VisiMix Turbulent. Mathematical Modeling of Heat Transfer . Initial Data and Calculation.

1. Subject of calculations and initial data.

This example demonstrates the **INPUT SYSTEM** of VisiMix programs. It shows the data necessary for simulation of Heat Transfer and the method of entering them in VisiMix.

Subject of calculations – mixing in a reactor with a 2-stage pitch paddle.Volume of media – 4000 liters, density - 1050 kg/cub.m., viscosity 2 cP. Drawing of the reactor is shown in the Figure 1.

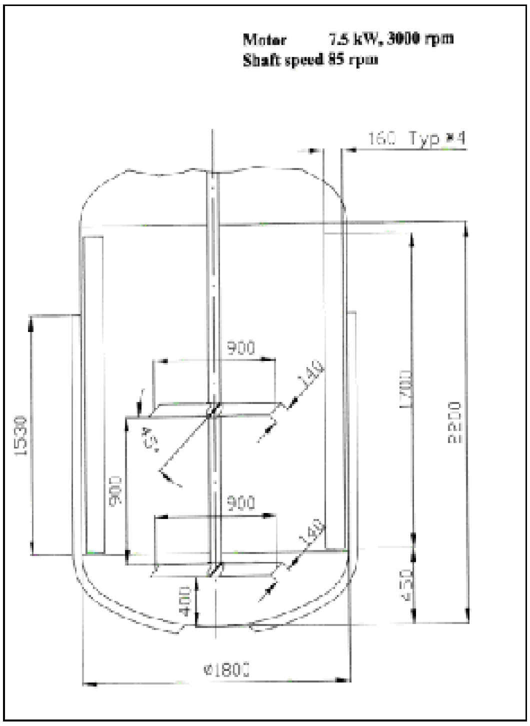

Figure 1. Drawing of the reactor.

Additional technical information.

Tank material – stainless steel.
Wall thickness – 6 mm.
Inside diameter of jacket – 1860 mm
Heat transfer area – 11.5 sq.m.
Media: water solution.
Volume of media – 4000 liter.
Density of media – 1050kg/cub.m.
Viscosity of media – about 2 cP.

2. Opening a Project.

Application of VisiMix program starts with Opening of a Project for this reactor. Start VisiMix program. The main menu appears on the screen (Figure 2).

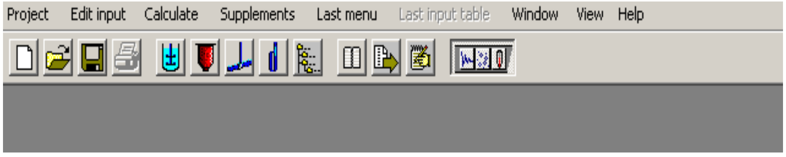

Figure 2. The main Menu bar.

Select **Project** in the Menu bar**.** Figure 3 appears.

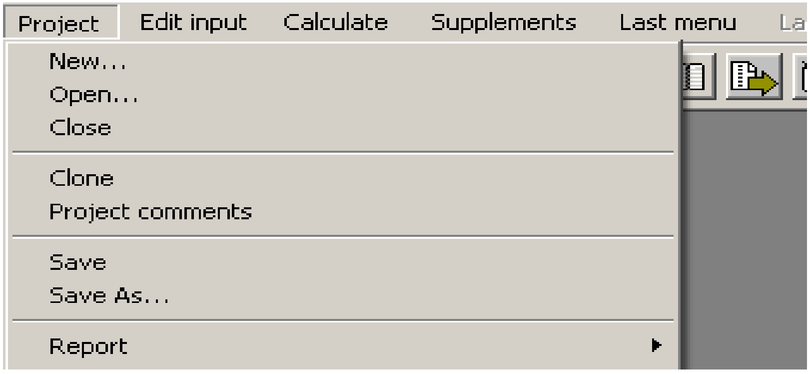

Figure 3. The **Project** *sub-Menu.*

Select **New** in this sub-Menu. A dialogue shown in Figure 4 will appear.

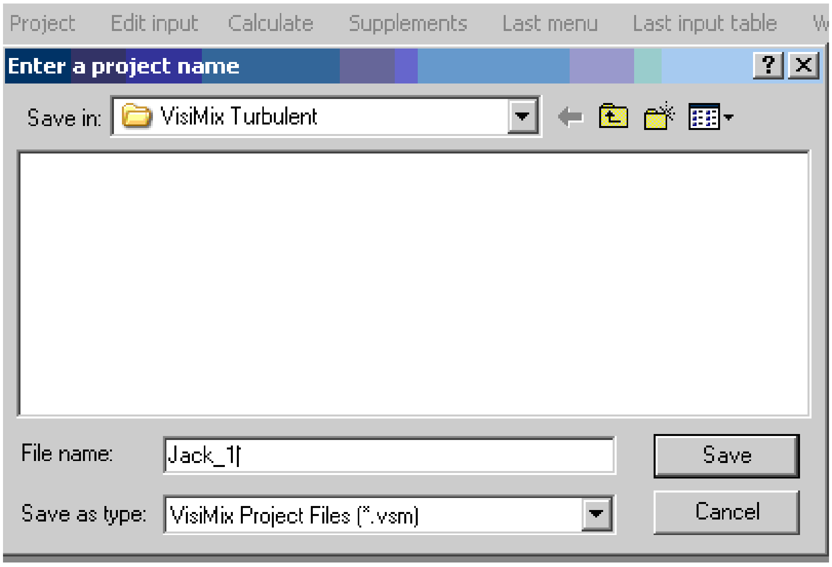

Figure 4. Dialogue box for opening of a new Project.

Print a name for the project in the **File name** window , for example, **Jack_1,** and confirm this name using the **Save** button.

3. <u>Entering dimensions of the tank.</u>

After you click **Save**, the program provides a **Tank selection** screen (Figure 5). We can select a tank with the type of bottom and heat transfer device corresponding to our initial data. Accordingly to the drawing (Figure 1), in the current case a Tank with Conventional Jacket and

Elliptic bottom has to be selected. Click the corresponding picture, and it will be repeated in the **Current choice** window of the same screen.

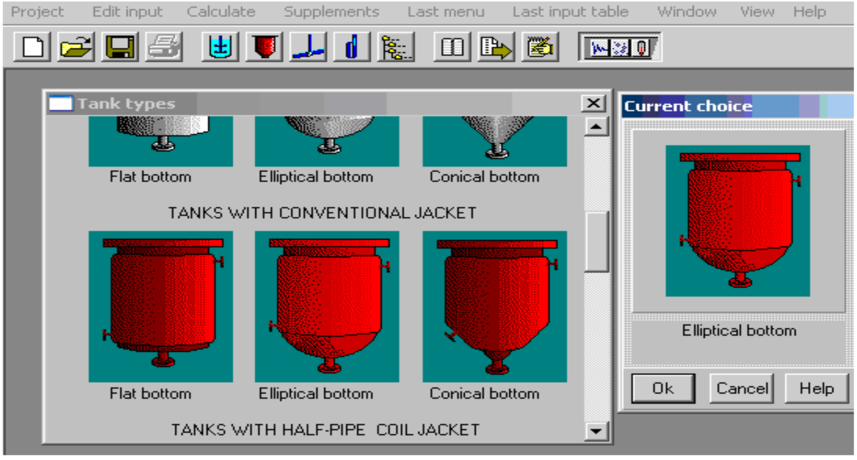

Figure 5. Selecting the tank type.

Confirm your tank choice by selecting **OK** button, and the program will open the Input window corresponding to the selected tank type (Figure 6).
Print the internal dimensions of the selected tank accordingly to the drawing above (Figure 1) - **Inside diameter** and **Total tank height.** Print also **Volume of media** (4000 l) in the corresponding window**.** The **Total volume** and **Level of media** will be calculated by the program and entered automatically. After the table has been completed, 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.

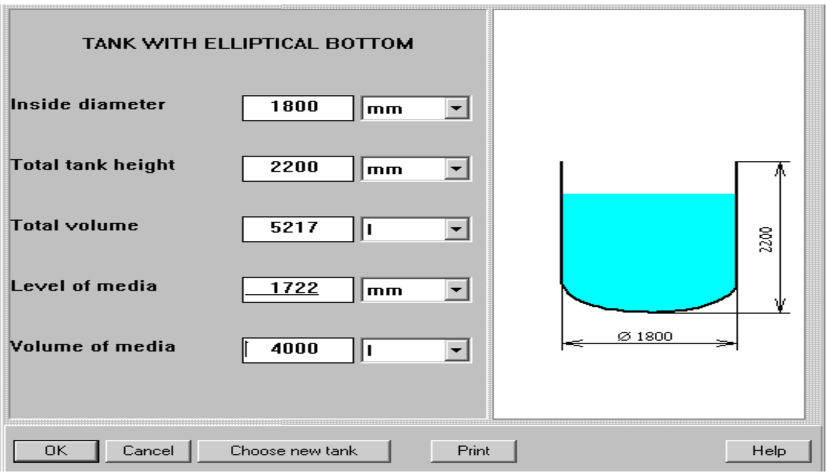

Figure 6. Entering the Tank dimensions.

4. <u>Entering baffles.</u>

After you click **OK**, the **Baffle types** graphical menu appears (Figure 7). To choose the required variant, click on the appropriate baffle diagram. Accordingly to the drawing, it corresponds to **Flat baffle-2**. The selected type appears in the **Current choice** window on the right. Click **OK** to confirm your choice and enter sizes of the baffles in the next input table (Figure 8).

*NOTE: Typical sizes of baffles are described in the Help section. Click **Help** button in the **Current choice** window, and the program will open the corresponding paragraph.*

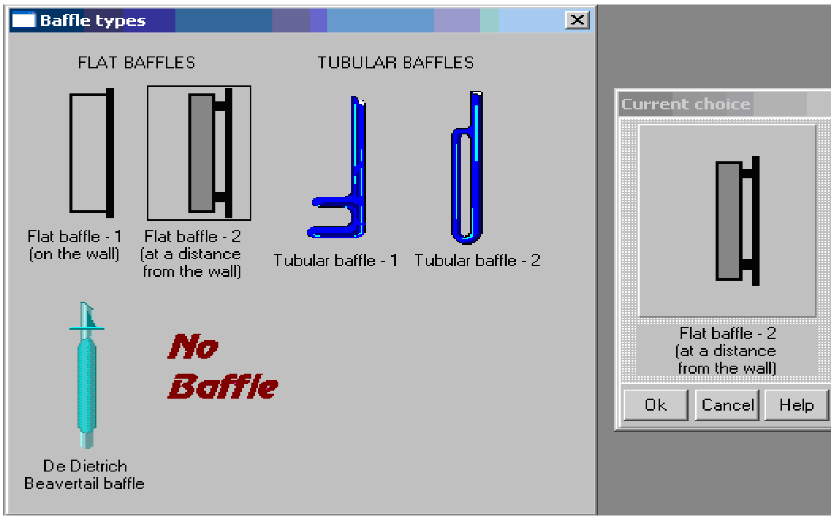

Figure 7. Defining the baffle type.

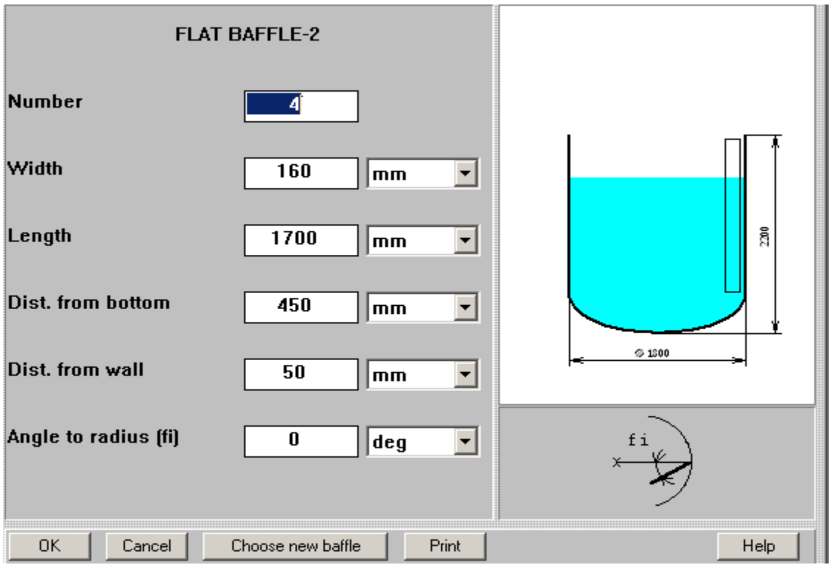

Figure 8. Entering sizes of the baffles.

5. <u>Entering mixing device.</u>

After you click **OK, Impeller types** menu appears (Figure 9). To choose the desired impeller type, click on the appropriate picture. The agitator you have selected (pitch paddle) appears 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. Our case corresponds to the **multistage** impeller. Click **OK** to confirm the choice.

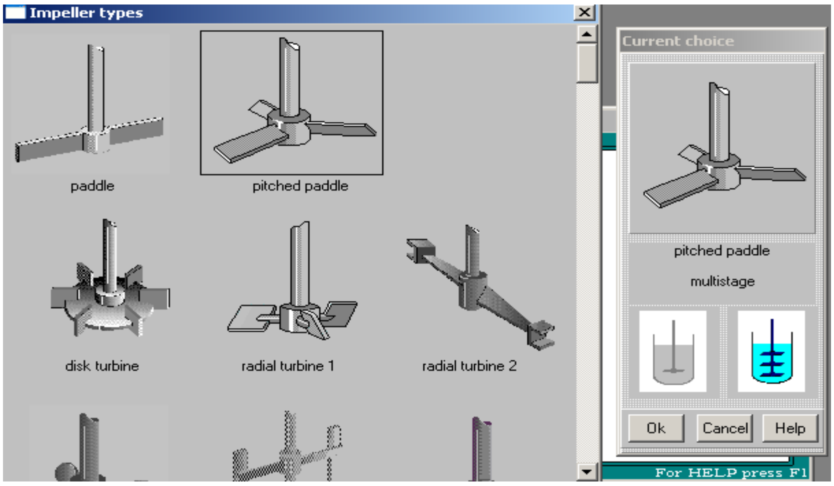

Figure 9. Defining the impeller type.

The next step - entering the data of the selected PITCHED PADDLE in the input table that arrives automatically (Figure 10).

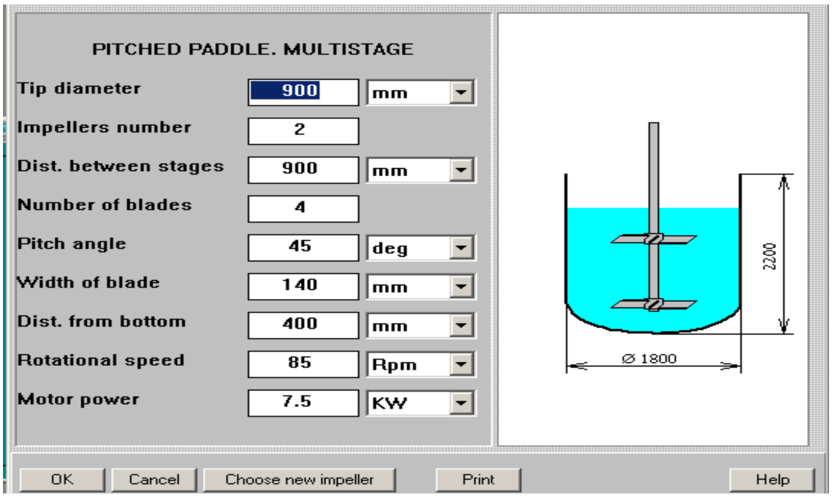

Figure 10. Entering data on the mixing device.

*NOTE. To find standard or the most typical relations of selected impeller, use **Help** button in the lower part of this table.*

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.

6. <u>Entering general data on heat transfer device.</u>

The next input table presented by the program – description of heat transfer device (Figure 11).

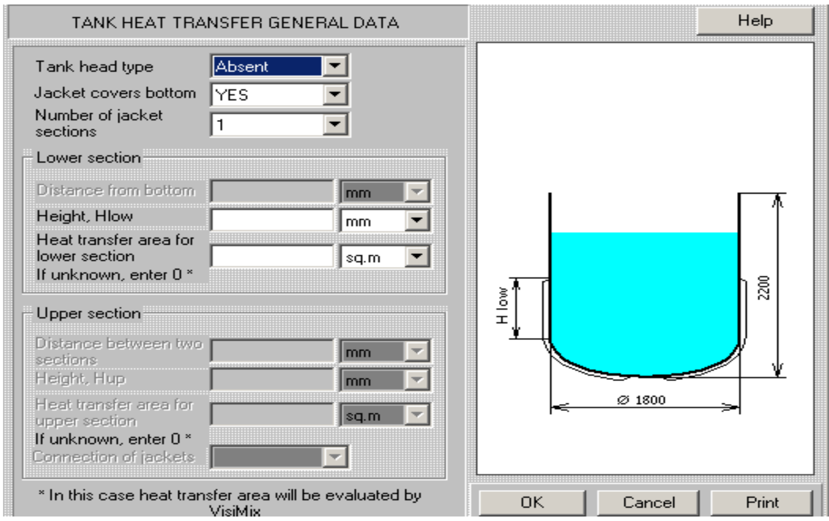

Figure 11. Input table for heat transfer device.

Use scrolling and select the **Elliptical** for **Tank head type,** the **Yes** for **Jacket covers bottom** and the **1** for **Number of jacket sections** accordingly to the reactor drawing. Enter also the **Height** of jacket shown in the drawing and Heat transfer area accordingly to the technical characteristic of the reactor.

*NOTE. The single jacket section is considered as the **lower** one.*
*If the **Heat transfer area** is unknown, enter **0**, and the program will perform the approximate calculation automatically.*

The filled input table is shown in the Figure 12.

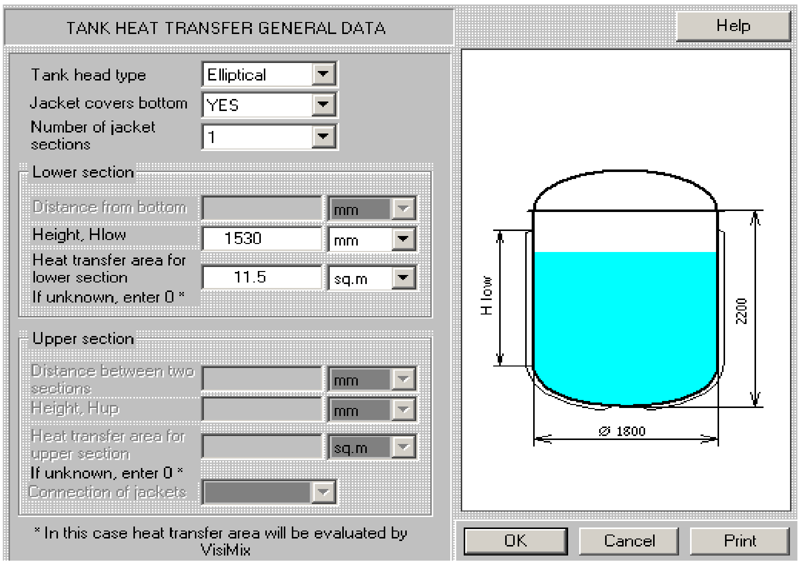

Figure 12. The general data on heat transfer device.

7. <u>Entering average properties of media.</u>

After this table has been completed and confirmed with **OK**, you will be asked to fill AVERAGE PROPERTIES OF MEDIA input table (Figure 13).

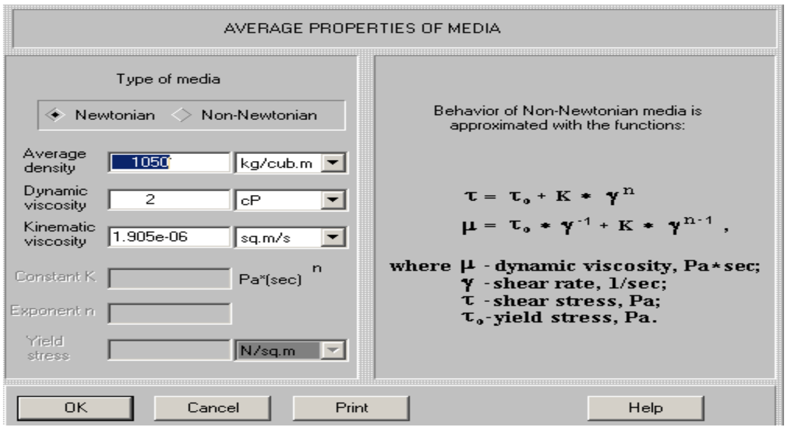

Figure 13. Input table of average properties of media.

Select **Newtonian** as the **Type of media** and enter the **Density** and **Dynamic viscosity** accordingly to the data of the par.1. The program will calculate **Kinematic viscosity** automatically accordingly to your input.

After these inputs are confirmed, a schematic diagram of the tank with mixing device will occur in the screen. (Figure 14). It means that the data are complete enough for mathematical modeling of the basic hydrodynamic characteristics of mixing process. However, when you start calculation of heat transfer in the tank, the program will ask you to enter additional data.

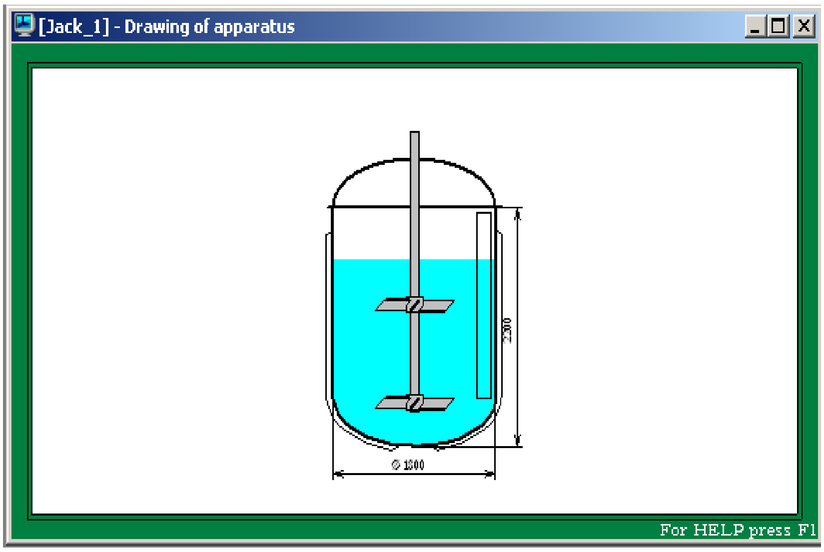

Figure 14. The reactor diagram corresponding to the inputs.

8. <u>Entering data for heat transfer calculations.</u>

This paragraph shows the method of entering specific data for calculation of heat transfer coefficients and heat transfer rate using VisiMix program. After you open the **Calculate** menu and select one of **Heat transfer** options the program automatically provides you with the corresponding input tables.

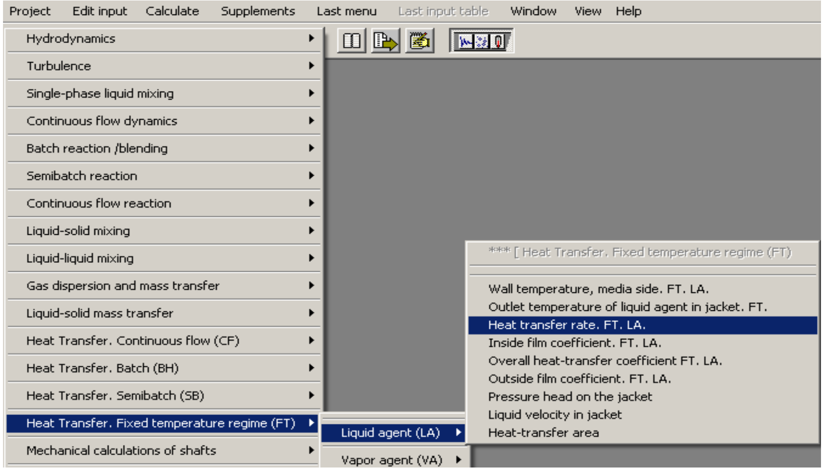

Figure 15. Selecting* Heat transfer *option.

Our example corresponds to the option **Heat transfer Fixed temperature regime**., cooling with a liquid heat transfer agent (Figure 15). After you select a parameter to be calculated – for example, Heat transfer rate from sub-Menu of Liquid agent (Figure 15), the program starts providing tables for some additional initial data. First you will obtain a table for more data on the tank itself (Figure 16). Use the scroll box for selection the tank material. The program will enter the heat conductivity and other properties of the material automatically using a built-in database. The next parameter – thermal resistance of fouling depends on the heat transfer agent. You can select the appropriate value using the table ***Thermal resistance of fouling for various media*** that is present in the Help section. You need only to click the Help button in the lower part of this window (Figure 16).

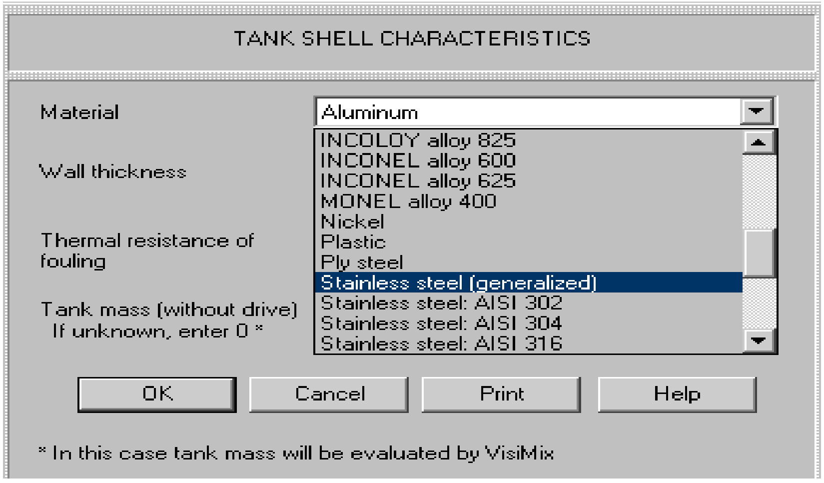

Figure 16. Selection of tank material.

Wall thickness and mass of tank are usually present in the technical data provided by manufacturer. If these data are absent, enter approximate wall thickness. If tank mass is unknown, enter **0** (Figure 17), and the program will perform approximate evaluation.

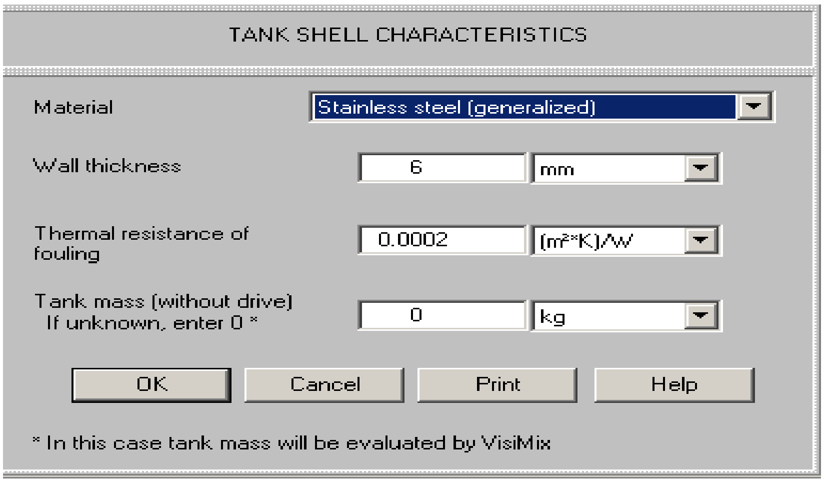

Figure 17. Tank heat transfer characteristics.

The next table provided by the program – specific characteristics of jacket. Accordingly to the drawing, in our case a tank with simple jacket is used, and you have to enter the **Width** and **Wall thickness** of the jacket (Figure 18).

NOTE. The program provides options for more complicated modern designs – jackets with agitation nozzles or spiral channeling. These options are selected by scrolling, the typical characteristics of the heat enhancing devices are presented in the ***Help*** *(see button in the lower part of the window).*

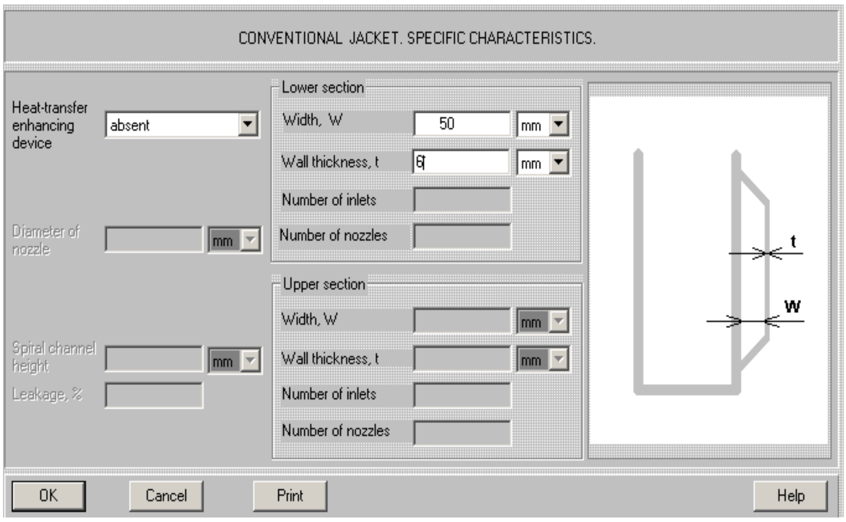

Figure 18. Entering specific data for the jacket.

After all the design data are entered, the program will provide a table for selecting a heating / cooling agent. The selecting is performed after you have entered data on temperature limits for your process (Figure 19) and confirmed it with **OK**.

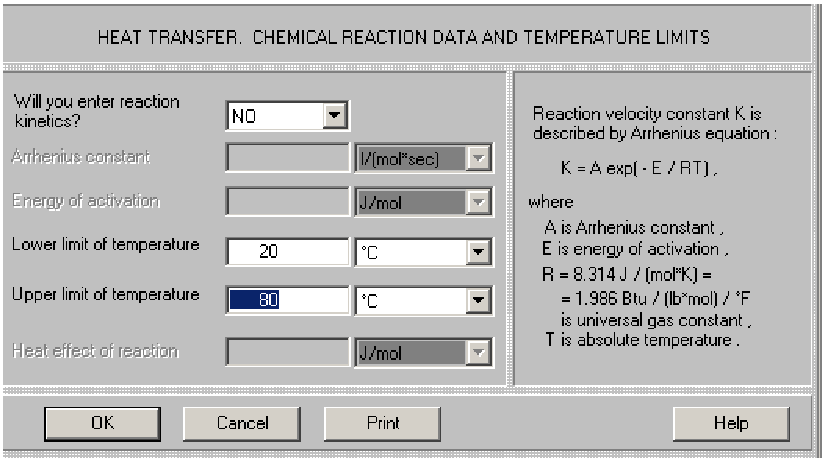

Figure 19. Entering of the temperature limits.

Names of the heating / cooling agents are shown in scrolling box (Figure 18). Temperature limits of application and physical properties of the selected agent occur in the lower part of the input window (Figure 20).

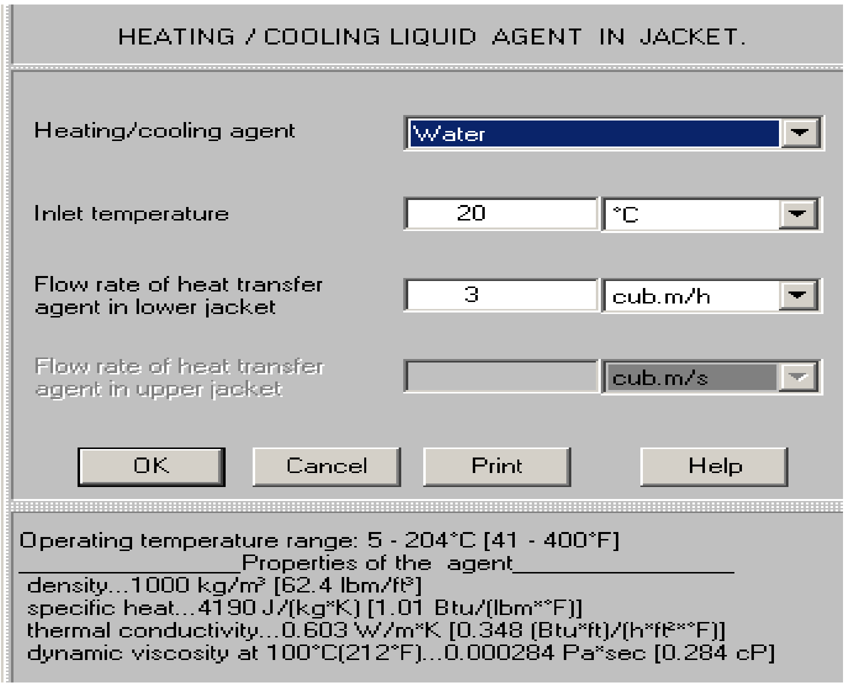

Figure 20. Selecting the cooling agent.

The next two input tables are related to the media in the tank. You have to defined a temperature (Figure 21) and physical properties of the media (Figure 22).

NOTE. If you have a problem with defining the physical properties, please click the ***Help*** *button in the lower part of this input window. It is possible that you will find some useful information in one of the VisiMix databases.*

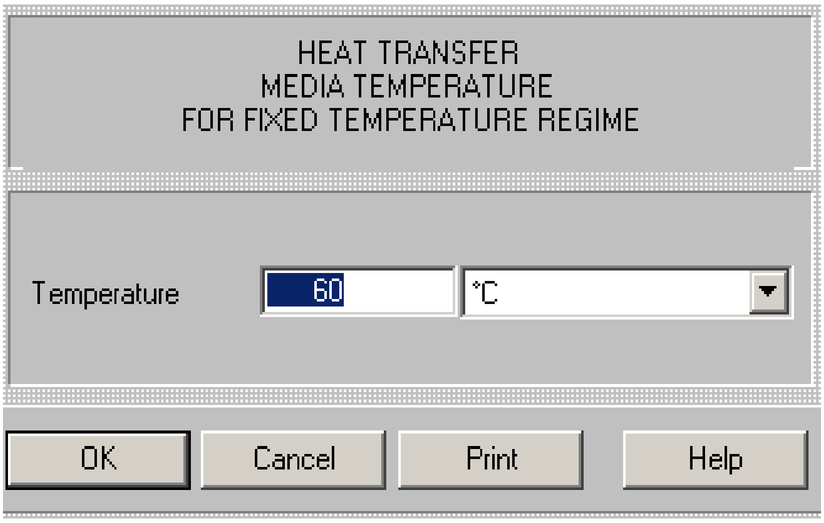

Figure 21. Entering temperature of the media.

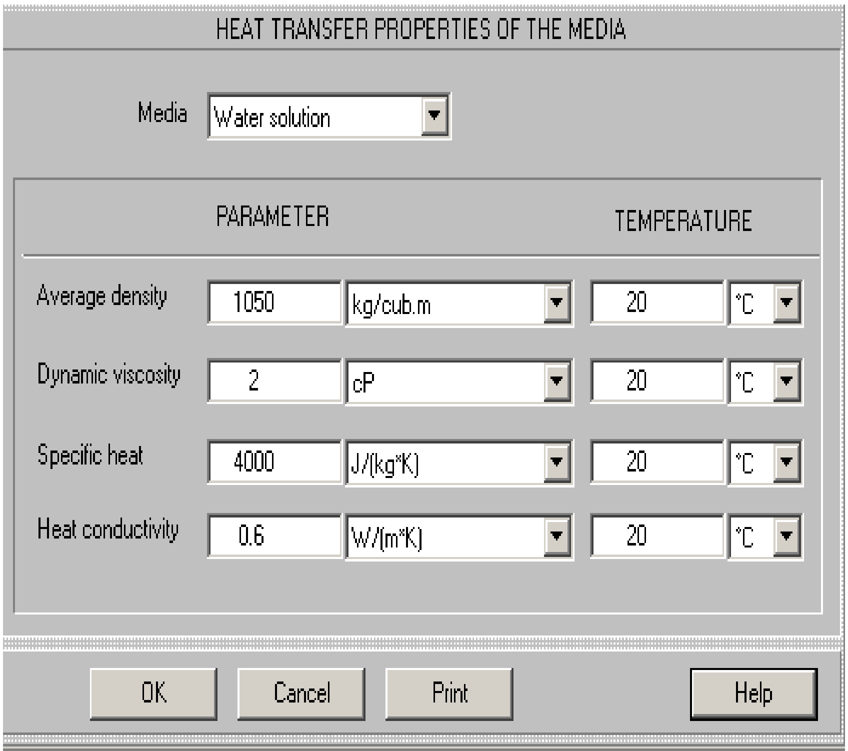

Figure 22. Entering physical properties of the media.

This input table is the last one. After you have filled it and click OK, the program provides the output table corresponding to the purpose of the mathematical modeling, in particular – to the parameter that you selected in the Calculate menu (Figure 15).

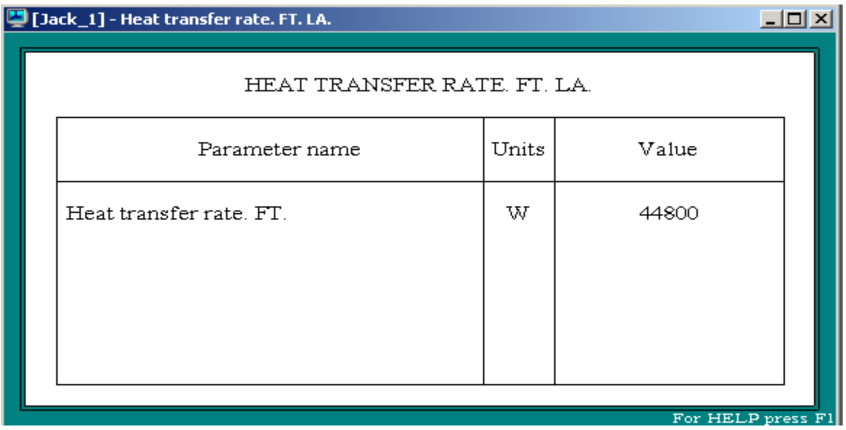

Figure 23. Output table corresponding to the requested parameter.

Defining of any other parameter in the selected sub-Menu (Figure 15) will be performed now without requesting any additional initial data.