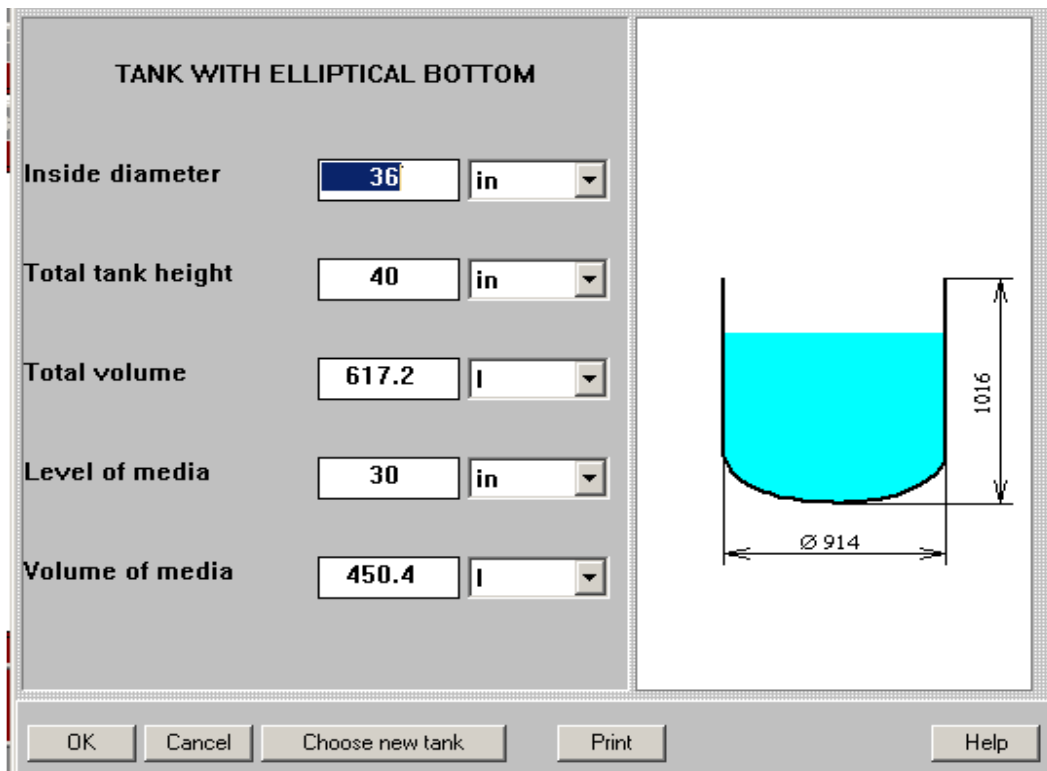


**VisiMix LAMINAR.**  
**HOMOGENIZING OF NON-NEWTONIAN COMPOSITION WITH HIGH-SHEAR IMPELLER.**

**Mixing tank:**

Bottom type – elliptical,  
 Inside diameter – 36 in,  
 Total height – 40 in,  
 Height of media – 30 in.

Tank entering table is shown in the Figure 1.



**Figure 1. Input of the Tank sizes.**

**Impeller:** a tooth-disk impeller with tangential teeth – see Figure 2.

**The media** is a viscous non-Newtonian mixture with the following properties:

Density	1200 kg/cub. m
Rheological constant, K	15 Pa*s <sup>1-m</sup>
Rheological exponent, m	0.3
Yield stress, $\tau_0$	6 N/m <sup>2</sup>

The corresponding VisiMix input table is shown in the Figure 3.

### TOOTH DISK IMPELLER - 1

Tip diameter	<input type="text" value="12.5"/>	<input type="text" value="in"/>
Number of teeth	<input type="text" value="32"/>	
Tooth height, h	<input type="text" value="1"/>	<input type="text" value="in"/>
Tooth length, l	<input type="text" value="1"/>	<input type="text" value="in"/>
Dist. from bottom	<input type="text" value="12"/>	<input type="text" value="in"/>
Rotational speed	<input type="text" value="800"/>	<input type="text" value="Rpm"/>
Motor power	<input type="text" value="15"/>	<input type="text" value="hp"/>

**BLADE**

Figure 2. Input of impeller parameters.

### AVERAGE PROPERTIES OF MEDIA

Type of media

Newtonian  Non-Newtonian

Average density

Dynamic viscosity

Kinematic viscosity

Constant K

Yield stress

Behavior of Non-Newtonian media is approximated with the functions:

$$\tau = \tau_0 + K * \dot{\gamma}^n$$

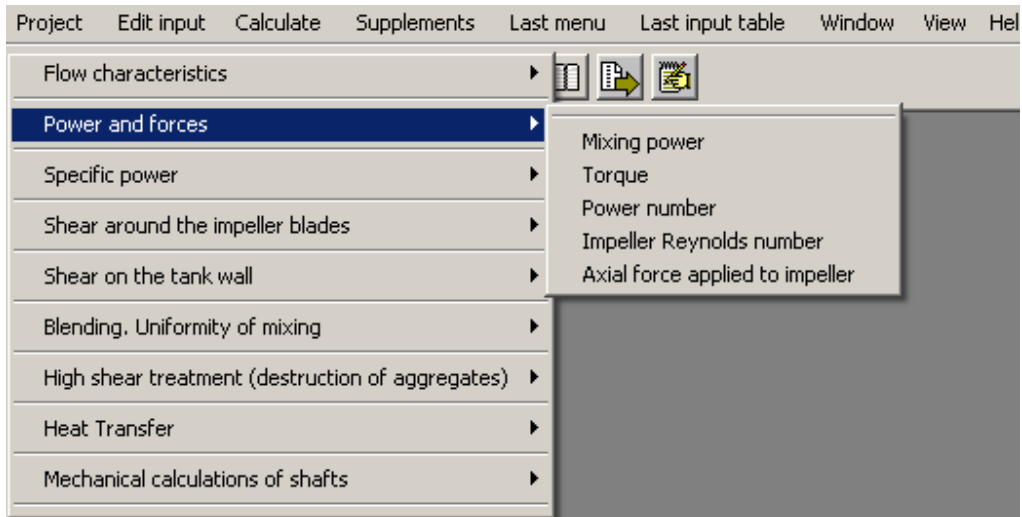
$$\mu = \tau_0 * \dot{\gamma}^{-1} + K * \dot{\gamma}^{n-1},$$

where  $\mu$  - dynamic viscosity, Pa\*sec;  
 $\dot{\gamma}$  - shear rate, 1/sec;  
 $\tau$  - shear stress, Pa;  
 $\tau_0$  - yield stress, Pa.

Figure 3. Entering rheological parameters on non-Newtonian liquid.

## Some results of VisiMix modeling.

1. Mixing power and torque – Figures 4 - 6.



**Figure 4. Main menu of the program VisiMix Laminar.**

MIXING POWER		
Parameter name	Units	Value
Mixing power	W	5790

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**Figure 5. Calculated value of mixing power.**

TORQUE		
Parameter name	Units	Value
Torque	N*m	69.1

**For HELP press F1**

**Figure 6. Calculated value of torque moment.**

2. Calculation of shear characteristics in zone around the blades – see Figures 7-10.

Shear around the impeller blades	▶	Shear rate near the impeller blades
Shear on the tank wall	▶	Shear stress near the impeller blades
Blending, Uniformity of mixing	▶	Effective viscosity near the impeller blades
High shear treatment (destruction of aggregates)	▶	Relative volume of impeller shear zone

**Figure 7. Sub-menu of shear parameters in the impeller zone.**

SHEAR RATE NEAR THE IMPELLER BLADES		
Parameter name	Units	Value
Shear rate near the impeller blades	1/sec	8010

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**Figure 8. Maximum shear rate in the impeller zone.**

EFFECTIVE VISCOSITY NEAR THE IMPELLER BLADES		
Parameter name	Units	Value
Effective viscosity near the impeller blades	Pa*s	1.01

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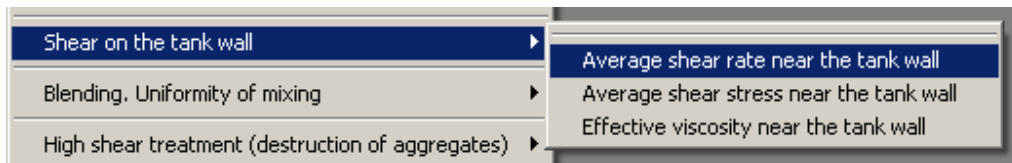
**Figure 9. Local effective viscosity in the impeller zone.**

SHEAR STRESS NEAR THE IMPELLER BLADES		
Parameter name	Units	Value
Shear stress near the impeller blades	N/sq.m	8110

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**Figure 10. Maximum shear stress in the impeller zone.**

3. Calculation of shear on the tank wall – see Figures 11 - 14.



**Figure 11. Sub-menu of shear characteristics on the tank wall.**

AVERAGE SHEAR RATE NEAR THE TANK WALL		
Parameter name	Units	Value
Average shear rate near the tank wall	1/sec	9.17

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**Figure 12. Shear rate on the tank wall.**

EFFECTIVE VISCOSITY NEAR THE TANK WALL		
Parameter name	Units	Value
Effective viscosity near the tank wall	Pa*s	8.37

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**Figure 13. Effective viscosity on the tank wall.**

AVERAGE SHEAR STRESS NEAR THE TANK WALL		
Parameter name	Units	Value
Average shear stress near the tank wall	N/sq.m	76.7

**For HELP press F1**

**Figure 14. Shear stress on the tank wall.**

4. Mathematical modeling of mixing dynamics.

Expected mixing duration- 30 min. Figure 15.

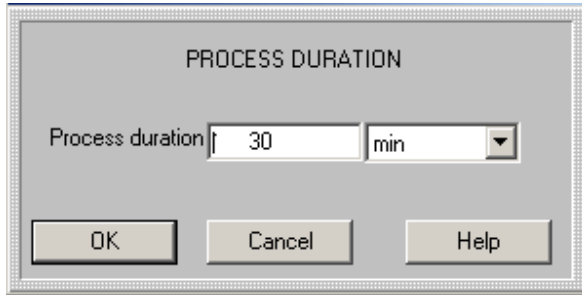


Figure 15. Entering mixing duration.

Results of mathematical modeling of blending – Figures 16 - 18.

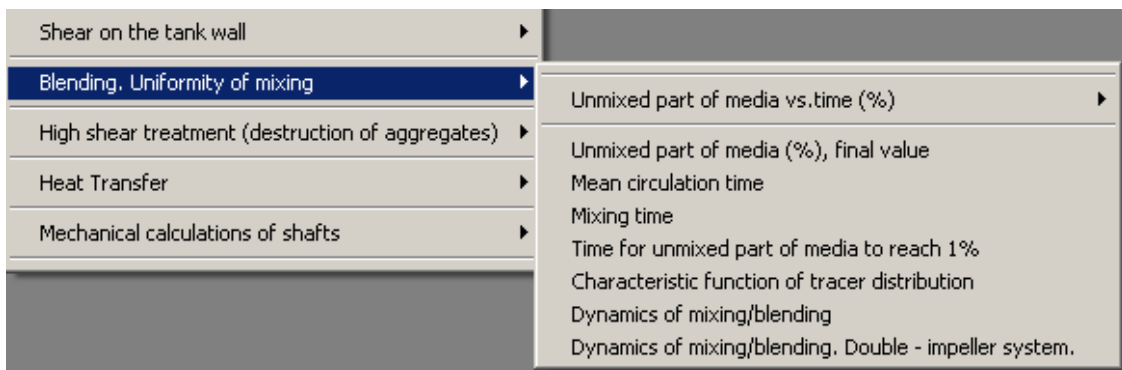


Figure 16. Sub-menu of macro-scale mixing (blending).

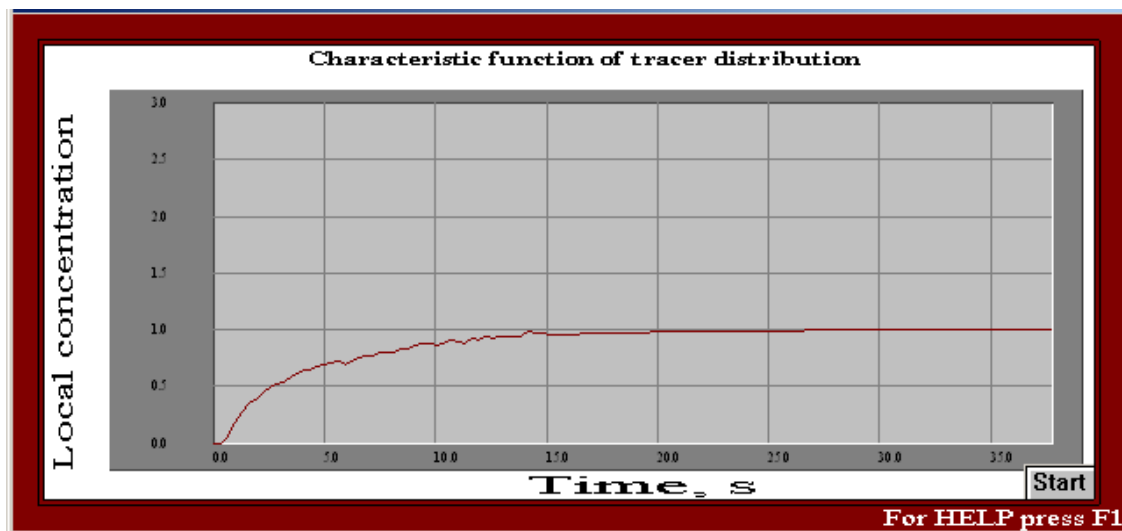


Figure 17. Macro-scale mixing dynamics.

UNMIXED PART OF MEDIA (%), FINAL VALUE		
Parameter name	Units	Value
Process duration	s	1800
Unmixed part of media (%), final value		0.0185

**For HELP press F1**

**Figure 18. Completeness of mixing (stochastic evaluation).**

High shear treatment of mixture in impeller zone (homogenizing) – Figures 19-21.

High shear treatment (destruction of aggregates) ▶	Shear stress near the impeller blades
Heat Transfer ▶	Relative volume of impeller shear zone
Mechanical calculations of shafts ▶	Untreated fraction of media
	Untreated fraction of media. Double - impeller system

**Figure 19. High shear treatment sub-menu.**

RELATIVE VOLUME OF IMPELLER SHEAR ZONE		
Parameter name	Units	Value
Relative volume of impeller shear zone		0.000192

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**Figure 20. Relative volume of the maximum shear zone.**



UNTREATED FRACTION OF MEDIA		
Parameter name	Units	Value
Untreated fraction of media (%), less than 1 cycle of treatment		0.000498
Untreated fraction of media (%), less than 2 cycles of treatment		0.00659
Untreated fraction of media (%), less than 5 cycles of treatment		0.659

**For HELP press F1**

**Figure 21. Fraction of media that is blended but not completely homogenized in the high shear zone (stochastic evaluation).**