

VisiMix TURBULENT. TANK WITH DISK TURBINE IMPELLER. POWER. SHEAR. MIXING TIME.

This example shows how to calculate main hydrodynamic parameters - flow velocities, vortex formation, local values of turbulent dissipation, mixing power, torque, vortex depth, axial circulation, general flow pattern and other parameters for fully baffled tanks. You will obtain some general data on your mixing equipment, which will enable you to evaluate the general suitability of your equipment, compare different designs, etc. These parameters are used as basic data for calculations of other mixing problems.

They include:

1. Hydrodynamics characteristics;
2. Turbulence characteristics;
3. Single-phase liquid mixing characteristics.

This example shows how to calculate these main characteristics for a flat-bottom baffled tank with disc turbine impeller.

Problem description:

You have a flat-bottom baffled tank with a disc turbine impeller. Its parameters and the properties of the media are given below.

Initial data

Tank with a flat bottom:

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

Baffle (flat, attached to the tank wall)

Number = 4;
Width = 300 mm;
Length = 3000 mm;
Distance from bottom = 0 mm;
Angle to radius = 0 deg.

Impeller: disc turbine type

Tip diameter = 1000 mm;
Diameter of disc = 750mm;
Number of blades = 6;
Pitch angle = 90deg;
Width of blade = 200 mm;
Length of blade = 250 mm;
Distance from bottom = 600 mm;
RPM = 60;

Power of drive = 10000 W;
Pumping direction: down

Media properties

The media is a Newtonian liquid with the following average properties:
density = 1100 kg/cub. m;
dynamic viscosity = 0.0045 Pa*s.

The task is to calculate general characteristics - hydrodynamics, turbulence and single-phase-liquid mixing.

The Solution:

The general sequence of operations is as follows: you must start a new project file for your case, select your equipment from the VisiMix graphical menus, enter the initial data requested by the program, and then select the parameter you want to calculate from the **Calculate** menu. After you have selected a parameter, the program may request additional data if required, and when all the requested data has been entered, you will obtain the result, usually presented as a table or a graph.

In your case, the required parameters for calculations are listed in the submenus corresponding to the following three items of the **Calculate** option: **Hydrodynamics**, **Turbulence** and **Single-phase liquid mixing**.

You will now follow the whole procedure step by step, create a new project, enter initial data and finally obtain the desired result.

After installing **VisiMix**, the main menu appears on the screen (Figure 1-1). Select **Project-New**.

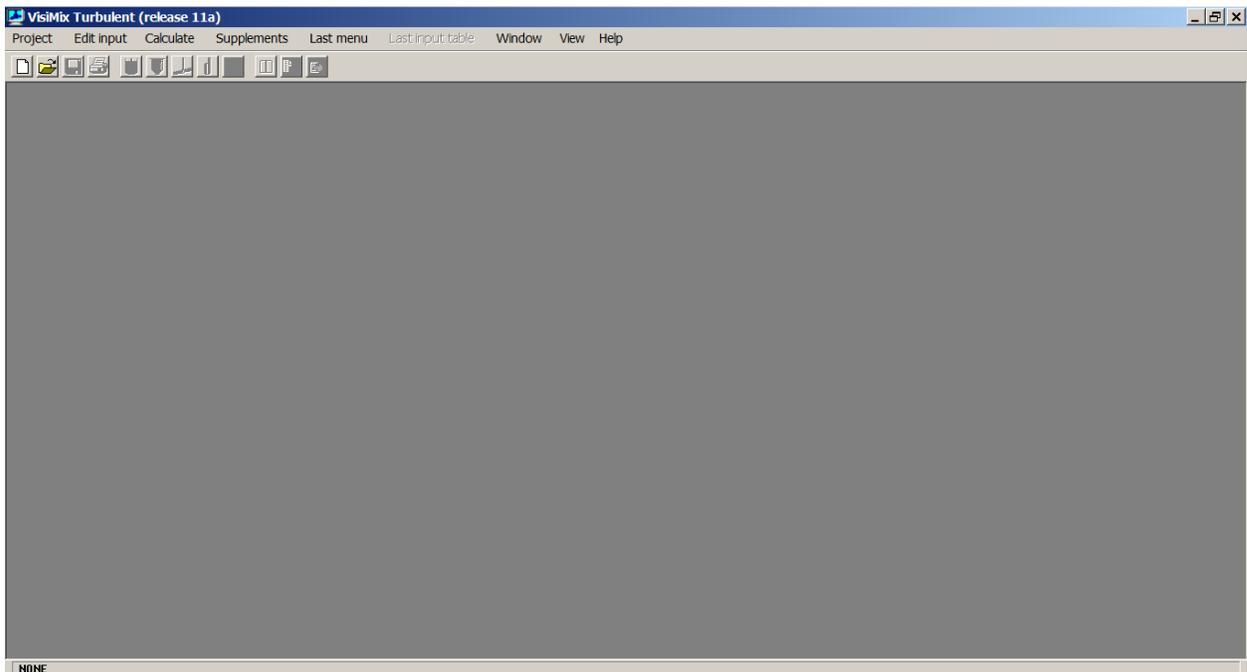


Figure 1-1. VisiMix main menu.

A dialogue shown in Figure 1-2 will appear. Enter a name for the project, for example, **hydrod.vsm**. You may create a special directory for your VisiMix projects, or choose an existing directory. In this case, the directory name is **tutorial**.

After you click **Save**, the **Tank types** menu with tanks differing by **bottom type** (flat, conic and elliptical) and **type of heat transfer device** (unjacketed tanks, and tanks with conventional, half-pipe coil or dimpled/embossed jacket) appears. To choose the required tank type, click on the appropriate tank diagram. The tank you have selected (a flat-bottomed tank without heat transfer device) will appear in the **Current choice** window on the right (Figure 1-3). Click **OK** to confirm your choice.

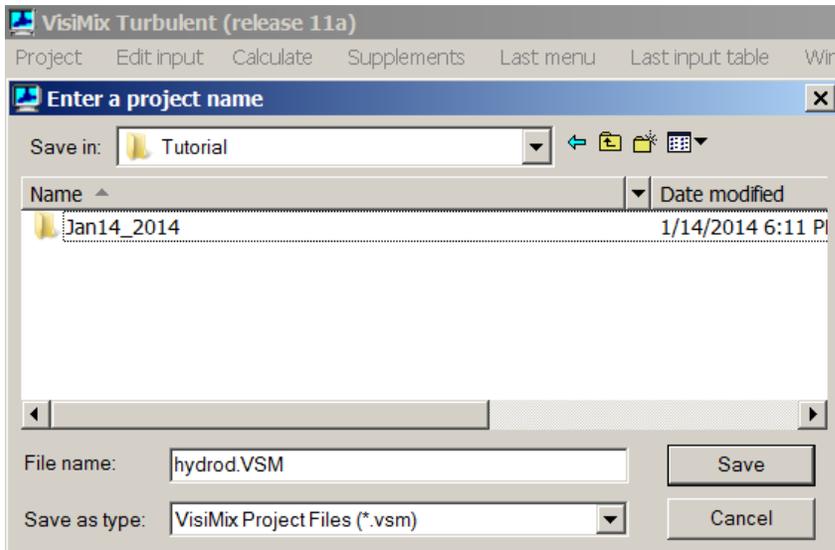


Figure 1-2. Starting a new project.

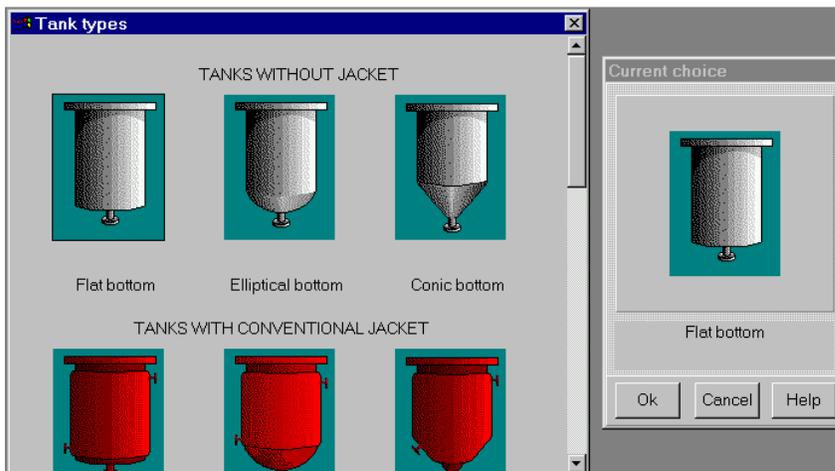


Figure 1-3. VisiMix tanks selection.

The next step is to enter the initial data for your project. You do not need to choose the initial data that must be entered. The program will request all the information it needs by invoking the appropriate input tables. At this stage, you will be asked to enter all the required tank parameters. After you confirm your tank choice, TANK WITH FLAT BOTTOM input table with the selected tank diagram appears. Supply the internal dimensions of the selected flat-bottomed tank. Enter **Inside diameter**, **Total tank height**, and **Level of media**. The **Total volume** and **Volume of media** will be

calculated by the program and entered automatically. After the table has been completed (Figure 1-4), click anywhere on the field of the window, and the tank diagram on the screen will change to reflect your input. Click **OK** to confirm the input.

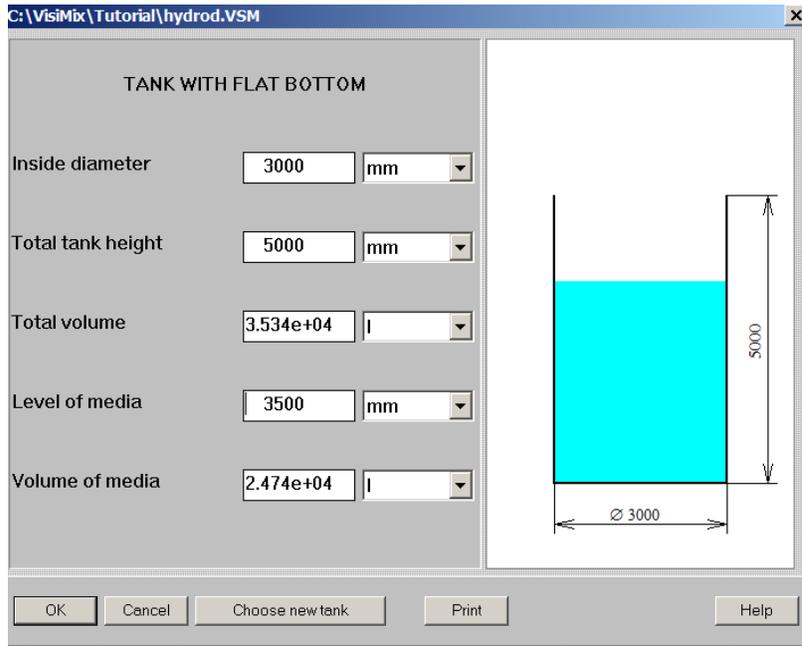


Figure 1- 4. Entering tank data.

After you click **OK**, the **Baffle types** graphical menu with several options (no baffle, two types of flat baffles and two types of tubular baffles) appears (Figure 1-5). To choose the required variant, click on the appropriate baffle diagram. The one you have selected (flat baffle–1 in your case) will appear in the **Current choice** window on the right. Click **OK** to confirm your choice.

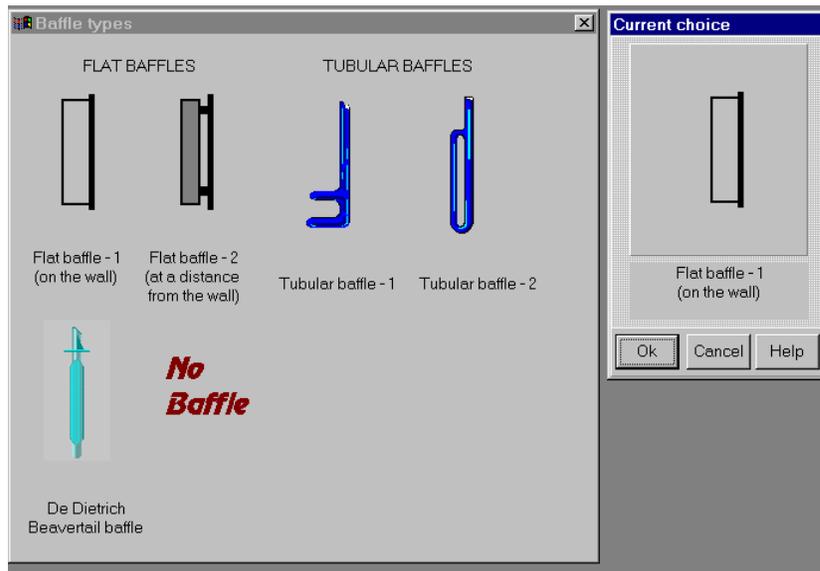


Figure 1-5. VisiMix reactor baffle selection.

Now enter the baffle data in the table FLAT BAFFLE - 1 that appears (Figure 1-6).

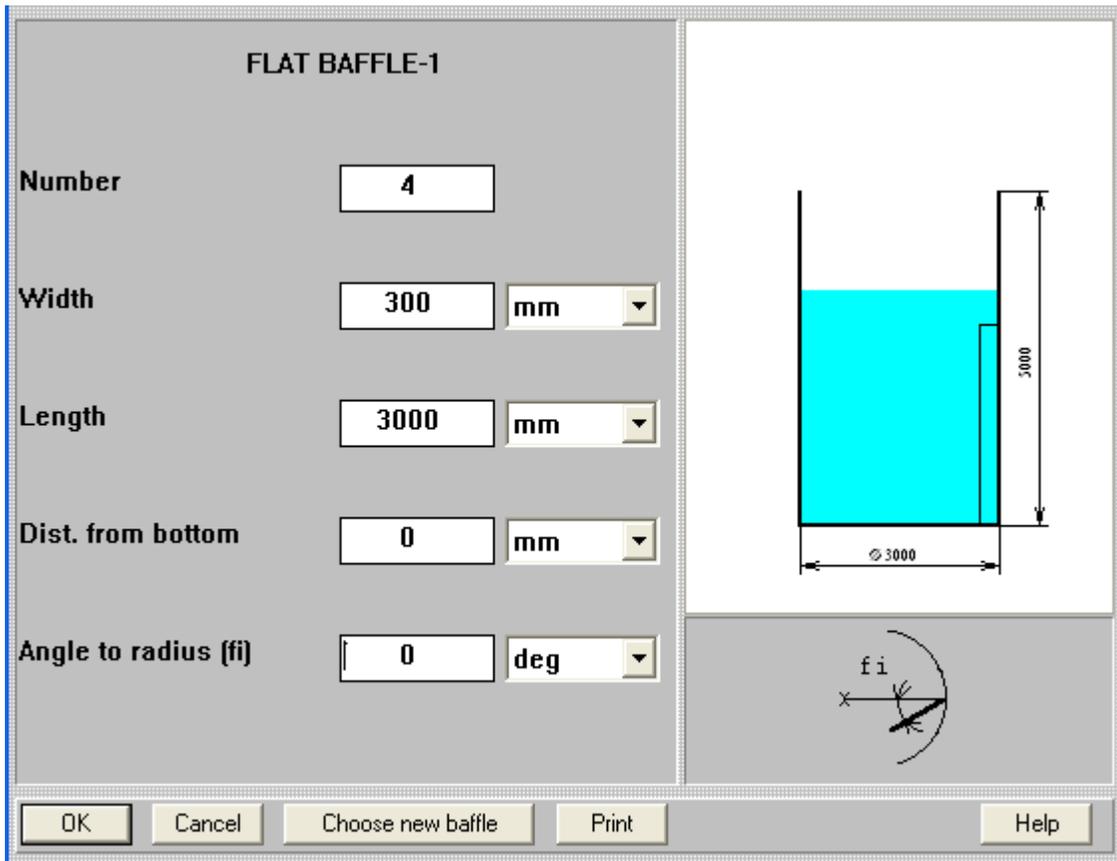


Figure 1- 6. Entering data for Flat baffle - 1.

After you click **OK**, **Impeller types** menu appears (Figure 1-7). To choose the desired impeller type, click on the appropriate diagram. The agitator you have selected (disc turbine) will appear in the **Current choice** window on the right. In this window, you can also select **single**, or **multistage** mixing system by clicking on the appropriate icon. Your case corresponds to a single impeller. Click **OK** to confirm your choice.

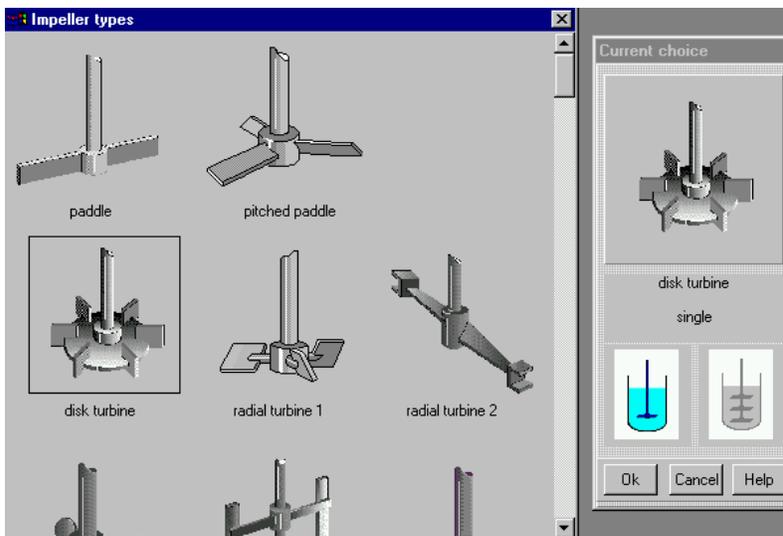


Figure 1-7. VisiMix impeller selection.

Now you will be asked to enter the data of the selected disk turbine impeller in the DISK TURBINE input table (Figure 1-8). After completing this table, click anywhere on the field of the window, and the impeller diagram on the screen will change to reflect your input. Click **OK** to confirm your input.

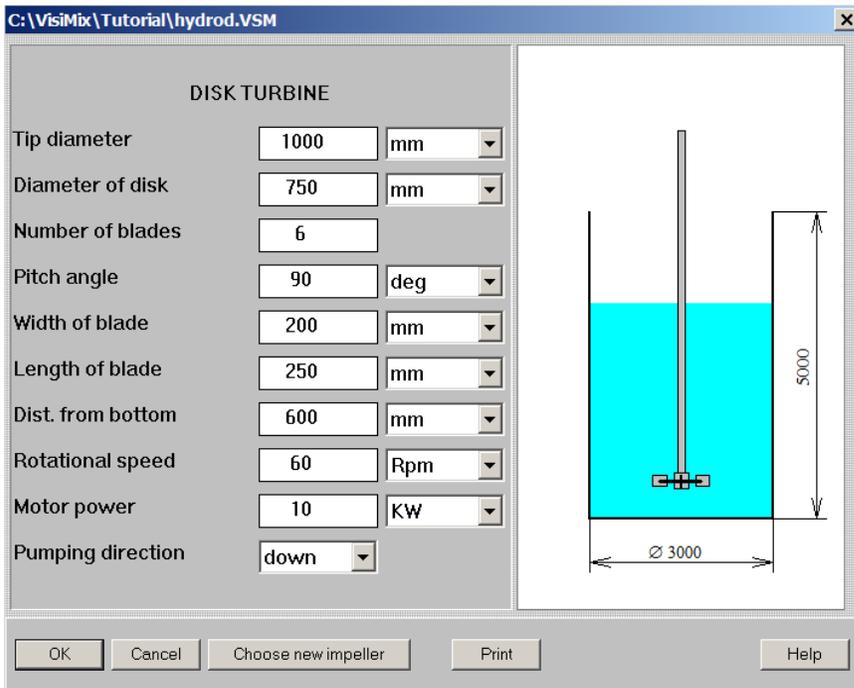


Figure 1-8. Entering data for disk turbine impeller.

After this table has been completed, you will be asked to fill two input tables with average properties of media: at first DENSITY AND TYPE OF MEDIA (Figure 1-9a) and after you entered the media density 1100 kg/m^3 , selected Newtonian type of media and clicked **OK** to confirm your input another input table (Figure 1-9b).

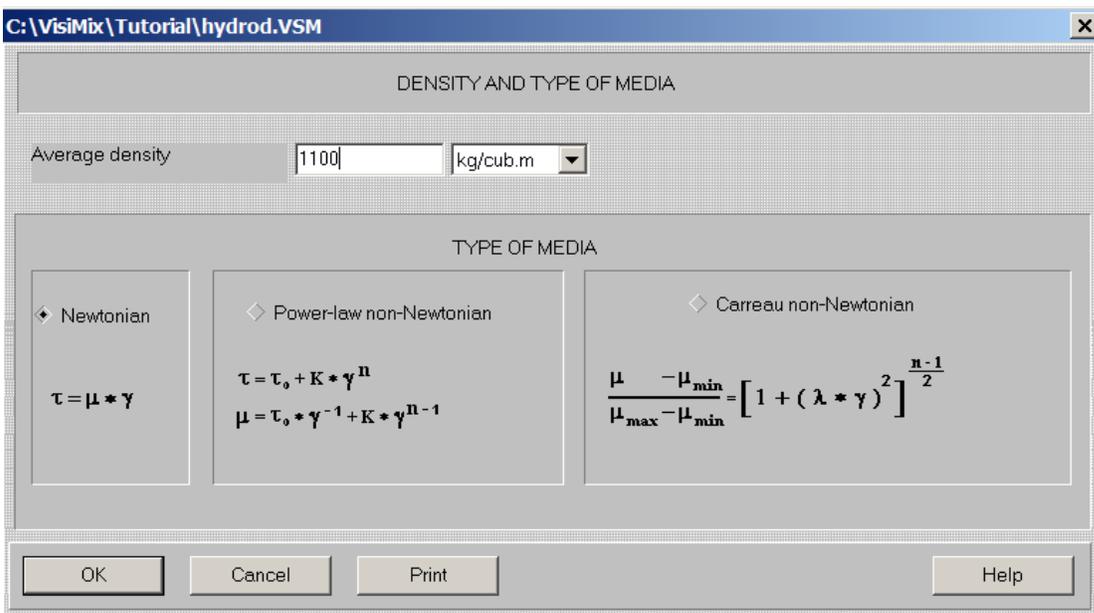


Figure 1-9a. Entering density and type of media

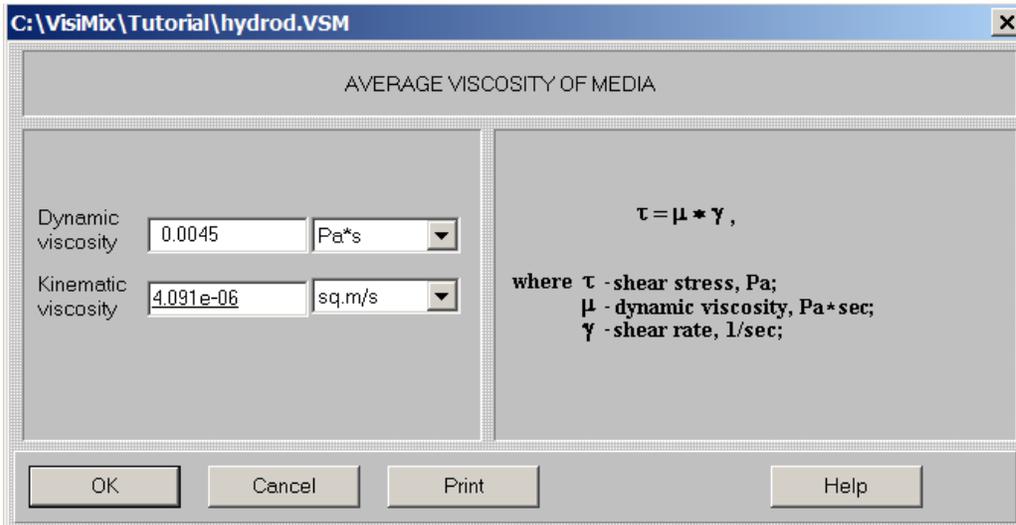


Figure 1-9b. Entering viscosity of media

After you enter the properties of the media and click **OK**, a diagram of your tank appears, corresponding to the data you have entered (Figure 1-10).

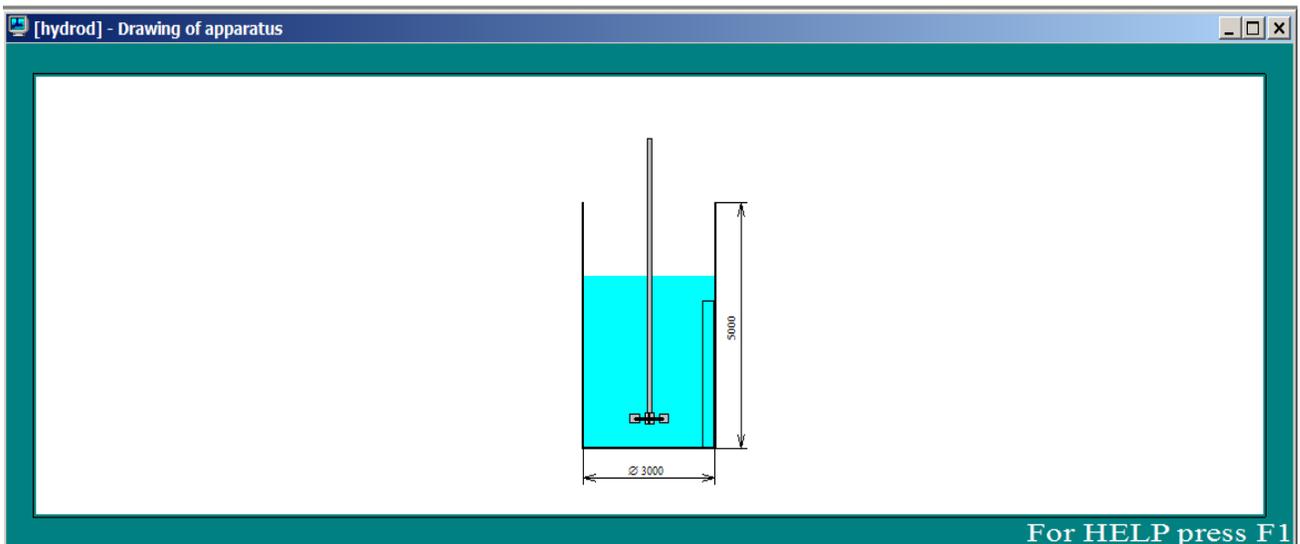


Figure 1-10. Diagram of the mixing system.

We recommend closing this window before proceeding to calculations.

The appearance of this diagram means that you have entered all the basic data for your equipment and media properties.

You can now proceed to calculations. First, let us calculate the main hydrodynamic parameters. Select **Calculate** in the main menu and click on **Hydrodynamics**, then on **Hydrodynamics. Main characteristics**. VisiMix will start calculations, and in a short time the corresponding output table appears (Figure 1-11). To see all the calculated parameters, use scrolling.

Now let us calculate the characteristics of Turbulence. Select **Turbulence** in the **Calculate** option, and click on **Turbulence. Main characteristics**. The output table shown in Figure 1-12 will appear.

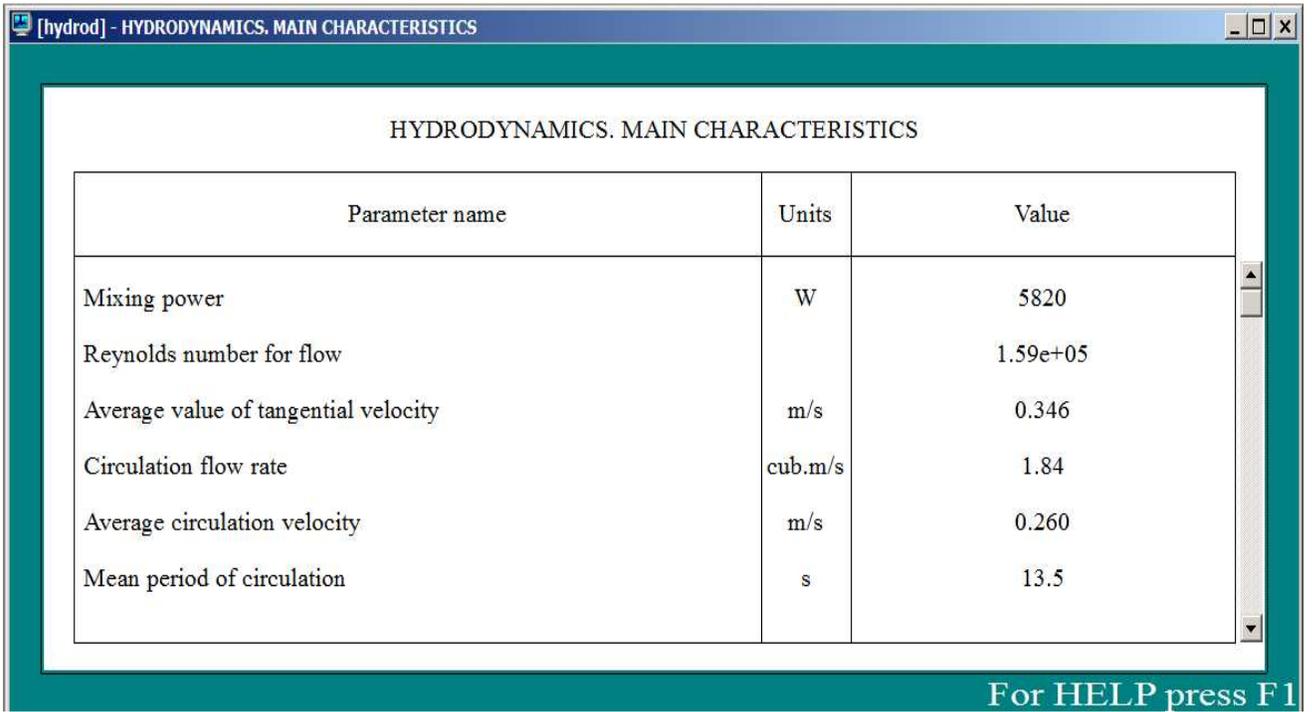


Figure 1-11. Hydrodynamics. Main characteristics.

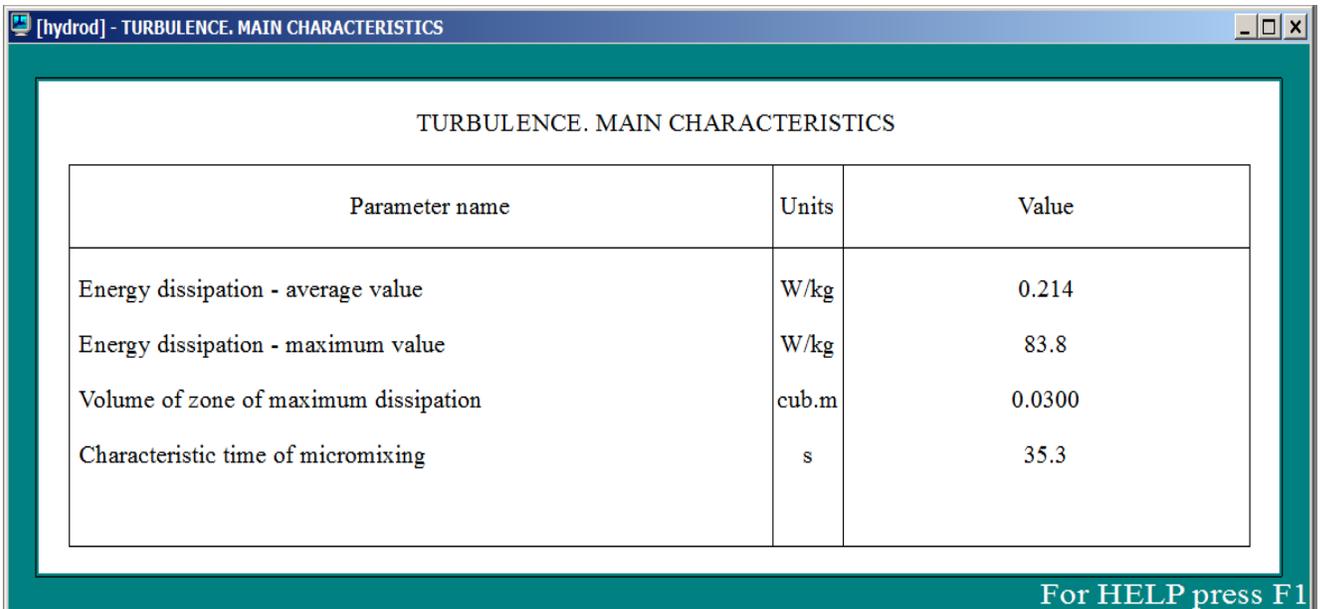


Figure 1-12. Turbulence. Main characteristics.

Now let us check some other parameters in the **Turbulence** menu. Click on **Last menu** in the main VisiMix menu and select a parameter of interest to you, for instance **Dissipation of energy around the impeller**. The result will be presented as a graph. Click on **Start** to start the simulation (Figure 1-13).

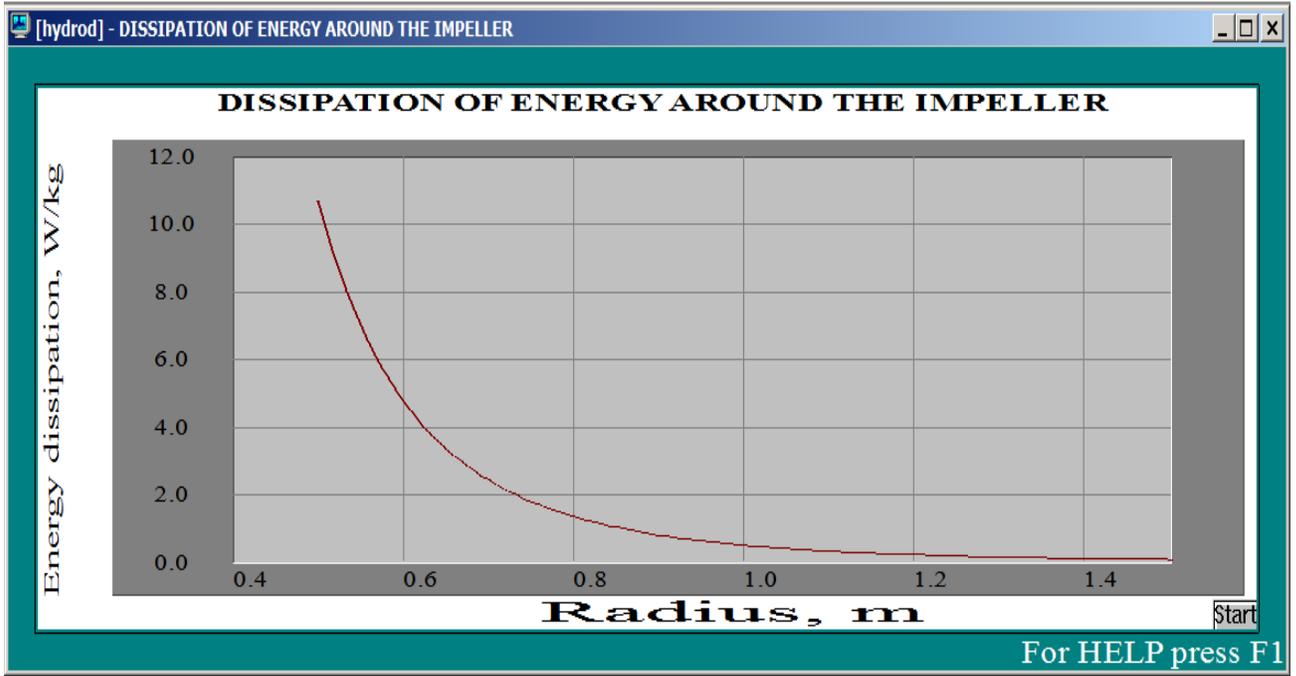


Figure 1-13. Dissipation of energy around the impeller.

Click on **Last menu** again to obtain more parameters, for example, **turbulent shear rates** (Figure 1-14), and **turbulent shear stress** (Figure 1-15).

Parameter name	Units	Value
Microscale of turbulence near the impeller blade	m	3.01e-05
Microscale of turbulence near the baffle	m	0.000171
Microscale of turbulence in the bulk volume	m	0.000188

Figure 1-14. Turbulent shear rates in different zones.

TURBULENT SHEAR STRESS NEAR THE IMPELLER BLADE

Parameter name	Units	Value
Turbulent shear stress near the impeller blade	N/sq.m	20.5

For HELP press F1

Figure 1-15. Turbulent shear stress near the impeller blade.

Now let us check **Single-phase liquid mixing** characteristics. Select **Single phase liquid mixing** in the **Calculate** option and click on **Single phase mixing. Main characteristics**. The corresponding output table shown in Figure 1-16 will appear.

SINGLE-PHASE MIXING. MAIN CHARACTERISTICS

Parameter name	Units	Value
Macromixing time	s	65.7
Mean period of circulation	s	13.5
Characteristic time of micromixing	s	35.3

For HELP press F1

Figure 1-16. Single phase mixing. Main characteristics.

These general characteristics will enable you to evaluate the general suitability of your equipment with respect to power consumption, mixing time, etc. They are used by the program as basic data for calculation of other unit operations, as shown in other examples in this tutorial.