

VisiMix DI – Main Hydrodynamic Parameters in Tank with Different Impellers on the shaft

Subject of this example: application of the program **VisiMix DI** for calculation of the main mixing parameters – flow, turbulence, shear and mixing time in a tank with two different impellers on the shaft.

Initial data

Tank with a flat bottom:

Inside diameter = 3000 mm;
Total tank height = 5000 mm;
Level of media = 3500 mm.

Baffles (flat, attached to the tank wall)

Number = 4;
Width = 300 mm;
Length = 4000 mm;
Distance from bottom = 0 mm;
Angle to radius = 0 deg.

Impellers:

1. Disc turbine (Rushton) type

Tip diameter = 1000 mm;
Diameter of disc = 750mm;
Number of blades = 6;
Pitch angle = 90 deg;
Width of blade = 200 mm;
Length of blade = 250 mm;
Distance from bottom = 600 mm;

2. Lightnin A310 type.

Tip diameter – 1400 mm;
Pumping direction:down;
Distance between impellers – 1200 mm;

Shaft rotation speed: 60 r.p.m.;

Power of drive = 10,000 W;

Media properties

The media is a Newtonian liquid with the following average properties:

density = 1000 kg/cub. m;
dynamic viscosity = 0.001Pa*s.

1. Entering the initial data.

After installing **VisiMix DI**, the main menu appears on the screen (Figure 1).



Figure 1. VisiMix DI starting screen.

This menu is used to start a new project corresponding to the initial data above. Select **Project > New** and create a project **Ex_1**. It will have extension **.vsd**. Selecting and input of data on **Tank** (Figure 2) and **Baffles** (Figure 3) is performed exactly the same way as in other VisiMix programs.

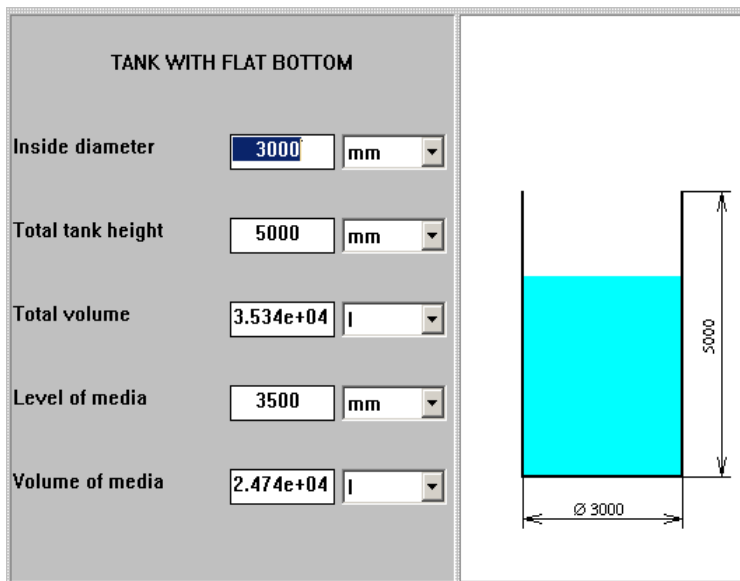


Figure 2. Entering tank data.

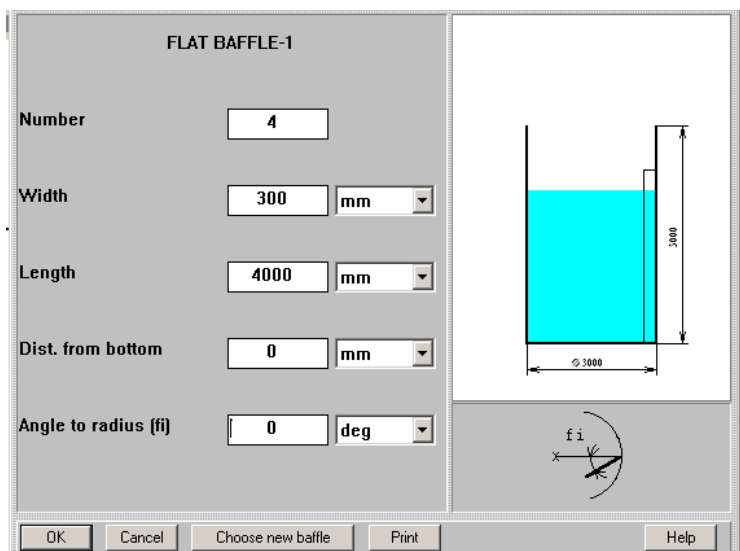


Figure 3. Entering data for the baffles.

After these data are entered, the **Mixing device** input table appears (Figure 4).

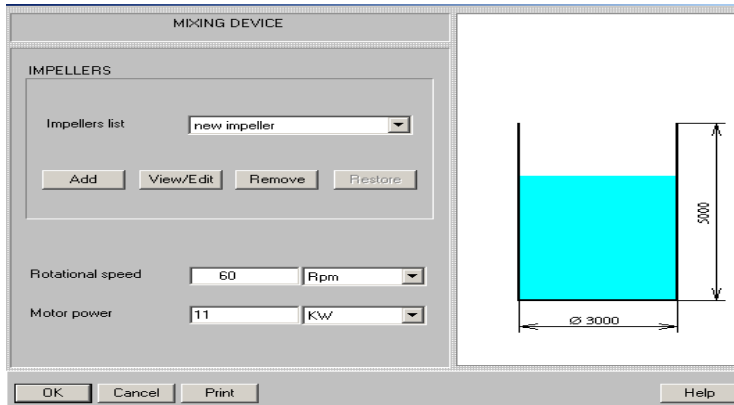


Figure 4. Entering general data for Mixing device.

This table is used for entering general characteristics of the mixing device - **Rotational speed** and **Motor power**.

The next step – entering the first impeller - **Impeller 1**.

It is performed using **Add** button. The impeller type, in this case – the **disc turbine** impeller – is selected and the impeller data are entered in usual way (Figures 5,6).

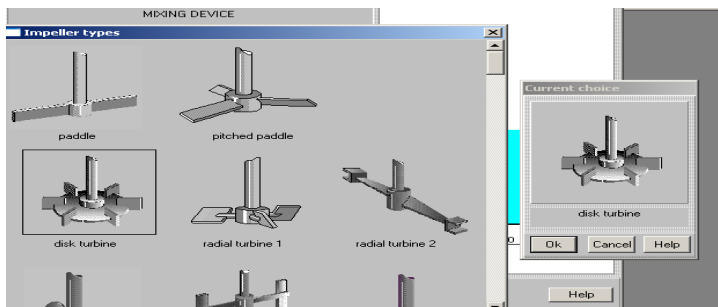


Figure 5. Selecting the impeller 1 - disc turbine

After completing this table, the **Mixing device** with the impeller 1 in the **Current choice** window arrives. The **Impeller 1** line is shown in **Impellers list** scrolling box (see Figure 4).

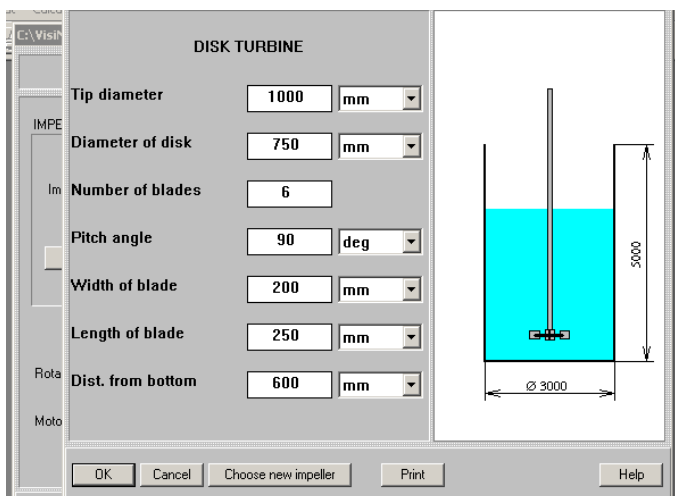


Figure 6. Entering parameters of the impeller 1.

After selection **New impeller** in the scrolling box , the **Impeller selection** screen will arrive once more, and it is possible to select and enter the next impeller. In our case impeller A310 is entered as the impeller 2 (Figure 7).

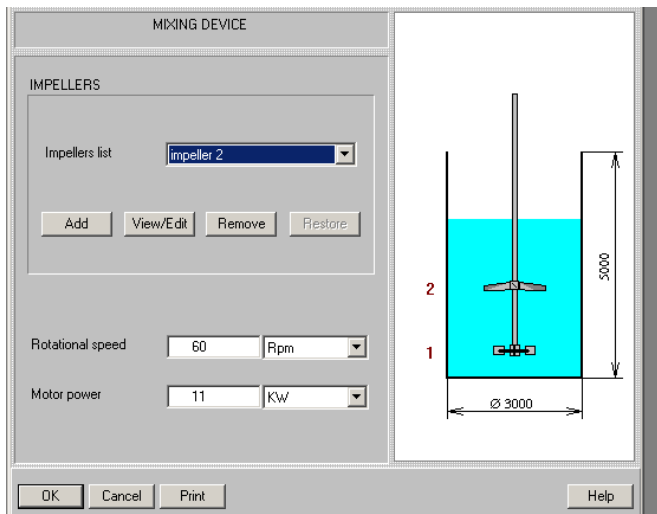


Figure 7. Mixing device after entering impellers 1 and 2.

After the scheme is confirmed, the average properties of media are entered, and it is possible to start the calculations. A scheme of the tank is shown in the Figure 8.

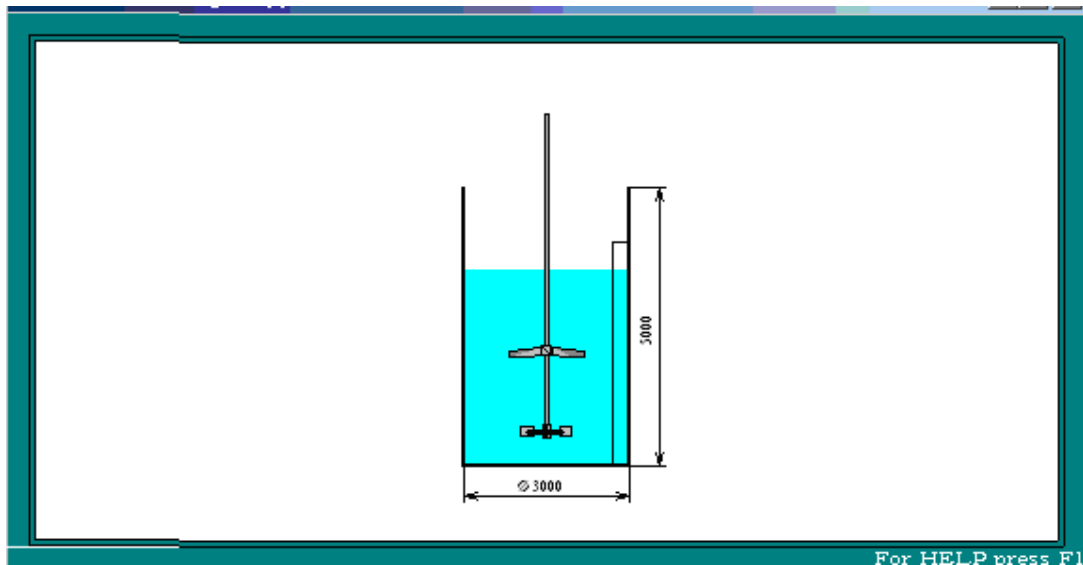


Figure 8. Diagram of the tank with two different impellers.

2. Calculation of Hydrodynamics.

First, let us calculate the main hydrodynamic parameters. Select **Calculate** in the main menu and click on **Hydrodynamics**, then on **Hydrodynamics. Main characteristics** (Figure 9).

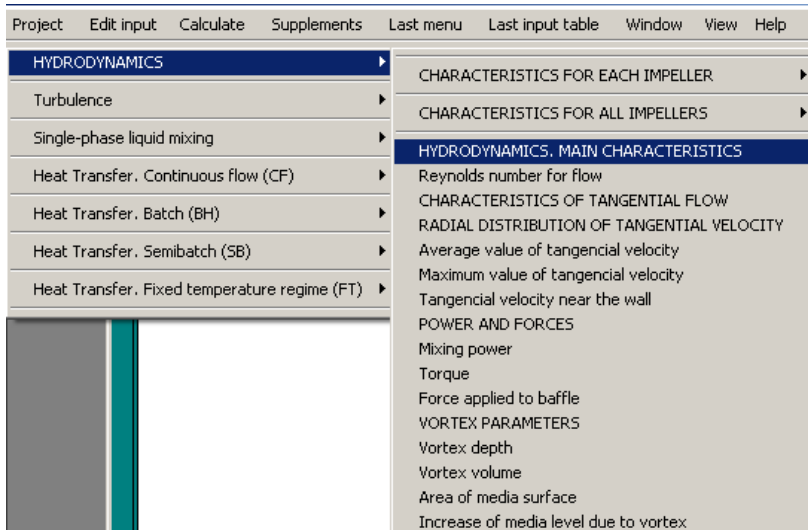


Figure 9. Menu HYDRODYNAMICS.

VisiMix will start simulation, and in a short time the corresponding output table appears (Figure 10).

Parameter name	Units	Value
Mixing power	W	6650
Reynolds number for flow		6.17e+05
Average value of tangential velocity	m/s	0.319
Vortex depth	m	0.0362

Figure 10. Main hydrodynamic characteristics.

The program allows also to get complete data for each of the impellers. Click **Last menu > Characteristics for each impeller** and select **Impeller 1** (Figure 11).

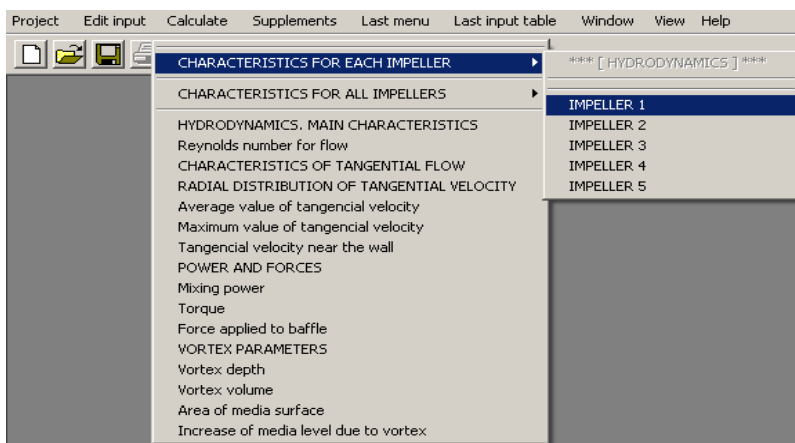


Figure 11. Menu of impellers.

A table arrives containing the main initial data and calculated results for the selected impeller (Figure 12).

HYDRODYNAMICS. CHARACTERISTICS FOR EACH IMPELLER : IMPELLER 1		
Parameter name	Units	Value
Tip diameter	m	1
Pitch angle of blades	rad	1.57
Tip velocity	m/s	3.14
Impeller Re number		1e+06
Mixing power	W	5190
Power number		5.19
Torque	N*m	825
Force applied to impeller blade	N	338
Circulation flow rate	cub.m/s	2.13

For HELP pres

Figure 12. Hydrodynamics. Data for the Impeller 1.

Comparison of the data, for example – power, of different impellers, is performed using options of the sub-menu **Characteristics for all impellers** (Figure 13).

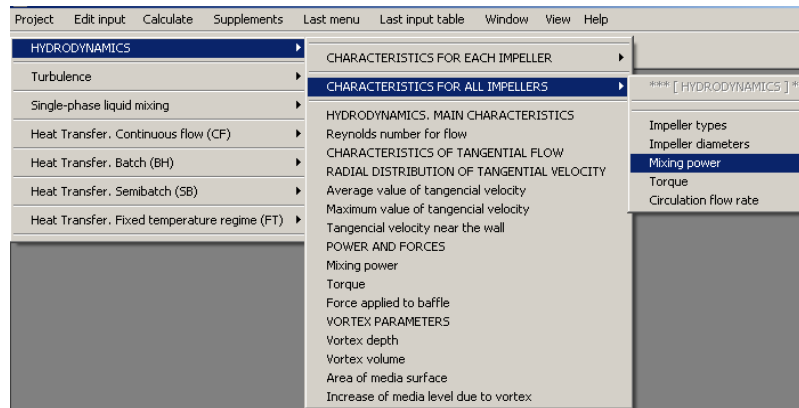


Figure 13. Menu of characteristics for all impellers.

A table with the corresponding results arrives on the screen (Figure 14).

MIXING POWER		
Parameter name	Units	Value
Impeller 1	W	5190
Impeller 2	W	1470

For HELP press F1

Figure 14. Data for all impellers. Mixing power.

3. Calculation of Turbulence.

Select **Turbulence** in the **Calculate** option, and click on **Turbulence. Main characteristics** (Figure 15).

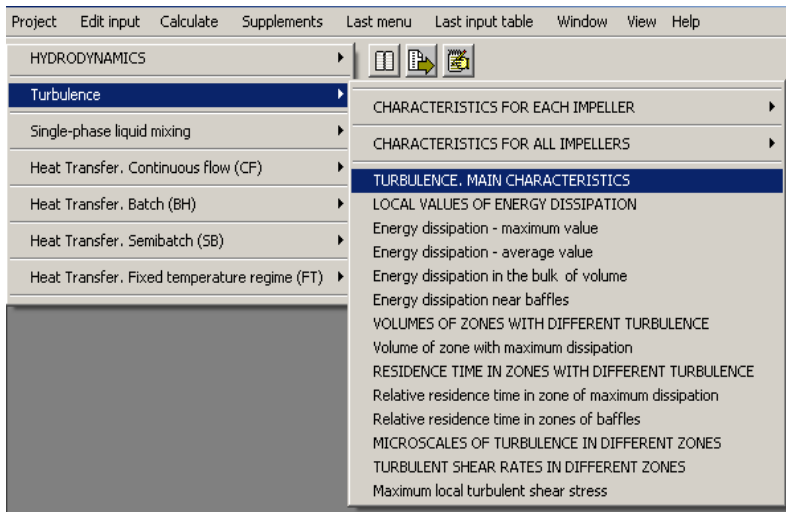
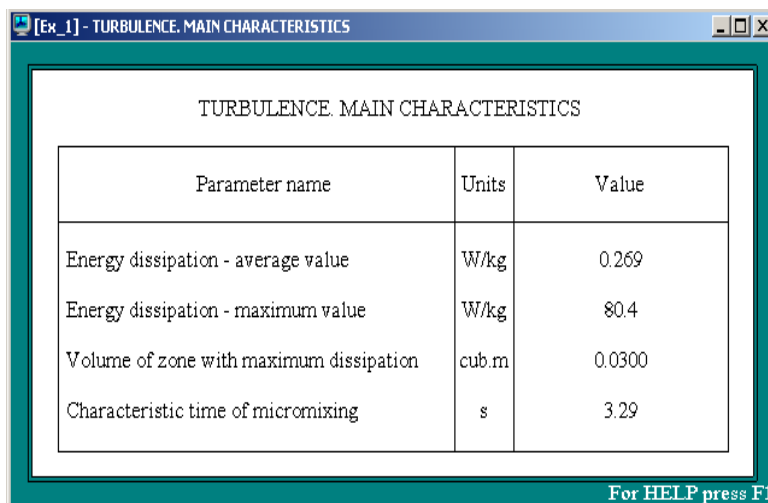


Figure 15. Menu Turbulence.

The output table shown in Figure 16 will appear.

The image shows a window titled 'Ex_1] - TURBULENCE. MAIN CHARACTERISTICS' containing a table with the following data:

Parameter name	Units	Value
Energy dissipation - average value	W/kg	0.269
Energy dissipation - maximum value	W/kg	80.4
Volume of zone with maximum dissipation	cub.m	0.0300
Characteristic time of micromixing	s	3.29

For HELP press F1

Figure 16. Main characteristics of turbulence.

The same as with the Hydrodynamics, the Turbulence menu provides characteristics of turbulence created with each impeller and tables of the main parameters for all impellers (Figure 17).

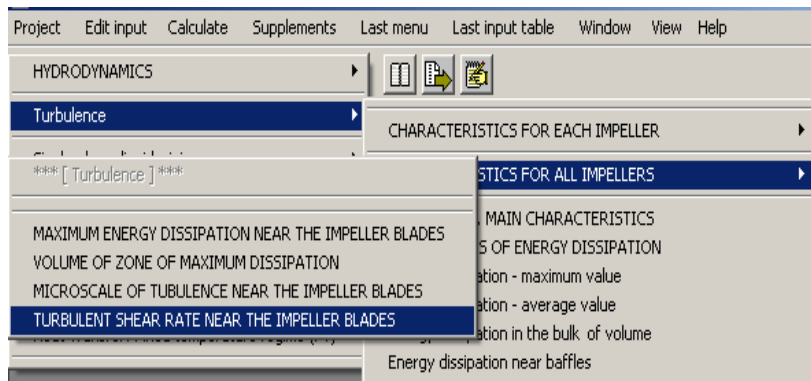


Figure 17. Menu of characteristics for all impellers.

Local characteristics of turbulence created by the impeller 1 are obtained as a table shown in the Figure 18.

The screenshot shows a window titled 'General data' containing a table of turbulence characteristics for Impeller 1. The table has three columns: 'Parameter name', 'Units', and 'Value'. The data is as follows:

Parameter name	Units	Value
Maximum energy dissipation near the impeller blades	W/kg	80.4
Volume of zone of maximum dissipation	cub.m	0.0300
Microscale of turbulence near the impeller blades	m	1.06e-05

Figure 18. Characteristics of turbulence around impeller 1.

The results obtained using the menu option **Maximum shear rates near the impellers blades**, accordingly to submenu in Figure 17, are shown in the Figure 19.

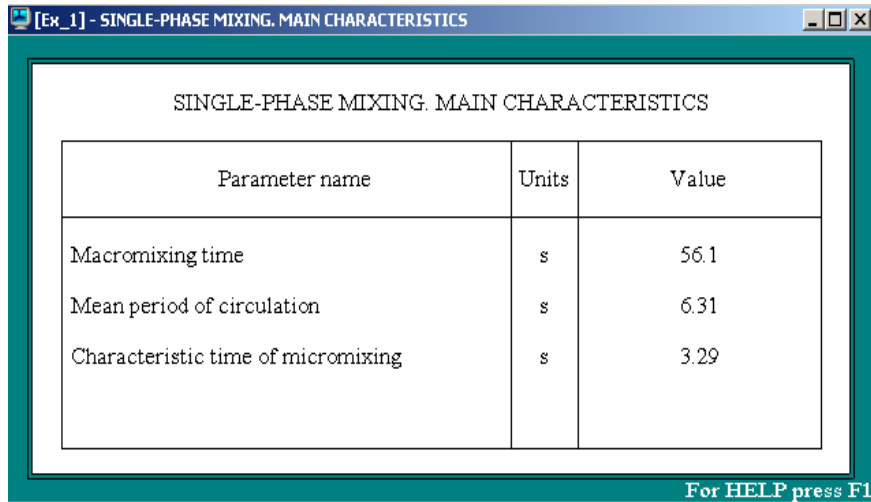
The screenshot shows a window titled 'TURBULENT SHEAR RATE NEAR THE IMPELLER BLADES' containing a table of shear rates for Impeller 1 and Impeller 2. The table has three columns: 'Parameter name', 'Units', and 'Value'. The data is as follows:

Parameter name	Units	Value
Impeller 1	1/s	8970
Impeller 2	1/s	5850

Figure 19. Maximum shear rates created by impellers.

4. Calculation of Mixing time.

Estimation of macro-mixing and micro-mixing time is based on mathematical simulation of **Single-phase liquid mixing** in the **Calculate** menu. The calculated results for the project Ex_1.vsd are presented in the Figure 20.



Parameter name	Units	Value
Macromixing time	s	56.1
Mean period of circulation	s	6.31
Characteristic time of micromixing	s	3.29

Figure 20. Results of simulation of single-phase mixing.