

VisiMix RSDE. Batch Emulsifying with Rotor/Stator Homogenizer.

Problem description.

Subject of the batch operation – preparation of diluted emulsion of an organic agent in stabilizing water solution containing highly active emulsifier. Main properties of substances are presented in the table below.

Desired size of the main part of droplets in the product – from 5 to 15 μm or less.

Parameter	Continuous phase (aqueous)	Disperse phase (organic)
Density, kg/m ³	1000	960
Dynamic viscosity, cP	1	4
Volume fraction	0.99	0.01
Interfacial tension, N/m	About 0.01	

Optional equipment unit – a 750 liter mixing tank with a bottom-entering variable speed rotor/stator homogenizer. Optional rotational speeds – 1500 and 2200 rpm, power of drive – 15 KW.

Purpose of calculations: check applicability and define expected operational parameters of the equipment.

Step 1. Start new project RSDE_001 and enter design data of the RSD and average properties of media.

Select a scheme corresponding to design of the homogenizer (Fig. 1) and enter the rotor speed (start with 1500 rpm) and main dimensions accordingly to arriving input table (Figs 2).

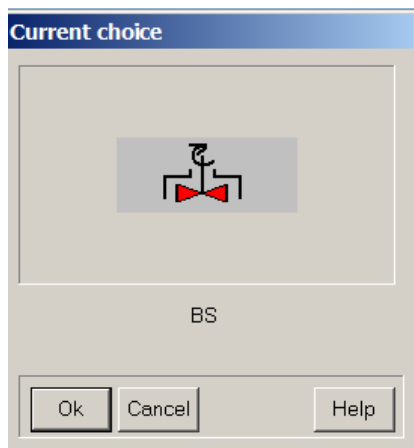


Figure 1.

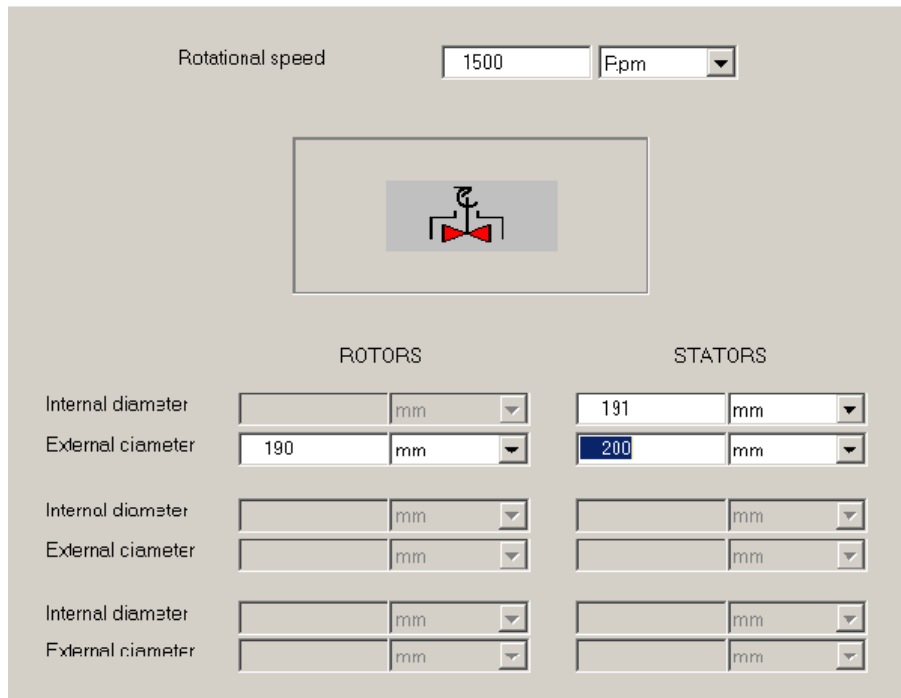


Figure 2.

Click **Calculate** in the main menu and select **BATCH EMULSIFYING>Mean drop size** as is shown in the Fig.3.

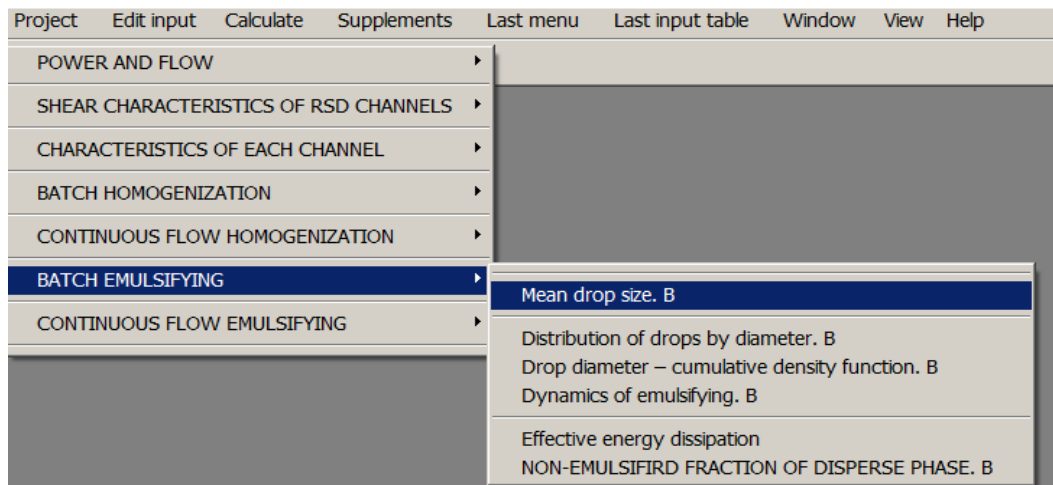


Figure 3.

Now, we have to enter **Average properties of media**. In general case, average density and viscosity of emulsion may depend on concentration and density of the disperse phase. However in the current case, due to very low volume fraction of the oil phase, the average properties of media cannot differ from the properties of the continuous phase (see Figs 4 and 5).

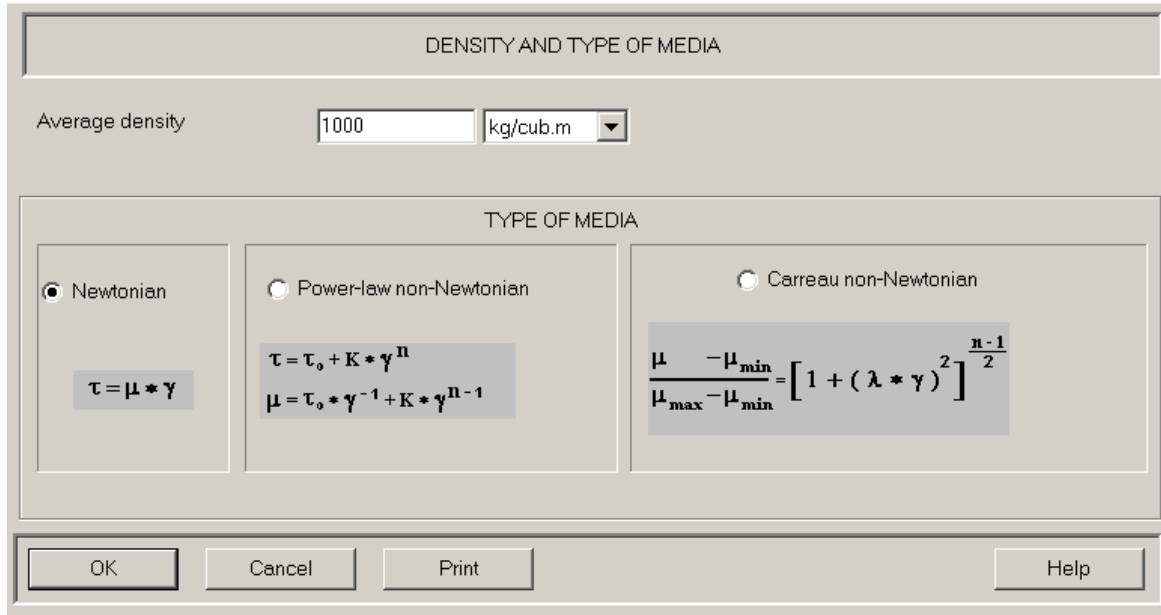


Figure 4.

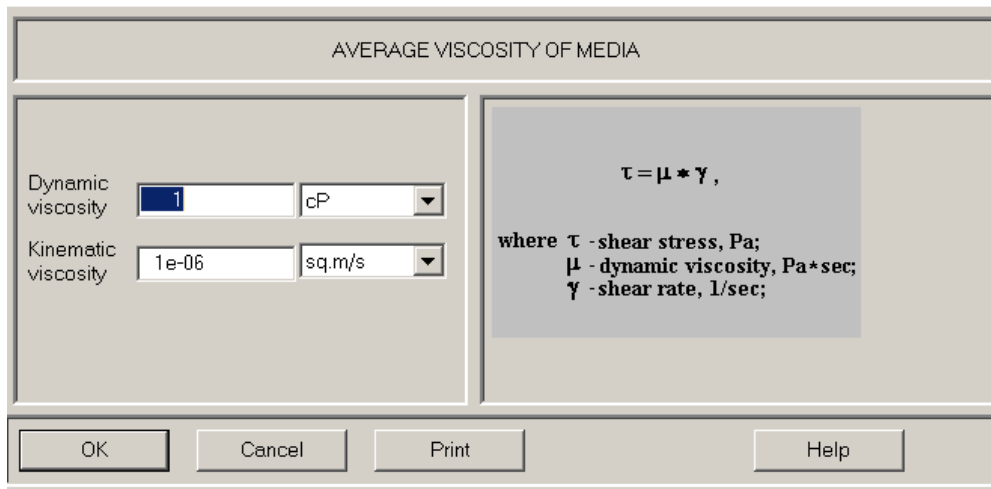


Figure 5.

Next, accordingly to the program requests, we have filled these tables and OK'd the input, we have to select the type (Fig 6) and enter dimensions (Fig.7) of stator and rotor (Fig.8) of the rotor/stator homogenizer (RSD).

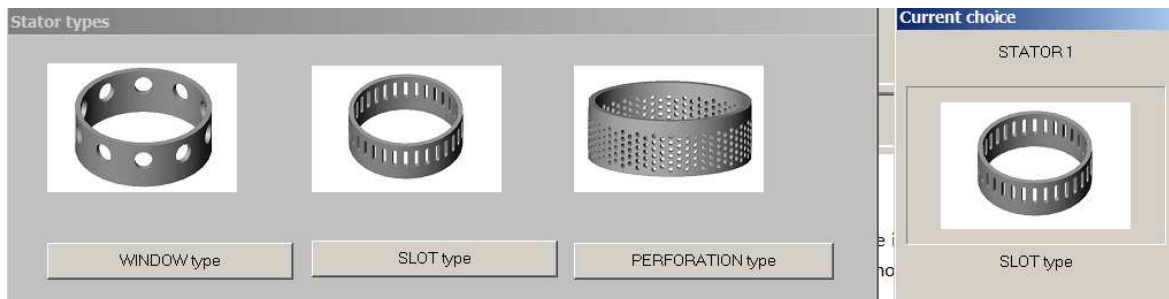


Figure 6.

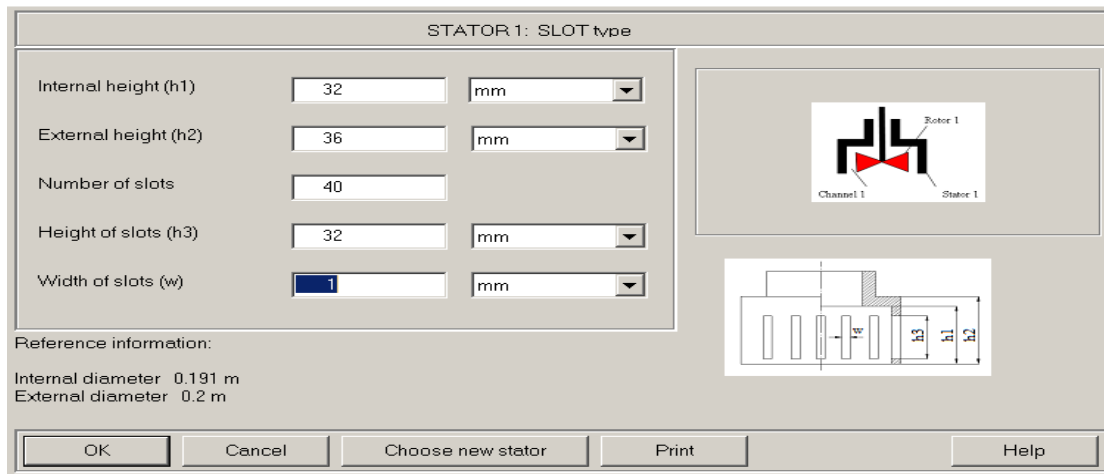


Figure 7.

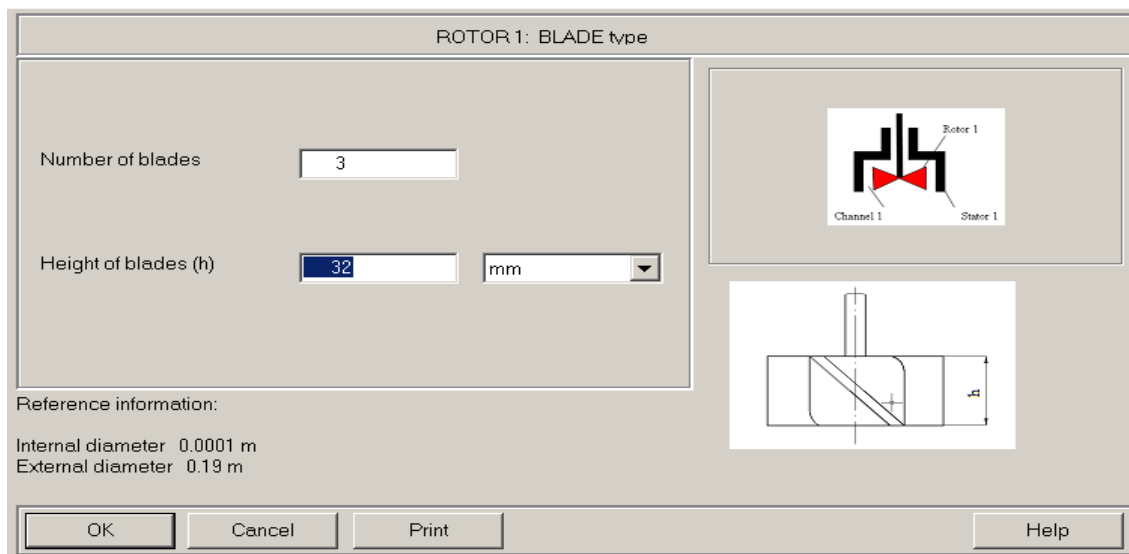


Figure 8.

Step 2. Enter design and process data for the installation.

After the rotor and stator dimensions are entered, the program provides a visual menu for selection of an installation scheme (Fig.9).

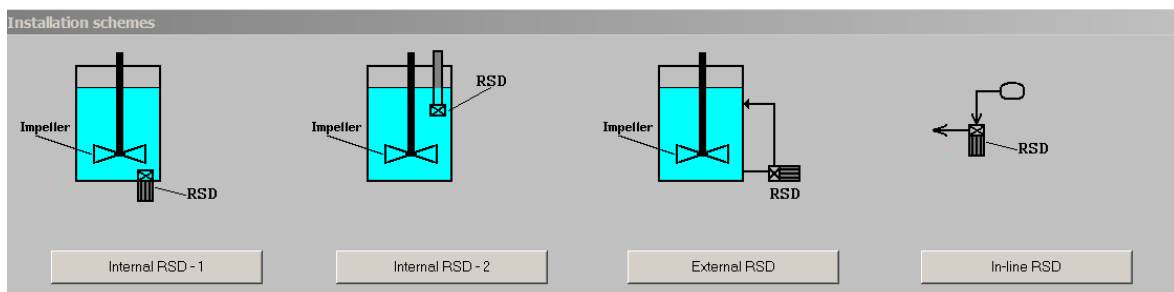


Figure 9.

By pushing the button, select a scheme **Internal RSD-1** and confirm the **Current choice** (Fig.10) with **OK**.

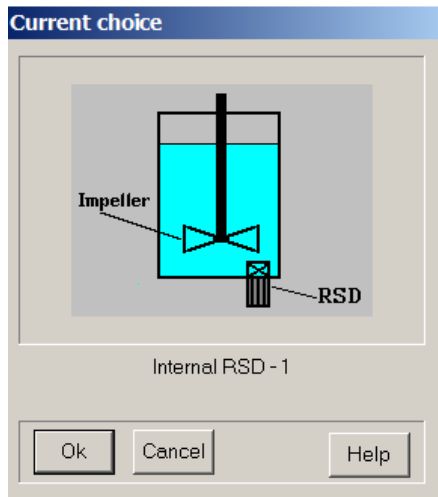


Figure 10.

Now the program provides request for technical information corresponding to the selected scheme. Let us fill the presented tables (Figs 11,12). The Mixing time value requested by table in the Fig.11 has to be calculated using one of the VisiMlx programs. In the absence of VisiMlx, you can estimate the Mixing time in your tank using one of accessible empirical correlations.

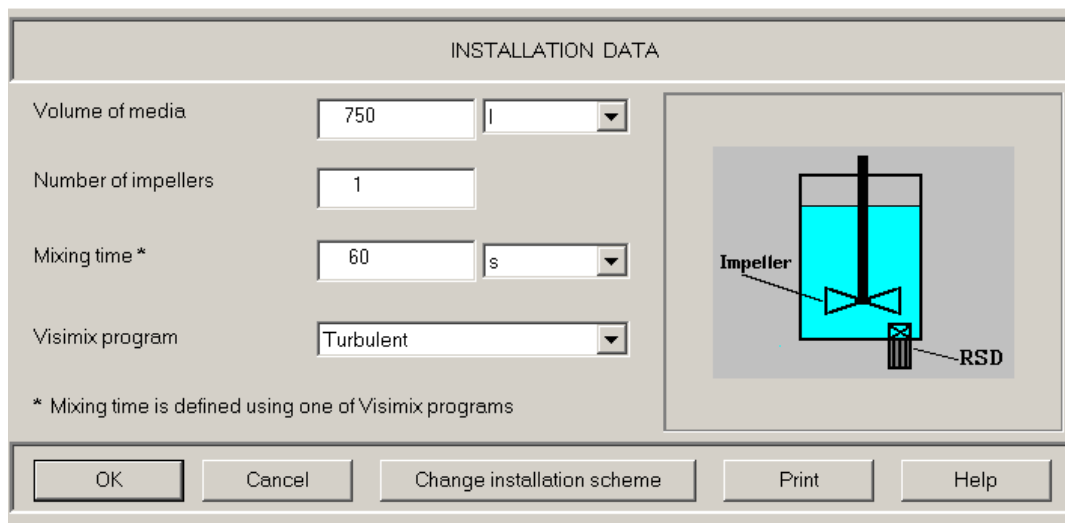


Figure 11.

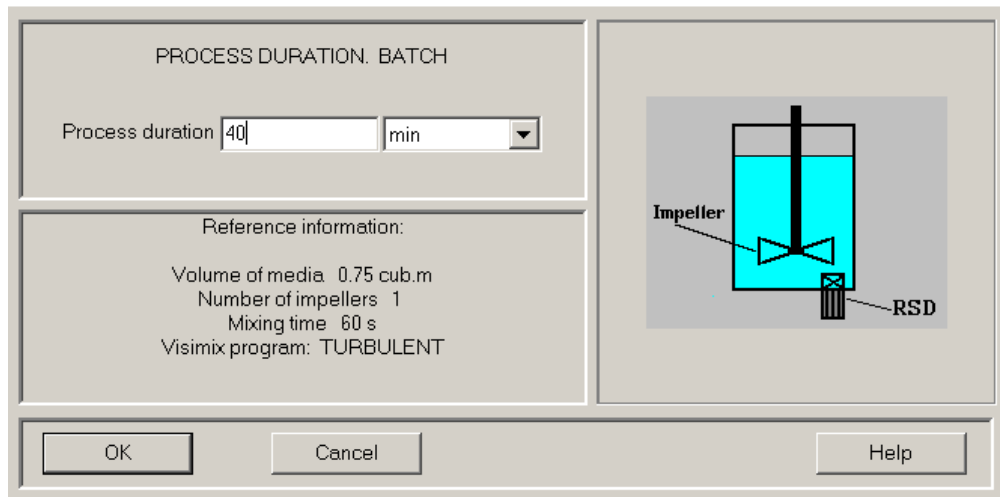


Figure 12.

Step 3. Enter specific data for emulsifying.

After all general data are entered, the program displays request for specific information necessary for modeling of emulsifying. First of all, it is a table that defines necessary physical properties of phases (Fig.13). The most of data requested for input are accessible (see Table 1 above).

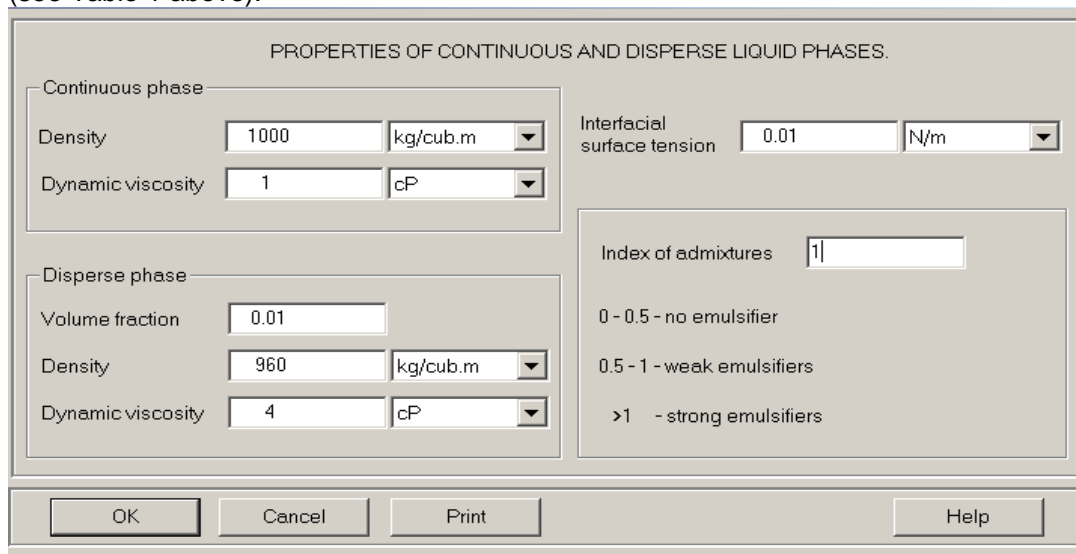


Figure 13.

The only un-known parameter in this table – Index of admixtures. As can be seen in the accompanying documentation (Help or User's Guide), value of the Index of admixtures is connected with the interphase electrostatic repulsing pressure: the higher is Index, the higher is the restricted pressure and the lower is frequency of coalescence of droplets. In emulsion with efficient emulsifiers the Index is usually higher than 1, and entering value '1' will provide some reservation.

The last input parameter of this section Initial drop size. As you can learn in Help section, for installation with bottom-entering RSD input of this parameter is optional. So, you can confirm the value 1000 micrometers that is displayed in the input line of the table (Fig.14).

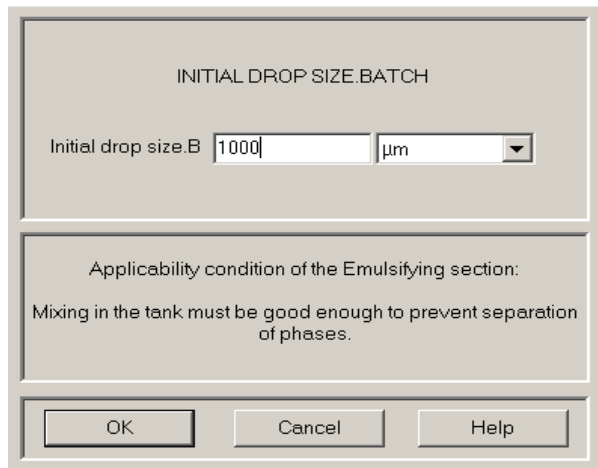


Figure 14.

Step 4. Calculations.

After the last input is confirmed, the program performs calculations, and the output table corresponding to the requested parameters (see Fig.3) is displayed. As follows from the data presented in the output table (Fig.15), the selected installation provides complete emulsifying of the disperse phase in the tank. However, the mean drop size seems to be somewhat too high.

EMULSIFIED FRACTION OF DISPERSE PHASE. MEAN DROP SIZE. B		
Parameter name	Units	Value
Mean drop size of emulsified fraction. B	µm	18.5
Emulsified fraction of disperse phase. B	%	100

For HELP press F1

Figure 15.

For additional checking, click **Last menu** (Fig.16) and select **Drop diameter – cumulative density function**. Press **Start** button. As follows from the arriving graph (Fig.17), only about 30% of the emulsion is contained in the droplets smaller than 15 µm, and the main part of droplets is significantly larger.

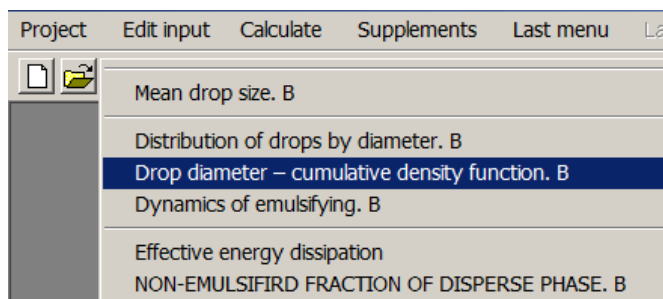


Figure 16.

One of the acceptable ways to reduce drop size of the final emulsion – increase the process duration. In order to check this option, go to the **Last menu** and select **Dynamics of emulsifying**. Press **Start**. As follows from the graph (Fig.18), the selected process duration (40 min) is long enough, and further increase of emulsifying time will not be efficient. The second possibility – to increase rotational velocity of the RSD.

Select the **Disperser design** icon in the main menu and change the Rotational velocity from 1500 rpm to 2200 rpm (Fig.19) and press OK. The program repeats the calculations automatically, and previous results are replaced in the output tables with the new ones.

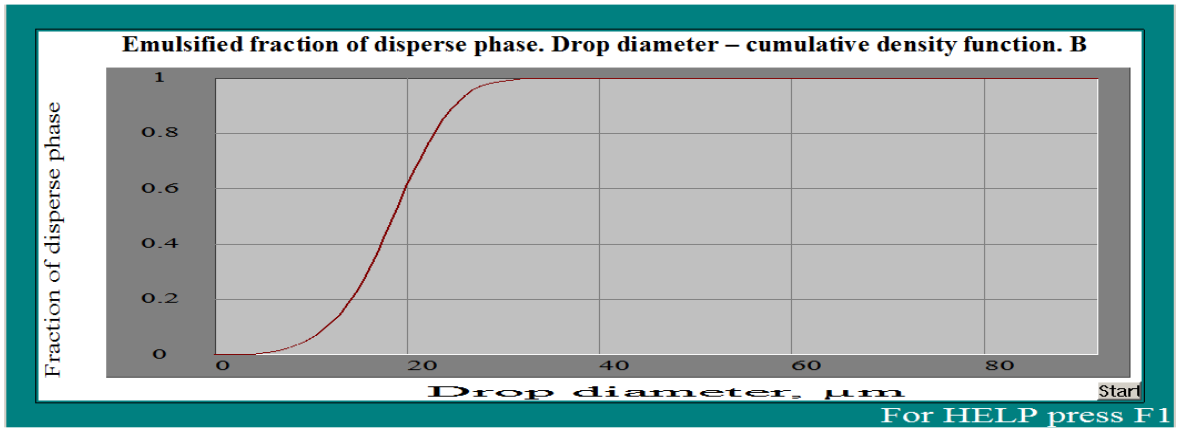


Figure 17.

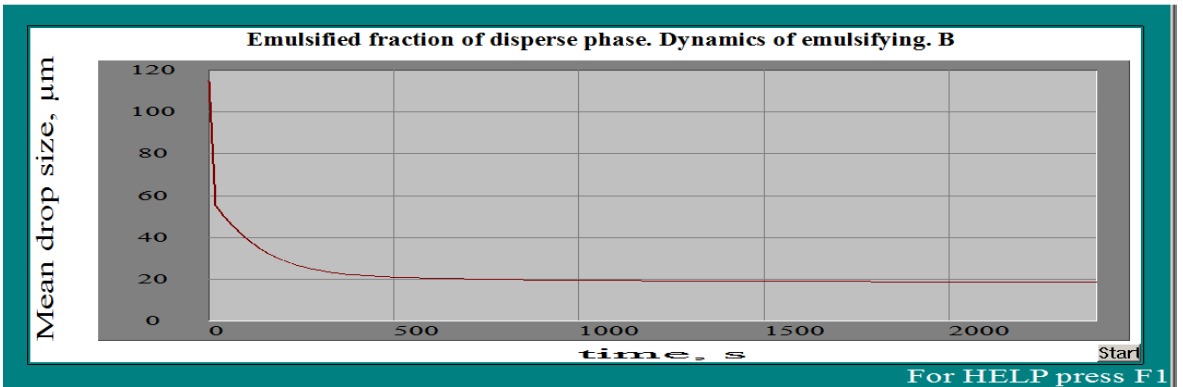


Figure 18.

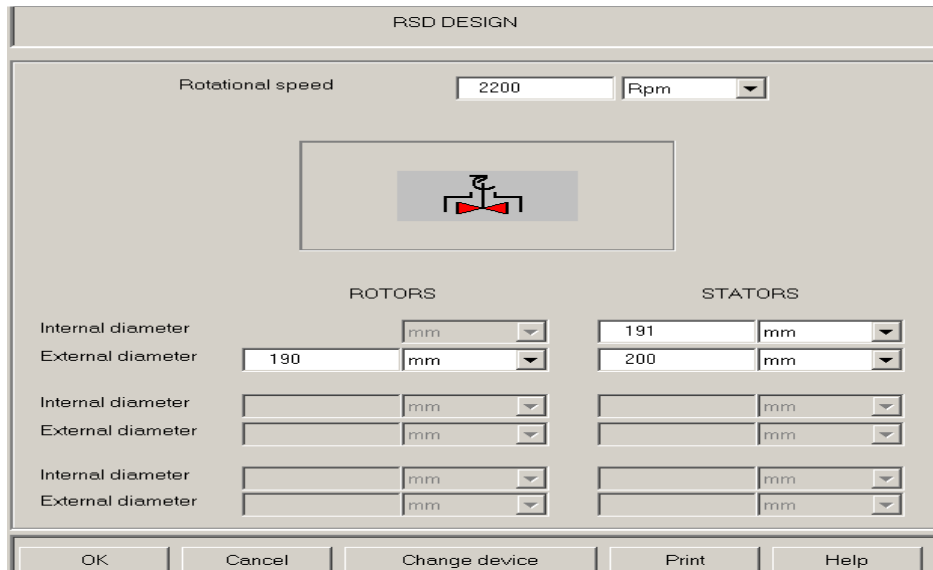


Figure 19.

As follows from the Fig.20, increasing of the rotational speed results in reduction of the expected Mean drop size value from 18.5 to 12.5 μm . The graph on the Fig.21 shows also that diameter of the min part of the droplets - about 80% - is less than 15 μm .

Basing on the results of the Fig.22, we can expect this result to be achieved in less than the outlined 40 min.

Select **Last menu>Non-emulsified fraction of disperse phase**. Accordingly to results presented in the output tables in the Figs. 22 and 23, emulsifying is completed within 15-20 min.

EMULSIFIED FRACTION OF DISPERSE PHASE. MEAN DROP SIZE. B		
Parameter name	Units	Value
Mean drop size of emulsified fraction. B	μm	12.5
Emulsified fraction of disperse phase. B	%	100

For HELP press F1

Figure 20.

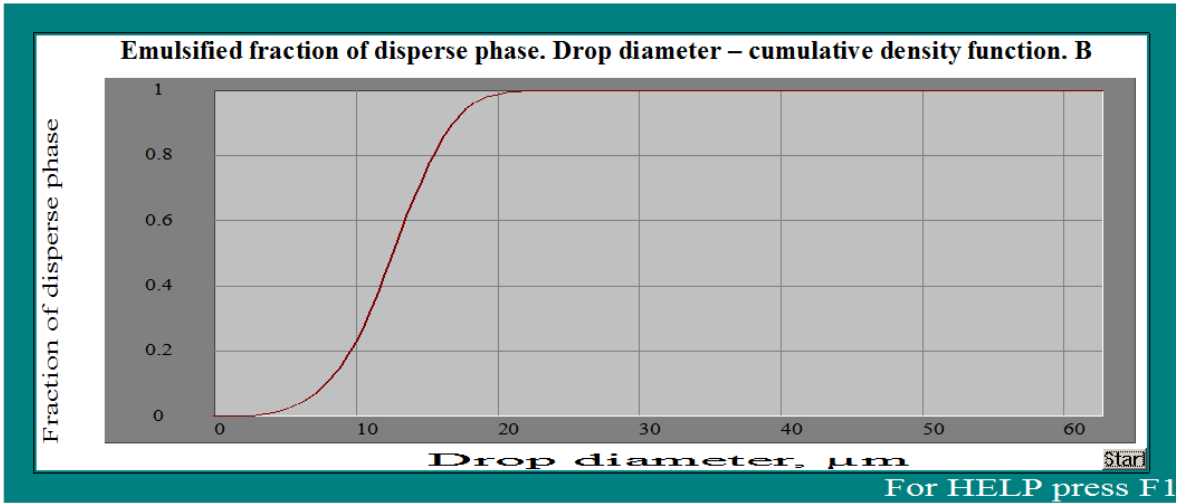


Figure 21.

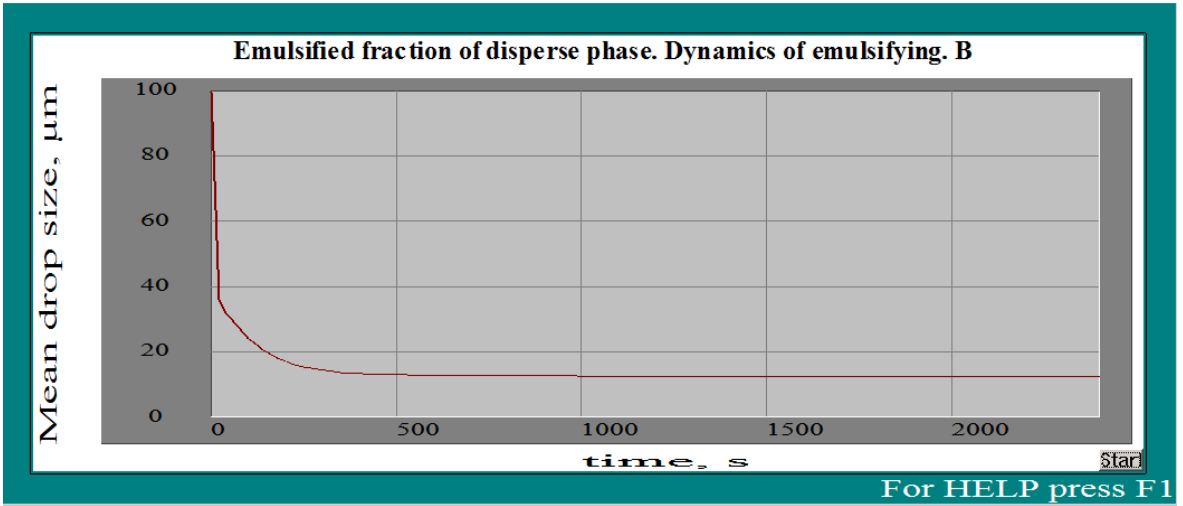


Figure 22.

NON-EMULSIFIED FRACTION OF DISPERSE PHASE. B

Emulsifying time	Fraction
8.0 min	0.035 %
16.0 min	0.000 %
24.0 min	0.000 %
32.0 min	0.000 %
40.0 min	0.000 %

For HELP press F1

Figure 23.

Before taking the final decision to use RSD at the maximum rotating speed, let us make sure that the power consumption will not be too high. Select Calculate>Power and flow>Power. As follows from the arriving output table, the existing 15 kW motor ensures operation of the selected RSD at 2200 rpm with reasonable reservation.

POWER		
Parameter name	Units	Value
Power	W	11400

For HELP press F1

Figure 24.