A SCHEMATIC DESIGN AND ANALYSIS OF A HEAT EXCHANGERS WITH PARALLEL AND COUNTER FLOW ANALYSIS- CFD APPORACH

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ABSTRACT:
Heat exchangers have dependably been a vital part to the life cycle and operation of numerous frameworks. A Heat exchanger is a gadget worked for proficient heat exchange starting with one medium then onto the next keeping in mind the end goal to convey and process vitality. Commonly one medium is cooled while the other is heated. They are broadly utilized as a part of oil refineries, compound plants, and petrochemical plants. The reason for this proposal work is to outline an Oil Cooler, particularly for shell and tube heat trade which is the dominant part kind of fluid to fluid heat exchanger with puzzle for actuated turbulence and higher heat exchange coefficient. Displaying is finished by utilizing CATIA and examination completed in Ansys delicate product 16.0. General plan thought and outline methodology are likewise delineated in this proposal in outline estimation; the Ansys delicate product 16.0 Within the task work the investigation are improved the situation Heat exchanger with perplex and without astound additionally utilized four material for tubes and watched the heat exchange rate is expanded for heat exchanger with bewilder and when we utilized metal material. From the hypothetical demonstrating the convection heat exchange coefficient alongside the mass temperature are discovered and forced as limit condition to anticipate the. Temperature dispersion, heat motion and heat inclination in heat exchange examination. Additionally when we do auxiliary investigation for heat exchanger by utilizing Ansys 16.0 programming we watching the examination result the removal and stresses are less, when we utilized heat exchanger with astound than when we utilized heat exchanger without confound. Additionally by contrasting the outcome for four materials, the anxiety is less when metal material is utilized.

1.0 Introduction:

DEFINITION OF HEAT EXCHANGER

Heat exchanger is a gadget, for example, a car radiator, used to exchange heat from a liquid on one side of a hindrance to a liquid on the opposite side without bringing the liquid into coordinate contact. As a rule, this obstruction is produced using metal which has great heat conductivity with a specific end goal to exchange heat successfully starting with one liquid then onto the next liquid. Other than that, heat exchanger can be characterized as any of a few gadgets that exchange heat from a hot to a cool liquid. In building handy, by and large, the hot liquid is expected to cool by the chilly liquid. For instance, the hot vapor is should have been cool by water in condenser down to earth. Besides, heat exchanger is characterized as a gadget used to trade heat starting with one medium then onto the next frequently through metal dividers, as a rule to remove heat from a medium streaming between two surfaces. In car hone, radiator is utilized as heatexchanger to cool high temp water from motor via air encompassing same like intercooler which utilized as heatexchanger to cool hot air for motor admission complex via air encompassing. More often than not, this gadget is produced using aluminum since it is lightweight and great heat conductivity

DESTINATIONS OF RESEARCH:

The goal of the present examination is to give more total understanding Flow mal dissemination in tubular heatexchanger by considering region weighted and mass weighted temperature profiles formal circulation without reverse and mal conveyance with reverse. What's more, examination of normal temperature profiles of stream mal circulation with the normal temperature profiles of uniform mass stream appropriation. This numerical examination was done for the concentric tube game plan with various measurement of tubes. A limited volume numerical plan is utilized to foresee the conjugate heatexchange and liquid stream qualities with the guide of the computational liquid elements (CFD) business code, FLUENT. A viable model, the standard based k-ε turbulence demonstrate was connected in this examination. In this way, temperature appropriations inside the package were contemplated numerically. The target of this examination is to build up a CFD recreation to foresee heat Transfer in concentric tube heat exchanger by utilizing diverse liquids.

Applications for Counter and Parallel Flows

We have seen two focal points for counter stream,

(a) Larger successful LMTD and

(b) Greater potential vitality recuperation.

The benefit of the bigger LMTD, as observed from the heatexchanger condition, is that a bigger LMTD grants a littler heatexchanger zone, Ao, for a given heatexchange, Q. This would regularly be required to bring about littler, more affordable hardware for a given application. At times, nonetheless, parallel streams are alluring

(a) Where the high introductory heating rate might be utilized to advantage and

(b) Where it is required the temperatures created at the tube dividers are direct.

In heating exceptionally thick liquids, parallel stream accommodates fast beginning heating and subsequent abatement in liquid thickness and decrease in pumping prerequisite. In applications where control of tube divider temperatures is required, parallel stream brings about cooler dividers. This is particularly advantageous in situations where the tubes are touchy to fouling impacts which are bothered by high temperature.

2.0 literature review:

1. **Sell and Hudson [1]** Fluid with a consistent speed profile streaming past a limited length plate was considered for the examination. The liquid methodologies at a known temperature, and heatis presented by methods for a known heatmotion at the base of the plate or by conveyed heat source in the strong. Conduction happens in the plate in both the longitudinal and transverse headings; heat streams in the liquid by convection toward the stream and by conduction far from the plate. Articulations for the temperature dispersions in the strong and the liquid are found and the impact of two dimensional divider conduction on heat exchange to a slug stream is resolved.

2. **Rotem [2]** has contemplated the impact of the divider heat conduction upon the interface temperature circulation for thin divider cooled by constrained laminar convection. He determined a fast surmised figuring technique both for temperature and film coefficient for two instances of a practically isothermal divider and a divider with consistent heatmotion.

3. **Davis and Cooper [3]** have contemplated heat move qualities in the heat passage locale for even simultaneous air-water stream over a level plate. Heatexchange and liquid mechanics parameters are measured for consistent divider temperature and steady divider heat transition limit conditions. The outcomes are contrasted and the hypothetical examination. Both the hypothetical and trial comes about are likewise contrasted as far as dimensionless gatherings with describe the framework, as far as divider temperature and divider heat motion profiles and nearby Nusselt number.

4. **Luikov et al. [4]** announced two general arrangement strategies for inward and outer conjugated issues of convective heatexchange. The general technique produced for inside heatexchange conjugate heatexchange issues depends on diminishing the issue to a solitary essential condition for the obscure temperature of the surface. This technique gave the correct answers for both enduring and

flimsy heatmove in laminar and turbulent stream. The second broad technique created for outside stream conjugated issues decided the answer for both enduring and shaky heatexchange issues for a plate in fluid and gas streams alongside radiation and additionally infusion (suction) impact.

5. **Olsson [5]** has examined that the heatexchange attributes of a limited wedge formed blade in a laminar stream. The vitality conditions for the liquid and the strong body are explained all the while under the states of coherence in heat transition and temperature at the interface. The impact of heatconduction in the wedge is examined utilizing an essential strategy for arrangement which is appeared in great concurrence with a numerical technique in light of the Blasius system and furthermore with tests gave radiation is considered. The outcomes are displayed for different wedge materials and distinctive sort of liquids.

6. **Sohal and Howell [6]** have decided the temperature profile of heat framework including interior heatage with conduction in the strong. Heatis rejected to a streaming straightforward gas by convection and to steady temperature dark surroundings by radiation which is generally connected to the outline of air specialty and rockets, hot wire anemometry cooling of electronic instruments and different territories.

7. **Luikov [7]** has inferred two estimated designing arrangements of conjugate heatexchange issue in view of neighborhood Nusselt number for laminar incompressible stream around a level plate of limited thickness for Prandtl number close or not as much as solidarity. One depends on a differential investigation expecting a uniform speed profile in the heat limit layer and the other is a basic examination in view of polynomial portrayals of speed profiles and temperature profiles. Incompressible stream past level plate has likewise been examined by for laminar limit layer heat exchange issues and acquired helpful answers for higher Prandtl numbers moreover.

8. **Chida and Katto [8]** contemplated conjugate heatmove in a framework between a ceaselessly moving strong surfaces and the liquid. The impact of heatconduction in the moving solids was spoken to utilizing the conjugate dimensionless gatherings. The impact of mix of the strong and liquid is considered hypothetically and demonstrated tentatively for level plate in the water.

9. **Fiebig et al [9]** considered that the conjugate heat move in an elite finned tube heat exchanger for three dimensional thermally and hydro dynamically creating laminar streams. The impact of Reynolds and balance proficiency parameter (proportion of blade to liquid conductivity times balance thickness to balance pitch) on heat exchange conduct has been considered and the stream designs, weight dispersion, Nusselt number circulation, heat transition conveyance and balance effectiveness are displayed. A one of a kind heat exchange wonders, a directional inversion of heat exchange happened locally on the blade in the tube wake for little balance effectiveness and extensive Reynolds number which are deciphered as three dimensional connection of convection and the balance conduction in the tube wake, when the stream is ruled by a solid vertex and dead water zone with distribution.

3.0 Methodologies:

After the combustion in the burner, the gases attain a temperature of 1020°F. These gases are blown into the heat exchanger with the help of an indoor blower for 150 seconds. The pressure gradient induced by the blower (Δp = 0.0093128 lb/in^2) and temperature of the gases from the burner (1020°F) are applied as boundary conditions for the fluid flow analysis of gas flow region. With the obtained temperature distribution in the gas flow region as input, the thermal analysis of clamshell heat exchanger is performed to plot the temperature distribution in it. With the obtained temperature distribution in the clamshell heat exchanger as input, the structural analysis of clamshell heat exchanger is performed to plot the thermal stress distribution in it.

In the cooling cycle, the air is blown over the hot clamshell heat exchanger with the help of the blower for next 150 seconds. For this purpose a two-inch airflow region is modeled over the clamshell heat exchanger. The temperature distribution in the clamshell heat exchanger after heating cycle is given as initial condition i.e., at t=0. The pressure gradient induced by the blower (Δp = 0.127781e-3 lb/in^2) is applied as boundary condition. With the above initial and boundary conditions the fluid flow analysis of airflow region over the clamshell heat exchanger is performed to plot the velocity, pressure and temperature distributions in it. With the obtained temperature distribution in the airflow region as input, the thermal analysis of clamshell heat exchanger is performed to plot the temperature distribution in it. With the obtained temperature distribution in the clamshell heat exchanger as input, the structural analysis of clamshell heat exchanger is performed to plot the thermal stress distribution in it. Using these stress distributions the thermal fatigue life is calculated with the help of the Modified Goodman Diagram.

The clamshell heat exchanger is found to be failing after 9399.37 cycles due to thermal fatigue near the first bend region. The large thermal gradient existing in the region near the first bend is observed to be the critical parameter for the failure of the clamshell heat exchanger.

Flow Environment

In this reference conditions like reference pressure, bulk modulus parameter, nominal temperature, bulk temperature, stagnation temperature, temperature offset from absolute temperature, gravitational acceleration are specified. In the present problem reference conditions are specified in BIN unit system.

- Reference pressure

  14.7
- Bulk modulus parameter

  1E+15
- Nominal temperature

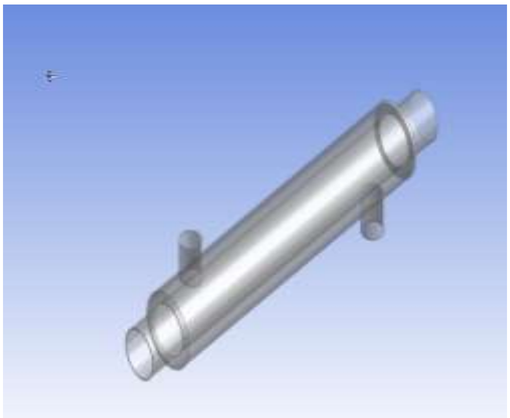
  70
- Bulk temperature

  70
- Stagnation temperature

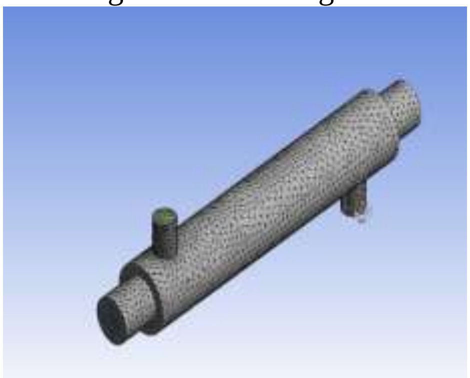
  70
- Temperature offset from absolute temperature 450

Turbulence model

The Standard k-epsilon Model and the Zero Equation Turbulence Model are the simplest models. Normally, the Standard k-epsilon Model is the first model to apply. It usually provides a realistic picture of the flow. It is fine for the analysis of turbulent flow in pipes and channels. However, it over predicts the amount of turbulence in a number of situations. For example, the flow in a converging nozzle undergoes significant normal strain and the Standard k-epsilon Model over predicts the amount of turbulence. The resulting kinetic energy is over predicted, and the resulting effective viscosity prevents simulation of shock waves in some cases. Here in the present case we use Standard k-epsilon Model.



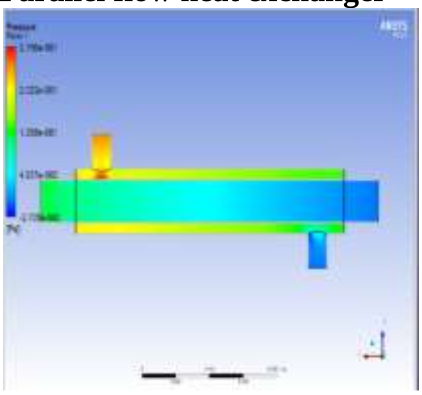
Modeling of heat exchanger



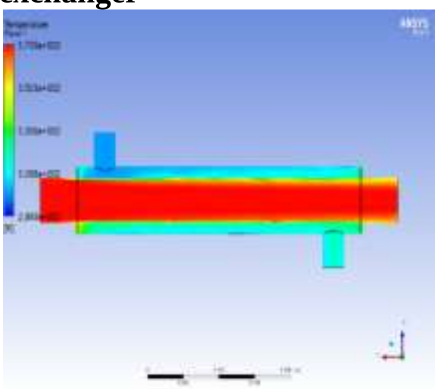
Meshing view of heat exchanger

4.0 RESULTS

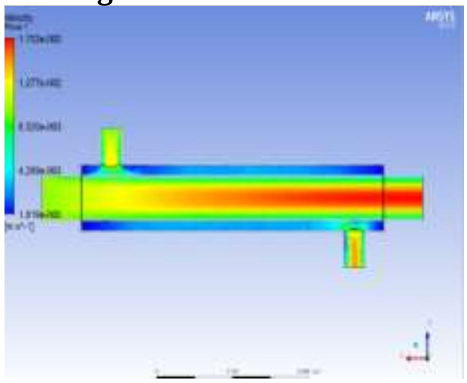
Parallel flow heat exchanger



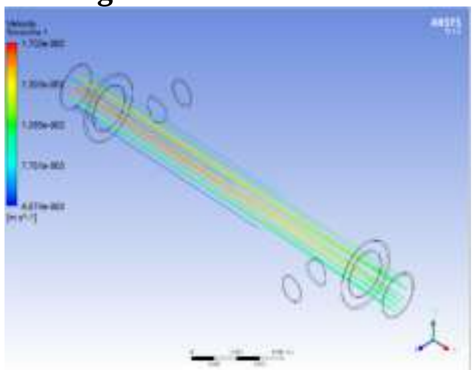
Pressure plane of parallel flow heat exchanger



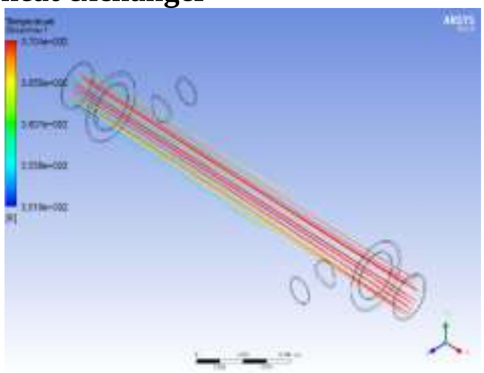
Temperature plane of parallel flow heat exchanger



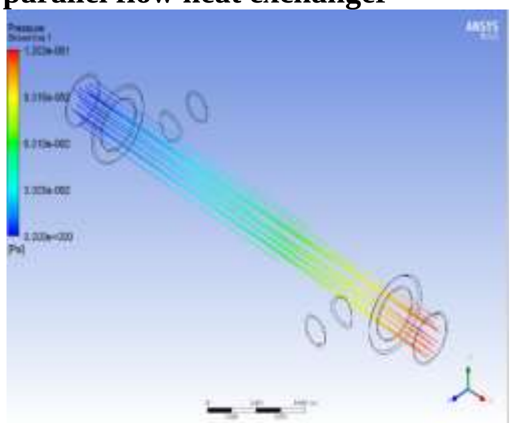
Velocity plane of parallel flow heat exchanger



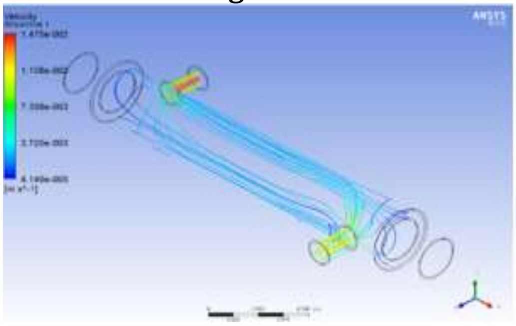
Velocity stream line inlet of parallel flow heat exchanger



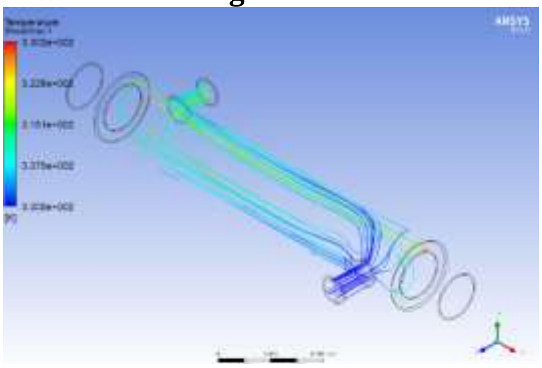
Temperature stream line inlet of parallel flow heat exchanger



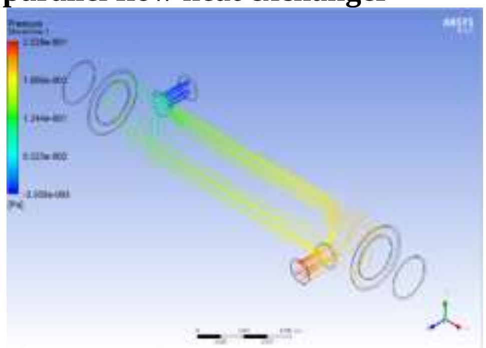
Pressure stream line inlet of parallel flow heat exchanger



Velocity streamline outlet of parallel flow heat exchanger

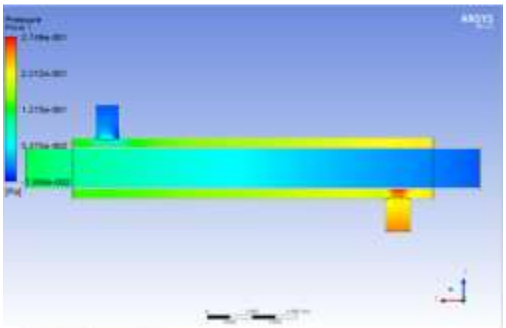


Temperature streamline outlet of parallel flow heat exchanger

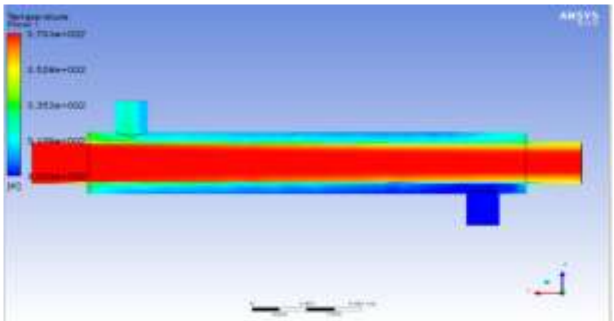


Pressure streamline outlet of parallel flow heat exchanger

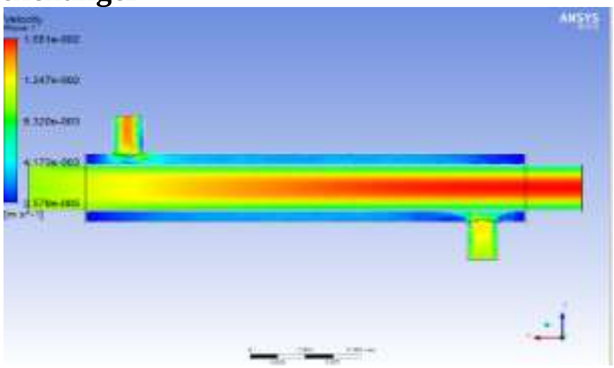
Counter flow:



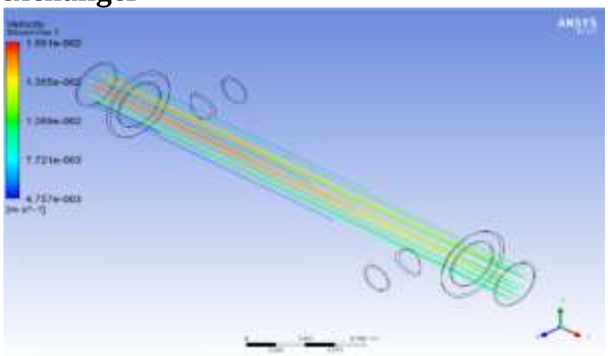
Pressure plane of counter flow heat exchanger



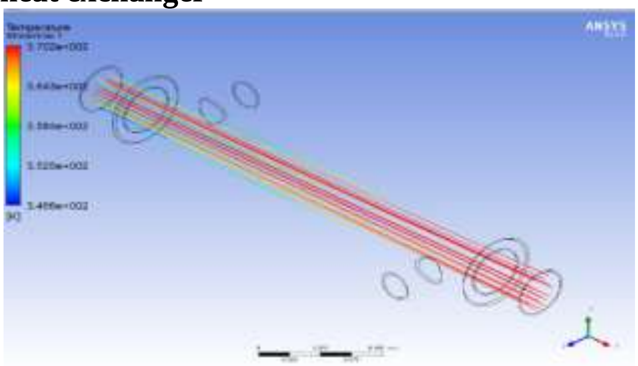
Temperature plane of counter flow heat exchanger



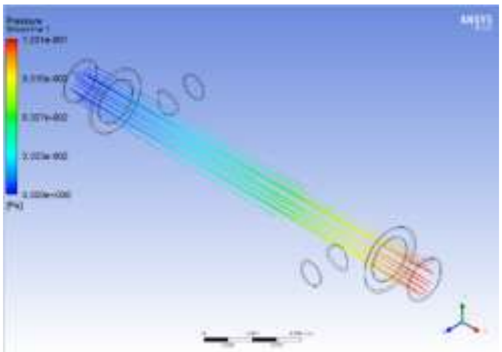
Velocity plane of counter flow heat exchanger



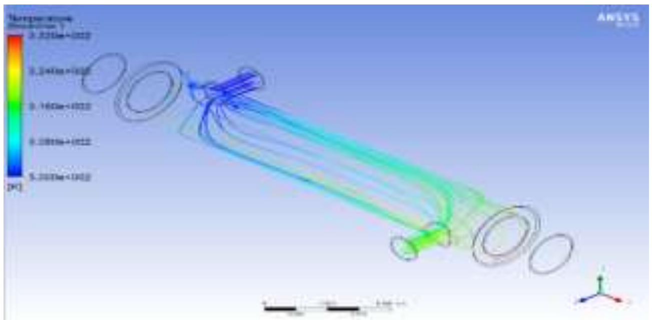
Velocity stream line inlet of counter flow heat exchanger



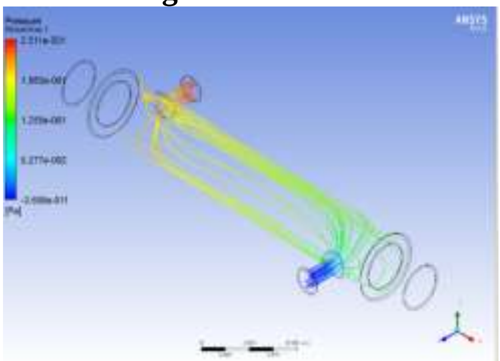
Temperature stream line inlet of counter flow heat exchanger



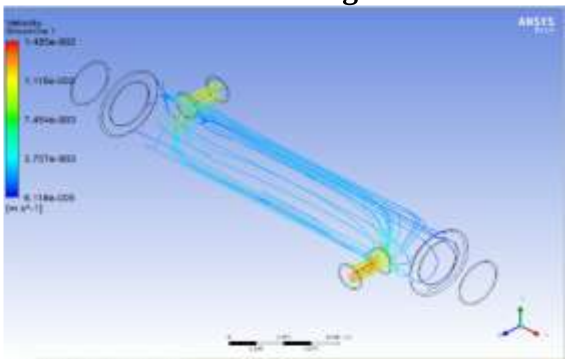
Pressure streamline inlet of counter flow heat exchanger



Temperature stream line outlet of counter flow heat exchanger



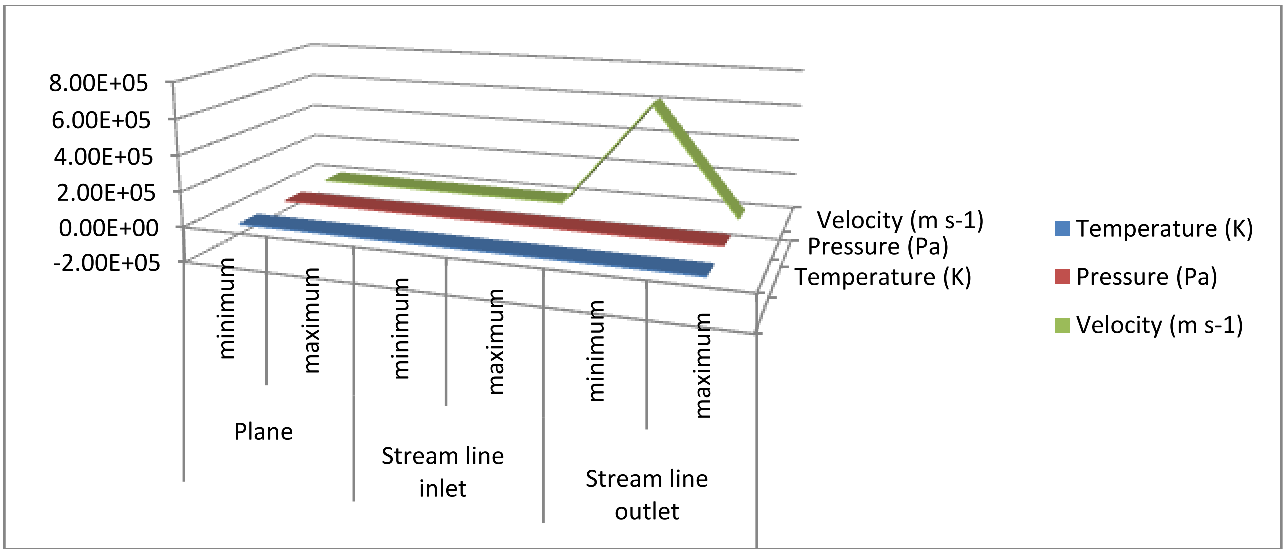
Pressure stream line outlet of counter flow heat exchanger



Velocity streamline outlet of counter flow heat exchanger

Table shows Variations in heat exchangers due to parallel flow

Parameters	Plane		Stream line inlet		Stream line outlet	
	minimum	maximum	minimum	maximum	minimum	Maximum
Temperature (K)	2.90E+02	3.71E+02	3.51E+02	3.70E+02	3.00E+02	3.24E+02
Pressure (Pa)	-2.07E-02	2.79E-01	0	1.20E-02	-3.70E-01	2.51E+01
Velocity (m s^{-1})	1.82E-05	1.70E-02	4.67E-03	1.70E-02	6.18E+05	1.48E-02



Graph shows parallel flow in heat exchangers

Table shows Variations in heat exchangers due to counter flow

Parameters	Plane		Stream line inlet		Stream line outlet	
	minimum	maximum	minimum	maximum	minimum	maximum
Temperature (K)	3.00E+02	3.704E+02	3.466E+02	3.702E+02	3.00E+02	3.320E+02
Pressure (Pa)	-1.96E-02	2.749E-01	0	1.201E-02	-3.698 E-011	2.51E+01
Velocity (m s^{-1})	2.578 E-05	1.661E-02	4.757E-03	1.661E-02	6.118E+05	1.485E-02

5.0 Conclusions:

The performance, CFD analysis of different fluids and different pipe materials were investigated on parallel and counter flow in concentric tube heat exchanger. The conclusions of this investigating at are as a 3D model of a multilayered counter flow and parallel heat exchanged was developed to simulate the heat transfer and fluid flow pattern in a unit cell of one cold channel and one hot channel. The model was simulated in ANSYS with working fluids. The detailed temperature, velocities, and pressure distributions in the channels can be used as guidance for an optimal heat exchanger design.

References:

*[1] **Sell and Hudson**, Heat Exchangers: Selection, Rating and Thermal Outline, second ed, CRC Press, 2002.*

*[2] **Rotem and B. Rivero-deAguilar**, Wall conduction impacts in laminar counterflow parallel-plate heat exchangers, Global Journal of Heat and Mass Transfer, 70, 2014, pp. 939-953.*

*[3] **Davis and Cooper**, Laminar counterflow parallel-plate heat exchangers:exact and surmised arrangements, International Journal of Heatand Mass Transfer, 53, 2010, pp. 4885-4898.*

*[4] **Luikov et al.**, Modeling heat exchangers for thermoelectric generators, J. Power Sources, 93, 2001, pp. 72-76.*

*[5] **Olsson**, R.F.W. Pease High-execution heat sinking for VLSI IEEE Elect. Gadget Lett., 2 (5) (1981), pp. 126– 129.*

*[6] **Sohal and Howell**, A numerical model for thermoelectric generator with the parallel-plate heat exchanger, J. Power sources 172, 2007, pp. 428-434.*

*[7] **Luikov**, New counter stream heat exchanger intended for ventilation frameworks in cool atmospheres, Vitality and Buildings, 39, 2007, pp. 1151-1158.*

*[8] **Chida and Katto** Energy Volume 36, Issue 12, December 2011, Pages 6790– 6805.*

*[9] **Fiebig et al** Influence of channel geometry on the execution of a counter stream micro channel heat exchanger Int. J. Therm. Sci., 48 (8) (2009), pp. 1607– 1618.*

*[10] **Tsung-Lin Liu, Ben-Ran Fu, Chin Pan** International Journal of Heat and Mass Transfer Volume 56, Issues 1– 2, 1 January 2013, Pages 20–29.*

*[11] **Harika Sammeta, Kalaichelvi Ponnusamy** Simulation Modeling Practice and Theory Volume 19, Issue 2, February 2011, Pages 777– 784.*

*[12] **H.D. Hettiarachchi, M. Golubovic, W.M. Worek, W.J.** Minkowycz -dimensional laminar slip-stream and heatmove in a rectangular with steady divider temperature International Journal of and Mass Transfer, 51 (2008), pp. 5088– 5096.*