

VisiMix DI. *Modeling of Suspending in Tanks with Different Impellers on the Shaft.*

LIQUID-SOLID MIXING IN REACTOR *SUSP D* WITH DISC TURBINE AND A310 IMPELLERS.

1. Entering the data for reactor in VisiMix DI and calculation of energy dissipation in the bulk of volume.

The data of the reactor *Susp_D* are entered in a project *Susp_D.vsd*. Type and main dimensions of the tank are presented in the Figure 1. Characteristics of mixing device and positions of impellers corresponds to Figures 2, 3 and 4. Properties of liquid media are shown in the Figure

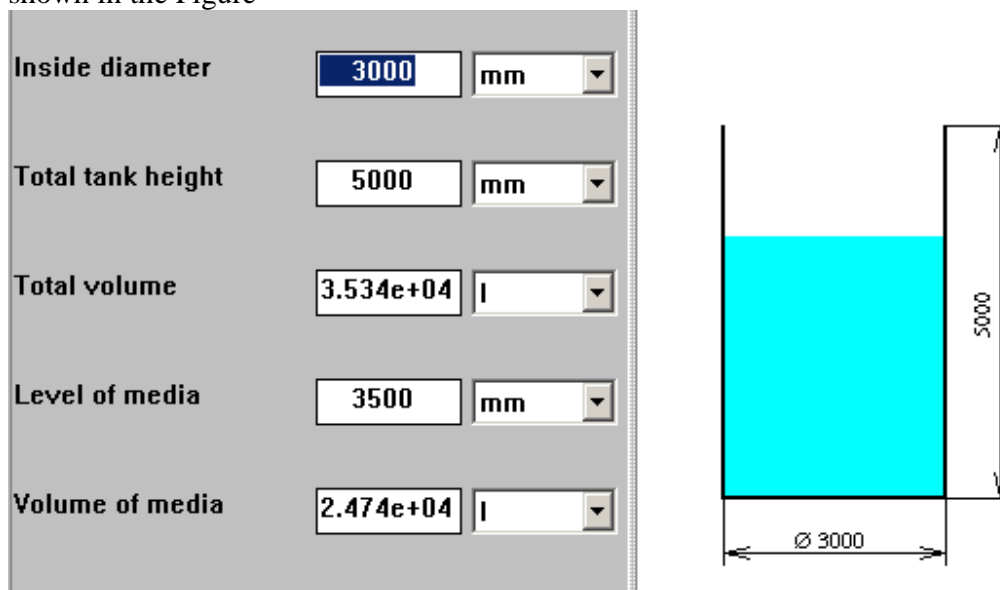


Figure 1. Reactor *Susp_D*. Type and dimensions of tank .

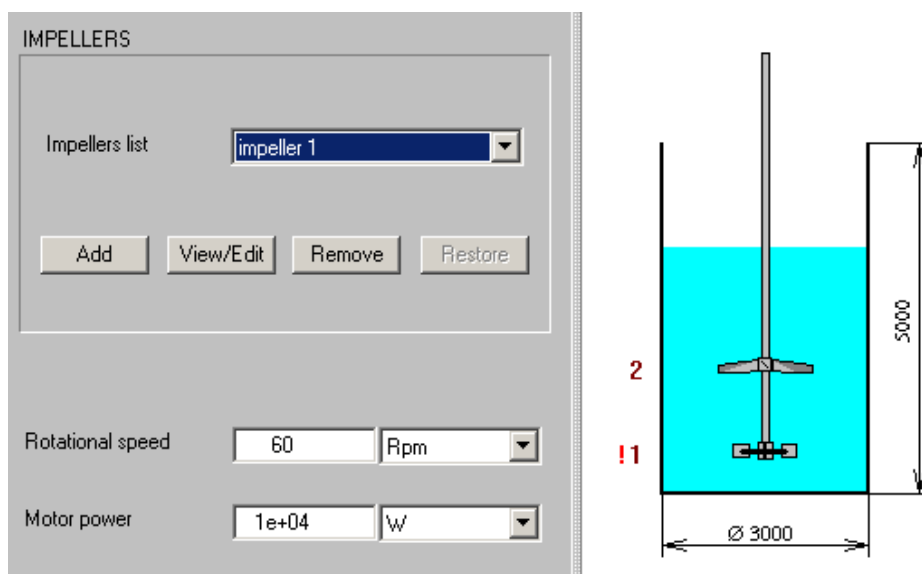


Figure 2. Reactor *Susp_D*. Mixing device.

DISK TURBINE

Tip diameter mm

Diameter of disk mm

Number of blades

Pitch angle deg

Width of blade mm

Length of blade mm

Dist. from bottom mm

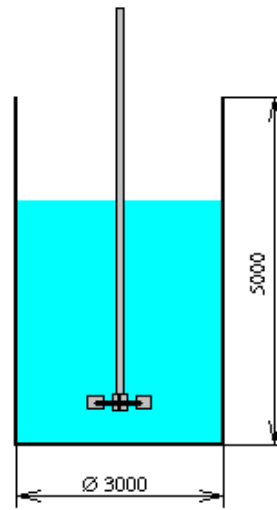


Figure 3. Reactor Susp_D. Impeller 1.

LIGHTNIN A310

Tip diameter mm

Dist. from bottom mm

Figure 4. Reactor Susp_D. Impeller 2.

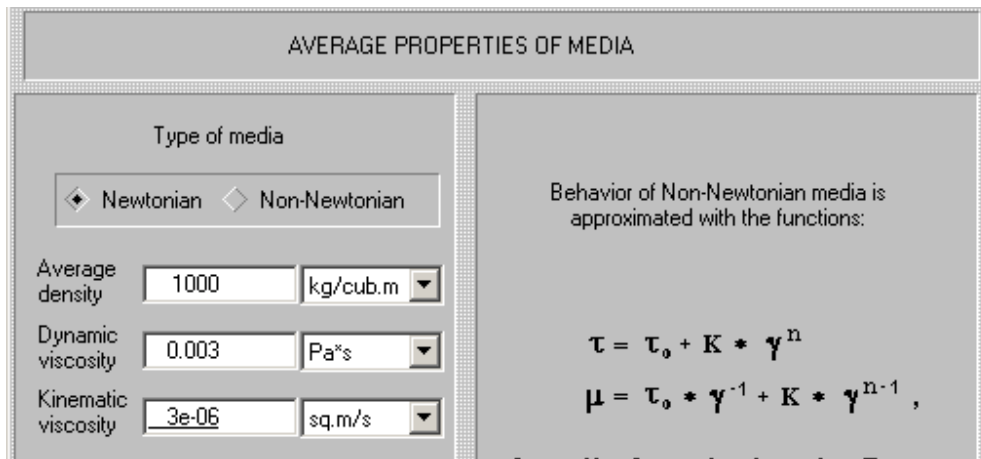


Figure 5. Reactor Susp_D. Properties of liquid media.

Calculation of *Energy dissipation in the bulk of volume* – see Figures 6 and 7.

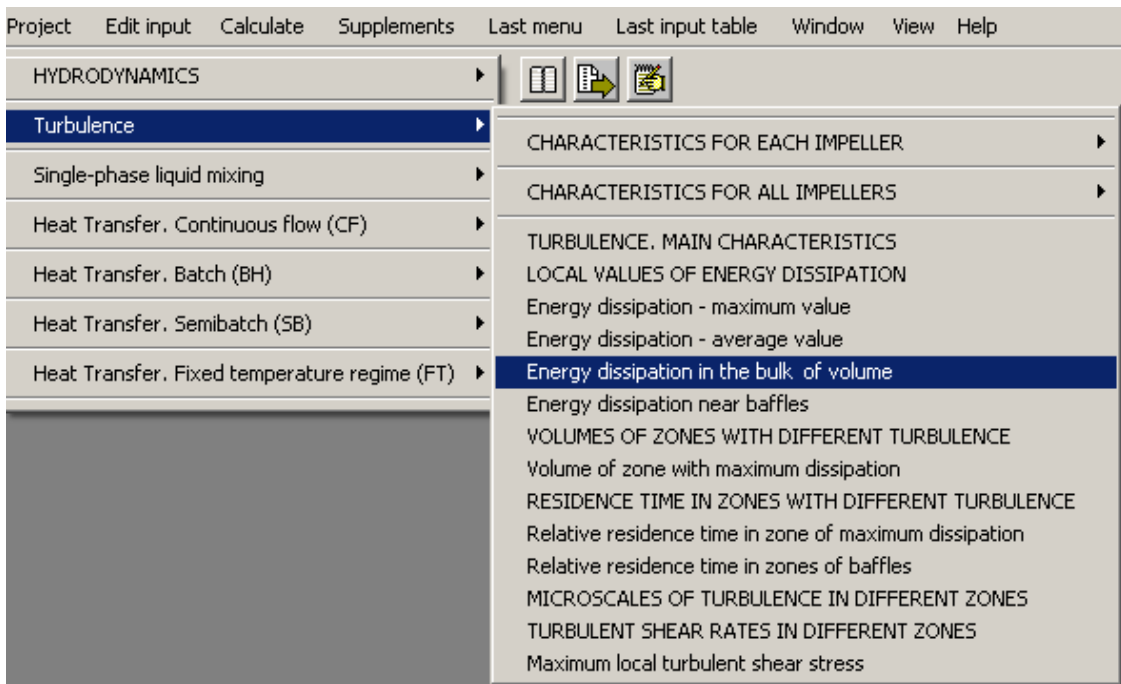


Figure 6. Reactor Susp_D. Menu Turbulence.

ENERGY DISSIPATION IN THE BULK OF VOLUME		
Parameter name	Units	Value
Energy dissipation in the bulk of volume	W/kg	0.0922

For HELP press F1

Figure 7. Reactor Susp_D. Energy dissipation in the bulk of volume.

2. Reproduction of the local energy dissipation in the tank using the program VisiMix Turbulent.

2.1 Open the project **Susp_T.vsm** in **VisiMix Turbulent**. Enter the tank corresponding to the data of Figure 1 and **Average properties of media** corresponding to Figure 5. Enter **2-stage Disk turbine** with dimensions corresponding to the data of Figure 3. Position of the upper turbine must correspond to position of the Impeller 2 – impeller A310 in Figure 4. Input table for the mixing device is shown in the Figure 8.

2.2 Select the **Rotational speed** of the turbines so as to provide the value of **Energy dissipation in the bulk of volume** in the limits 0.0922 ± 0.01 . As is shown in the Figure 9, this requirement is satisfied at 54 r.p.m.

Note. The calculated mixing power and overload of the drive (see Figure 10) in this case is not taken into account.

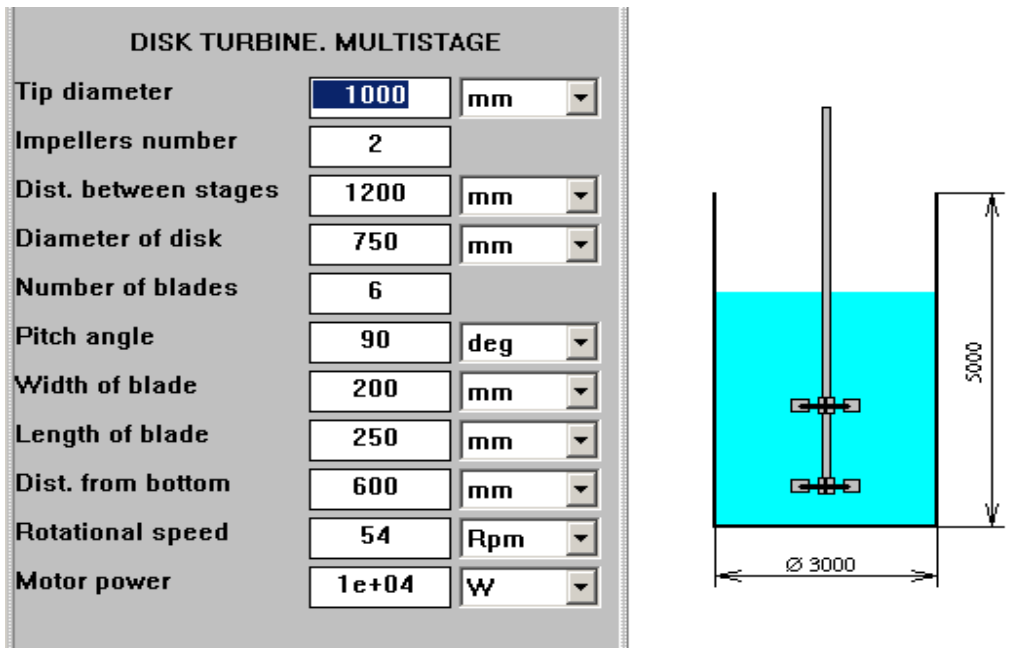


Figure 8. Project Susp_T.vsm. Equivalent mixing device for bottom turbulence.

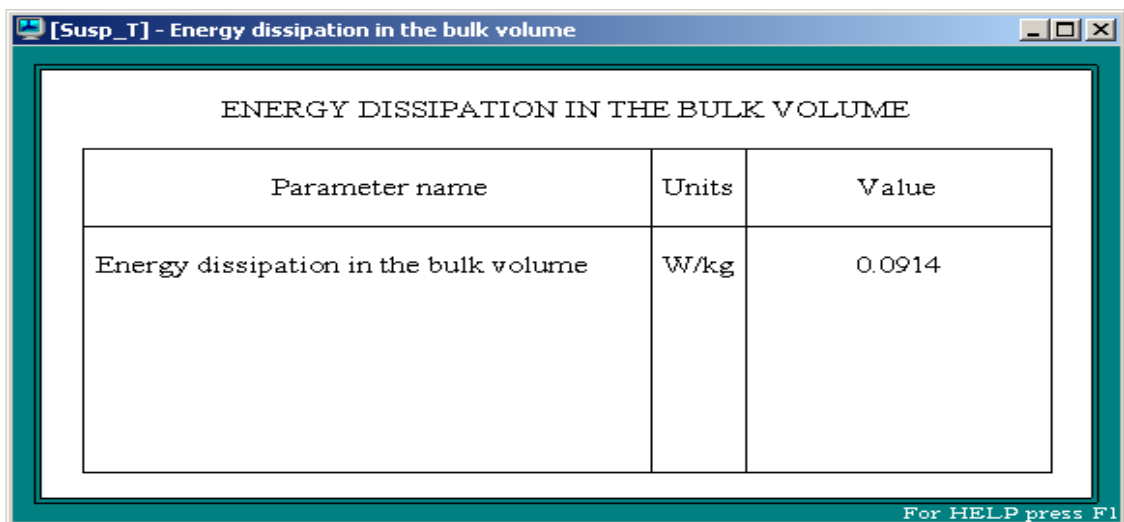


Figure 9. Project Susp_T.vsm. Energy dissipation corresponding to 54 r.p.m.

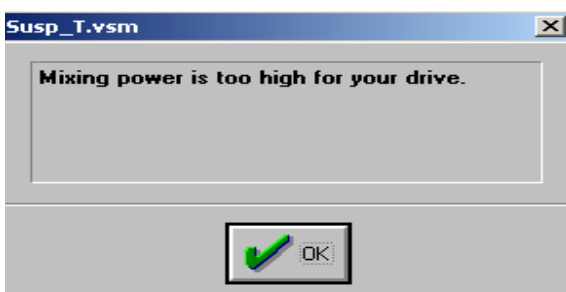


Figure 10. Project Susp_T.vsm. Calculated mixing power for the 'equivalent' project is not relevant.

2.3 Enter properties of solid and liquid phase (see Figure 11), click *Calculate>Liquid-solid mixing>Complete/incomplete suspending* and correct *Average properties of media* (Figure 12).

2.4 Check pick-up conditions (via *Calculate>Liquid-solid mixing>Complete/incomplete suspending*). Accordingly to the results of calculations, the pick-up conditions are satisfied – see Figure 13.

The screenshot shows a dialog box titled "E:\2006\New Folder\Susp_T.vsm" with a close button. The main title is "PROPERTIES OF SOLID AND LIQUID PHASES." Below this, there are seven rows of input fields:

- Density of liquid phase: 1000 kg/cub.m
- Dyn. viscosity of cont.phase: 0.003 Pa*s
- Concentration of solid phase: 200 kg/cub.m
- Density of solid phase: 2300 kg/cub.m
- Average particle size: 150 micron
- Size of largest particles: 250 micron
- Position of outlet-height: 0 mm

Figure 11. Project Susp T.vsm. Entering properties of solid and liquid phase

The screenshot shows a dialog box titled "AVERAGE PROPERTIES OF MEDIA". On the left, under "Type of media", the "Newtonian" radio button is selected. Below this are three input fields:

- Average density: 1117 kg/cub.m
- Dynamic viscosity: 0.00417 Pa*s
- Kinematic viscosity: 3.733e-06 sq.m/s

On the right side, there is text stating "Behavior of Non-Newtonian media is approximated with the functions:" followed by two mathematical equations:

$$\tau = \tau_0 + K * \gamma^n$$

$$\mu = \tau_0 * \gamma^{-1} + K * \gamma^{n-1},$$

Figure 12. Project Susp_T.vsm. Correction of average properties of media.

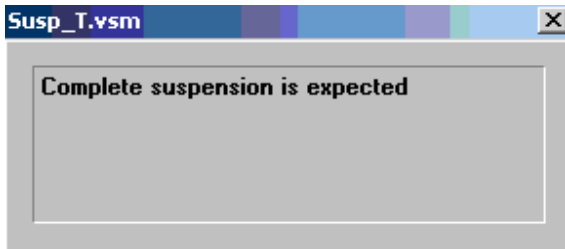


Figure 13. Project Susp_T.vsm. Checking the pick-up conditions.

3. Reproduction of macroscale transport rate and modeling of suspension distribution.

3.1 Return to the program **VisiMix DI**. Calculate *Macromixing time* in the reactor **Susp_D.vsd** – see Figure 14.

MACROMIXING TIME		
Parameter name	Units	Value
Macromixing time	s	37.8

For HELP press F1

Figure 14. Project Susp_D.vsd. Macromixing time in reactor.

3.2. Return to the project **Susp_T.vsm** (program **VisiMix Turbulent**). Calculate *Macromixing time*. Accordingly to the results (Figure 15), at 54 r.p.m. the calculated value is 120 sec.

[Susp_T] - Macromixing time

MACROMIXING TIME

Parameter name	Units	Value
Macromixing time	s	120

For HELP press F1

Figure 15. Project Susp_T.vsm. Macromixing time for 54 r.p.m.

3.3. For reproduction of the macroscale mixing rate of the tank Susp_D_vsd (see Figure 14), the *Macromixing time* for the project Susp_T.vsm must be within the limits $35.9 \div 39.7$ sec. The corresponding rotation speed of turbines is about $54 \text{ r.p.m.} * 120 / 37.8 = 171.4$ r.p.m.

3.4 Change **Rotational speed** to 171 r.p.m. (Figure 16) and define *Macromixing time* (via *Calculate>Single-phase liquid mixing*). Accordingly to the Figure 17, the calculated value is within the required limits.

DISK TURBINE. MULTISTAGE

Tip diameter	1000	mm
Impellers number	2	
Dist. between stages	1200	mm
Diameter of disk	750	mm
Number of blades	6	
Pitch angle	90	deg
Width of blade	200	mm
Length of blade	250	mm
Dist. from bottom	600	mm
Rotational speed	171	Rpm
Motor power	1e+04	W

Figure 16. Project Susp_T.vsm. Correction of Rotational speed.

MACROMIXING TIME		
Parameter name	Units	Value
Macromixing time	s	37.9

For HELP press F1

Figure 17. Project Susp_T.vsm. Macromixing time for 171 r.p.m.

Notes. 1. *The calculated mixing power and overload of the drive (see Figure 10) in this case is not relevant.*

2. *Difference of density and viscosity of suspension (see Figure 12) and of liquid phase (Figure 5) is not important for this example.*

3.5 Modeling of distribution of suspension.

Calculate parameters of suspension distribution via Calculate>Liquid/solid mixing. For example, select **Liquid/solid mixing. MAIN CHARACTERISTICS** – Figure 18.

LIQUID-SOLID MIXING. MAIN CHARACTERISTICS		
Parameter name	Units	Value
Maximum degree of non-uniformity - axial, %		41.9
Maximum degree of non-uniformity - radial, %		3.15
Average concentration of solid phase in continuous flow	kg/cub.m	141

For HELP press F1

Figure 18. Calculated parameters of suspension distribution.