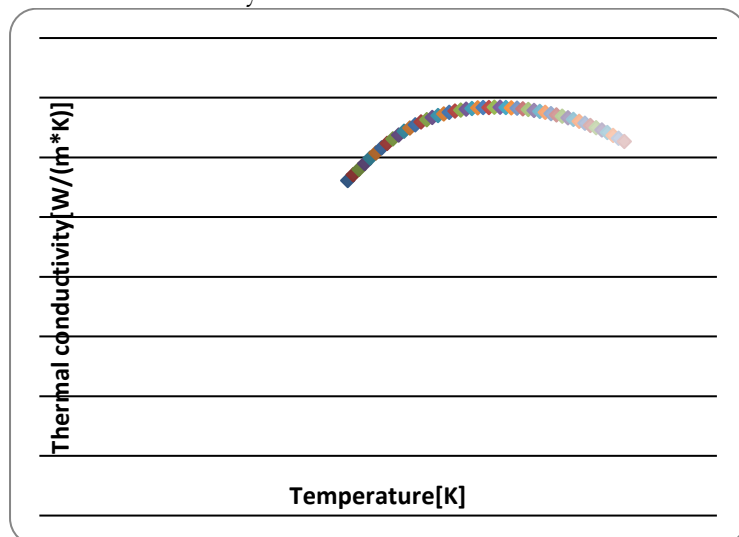


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Specific heat (C_p)



Thermal conductivity



Cavitation effect: Yes

Temperature: 0 K

Saturation pressure: 0 Pa

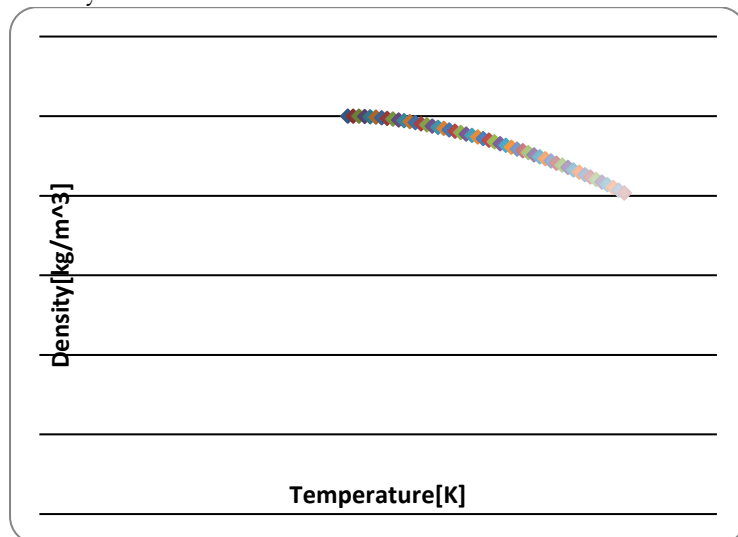
Radiation properties: No

Water (Dyed)

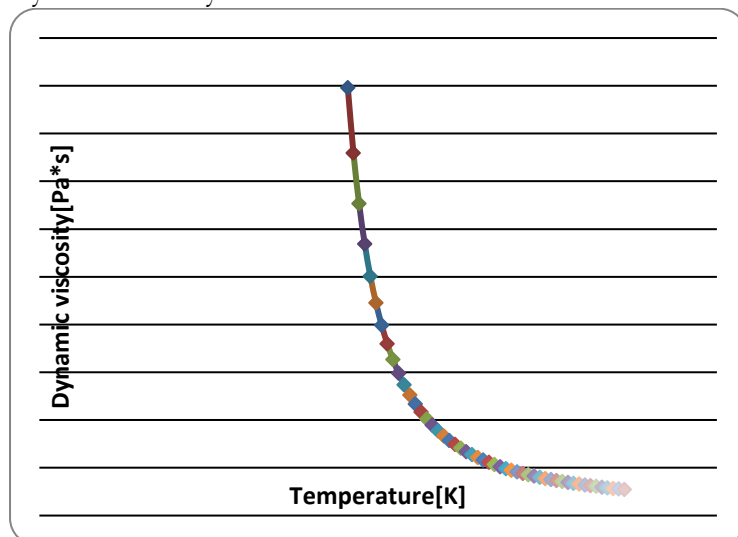
Path: Liquids User Defined

Fluid Flow Simulation Report

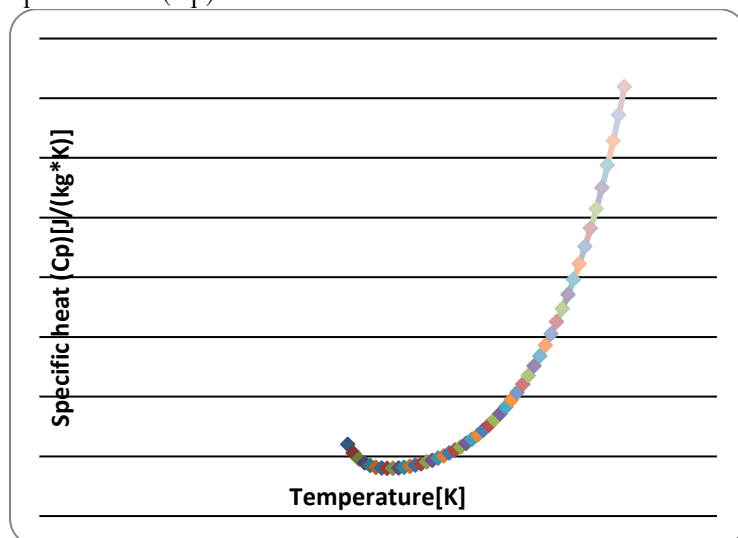
Density



Dynamic viscosity

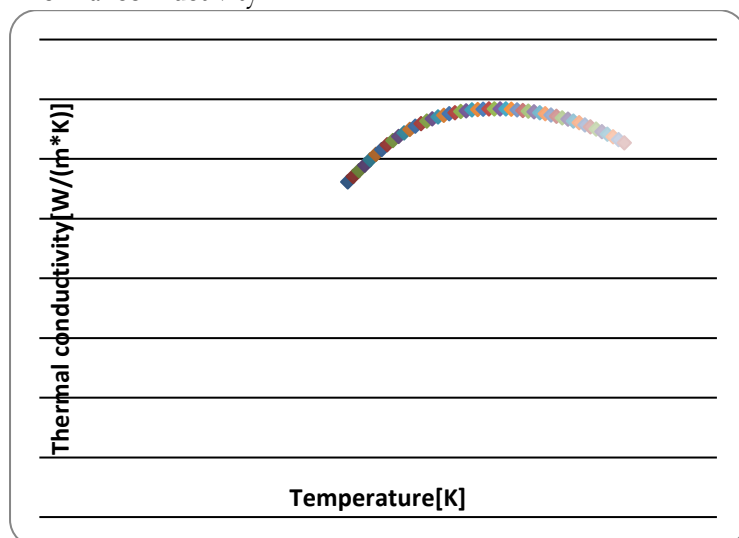


Specific heat (Cp)



Fluid Flow Simulation Report

Thermal conductivity



Cavitation effect: No

Radiation properties: No

