

Heat Transfer Analysis of Helical Tubes Using Ansys and Catia

Md Ameer Basha, Assoc.Prof. K Supriya

Abstract: - A CFD package (ANSYS FLUENT 15.0) was used for the numerical study of heat transfer characteristics of a helical coiled double pipe heat exchanger for counter flow. The CFD results when compared with the results from different studies were well within the error limits. The study showed that the effective configuration of heat transfer performances of the counter-flow. The simulation was carried out for fluid to fluid heat transfer characteristics for different fluids, solids and different inlet temperatures were studied. Effectiveness of Helical Tube Heat Exchanger is calculated on different fluids and solid configurations. Among different fluids and solid configurations copper-water combination gives more effectiveness **16.33%** than other combinations. From the velocity vector plot it was found that the fluid particles were undergoing an oscillatory motion inside both the pipes. From the pressure and velocity contours it was found that along the outer side of the pipes the velocity and pressure values were higher in comparison to the inner values.

Keywords –: Heat Exchanger, CFD, Helical coile heat exchanger

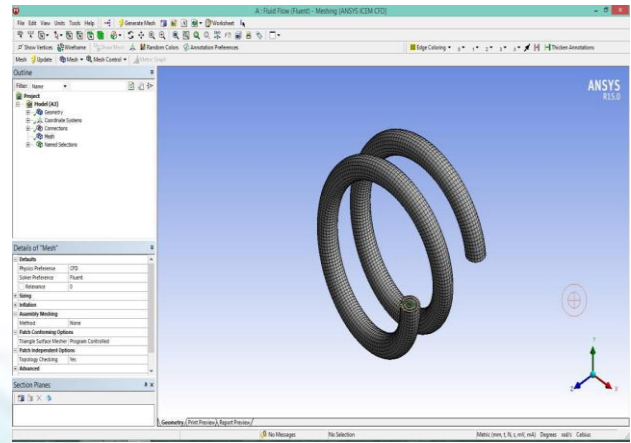
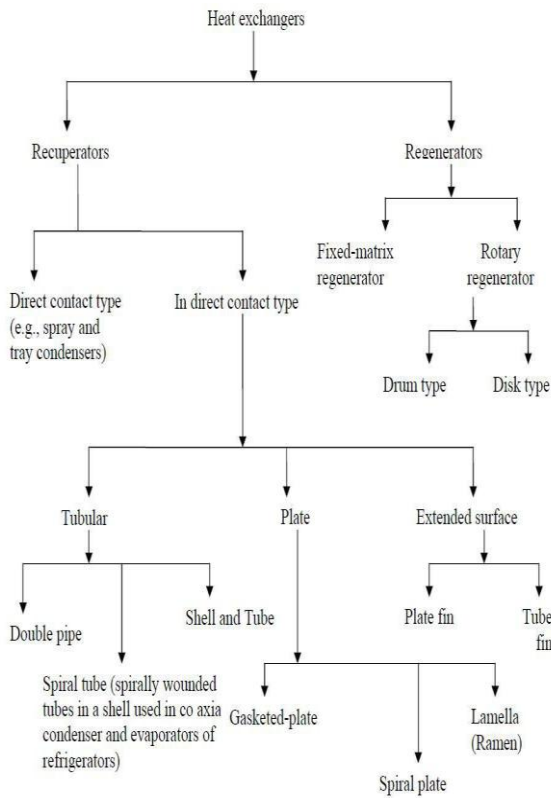
1. INTRODUCTION

Heat exchanger is a device, such as an automobile radiator, used to transfer heat from a fluid on one side of a barrier to a fluid on the other side without bringing the fluid into direct contact (Fogiel, 1999). Usually, this barrier is made from metal which has good thermal conductivity in order to transfer heat effectively from one fluid to another fluid. Besides that, heat exchanger can be defined as any of several devices that transfer heat from a hot to a cold fluid. In engineering practical, generally, the hot fluid is needed to cool by the cold fluid. For example, the hot vapor is needed to be cool by water in condenser practical. Moreover, heat exchanger is defined as a device used to exchange heat from one medium to another often through metal walls, usually to extract heat from a medium flowing between two surfaces. In automotive practice, radiator is used as heat exchanger to cool hot water from engine by air surrounding same like intercooler which used as heat exchanger to cool hot air for engine intake manifold by air surrounding. Usually, this device is made

from aluminum since it is lightweight and good thermal conductivity.

FUNCTION OF HEAT EXCHANGER

Heat exchanger is a special equipment type because when heat exchanger is directly fired by a combustion process, it becomes furnace, boiler, heater, tube-still heater and engine. Vice versa, when heat exchanger make a change in phase in one of flowing fluid such as condensation of steam to water, it becomes a chiller, evaporator, sublimate, distillation-column reboiler, still, condenser or cooler-condenser. Heat exchanger may be designed for chemical reactions or energy-generation processes which become an integral part of reaction system such as a nuclear reactor, catalytic reactor or polymer (Fogiel, 1999). Normally, heat exchanger is used only for the transfer and useful elimination or recovery of heat without changed in phase. The fluids



Materials

The create/edit option is clicked to add appropriate fluid and solid to the list of fluid and solid respectively from the fluent database. The taken fluid and solid are tabulated below

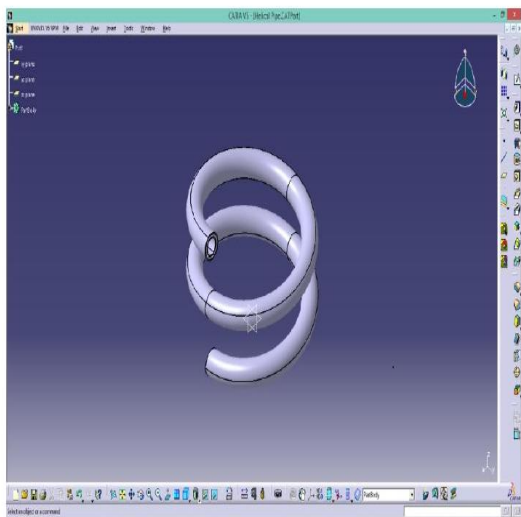
S.No	Solid	Fluid
1.	Copper	Water
2.	Copper	Benzene
3.	Copper	Kerosene
4.	Aluminum	Water
5.	Aluminum	Benzene
6.	Aluminum	Kerosene

Table3 List of Materials

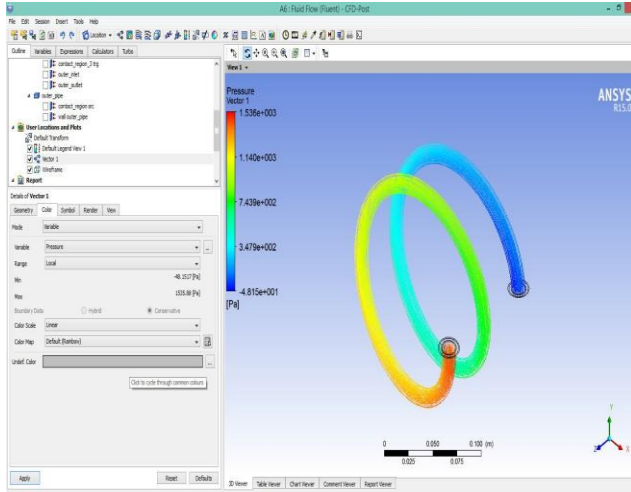
Boundary Conditions

Boundary conditions are used according to the need of the model. The inlet and outlet conditions are defined as velocity inlet and pressure outlet. As this is a counter-flow with two tubes so there are two inlets and two outlets. The walls are separately specified with respective boundary conditions. No slip condition is considered for each wall. Except the tube walls each wall is set to zero heat flux condition. The details about all boundary conditions can be seen in the table 3 as given below.

2. MODELLING OF HEAT EXCHANGER THROUGH CATIA



3. MESHING OF MODEL



	Boundary Condition Type	Velocity Magnitude	Turbulent Kinetic Energy	Turbulent Dissipation Rate	Temperature
InnerInlet	Velocity Inlet	0.9942 m/s	$0.01 \text{ m}^2/\text{s}^2$	$0.1 \text{ m}^2/\text{s}^3$	348 K
InnerOutlet	Pressure Outlet	-	-	-	-
OuterInlet	Velocity Inlet	1.8842 m/s	$0.01 \text{ m}^2/\text{s}^2$	$0.1 \text{ m}^2/\text{s}^3$	283 K
OuterOutlet	Pressure Outlet	-	-	-	-

Calculation

Temperature Variations (in K):

Case 1: Copper as Solid

Table5 Temperature Variations in Copper Configuration Fluid inner inlet inner outlet outer inlet outer outlet

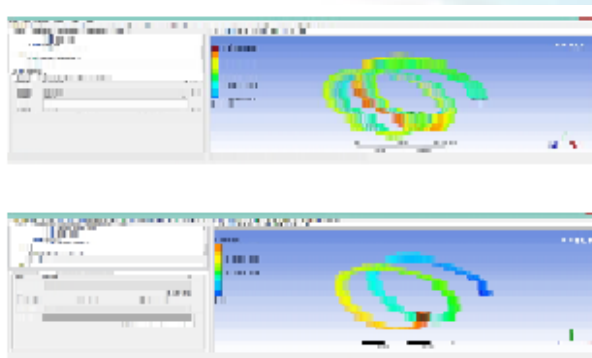
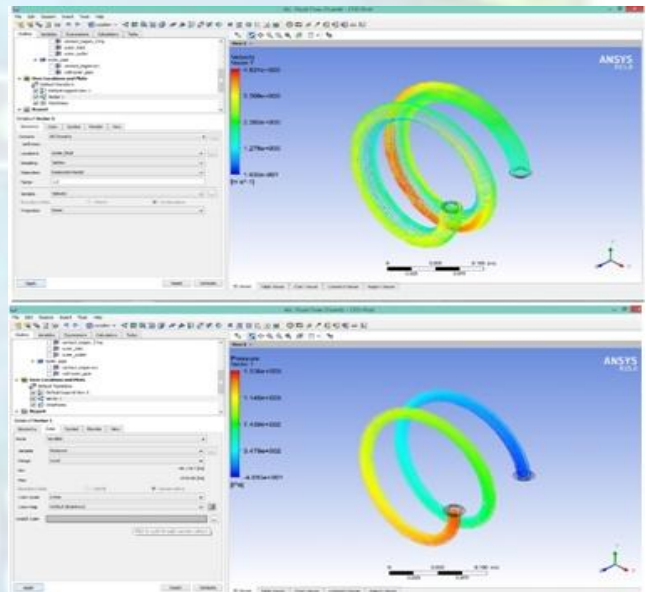
Water	348	334.83502	283	293.61945
Benzene	348	335.71158	283	290.61935
Kerosene	348	342.86499	283	284.78473

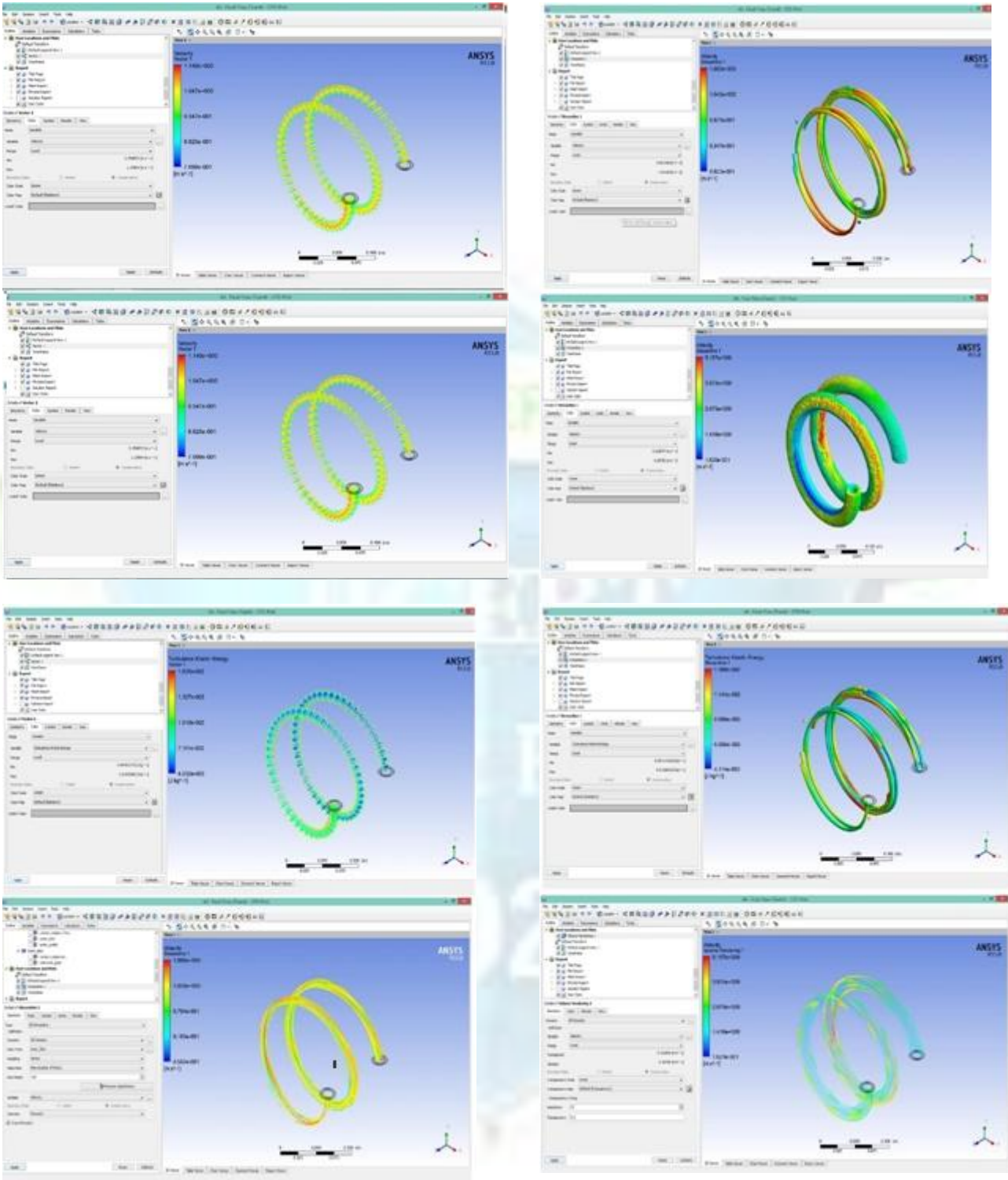
Case 2: Aluminum as Solid

Table6 Temperature Variations in Aluminum Configuration Fluid inner inlet inner outlet outer inlet outer outlet

Water	348	334.85919	283	291.75452
Benzene	348	335.21664	283	289.25629
Kerosene	348	341.82629	283	284.41977

4. RESULT AND DISCUSSION





CONCLUSION

A CFD package (ANSYS FLUENT 15.0) was used for the numerical study of heat transfer characteristics of a helical coiled double pipe heat exchanger for counter flow. The CFD results when compared with the results from different studies were well within the error limits.

The study showed that the effective configuration of heat transfer performances of the counter-flow. The simulation was carried out for fluid to fluid heat transfer characteristics for different fluids, solids and different inlet temperatures were studied.

Effectiveness of Helical Tube Heat Exchanger is calculated on different fluids and solid configurations. Among different fluids and solid configurations copper-water combination gives more effectiveness 16.33% than other combinations.

From the velocity vector plot it was found that the fluid particles were undergoing an oscillatory motion inside both the pipes. From the pressure and velocity contours it was found that along the outer side of the pipes the velocity and pressure values were higher in comparison to the inner values.

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