Design and CFD (Conjugated Fluid Dynamics) Analysis on Shell and Tube Heat Exchanger for Reduction of Temperature of Turbinol XT32

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Abstract - A lubricant is capable of reducing friction between surfaces in mutual contact, which ultimately reduces the generated heat when the surfaces are in contact. It may also have the function of transmitting forces, heating or cooling the surfaces. In HPCL (HINDUSTHAN PETROL CO-ORPERATION LIMITED) lube oil TURBINOL XT-32 is used for the turbines. In this process lube oil should be maintain at 60 degrees centigrade for this they need to provide a shell and tube heat exchanger which can easily reduce the temperature of oil while entering into the turbine bearings without damaging the bearings. In shell and tube heat exchanger the counter flow process is to be tested whether the design is optimized for the long run utility. The shell and tube heat exchanger is designed in CATIA -V5 and CFD analysis done in COMSOL simulation V12 to analyze the temperature and velocity and pressure drop of the lube oil throughout the length of pipe. Shell and tube heat exchanger software (S&HEX) is software for analyzing the design by giving the theoretical values to it and comparing with the standard values.

I. INTRODUCTION

Shell and tube heat exchangers we are having both flows parallel and counter flow directions. In parallel flow both water and fluid are travelling in same direction. In counter flow direction fluid and water travel in opposite direction so it has long run utility.
So we had chosen shell and tube heat exchanger in counter flow direction

II. METHODOLOGY

PROBLEM IDENTIFICATION

The lube oil (Turbinol XT32) is coming out through turbine equipment the temperature of lube oil increases to 80 degrees we need to reduce the temperature while the same lube oil for the turbine inlet. At that temperature the bearings are getting damaged we have the only way to rectify the problem by reducing the temperature of Lube oil (Turbinol XT32).

PARAMETERS

Name	Expression	Value	Description
u_water	0.002[m/s]	0.24 m/s	Inlet velocity, water
u_lube oil	0.002[m/s]	0.5 m/s	Inlet velocity, lube oil
T_water	27 [degC]	300 K	Inlet temperature, water
T_lube oil	100[degC]	373 K	Inlet temperature, lube oil

HEAT EXCHANGER DIMENSIONS

S.NO	DESCRIPTION	UNIT	VALUE
1	Over all dimensions	cm	128×20×28
2	Shell diameter	cm	20
3	Tube outer diameter	cm	1.1
4	Tube inner diameter	cm	1
5	Number of tubes	cm	34
6	Shell tube length	cm	100
7	Inlet length	cm	14
8	Outet length	cm	14

CALCULATIONS

Given:- Turbulent oil TX-32(shell side)

Water (tube side)

	Inlet temperature	Outlet temperature
Oil	100 C	62.31 C
	27	57.9

Single pass – SHELL AND TUBE HEAT EXCHANGERS

Inner diameter of tube= 1cm=0.01m
Outer diameter of tube= 1.1cm=0.011m

Number of tubes=34
Length of tube=14cm=0.014m

Now,

Uo= Over all heat transfer co-efficient

$$1/U_o=[r_o/r_i \times 1/h_o] + [r_o/r_i(R_{fi})] + [r_o/k\ln(r_o/r_i)] + R_{fo} + 1/h_o$$

$$1/U_o= [0.0055/0.055 + 1/4500] + [0.0055/0.055 \times(0.004)] + [0.0055/225 \ln(0.055/0.005) + 0.001 + 1/1250$$

$$U_o= 198.16\ w/m^{\circ}C$$

$$A_o=\pi\ d_o L$$

$$\pi \times 0.011\times 0.128=0.0442m$$

Logarithmic mean temperature difference(LMTD)

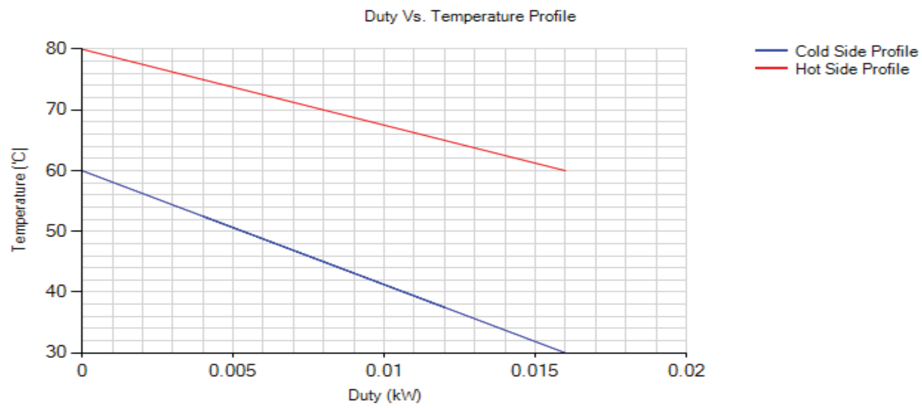
$$\theta_m=\theta_1-\theta_2/\ln(\theta_1/\theta_2)$$

$$(373-330.9)-(335.31-300)/\ln(42.1/35.31)$$

$$\theta_m= 38.35^{\circ}c$$

Q=UAOϴm

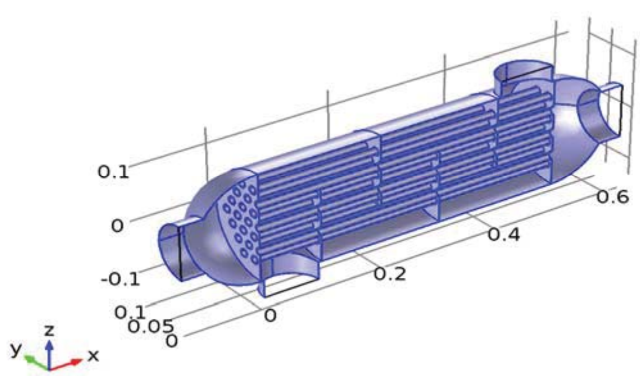
198.16×0.0442×38.35 = 335.89KW
Q=335.89KW

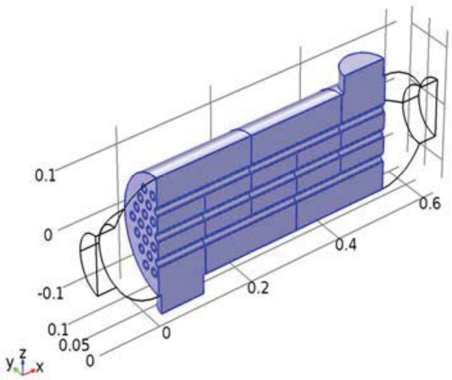


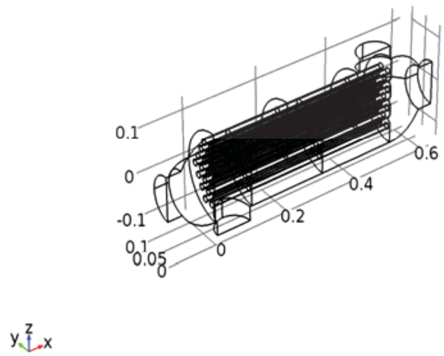
III. DUTY VS TEMPERATURE

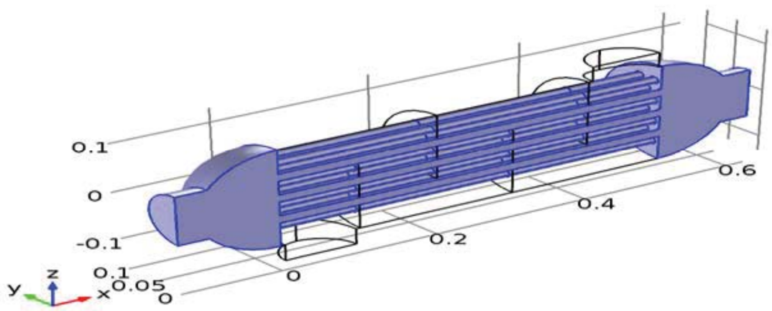
Number of tubes=34

Shell is made of alluminium & Tube is made of aluminum









Water, liquid

Velocity of the water decrases during the period and also increases with in limits. The velocity decreases near baffels and increses certainly.

Slice: Velocity Slice: Velocity magnitude (m/s)

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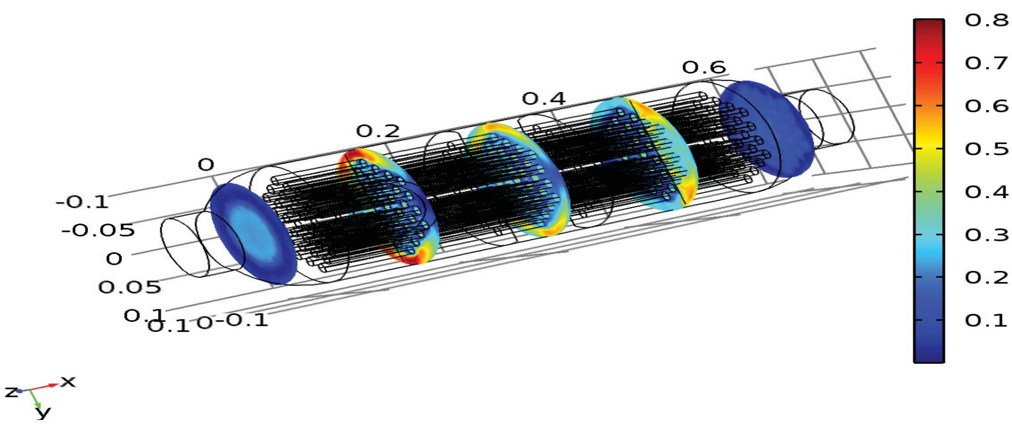
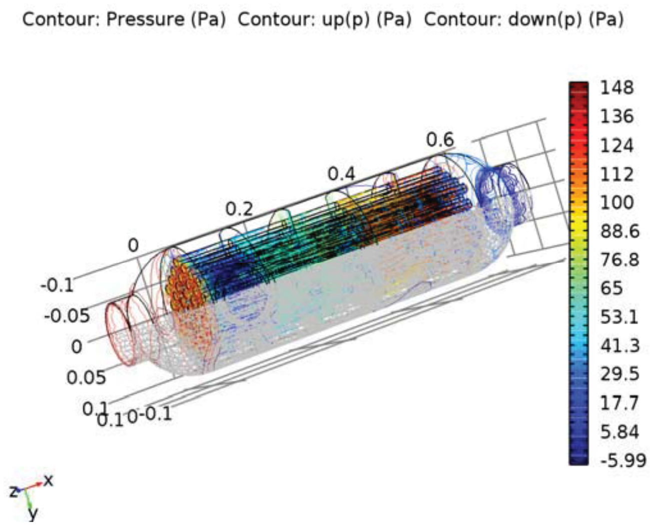


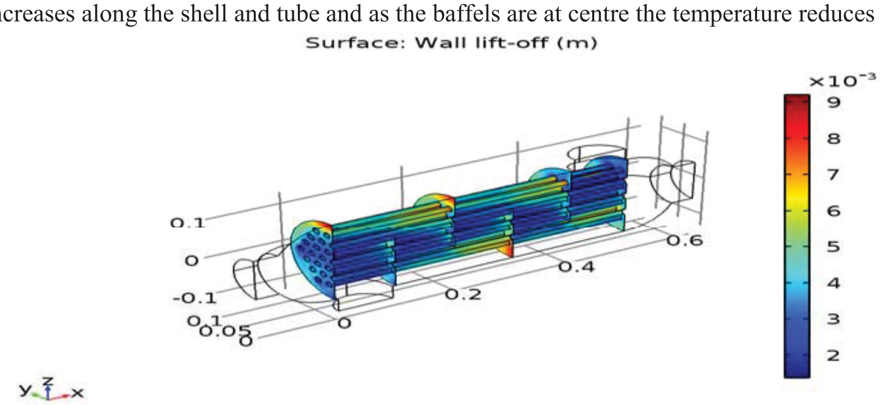
The pressure increases near baffels and the velocity reduces during the length of the tube

Slice: Velocity magnitude (m/s)



Contour: Pressure (Pa) Contour: up(p) (Pa) Contour: down(p) (Pa)

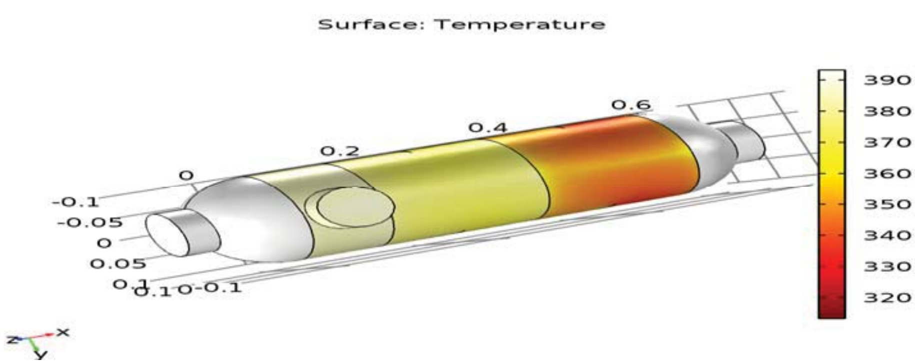
The temperature increases along the shell and tube and as the baffels are at centre the temperature reduces

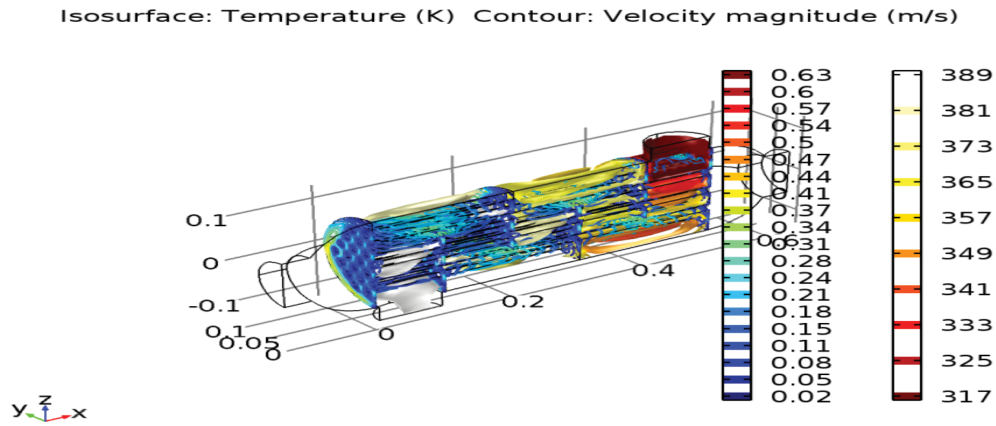


throughout the length

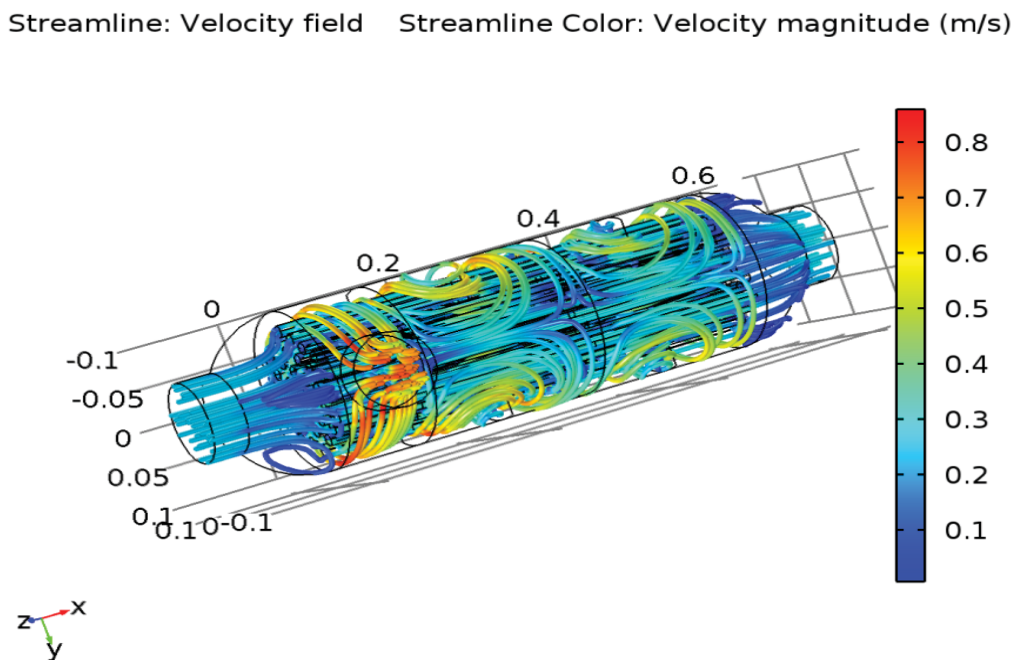
Surface: Wall lift-off (m)

The surface temperature along the shell also decreases as shown in the figure





Isosurface: Temperature (K) Contour: Velocity magnitude (m/s)



Streamline: Velocity field Streamline Color: Velocity magnitude (m/s)

IV. CONCLUSION

Comsol multi physics software designed the module by deriving with jacobian matrix relating with the velocity and the pressure relate shape functions.from the theoritical calculations and the analytical analysis the velocity counters and the temperature gradient change and the pressure distribution and the stream lines are analyzed and the temperature of the lube oil reduced to nearly 60 degrees as per the required design.

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