VISIMIX TURBULENT.
HEAT TRANSFER IN TANK WITH INTERNAL COIL.

1. <u>Introduction.</u>

This example illustrates application of the program VisiMix Turbulent for mathematical modeling of heat transfer in mixing tanks with internal coils.
Input system of VisiMix does not include internal coil option because of unlimited variability of the possible coil geometry. For modeling of mixing and heat transfer the tanks with coils is replaced with an equivalent tank of the same volume.

Principles for replacement:
1.1. It is established experimentally that influence of concentric pipe rings on the agitated flow is not significant. On the other hand, presence of coils is accompanied always with presence of additional radial structure elements that serve to keep the coil as a single unit and to fix it on the tank wall.
Due to high hydraulic resistance of these elements, the flow pattern in the tanks with coils is practically the same as in the fully baffled tanks.

1.2. For heat transfer calculations, the coil is replaced with equivalent external half-coil jacket. Equivalence requirements:
a) Heat transfer surface of jacket has to be equal to external surface of coil.
b) Flow cross-section of half-pipe has to be equal to cross-section of the coil.
c) In order to provide equivalence of hydraulic resistance to heating/cooling agent, length of the half-pipe has to be equal to length of the coil.

2. <u>Initial data.</u>

Reactor:
Tank with elliptical bottom
Internal diameter – 1.8 m,
Volume – 6000 l.

Mixing device:
Lightnin A310.
Tip diameter – 900 mm,
Distance from bottom – 600 mm.

Drive:
Rotation velocity - 120 rpm
Power – 3 HP.

Media- water solution.
Volume of liquid- 5000 l.

Density -1020 kg /cub.m.
Dynamic viscosity – 1cP.

Heat transfer coil.
Material – stainless steel
Pipe size -2 in
Outside diameter 60.3 mm.
Wall thickness 2.77 mm)
Heat transfer area – 7 sq.m.

Properties of media.
Density -1020 kg/cub.m.
Dynamic viscosity – 1 cP.
Temperature – 80^0 C

Cooling agent – water.
Temperature - 30^0 C.
Flow rate – 6 cub.m/h.

3. Entering main initial data.

3.1. Selecting a tank with half-pipe jacket from graphic menu and entering main dimensions (Figs.1, 2).

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Figure 1. Selecting the tank type.

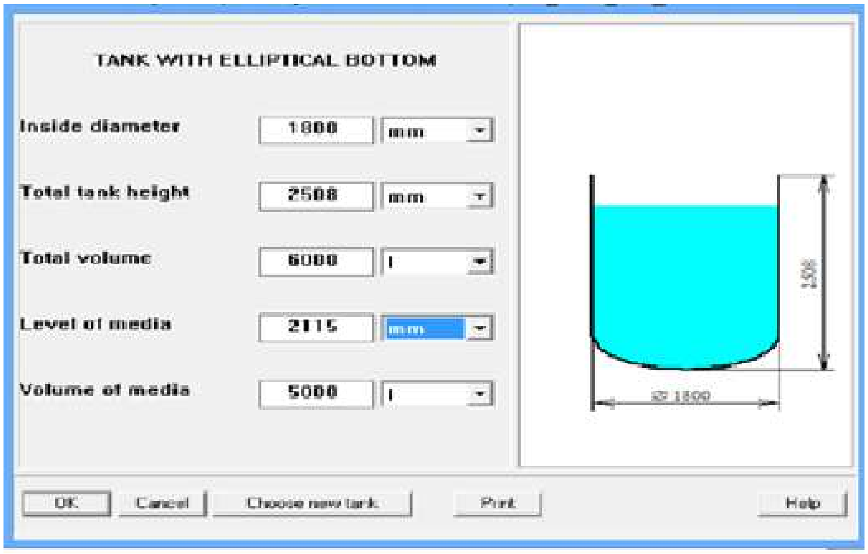


Figure 2. Main dimensions of tank.

3.2. Entering standard baffles as equivalent for hydraulic resistance of the coil elements (Fig.3).

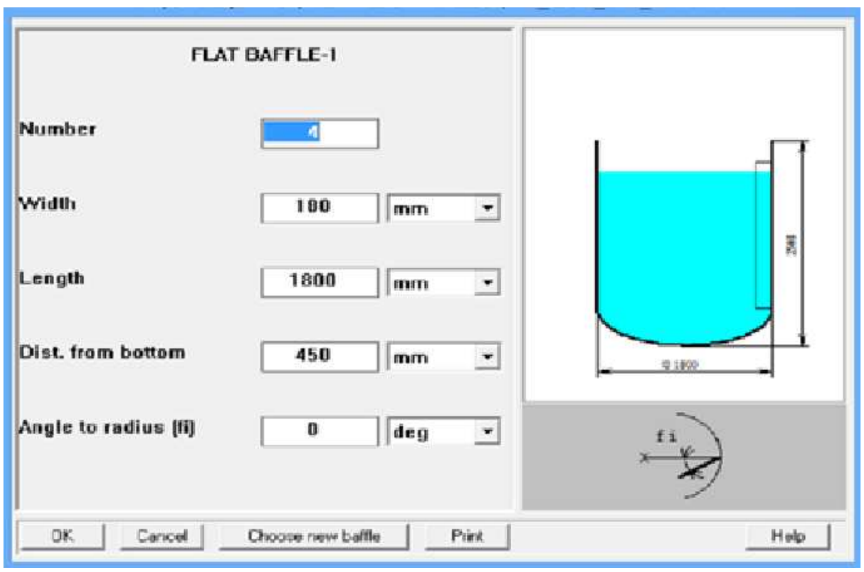


Figure 3. Baffles.

3.3. Entering impeller (Fig.4).

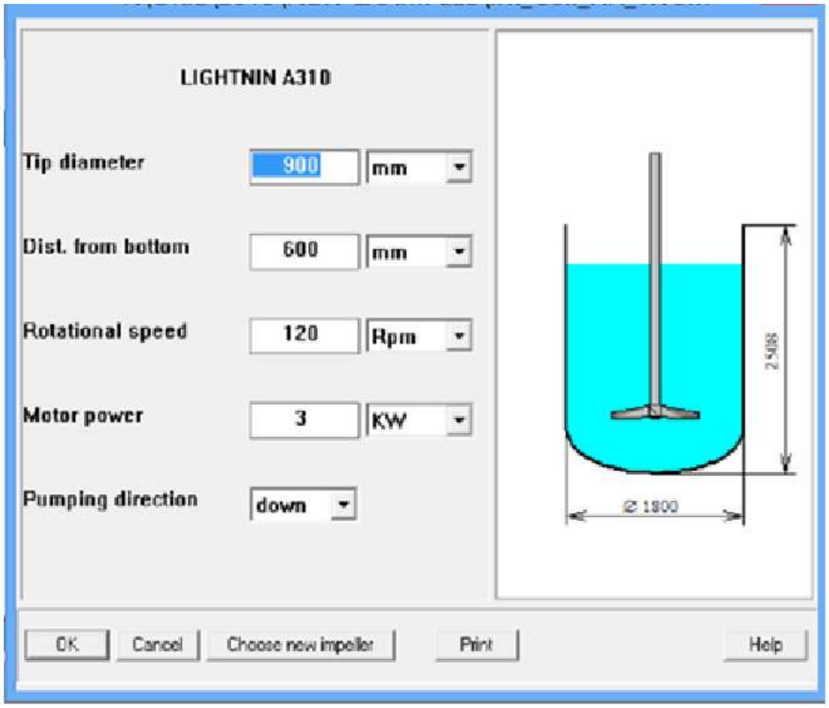


Figure 4. Impeller Lightnin A 310.

3.4. Entering main physical properties of media (Figs. 5, 6).

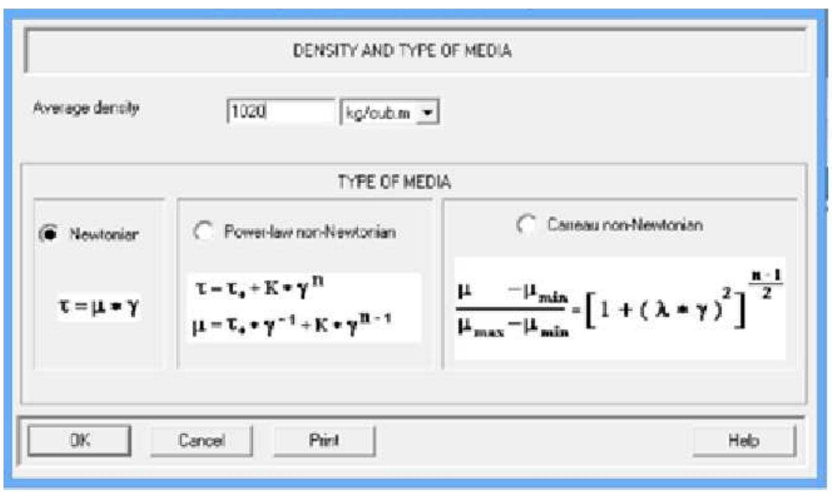


Figure 5.

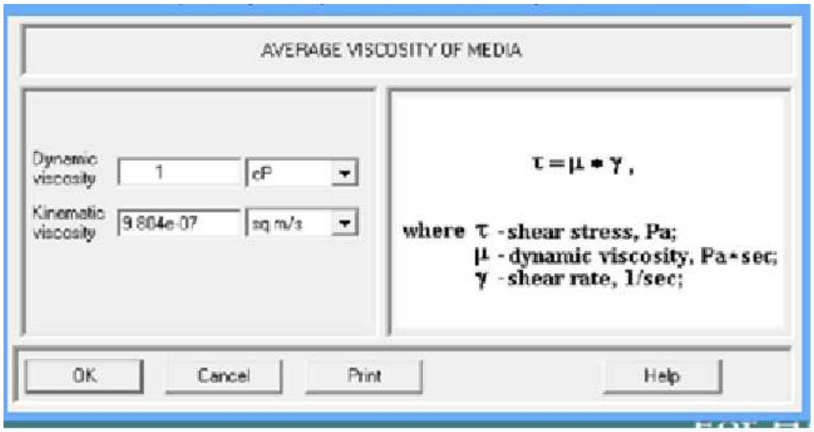


Figure 6.

4. Entering dimensions of the equivalent half-pipe jacket (Figs. 7,8).

4.1. Equivalent height of half-pipe jacket (Fig.8) corresponding to heat transfer area 7 sq.m is

7 / (3.14*1.8) = 1.24 m =1240 mm.

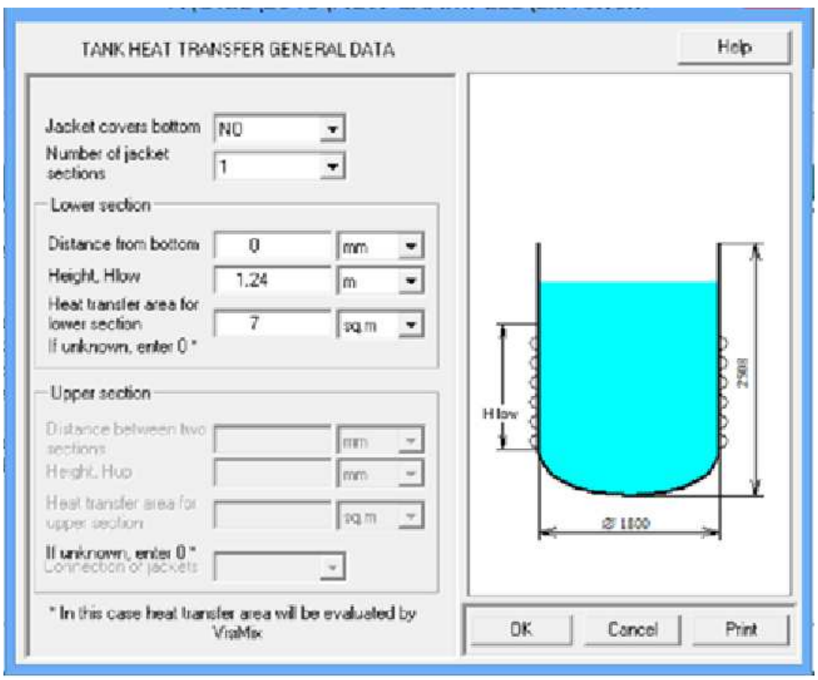


Figure 7.

4.2. The equivalent thickness of the tank wall for heat transfer calculations (Fig. 8) has to be equal to thickness of the coil pipe - 2.77 mm.

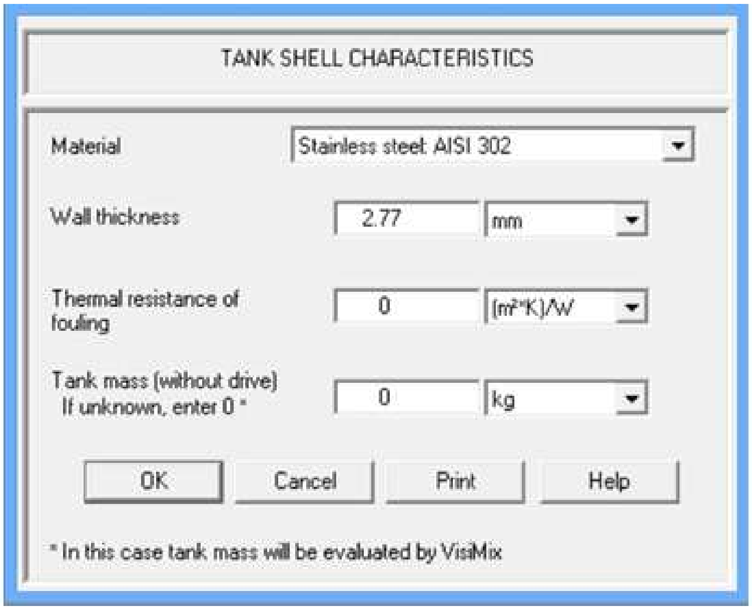


Figure 8.

4.3. Inside diameter of pipe of the coil is

60.3 - 2*2.77 = 54.76 mm;

Inside diameter of equivalent half-pipe is defined as diameter of a pipe with double cross-section. It is

54.76*$\sqrt{2}$ = 77.4 mm;

Accepted outside diameter – 80 mm (Fig.9).

4.4. Length of pipe in the coil is

7 m^2 / (3.14*0.0603m) = 37 m.

Length of each ring of the equivalent half-pipe is

3.14*1.8 = 5.65 m.

Equivalent number of rings is

S7 / 5.65 = 6.55.

Distance between the coils corresponding to length of the half-pipe 37 m is

1240 mm / 6.55 = 189.3 mm.

Accepted value – 190 mm (Fig. 9)

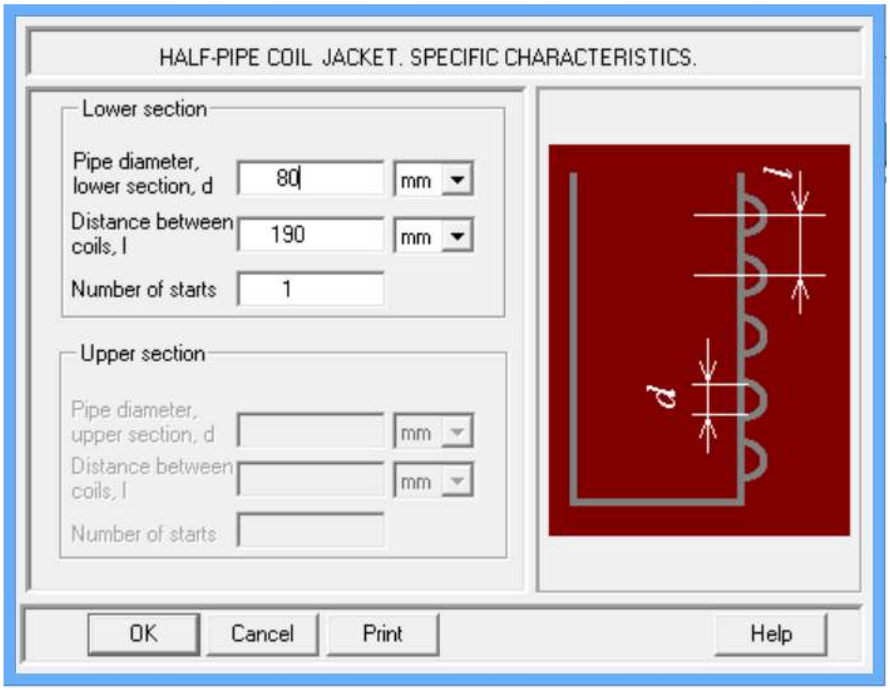


Figure 9.

5. Entering additional data and calculation of heat transfer parameters for a fixed temperature regime (Fig. 10)

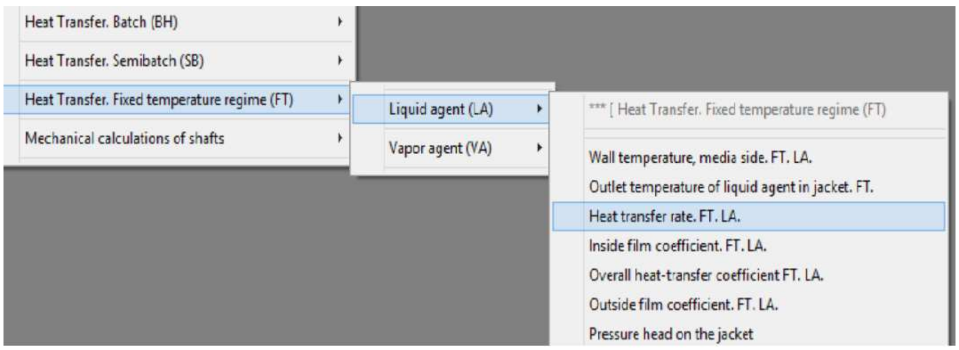


Figure 10. Heat Transfer calculation menu.

5.1. Entering additional Properties & Regime data accordingly to requests of the program (Figs 11-14)

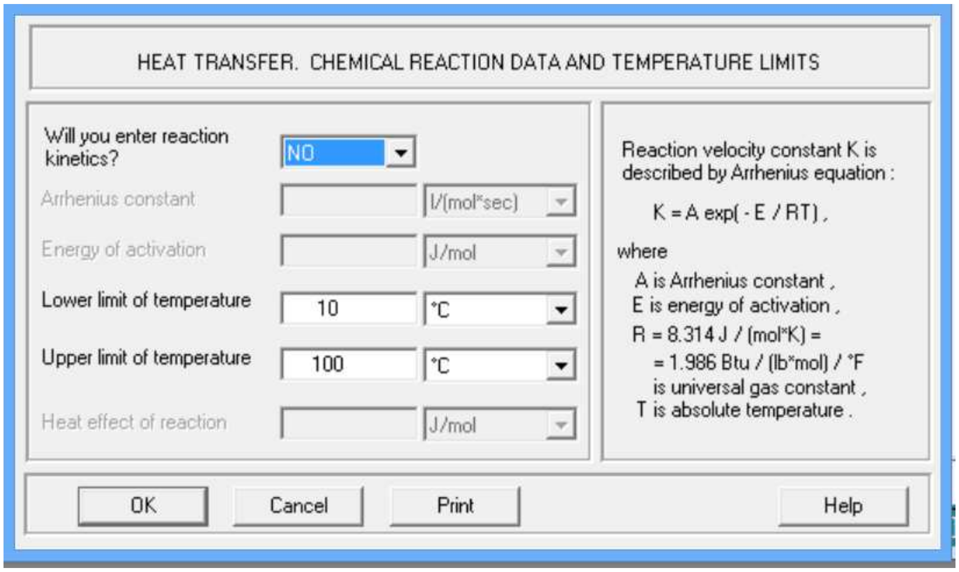


Figure 11. Entering additional process information.

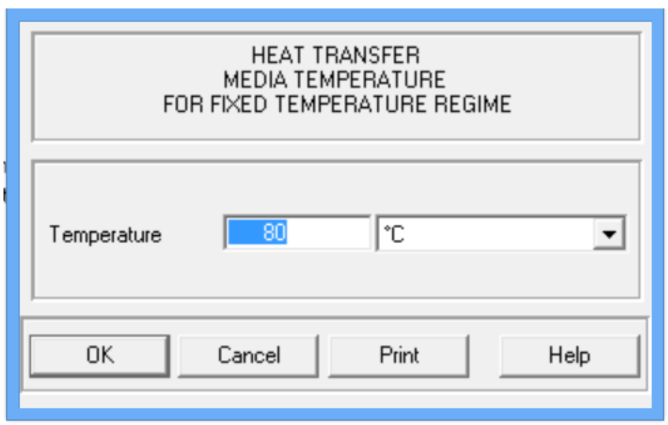


Figure 12. Entering additional process information.

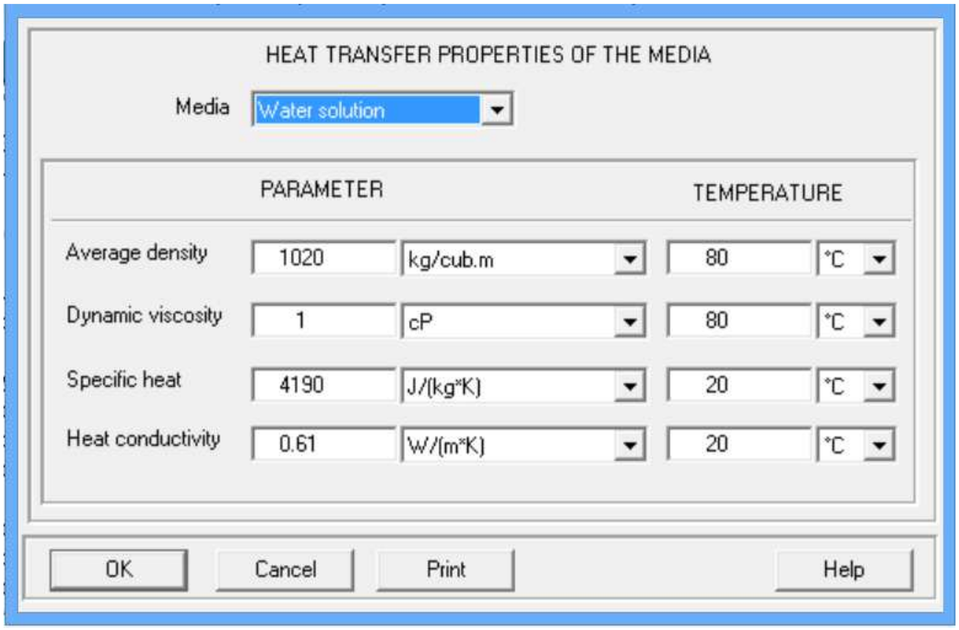


Figure 13. Entering physical properties of media.

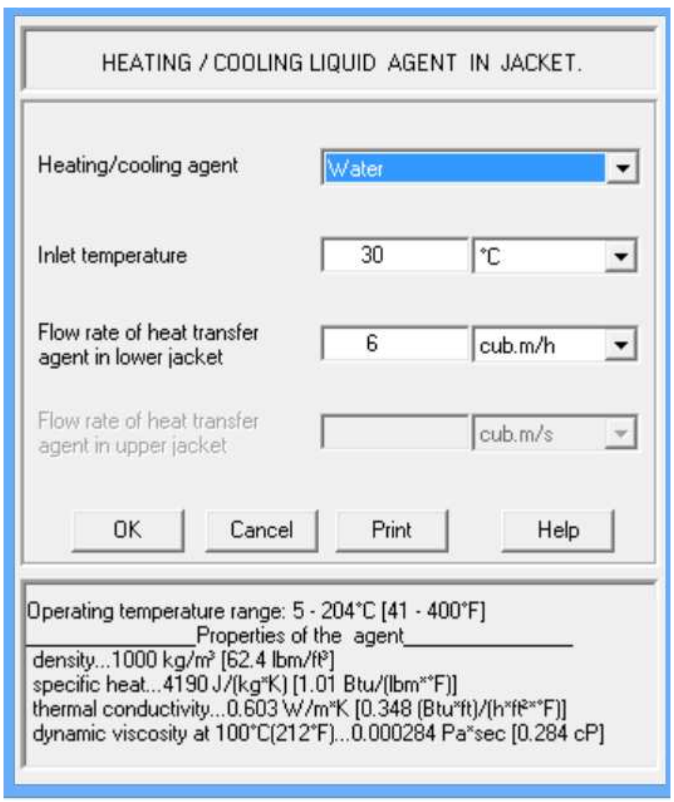
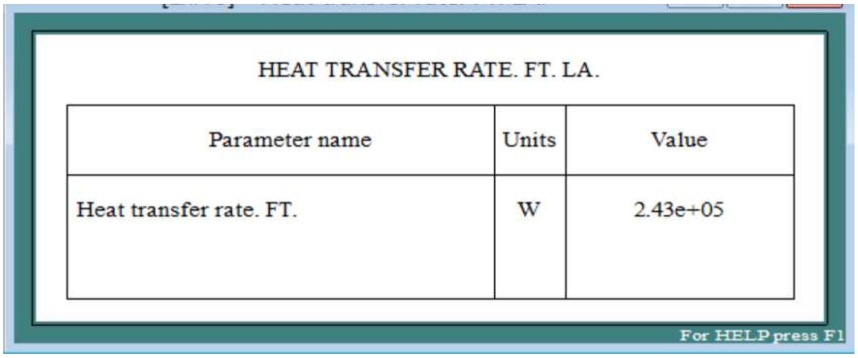


Figure 14. Entering data on cooling agent.

5.2. Calculating heat transfer parameters (Figs 15 -16) and water pressure on the inlet to internal coil (Fig. 17).

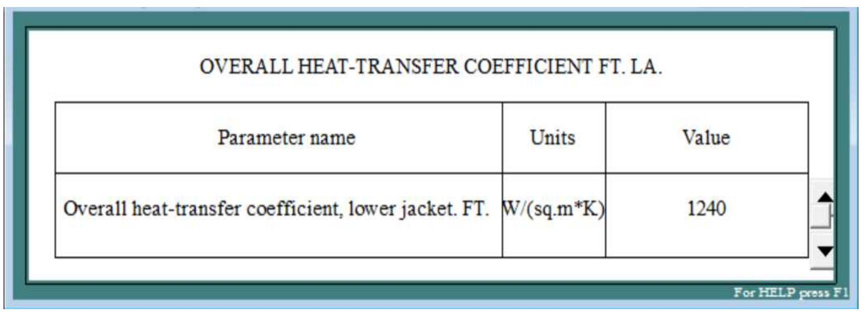


HEAT TRANSFER RATE. FT. LA.

Parameter name	Units	Value
Heat transfer rate. FT.	W	2.43e+05

For HELP press F1

Figure 15. Heat transfer rate.



OVERALL HEAT-TRANSFER COEFFICIENT FT. LA.

Parameter name	Units	Value
Overall heat-transfer coefficient, lower jacket. FT.	W/(sq.m*K)	1240

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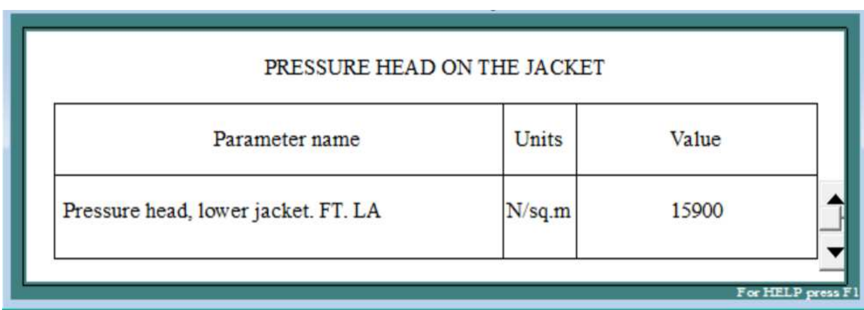
Figure 16. Overall heat transfer coefficient.



PRESSURE HEAD ON THE JACKET

Parameter name	Units	Value
Pressure head, lower jacket. FT. LA	N/sq.m	15900

For HELP press F1

Figure 17. Necessary pressure on the inlet to coil.