

**VisiMix RSDE.**  
**High Shear Homogenizing. Defining Process Duration.**

**Subject:** Mathematical modeling a homogenizing installation that includes a 500 liter mixing tank with a bottom-entering rotor / stator disperser (RSD).

**Equipment:**

Tank: 500 liter tank with a portable pitch paddle agitator.

**Bottom-entering RSD:**

**Design scheme:** a single-stage device consisting of slotted stator and internal slotted rotor.

**Stator** – shallow cylinder with radial slots.

External diameter – 110 mm,

Thickness – 4 mm,

Internal height – 36 mm,

Wall thickness – 4 mm,

**Slots:**

Number – 30,

Height – 30 mm,

Width – 1.5 mm.

**Rotor** - shallow cylinder with radial slots.

External diameter – 100 mm,

Wall thickness – 4 mm,

Internal height – 30mm,

External height – 34 mm

**Slots:**

Number –24,

Height – 30 mm,

Width – 1.7 mm.

Rotation velocity – variable, from 1400 to 3000 rpm

Power of drive – 3 kW.

**Media:**

Viscous multi-component liquid mixture.

Density – 1050 kg / cub.m.

Viscosity – about 300 cP.

**Process:**

Batch operation.

Purpose – homogenizing of the mixture with a high shear device

Outlined process duration – 45 min

**Step 1. Entering rotor / stator disperser data.**

After the program is started, it provides a graphic menu of essential design schemes of dispersers. (Fig.1). In our case a scheme RS with single stator and internal rotor is selected.

After the selection is confirmed, program defines the list of necessary dimensions and provides the corresponding input tables. The filled input tables are shown in the Figs 2 - 5.

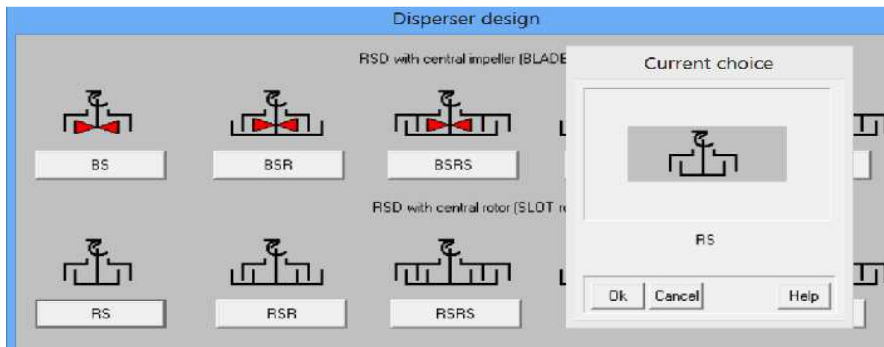


Figure 1. Graphic menu for selection of the design scheme (fragment)

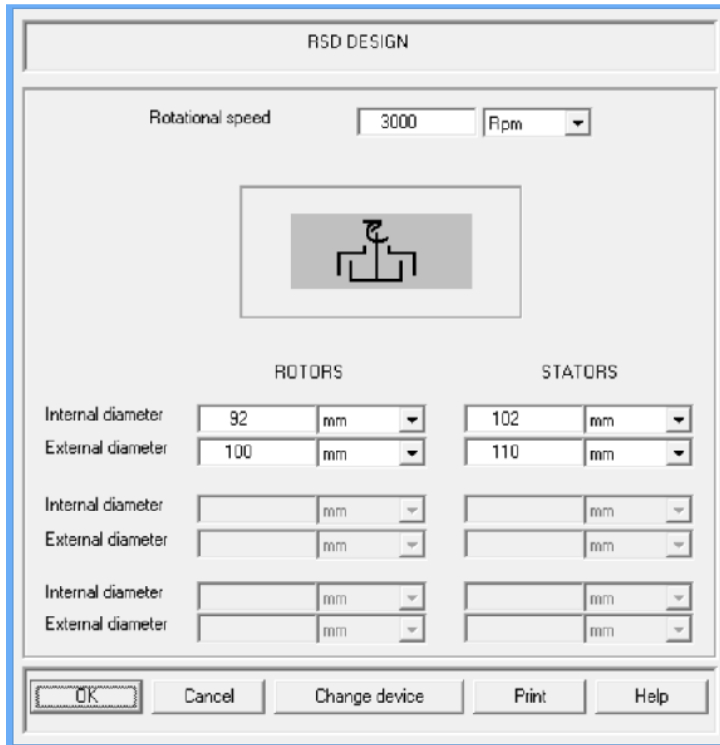


Figure 2. Entering of the main RSD parameters.

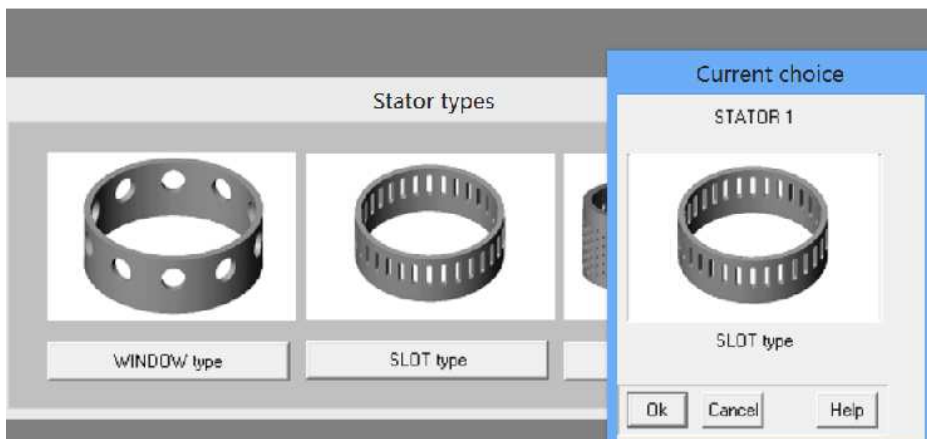


Figure 3. Graphic menu for selection of the stator type.

STATOR 1: SLOT type

Internal height (h1)	<input type="text" value="36"/>	<input type="text" value="mm"/>
External height (h2)	<input type="text" value="40"/>	<input type="text" value="mm"/>
Number of slots	<input type="text" value="30"/>	
Height of slots (h3)	<input type="text" value="30"/>	<input type="text" value="mm"/>
Width of slots (w)	<input type="text" value="1.5"/>	<input type="text" value="mm"/>

Reference information:  
 Internal diameter 0.102 m  
 External diameter 0.11 m

OK Cancel Choose new stator Print Help

Figure 4. Input table for slot-type stators.

ROTOR 1: SLOT type

Internal height (h1)	<input type="text" value="30"/>	<input type="text" value="mm"/>
External height (h2)	<input type="text" value="34"/>	<input type="text" value="mm"/>
Number of slots	<input type="text" value="24"/>	
Height of slots (h3)	<input type="text" value="30"/>	<input type="text" value="mm"/>
Width of slots (w)	<input type="text" value="1.7"/>	<input type="text" value="mm"/>

Reference information:  
 Internal diameter 0.092 m  
 External diameter 0.1 m

OK Cancel Print Help

Figure 5. Input table for slot-type rotors.

**Step 2. Entering average physical properties of media.**

After input of design data is completed, the program provides tables for entering of average properties of media. For our case, the density is entered, and the media is defined as Newtonian (Fig.6). The table for entering of viscosity is provided by the program (Fig.7). Note, that if the **Dynamic viscosity** is entered, the **Kinematic viscosity** is defined by the program.

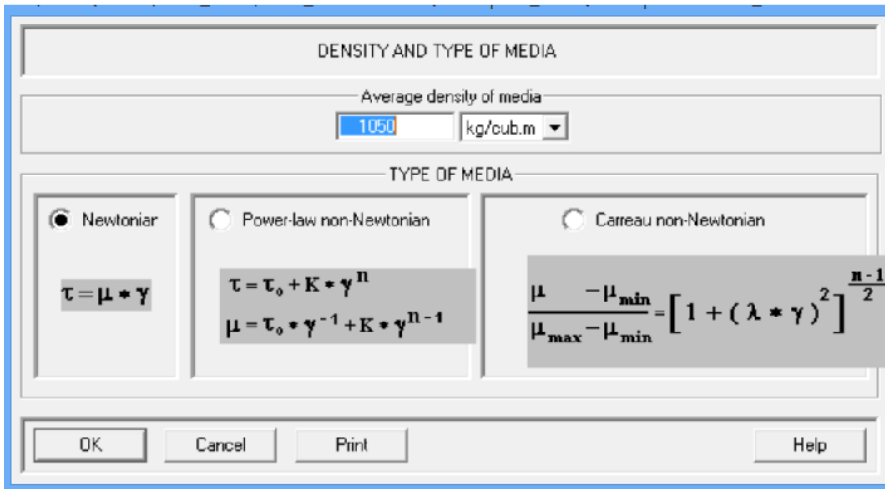


Figure 6. Entering density and type of media (rheological model).

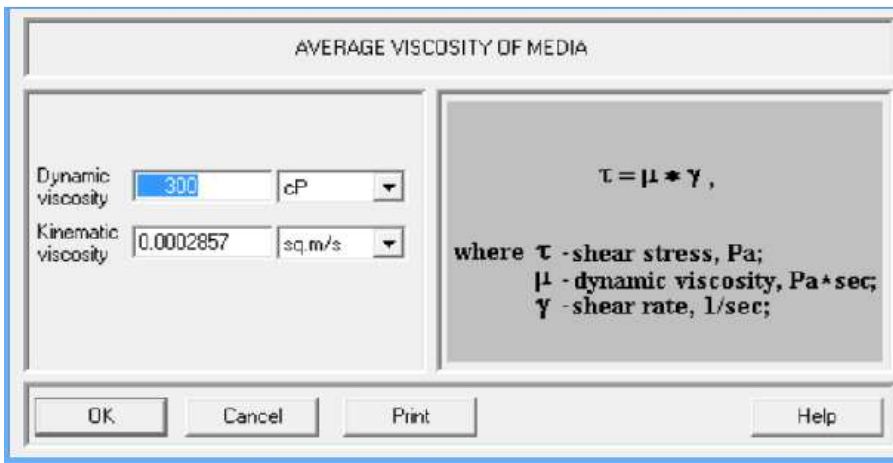


Figure 7. Entering viscosity of media.

### Step 3. Mathematical modeling of homogenization of media in the tank.

Modeling of homogenization is induced with pressing one of the **Calculate > Batch homogenization** menu options (Fig. 8), for example – **Non-homogenized fraction of media – final value**, that describes completeness of homogenization.

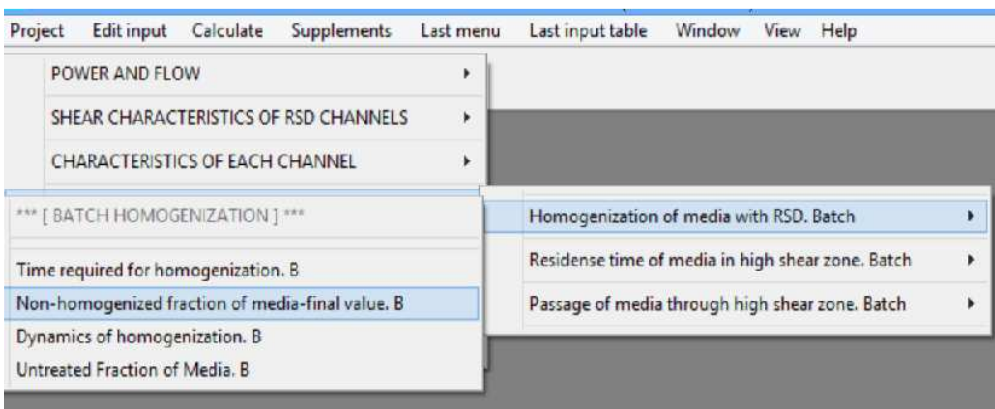


Figure 8. Menu options for batch homogenization.

Before start modeling, the program provides request for additional data related to the tank and installation. After we select the scheme of a tank with bottom-entering RSD in the graphic menu (Fig.9), the program provides the input table presented in the Fig.10.

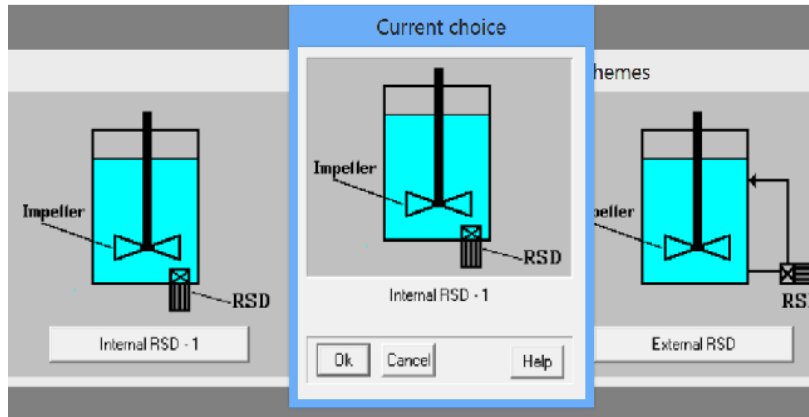


Figure 9. Graphic menu of installation schemes (fragment).

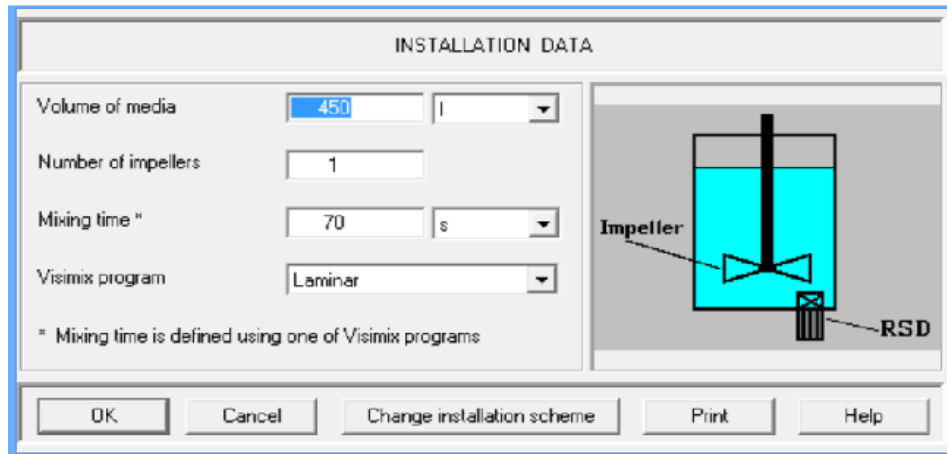


Figure 10. Input of the mixing tank data.

Filling of the first two boxes is clear – we enter 450 l as **Volume of media** and 1 as **Number of impellers** – accordingly to the initial data presented above. The last necessary input parameter – **Mixing time** – is necessary in order to define intensity of macro-scale mixing in the tank. It has to be calculated using one of the VisiMix programs.

Our case corresponds to field of application of the program VisiMix Laminar, calculated mixing time value is about 70 sec.

The completeness of homogenization increases along the time. Therefore before modeling the program presents an additional input window with a request for outlined value of the mixing duration.

After the next input table is also filled (see Fig. 11), the program performs calculations and provides the output corresponding to the selected menu option **Non-homogenized fraction of media**. (see Fig.8).

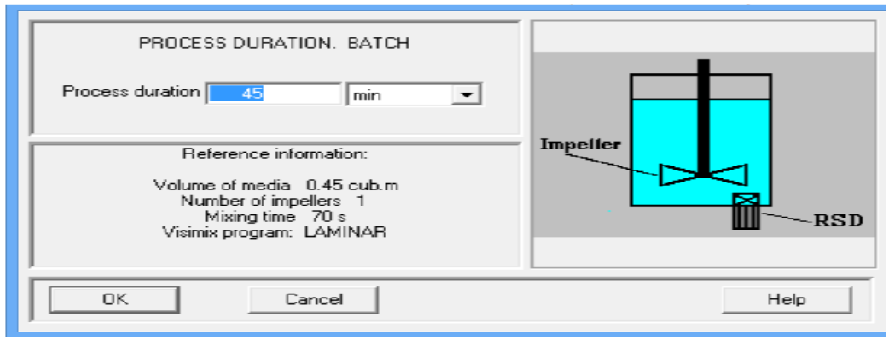


Figure 11. Entering the process duration.

Results of mathematical modeling are displayed in the Fig.12. Physical meaning of this parameter is explained in the **Help** section of the program, as it is shown below (Fig.13).

NON-HOMOGENIZED FRACTION OF MEDIA-FINAL VALUE. B		
Parameter name	Units	Value
Process duration	s	2700
Non-homogenized fraction of media-final value. B	%	0.0494

For HELP press

Figure 12. Completeness of homogenizing 95.5%. Calculated results.

#### 6.4.1.2. NON-HOMOGENIZED FRACTION OF MEDIA - FINAL VALUE. B

This parameter is defined as a part of media that has not passed high shear treatment in RSD during the time specified as the **Batch process duration** input table (see par.5.10). At reasonably good process conditions this part of the media is usually small as compared to the total volume of media, but its value is important for estimation and reproduction of quality of multi-component products. For convenience, the **Process duration** value is also shown in this output table (Figure 44).

Figure 13. Fragment of the Help section.

As follows from the obtained results, during the period of 45 min about 99.5% of the media will be homogenized by treatment in the high shear zone when passing the channels inside the rotor /stator homogenizing device (RSD).

#### **Step 4. Evaluation of the shear and specific power in the high shear channels of the RSD.**

To evaluate intensity of the high shear treatment of the mixture, let us use the menu options **Calculate > Shear characteristics of RSD channels > Shear rates** (Fig.14) and **Calculate > Shear characteristics of RSD channels > Specific power**. Results of modeling presented in the Figs 15 and 16 show fairly high values of shear and specific power. For comparison, average specific power in mixing tanks with common impellers usually is less than 1000 W/ cub.m, i.e. lower by more than 70000 times (Fig.16).

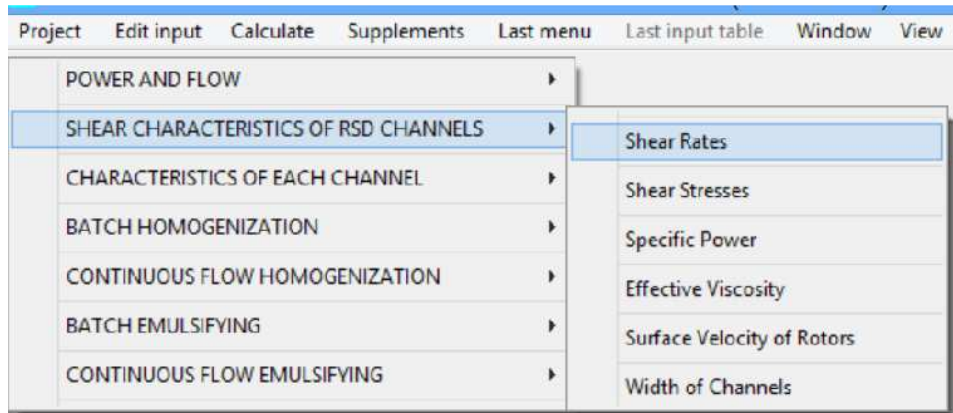


Figure 14. Menu options for modeling of local shear and specific power.

SHEAR RATES		
Parameter name	Units	Value
Channel 1	1/sec	16100

Figure 15. Average shear rate in the RSD channel

SPECIFIC POWER		
Parameter name	Units	Value
Channel 1	W/cub.m	7.75e+07

Figure 16. Average specific power in RSD channel.

**NOTE.** The calculated values of the **Non-homogenized fraction of media – final value** and **Specific power** or **Shear rate** are directly connected with quality of the homogenized mixture and can be used as scaling-up parameters.