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TRANSIENT HEAT TRANSFER ANALYSIS OF HEAT EXCHANGERS IN A MARNOCH HEAT ENGINE

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ABSTRACT:

The Marnoch heat engine (MHE) is a new type of power generation device that is under research and development at the University of Ontario Institute of Technology. In this thesis, the transient heat transfer behaviour of the source heat exchanger of the Marnoch heat engine is studied, and its operation for laminar and turbulent flows is modelled.

In this thesis, different nano fluids mixed with base fluid water are analyzed for their performance in the heat exchanger. The nano fluids are magnesium oxide for five volume fractions 0.25, 0.35,0.45,0.55 and 0.65 Theoretical calculations are done determine the properties for nano fluids and those properties are used as inputs for analysis.

3d model of the heat exchanger is done in creo parametric software. Cfd analysis is done on the hair pin heat exchanger for all nano fluids and volume fraction and thermal analysis is done in ansys for two materials aluminum and copper.

1.INTRODUCTION

Heat exchangers are one of the usually used equipment within the procedure industries. Heat Exchangers are used to transfer warmness between procedure streams. One can recognize their utilization that any technique which contain cooling, heating, condensation, boiling or evaporation would require a heat exchanger for those reason. Process fluids, commonly are heated or cooled before the process or undergo a phase exchange. Different heat exchangers are named according to their application. For instance, warmth exchangers being used to condense are called condensers, similarly heat exchanger for boiling purposes are called boilers. Performance and efficiency of warmth exchangers are measured via the amount of warmth transfer the use of least region of heat switch and pressure drop. A better presentation of its performance is accomplished by using calculating over all heat switch coefficient. Pressure drop and place required for a sure amount of warmth transfer, offers an insight about the capital value and power necessities (Running price) of a warmth exchanger. Usually, there is a lot of literature and theories to design a warmth exchanger consistent with the requirements.

Heat exchangers are of two sorts:-

Where each media between which warmth is exchanged are in direct contact with each other is Direct contact warmth exchanger, Where both media are separated by way of a wall thru which warmth is transferred in order that they never blend, Indirect contact heat exchanger.

A traditional heat exchanger, typically for better pressure programs up to 552 bars, is the shell and tube warmness exchanger. Shell and tube type heat exchanger, oblique contact type warmness exchanger. It Consists of a chain of tubes, thru which one of the fluids runs. The shell is the field for the shell fluid. Generally, it is cylindrical in shape with a circular cross segment, even though shells of various form are used in precise applications. For this particular examine shell is taken into consideration, which a one bypass shell is typically. A shell is the maximum commonly used because of its low value and ease, and has the best log-imply temperature-difference (LMTD) correction issue. Although the tubes might also have unmarried or multiple passes, there is one bypass at the shell side, even as the alternative fluid flows within the shell over the tubes to be heated or cooled. The tube side and shell aspect fluids are separated by way of a tube sheet.

2.LITERATURE SURVEY

Shell-and-Tube Heat Exchangers by **R. Shankar Subramanian**

Shell-and-tube warmth exchangers are used widely within the chemical procedure industries, specifically in refineries, due to the numerous blessings they provide over different kinds of warmness exchangers. A lot of records is available regarding their design and production. The gift notes are meant only to serve as a brief introduction.

Experimental have a look at on thermal and float techniques in shell and tube warmness exchangers -

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have an effect on of baffle reduce on warmth change efficiency - Nenad Radojković, Gradimir Ilić, Žarko Stevanović, Mića Vukić, Dejan Mitrović, Goran Vučković

Experimental investigations have been done to become aware of have an impact on of thermal and flow portions and shell facet geometry on STHE's heat exchange depth. In thismpaper unique interest changed into paid to segmental baffle cut influence on apparatus performance.

An assessment of counter glide shell and tube warmness exchanger by means of entropy technology minimization technique by using D. P Naik and V. K. Matawala

The motive of this paintings is to carry out design andassessment of counter flow shell and tube warmness exchanger by entropy technology minimization approach. In this paper warmness switch coefficient and strain drop at the shellside and tube aspect of a shell-and-tube warmness exchanger have been received for MS tubes. Some geometrical parameters of the shell and tube heat exchanger are taken because the design variables such astube inside diameter, tube out of doors diameter, tube pitch, and number of tubes and baffle spacing etc. In this paintings the ms fabric used for tube and shell of the shell and tube warmness exchanger. The three variety of unmarried segmental baffle, three variety of tube and e-type shell is used for shell and tube warmth exchanger. The layout and machine description is suggested. The entropy technology wide variety which is the ratio of entropygeneration fee and inlet temperature of fluid to the heat transfer rate is taken as the objective feature. Therefore the principle goal is to decrease the entropy generation variety to boom the effectiveness of shell and tube heat exchanger having ms as a tube material. We boom the variety of tubes via keeping the opposite parameters regular in the given utility of shell and tube warmth exchanger which increases the effectiveness of heat exchanger by means of minimizing the entropy generation range and also reduce the stress drop on both shell and tube aspect of shell and tube warmness exchanger.

An professional model for the shell and tube warmth exchangers Analysis by using synthetic neural networks

A.R. Moghadassi, S.M. Hosseini, F. Parvizian, F. Mohamadiyon, A. Behzadi Moghadam and A. Sanaeirad

Due to the significance of warmth exchangers in chemical and petrochical industries, heat exchangers analysis and warmth translate calculations are preceded. The traditional and widespread techniques (including KERN technique and and so on) are presented warmth translate calculation for the evaluation and choice of shell and tube heat exchanger primarily based on the acquired pressure drop and fouling factor after consecutive calculation. Also there are numerous residences and parameters in typical techniques. The present day paintings proposed a brand new approach primarily based on the artificial neural network (ANN) for the evaluation of Shell and Tube Heat Exchangers. Special parameters for warmth exchangers analysis were acquired with the aid of neural network and the required experimental information were collected form Kern's e-book, TEMA and Perry's manual. The work used back- propagation gaining knowledge of algorithm incorporating levenberg- marquardt schooling approach. The accuracy and trend stability of the trained networks have been validated in keeping with their capability to are expecting unseen records. MSE mistakes assessment become used and the error difficulty is 10-three-10-6. Parameters may be received without the usage of charts, exclusive tables and complex equations. During this research, twenty two networks have been utilized for all specific residences. The outcomes verified the ANN's capability to are expecting the analysis.

Design and Thermal Performance Analysis of Shell and Tube Heat Exchanger with the aid of Using CFD-A Review.

3. METHODOLOGY AND MATERIALS

METHODOLOGY

In all of these strategies the identical simple procedure is observed.

•During preprocessing

•The geometry (physical bounds) of the trouble is described.

•The extent occupied by means of the fluid is split into discrete cells (the mesh). The mesh may be uniform or non-uniform.

•The physical modeling is defined – as an example, the equations of motion + enthalpy + radiation + species conservation

•Boundary situations are described. This entails specifying the fluid behaviour and homes at the barriers of the problem. For transient problems, the initial situations are also defined.

•The simulation is started and the equations are solved iteratively as a regular-state or temporary.

•Finally a postprocessor is used for the analysis and visualization of the ensuing solution.

Calculations To Determine Properties Of Nano Fluid By Changing Volume Fractions

Volume fraction= (0.25,0.35,0.45,0.55 and 0.65)

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MATERIAL PROPERTIES

Magnesium Oxide

Density = 3560 kg/m3

Thermal conductivity =45 W/m-k

Specific heat = 955 J/kg-k

Water

Density = 998.2 kg/m3

Thermal conductivity = 0.6 W/m-k

Specific heat = 4182 J/kg-k

Viscosity = 0.001003kg/m-s

4. MODELING AND ANALYSIS

PTC CREO, formerly known as Pro/ENGINEER, is 3D modeling software used in mechanical engineering, design, manufacturing, and in CAD drafting service firms. It was one of the first 3D CAD modeling applications that used a rule-based parametric system. Using parameters, dimensions and features to capture the behavior of the product, it can optimize the development product as well as the design itself.

The name was changed in 2010 from Pro/ENGINEER Wildfire to CREO. It was announced by the company who developed it, Parametric Technology Company (PTC), during the launch of its suite of design products that includes applications such as assembly modeling, 2D orthographic views for technical drawing, finite element analysis and more.

PTC CREO says it can offer a more efficient design experience than other modeling software because of its unique features including the integration of parametric and direct modeling in one platform. The complete suite of applications spans the spectrum of product development, giving designers options to use in each step of the process. The software also has a more user friendly interface that provides a better experience for designers. It also has collaborative capacities that make it easy to share designs and make changes.

PTC also offers comprehensive training on how to use the software. This can save businesses by eliminating the need to hire new employees. Their training program is available online and in-person, but materials are available to access anytime.

A unique feature is that the software is available in 10 languages. PTC knows they have people from all over the world using their software, so they offer it in multiple languages so nearly anyone who wants to use it is able to do so.

3D MODEL OF SHELL AND TUBE HEAT EXCHANGER

Tube outer dia. = 23 mm

Tube inner dia. = 20 mm

Number of tube = 9

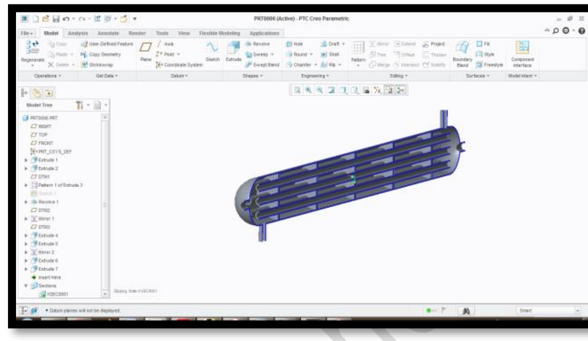
Shell inner dia. = 136 mm

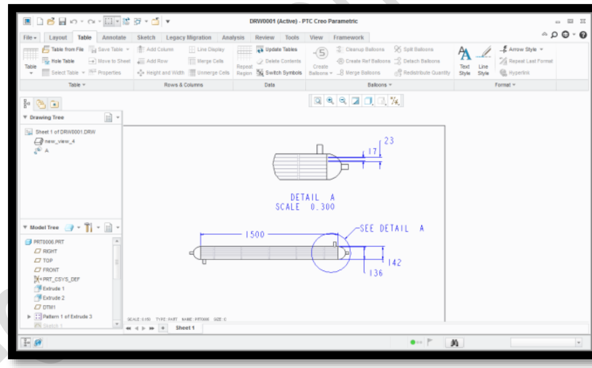
Shell outer dia. = 142 mm

Number of baffles = 5

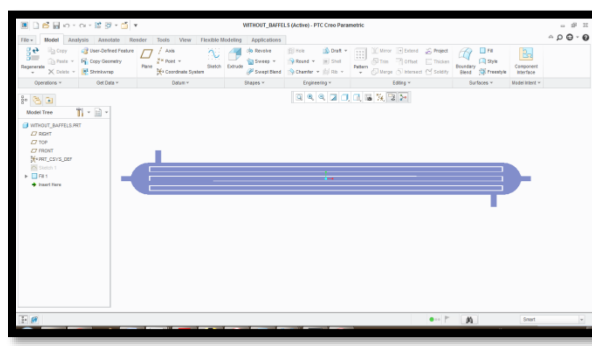
Diameter of baffles = 136 mm

Distance between baffles B = 300 mm





WITHOUT BAFFLES



ANSYS

Structural Analysis

ANSYS Autodyn is computer simulation tool for simulating the response of materials to short duration severe loadings from impact, high pressure or explosions.

ANSYS Mechanical

ANSYS Mechanical is a finite element analysis tool for structural analysis, including linear, nonlinear and dynamic studies. This computer simulation product provides finite elements to model behavior, and supports material models and equation solvers for a wide range of mechanical design problems. ANSYS

Mechanical also includes thermal analysis and coupled-physics capabilities involving acoustics, piezoelectric, thermal–structural and thermo-electric analysis.

FLUID FLOW

The ANSYS/FLOTRAN CFD (Computational Fluid Dynamics) offers comprehensive equipment for studying -dimensional and 3-dimensional fluid go with the flow fields. ANSYS is able to modeling a sizable variety of analysis sorts such as: airfoils for pressure analysis of plane wings (elevate and drag), drift in supersonic nozzles, and complicated, three-dimensional waft styles in a pipe bend. In addition, ANSYS/FLOTRAN may be used to carry out obligations together with:

•Calculating the gasoline pressure and temperature distributions in an engine exhaust manifold

•Studying the thermal stratification and breakup in piping systems

•Using drift blending research to evaluate ability for thermal surprise

•Doing herbal convection analyses to evaluate the thermal performance of chips in digital enclosures

•Conducting warmness exchanger research related to exceptional fluids separated by using strong regions

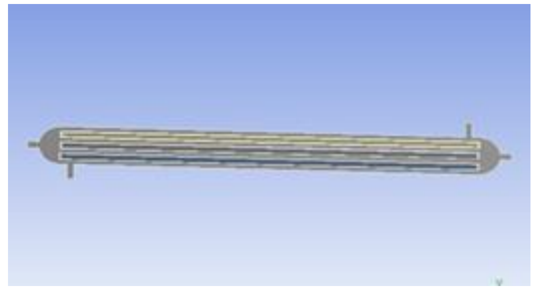
CFD

Computational fluid dynamics, commonly abbreviated as CFD, is a department of fluid mechanics that makes use of numerical strategies and algorithms to clear up and analyze problems that involve fluid flows. Computers are used to carry out the calculations required to simulate the interplay of beverages and gases with surfaces described by boundary conditions. With high-pace supercomputers, higher solutions can be performed. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios together with transonic or turbulent flows. Initial experimental validation of such software program is executed using a wind tunnel with the very last validation coming in complete-scale testing, e.g. Flight assessments.

5. CFD ANALYSIS OF SHELL AND TUBE HEAT EXCHANGER

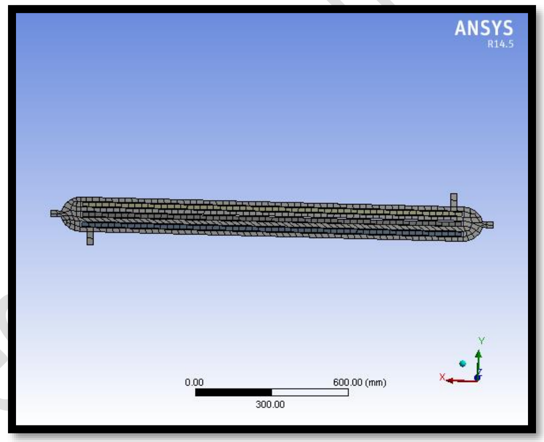
FLUID- WATER

Imported Model from CREO



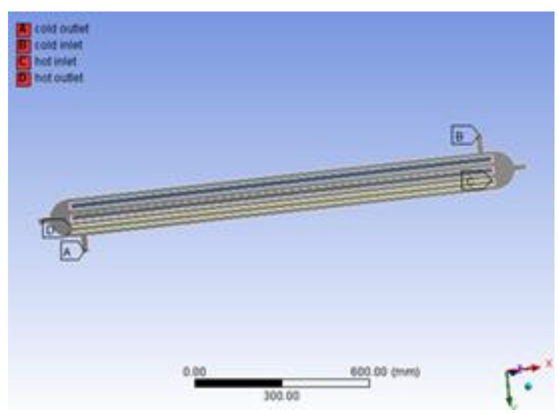
→→ select mesh on work bench → right click →edit → select mesh on left side part tree → right click → generate mesh →

Meshed Model



Select faces → right click → create named section → enter name → water inlet

Select faces → right click → create named section → enter name → water outlet



Model → energy equation → on.

Viscous → edit → k- epsilon

Enhanced Wall Treatment → ok

Materials → new → create or edit → specify fluid material or specify properties → ok

Select air and water

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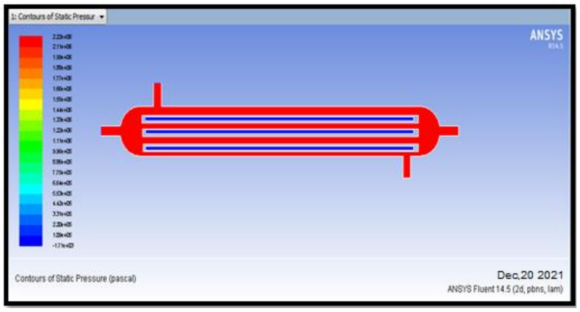
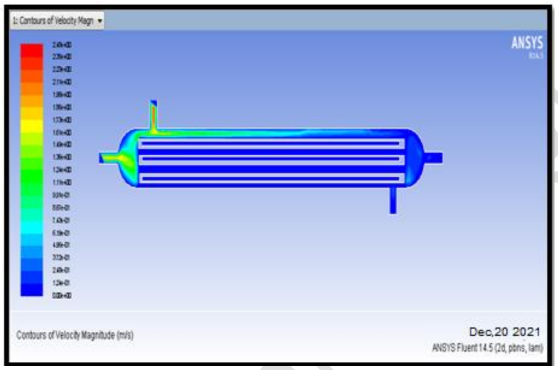
Boundary conditions → select water inlet → Edit → Enter Water Flow Rate → 2Kg/s and Inlet Temperature – 353K
Solution → Solution Initialization → Hybrid Initialization →done
Run calculations → no of iterations = 50 → calculate → calculation complete
→→ **Results → graphics and animations → contours → setup**

MAGNESIUM OXIDE NANO FLUID

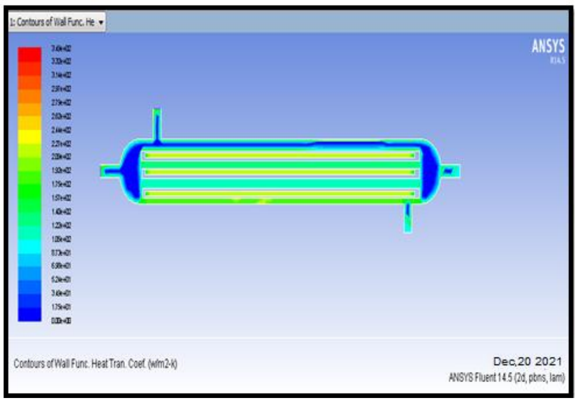
STATIC PRESSURE



VELOCITY MAGNITUDE



HEAT TRANSFER CO-EFFICIENT



REPORTS

Mass flow rate

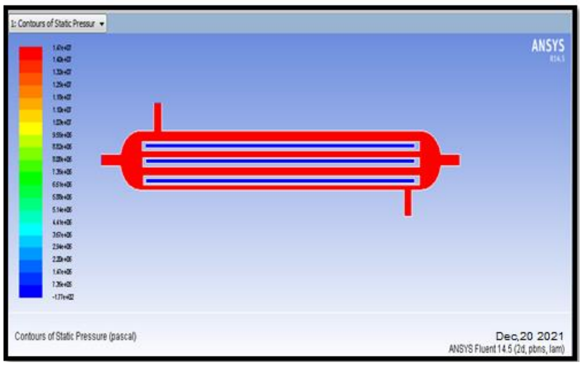
Mass Flow Rate	(kg/s)
ci	48.159702
co	0
hi	60.199669
ho	0
interior-_trm_srf	-869.11945
wall-_trm_srf	0
Net	108.35937

Total Heat Transfer Rate (w)

Total Heat Transfer Rate	(w)
ci	2335857.5
co	0
hi	10784670
ho	0
wall-_trm_srf	0
Net	13120528

VOLUME FRACTION - 0.35

STATIC PRESSURE



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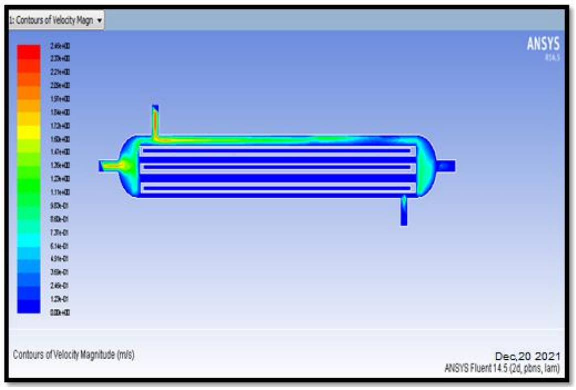
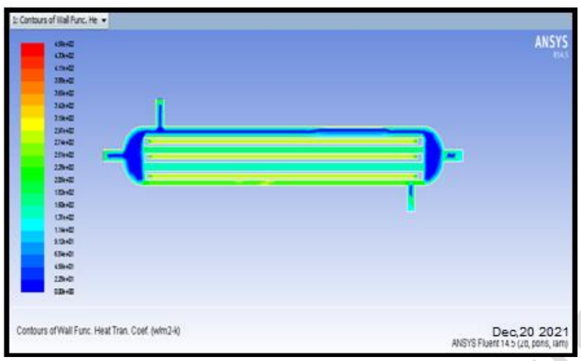
VELOCITY MAGNITUDE



HEAT TRANSFER CO-EFFICIENT



Mass flow rate

Mass Flow Rate	(kg/s)
ci	57.995285
co	0
hi	72.494156
ho	0
interior-_trm_srf	-1917.2665
wall-_trm_srf	0
Net	130.48944

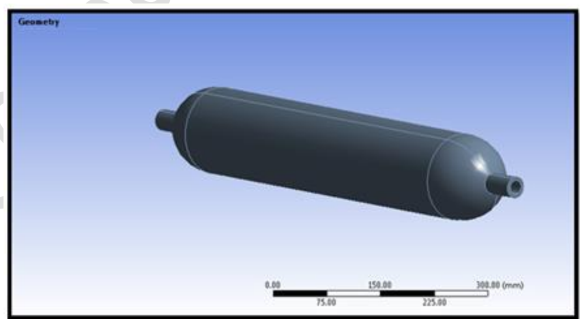
Heat transfer rate

Total Heat Transfer Rate	(w)
ci	4986936
co	0
hi	23024714
ho	0
wall-_trm_srf	0
Net	28011650

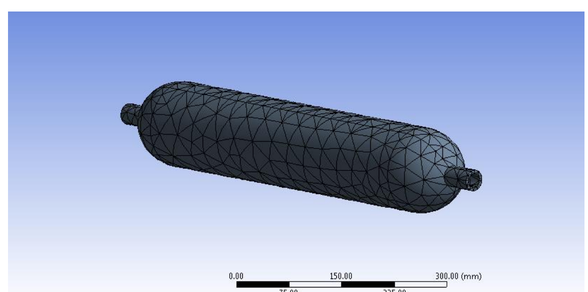
6. THERMAL ANALYSIS OF SHELL AND TUBE HEAT EXCHANGER

Materials-Aluminum Alloy, Copper Alloy

IMPORTED MODEL



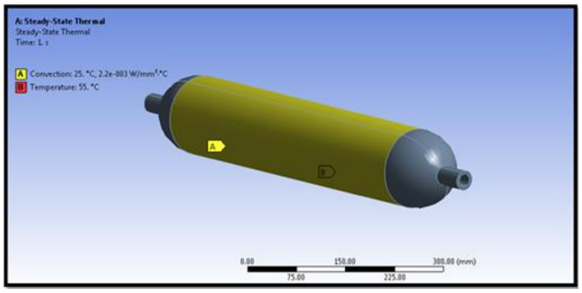
MESHED MODEL



BOUNDARY CONDITIONS

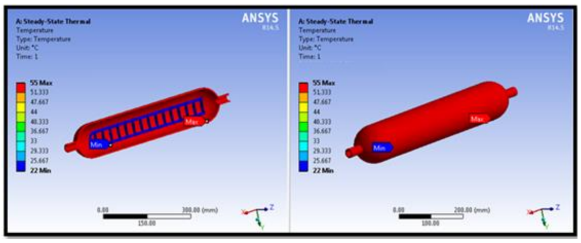
T_1 =55C
T2-25C

Select steady state thermal >right click>insert>select convection> enter film coefficient (from CFD analysis)

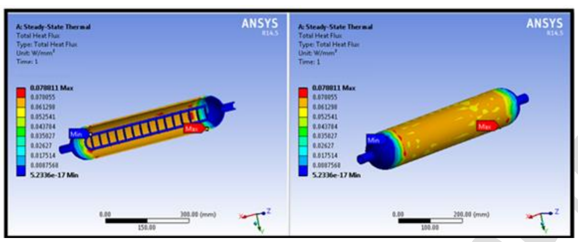


MATERIAL-ALUMINUM ALLOY

TEMPERATURE

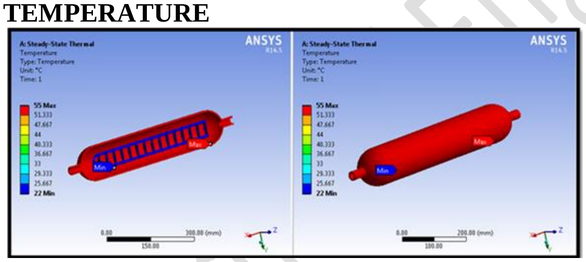


HEAT FLUX

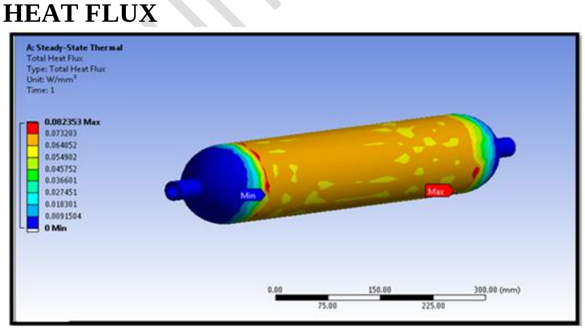


MATERIAL-COPPER

TEMPERATURE



HEAT FLUX



7. RESULTS AND DISCUSSIONS

CFD

CFD results

Fluid	Pressure (pa)	Velocity (m/s)	Heat transfer co-effient (w/mm2)	Mass flow rate(kg/s)	Heat transfer rate(w)
Water	1888796.58	2.42	312	100.01	114868
Mg(0.25)	2.2125+06	2.48	349	108.35	1312058
Mg(0.35)	1.47e+07	2.46	456	130.489	12872431
Mg(0.45)	1.38e+05	2.47	600	152.61	12643921
Mg(0.55)	4.11e+05	2.45	815	174.74	12376302
Mg(0.65)	1.26e+07	2.49	972	173.652	280116504

THERMAL ANALYSIS

Material	*Temperature (^0C)*	*Heat flux(W/m^2)*
Aluminum	*55*	*0.078811*
Copper	*55*	*0.082353*

8.CONCLUSION

In this thesis, different nano fluids mixed with base fluid water are analyzed for their performance in the shell and tube heat exchanger. The nano fluids are magnesium oxide 0.25,0.35,0.45,0.55 and 0.65 Theoretical calculations are done determine the properties for NANO fluids and those properties are used as inputs for analysis.

3D model of the e heat exchanger is done in CREO parametric software. CFD analysis is done in ANSYS software.

By observing the CFD analysis the heat transfer rate increases for magnesium oxide at volume fraction 0.65 when compare with aluminum oxide and water.

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