THERMAL INVESTIGATION OF HYDRAULIC OIL COOLER AT DIFFERENT MASS FLOW RATES AND DESIGN IMPROVEMENT TO OBTAIN THE BETTER HEAT TRANSFER RATE

BATCH 2

K.V.V SATYANARAYANA	16A31A03E9
M. SURYANARAYANA	16A31A03F3
V.VIKASH	16A31A03H1
G.AMARNADH	16A31A03D3
D.DAMODAR	16A31A03C7

Project Guide:
Mr. K. RAMAKRISHNA M. Tech.,
Assistant Professor
Department of ME

Head of the Department:
Dr. B.S.V.RAMA RAO M.E., Ph.D
Professor
Department of ME

DEPARTMENT OF MECHANICAL ENGINEERING

PRAGATI ENGINEERING COLLEGE

(AUTONOMOUS)

(Approved by AICTE, Permanently Affiliated to JNTUK, KAKINADA & Accredited by NAAC with 'A' Grade)

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CONTENTS

ABSTRACT

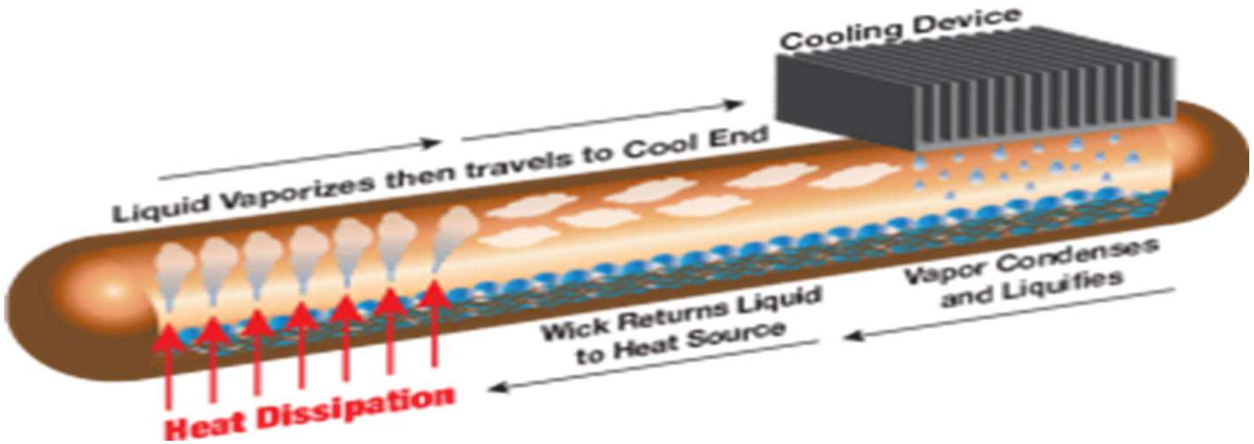
Overheating is most common problem with hydraulic equipment. Heating of hydraulic fluid in hydraulic system during operation is caused by inefficiencies. Inefficiencies are due to loss of input power, which is converted to heat. So to achieve stable fluid temperature, a hydraulic system capacity to dissipate heat must exceed its heat load. In current market, various types of heat exchanger are used to avoid overheating, but they require a lot of space, extra power and investment is required for the cooling water circuit and maintenance of the heat exchanger.

Therefore oil coolers are needed to design specifically for mobile hydraulic applications where high performance and efficiency are required and physical size is minimized to allow easy installation. Typical applications include mobile cranes, concrete mixers and pump trucks, road paving machines & transmission cooling. The oil cooler use a combination of high performance cooling elements and hydraulic motors to give long trouble free operation in mobile hydraulic applications. The compact design allows the coolers to fit most equipment and provide the highest cooling performance in heat dissipation with minimizing space required. The project focuses on the design modification and performance analysis of a single unit hydraulic oil cooler, In which we take different mass flow rates and compare the results of modified oil cooler with the original one and some other factors are also considered in order to obtain better heat transfer rate.

INTRODUCTION

- A heat pipe is a heat transfer device with an extremely high effective thermal conductivity. The heat pipe has its simple configuration is like a cylindrical vessel with the internal walls lined with a capillary structure or wick that is saturated with a working fluid.
- All heat pipes have an evaporator and condenser section where the working fluid evaporates and condenses, respectively.
- Heat pipes can be designed to operate over a wide range of temperatures from cryogenic applications utilizing titanium alloy/nitrogen heat.
- Heat pipe provided with cooling fins to enlarge its contact surface with surrounding medium.
- A heat pipe with cooling fin is generally termed as a heat pipe cooler.
- Application of heat pipe in hydraulic oil cooler results effective heat transfer rate.

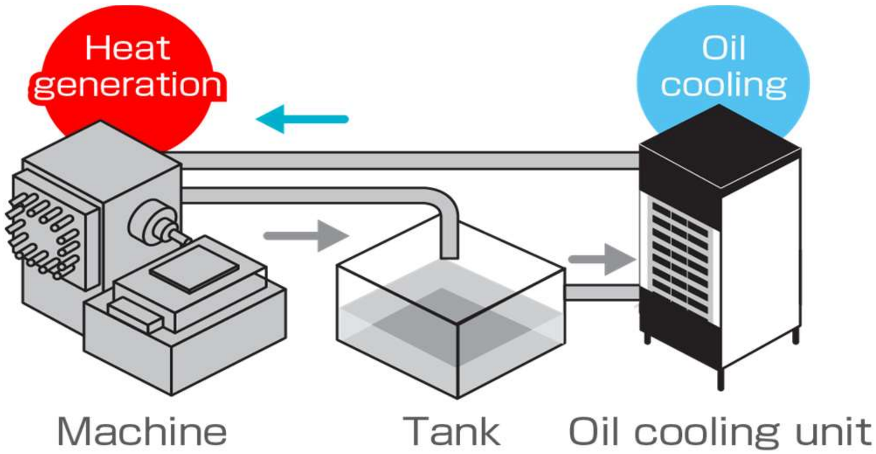
HEAT PIPE



Cooling Device
Liquid Vaporizes then travels to Cool End
Vapor Condenses and Liquifies
Wick Returns Liquid to Heat Source
Heat Dissipation

WORKING PRINCIPLE

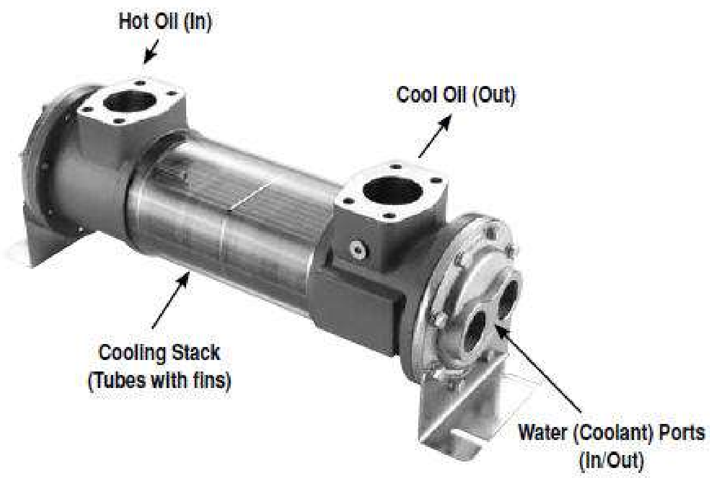
- Hydraulic coolers are primarily used on the circuits of hydraulic systems.
- During operation, the high-temperature oil in the hydraulic system flows through the hydraulic cooler device, and performs efficient heat exchange with the forced flow of cold air in the heat exchanger
- So that the oil temperature is lowered to the working temperature to ensure that the main machine can continuously perform normal operation, so that the work can be performed. Smooth development.

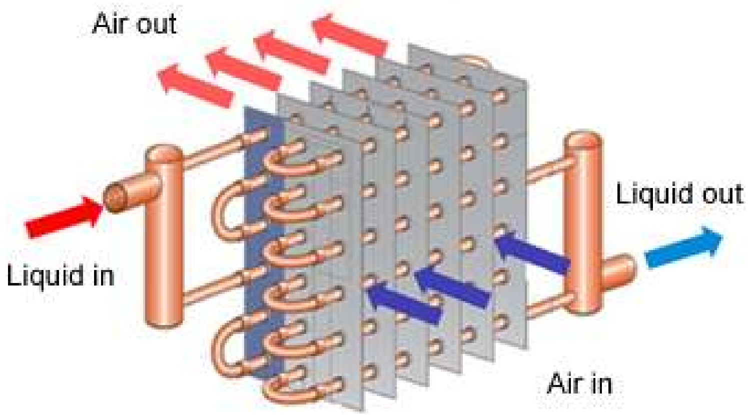


HYDRALUIC OIL COOLERS

Hydraulic oil coolers are generally broken into two types:

- **OIL–TO–WATER COOLERS**
- **OIL– TO–AIR COOLERS**



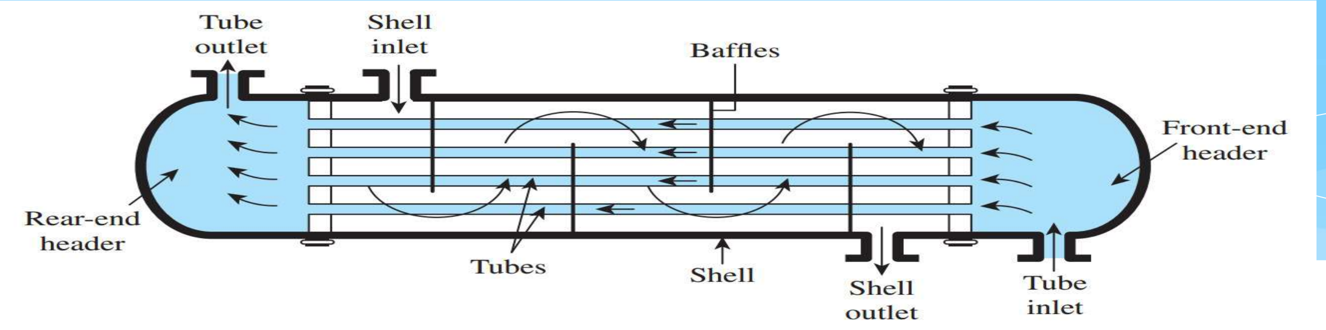


WHY THESE ??

- Heat kills hydraulic systems so hydraulic oil coolers are used
- They pass oil through a coil or core to cool the oil before it enters the system.
- Improves energy efficiency.
- Lowers corrosion.
- Lowers pressure drop.
- Increases heat transfer rate.

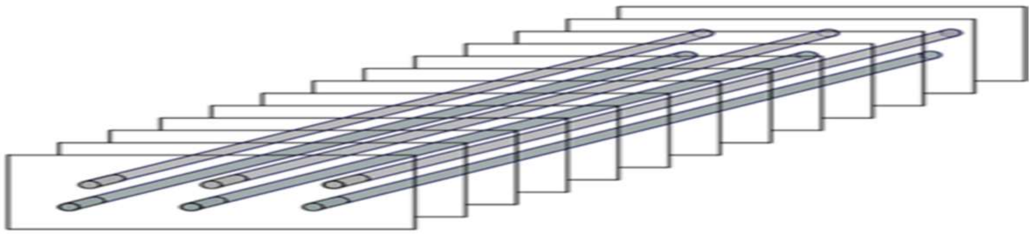
SHELL AND TUBE COOLER :

- It is the most common type of heat exchanger in oil refineries and other large chemical processes, and is suited for higher-pressure applications
- Two fluids, of different starting temperatures, flow through the heat exchanger. One flows through the tubes (the tube side) and the other flows outside the tubes but inside the shell (the shell side).
- Heat is transferred from one fluid to the other through the tube walls, either from tube side to shell side or vice versa.
- This is an efficient way to conserve energy.



FINNED TUBE COOLER :

- Finned tube exchangers/coolers are known for maximizing heat transfer surface area, by design.
- Finned tube heat exchangers have tubes with extended outer surface area or fins to enhance the heat transfer rate from the additional area of fins.
- Finned tubes or tubes with extended outer surface area enhance the heat transfer rate by increasing the effective heat transfer area between the tubes and surrounding fluid.
- The fluid surrounding finned tubes maybe process fluid or air.



Finned tubular heat exchanger

Advantages of Hydraulic oil coolers

- Maintain the correct temperatures
- Extend the lifespan of the machine’s components
- Improves efficiency
- Reduces the cost of maintenance and repairs

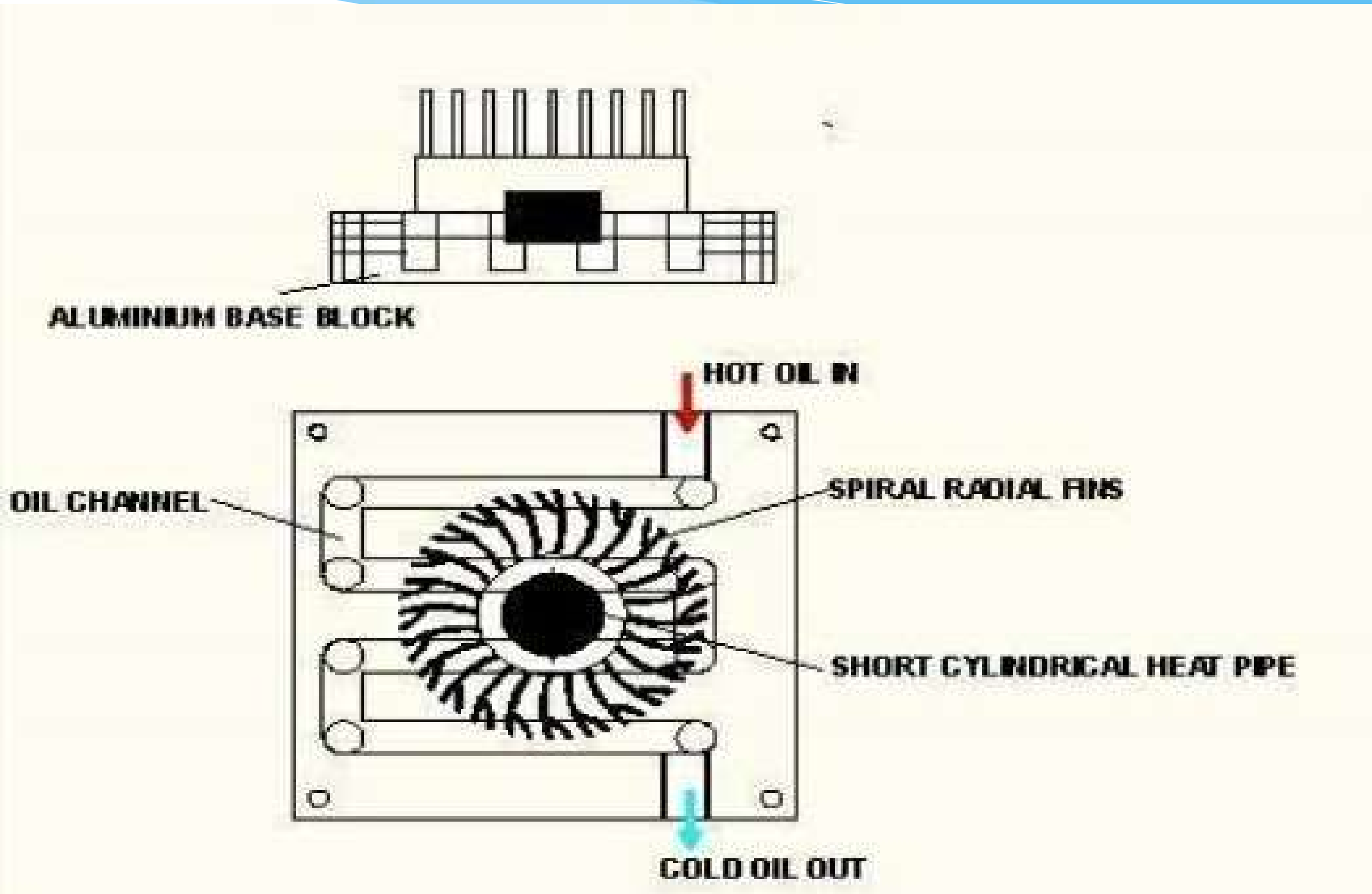
Disadvantages

- Coolant oil may be limited to cooling objects under approximately 200–300 °C, otherwise the oil may degrade and even leave ashy deposits.
- Pure water may evaporate or boil, but it cannot degrade, although it may become polluted and acidic.
- Water is generally available should coolant need to be added to the system, but oil may not be.
- Unlike water, oil may be flammable.

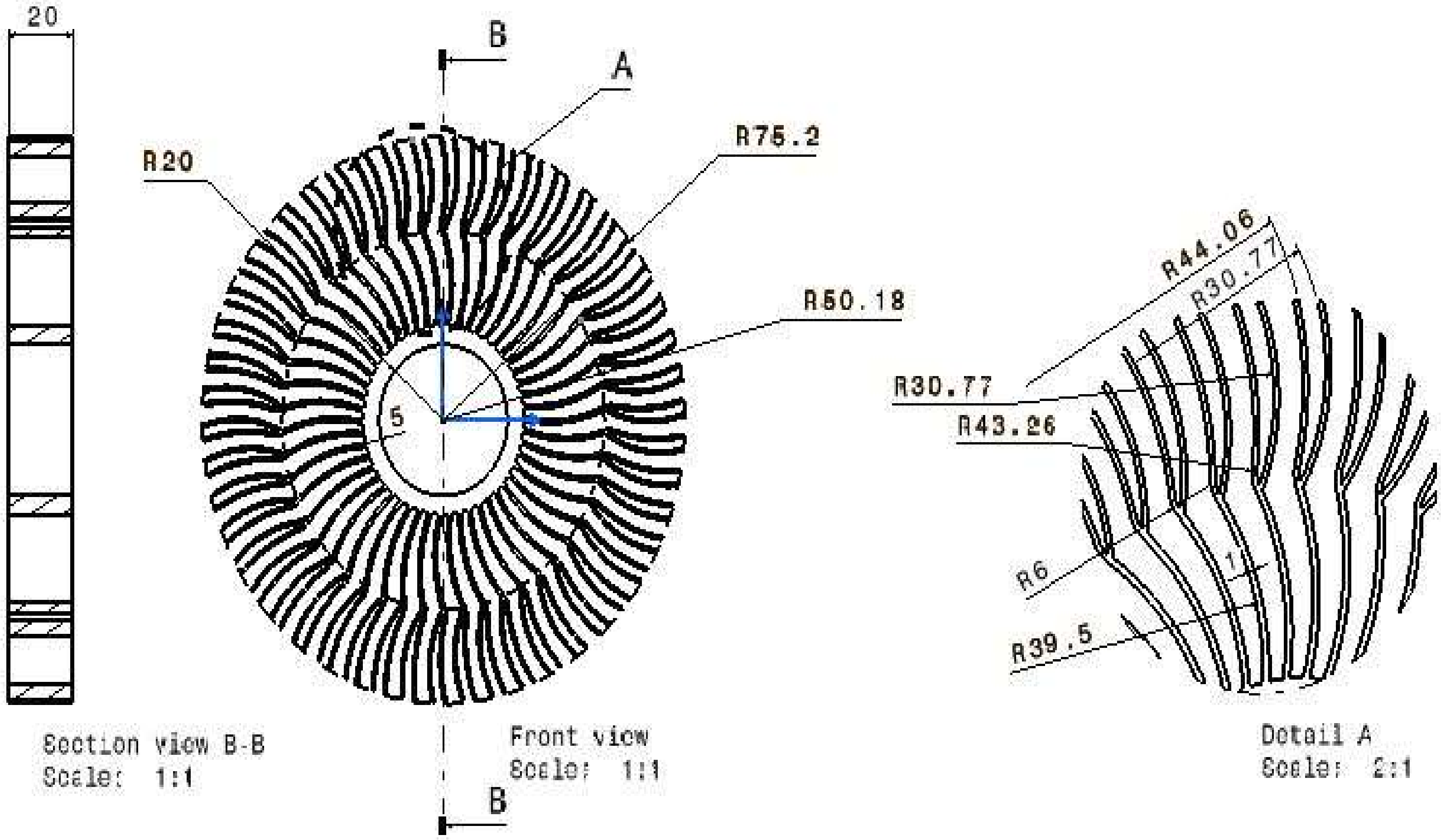
Applications

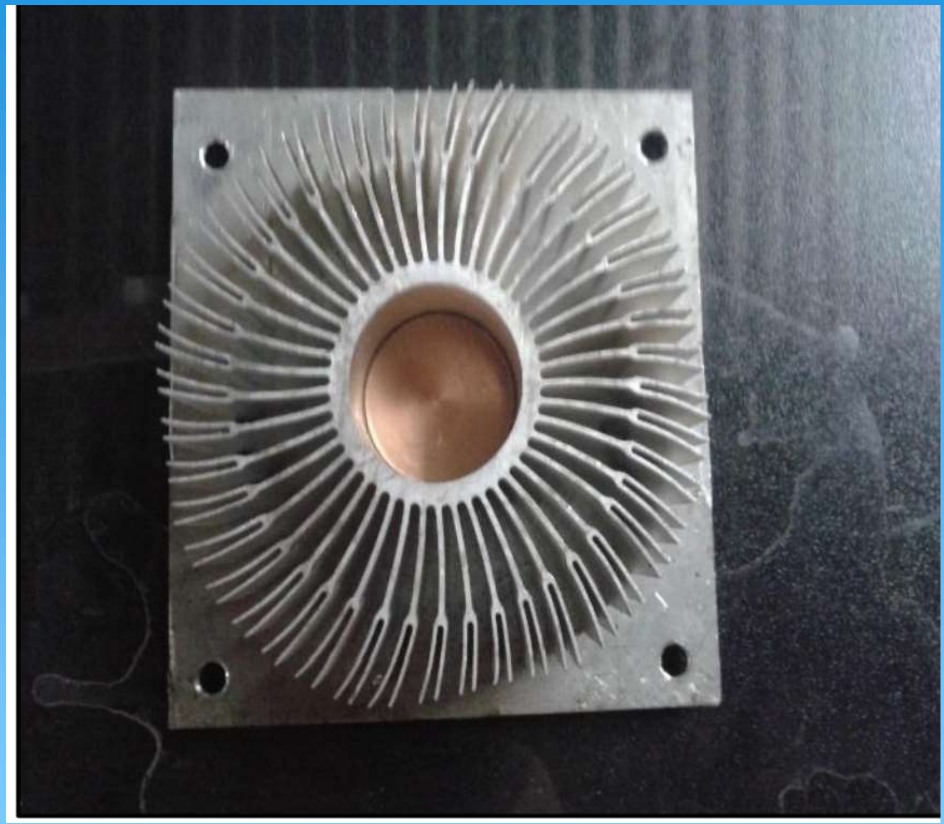
- Steel and heavy industry
- Petroleum Industry
- Marine Equipment
- Industrial Machinery
- Agriculture
- Automotive
- Gear boxes

Hydraulic Oil cooler Details



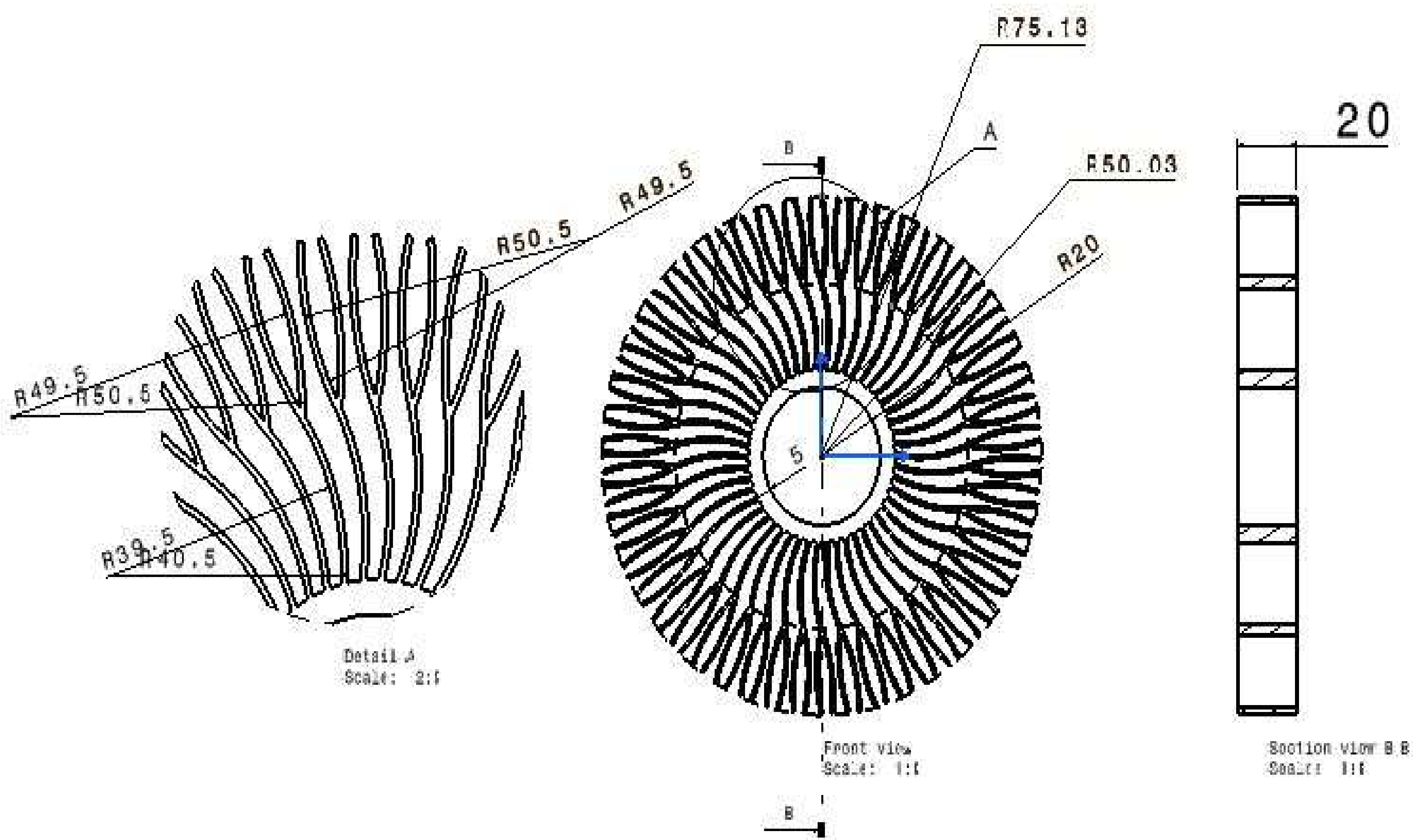
DRAFT IMAGES OF HYDRALUIC OIL COOLER





Hydraulic oil cooler without design modifications

DESIGN WITH MODIFICATIONS

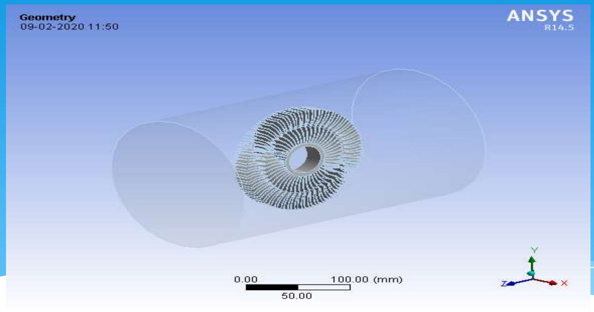


HYDRAULIC OIL (SAE20W-40) PROPERTIES

Property	Units	Typical	ASTM
Viscosity			D445
@ 100°C	mm²/s	14	
@ 40°C	mm²/s	110	
Apparent Viscosity	mPa.s	3900	D5293
Viscosity Index		115	D2270
Pour Point	°C	-21	D97
Flash Point (COC)	°C	230	D92
Specific heat of oil	kJ/kg 0C	1.6987	D3947
Density @ 20°C	kg/m3	890	D4052
Sulphated Ash	% m/m	1.5	D874
Total Base Number	mg KOH/g	10.6	D2896

SOFTWARE

- AUTO CAD
- CATIA
- ANSYS FLUENT



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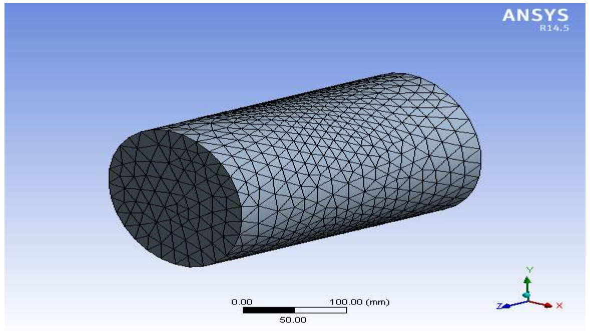
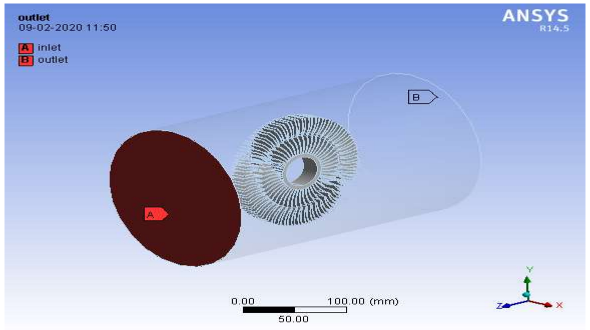
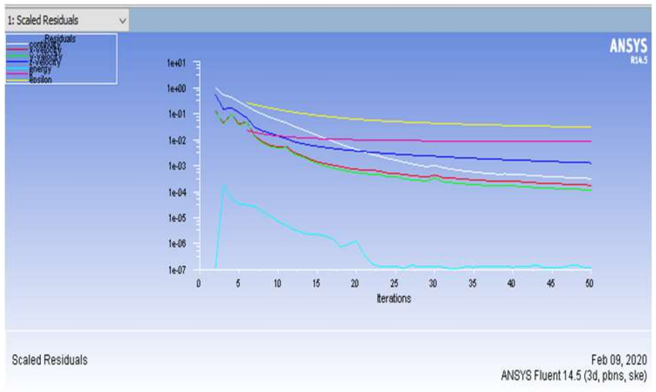


Meshing





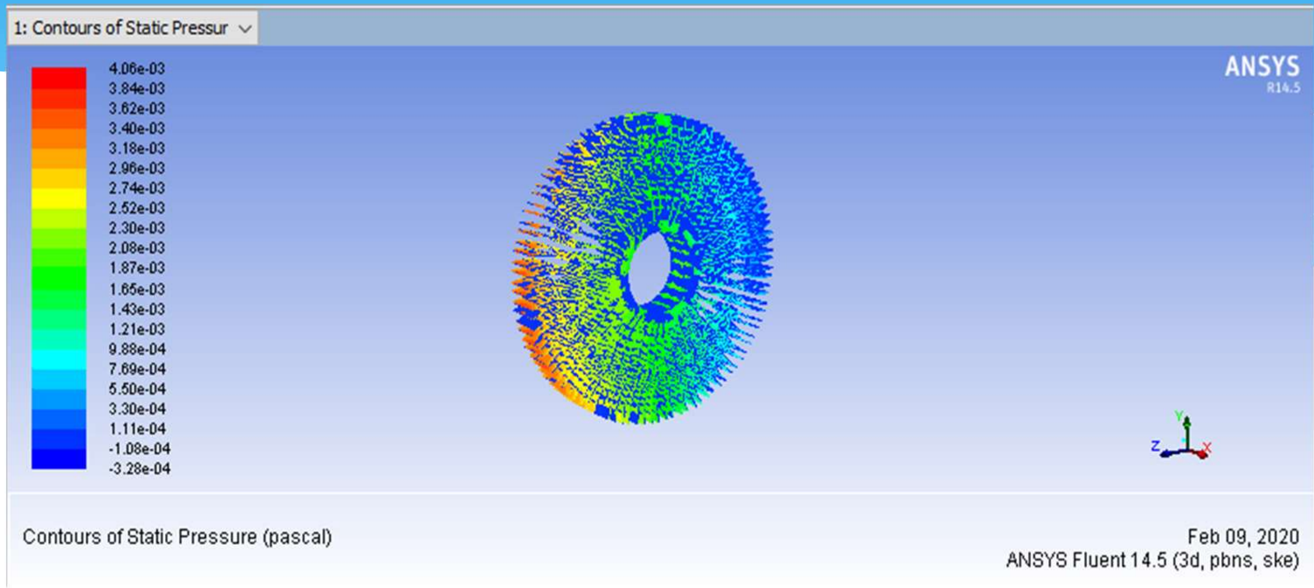
Boundary Conditions

Scale Residuals

ANALYSIS RESULTS

STATIC PRESSURE VARIATIONS

ORIGINAL



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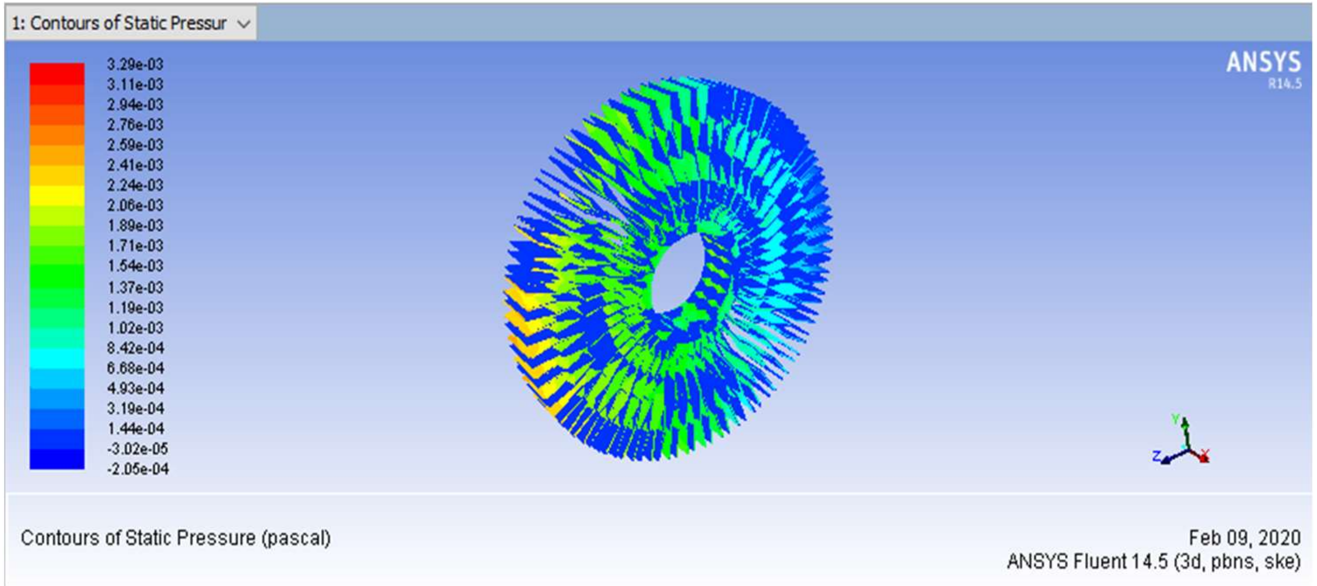

WALL SHEAR STRESS VARIATIONS

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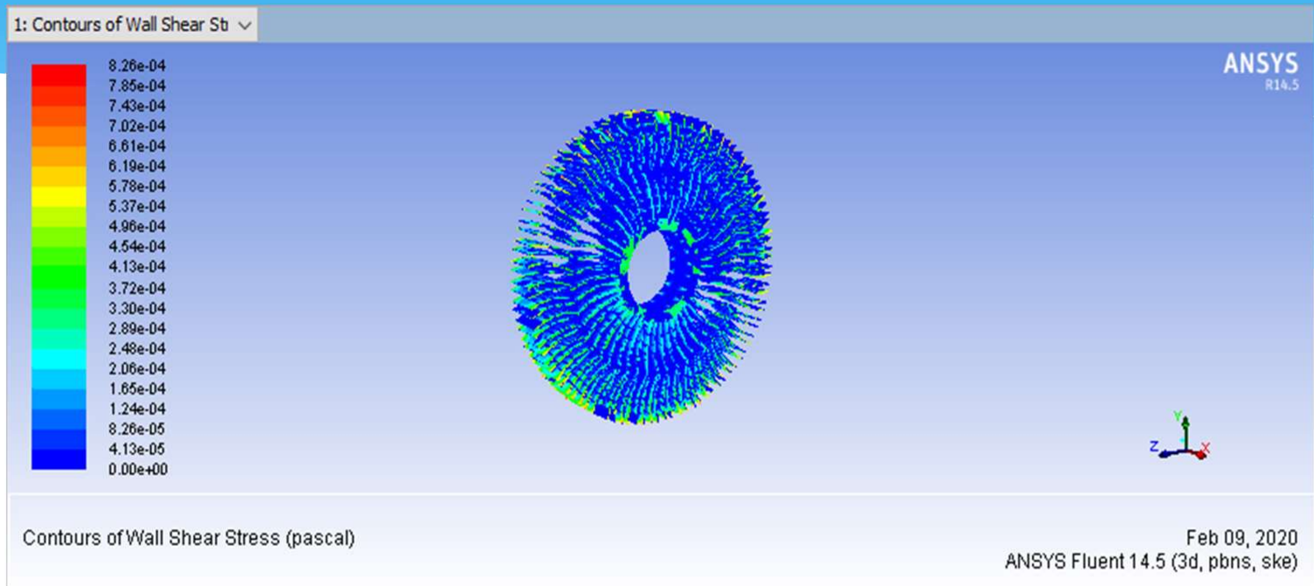

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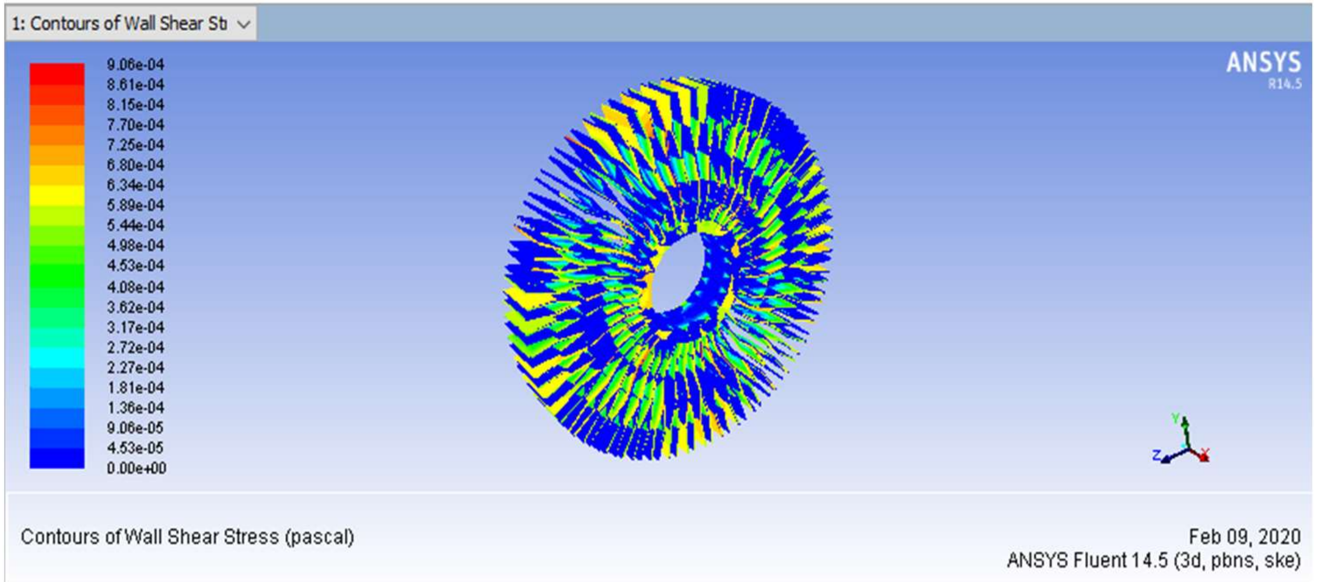

STATIC TEMPERATURE VARIATION

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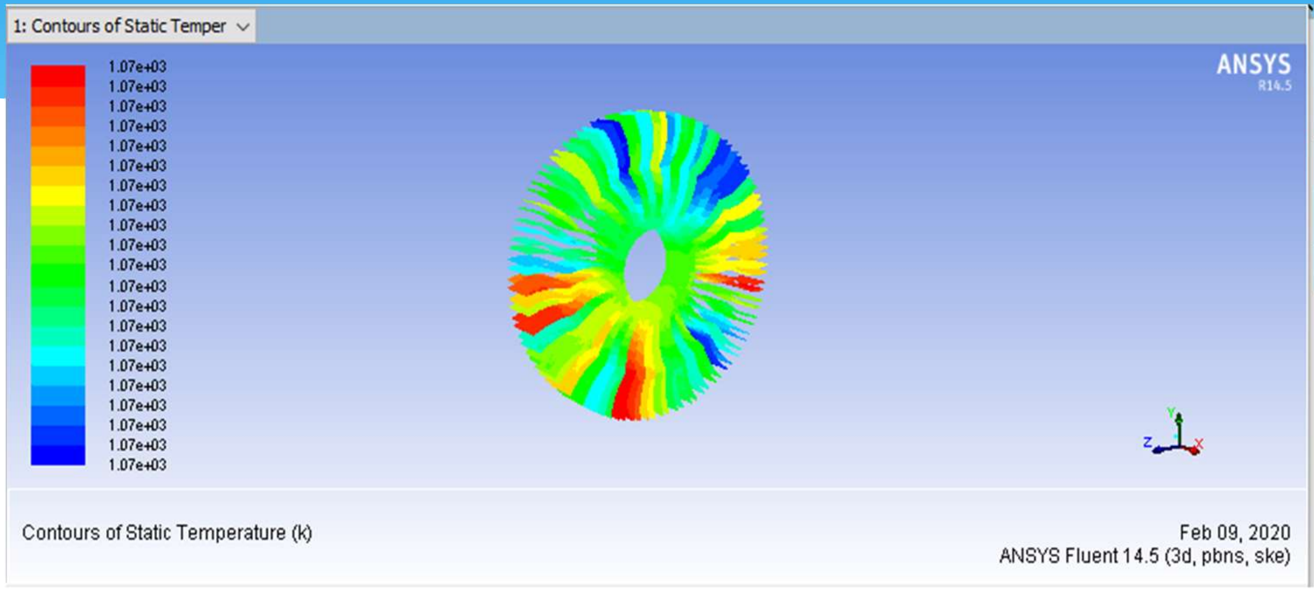

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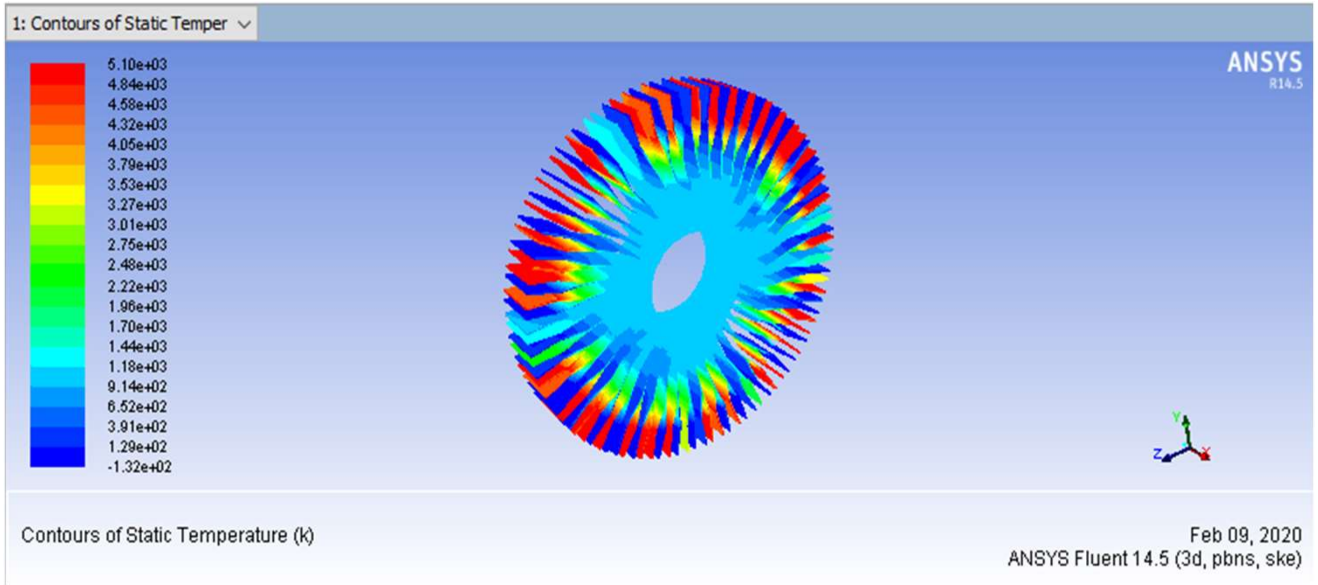

VELOCITY STREAMLINES

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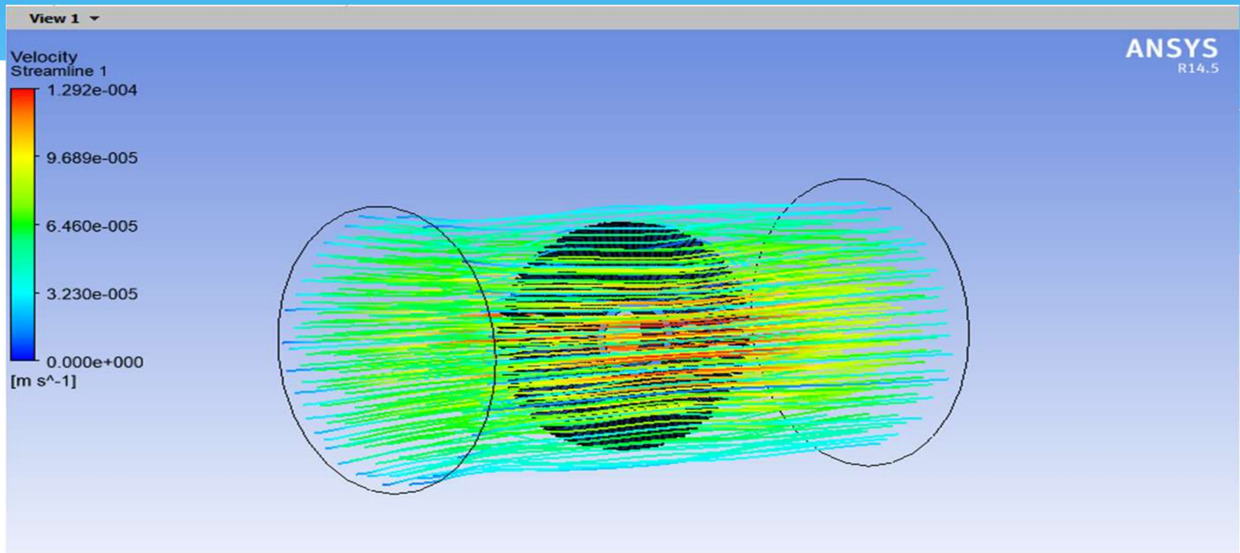

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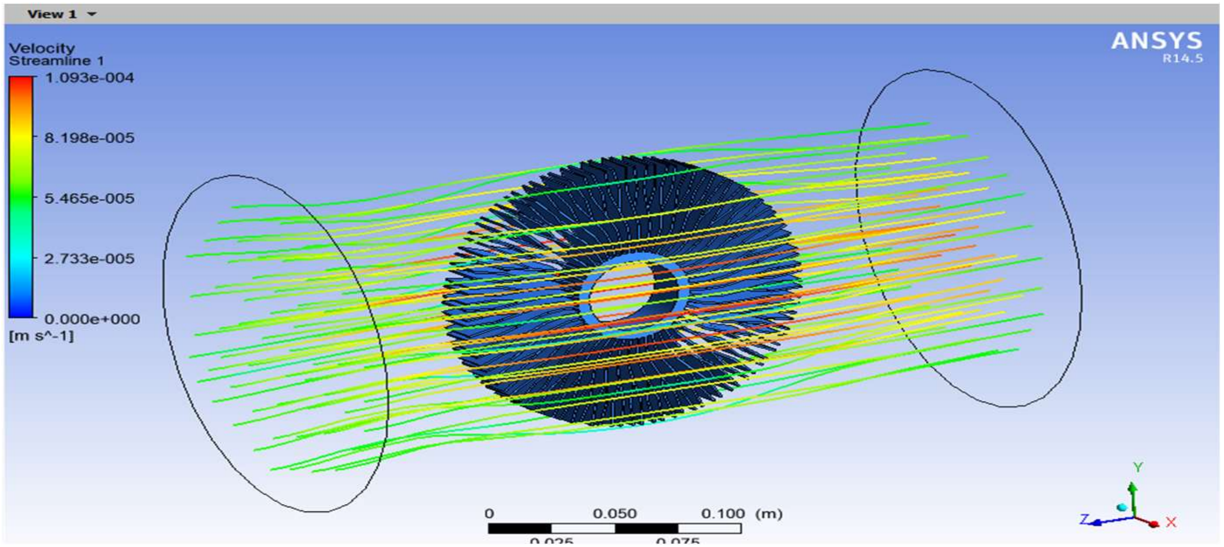
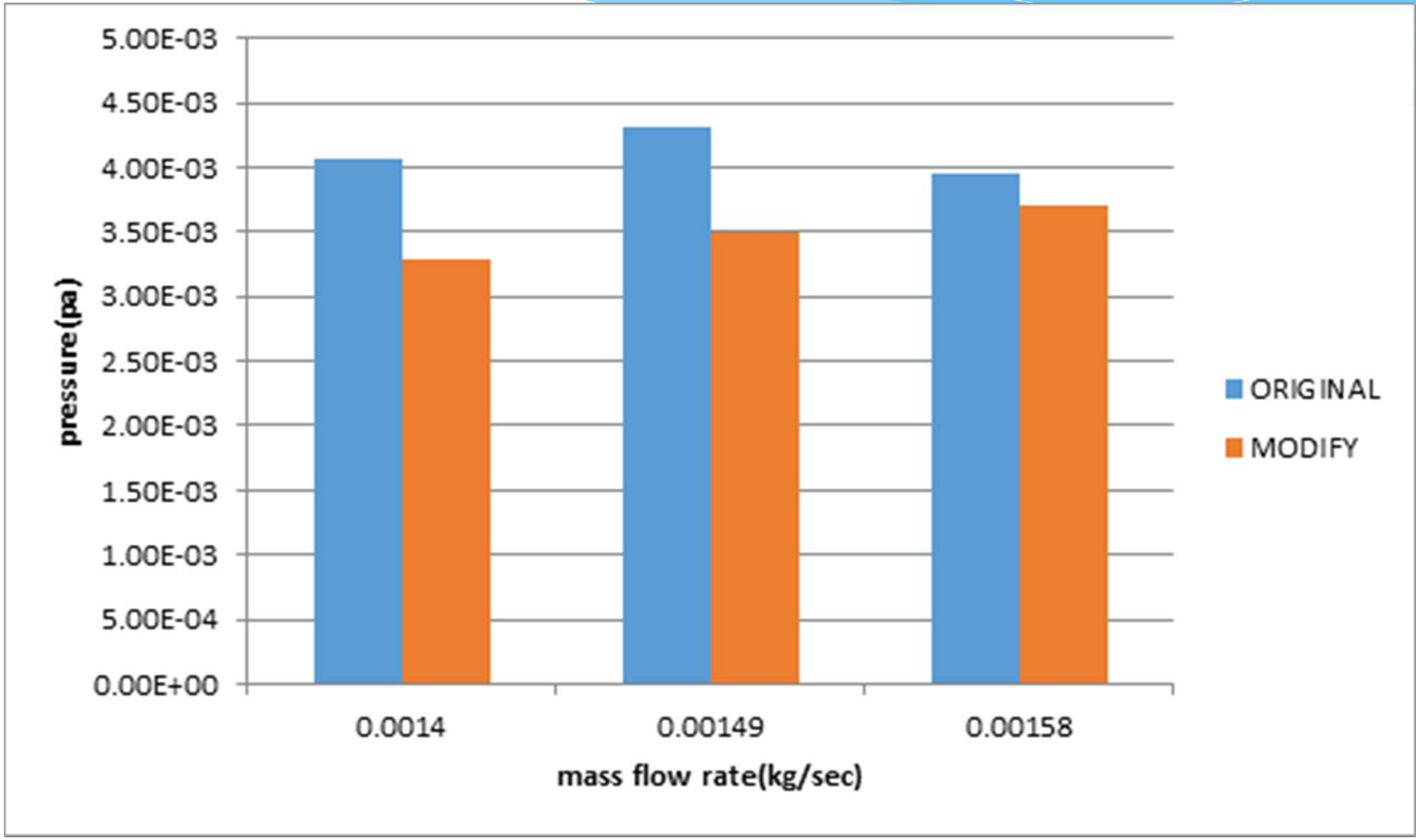
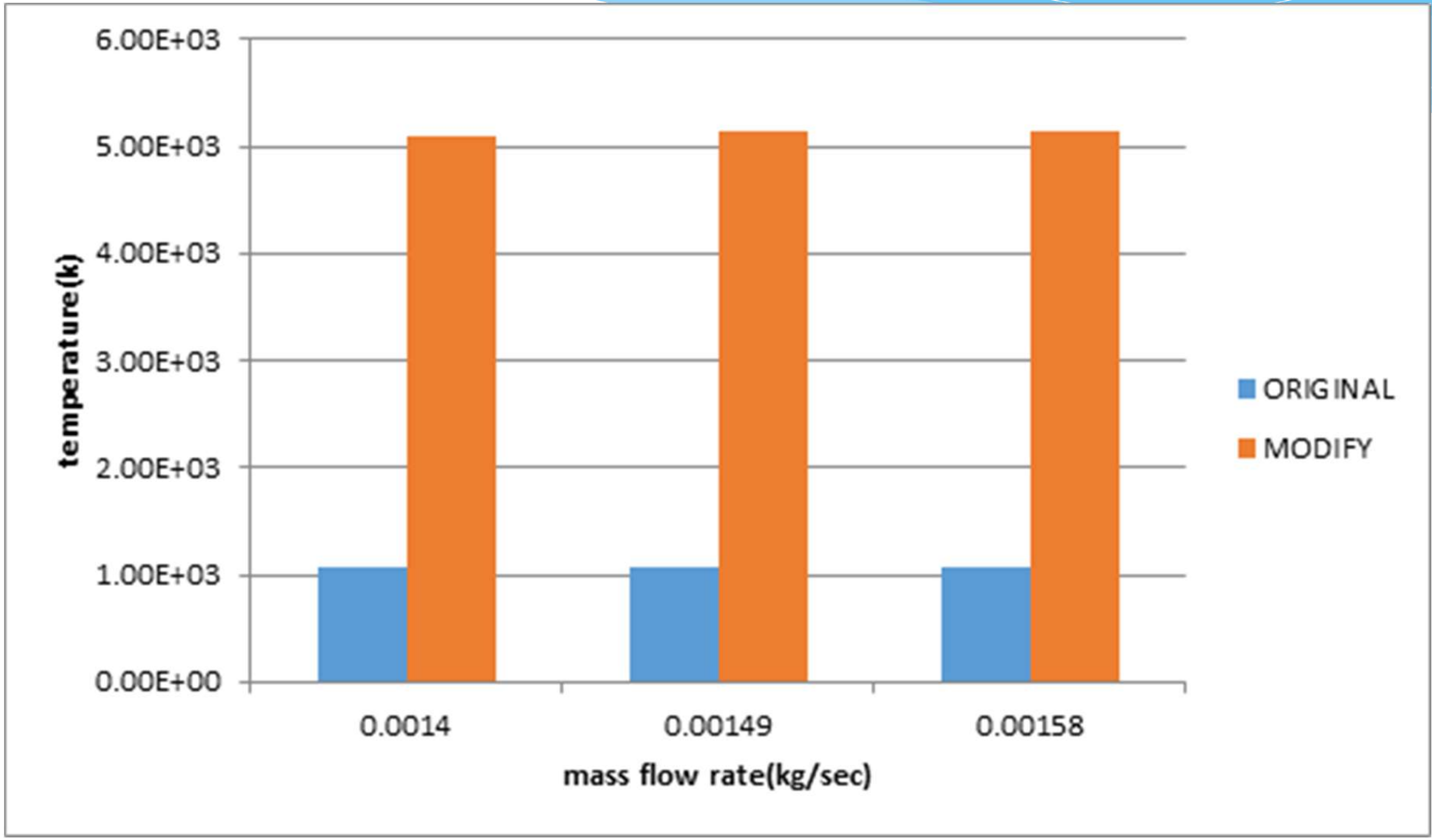


COMPARISIONS

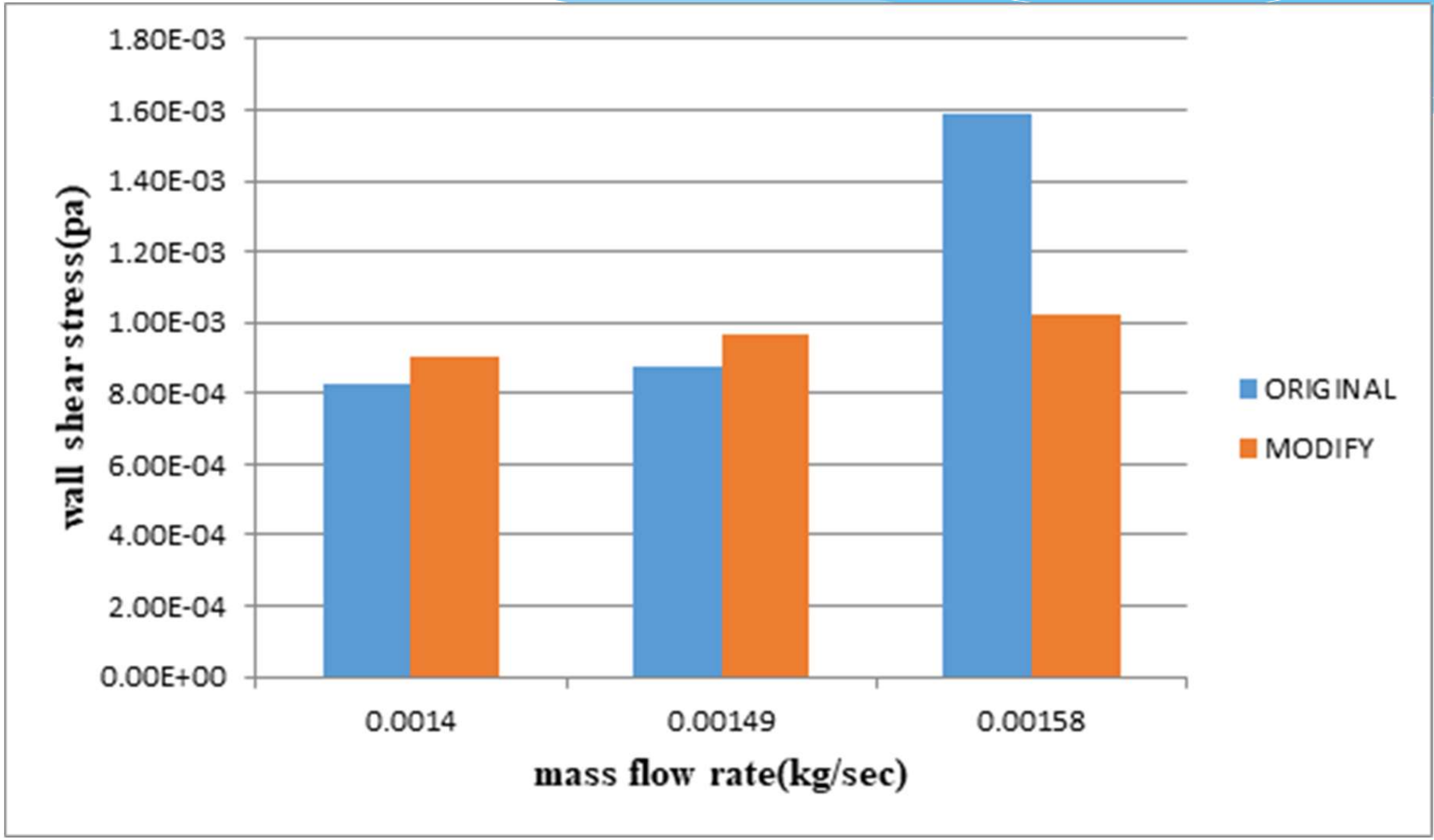
PRESSURE



TEMPERATURE:



WALL SHEAR STRESS:



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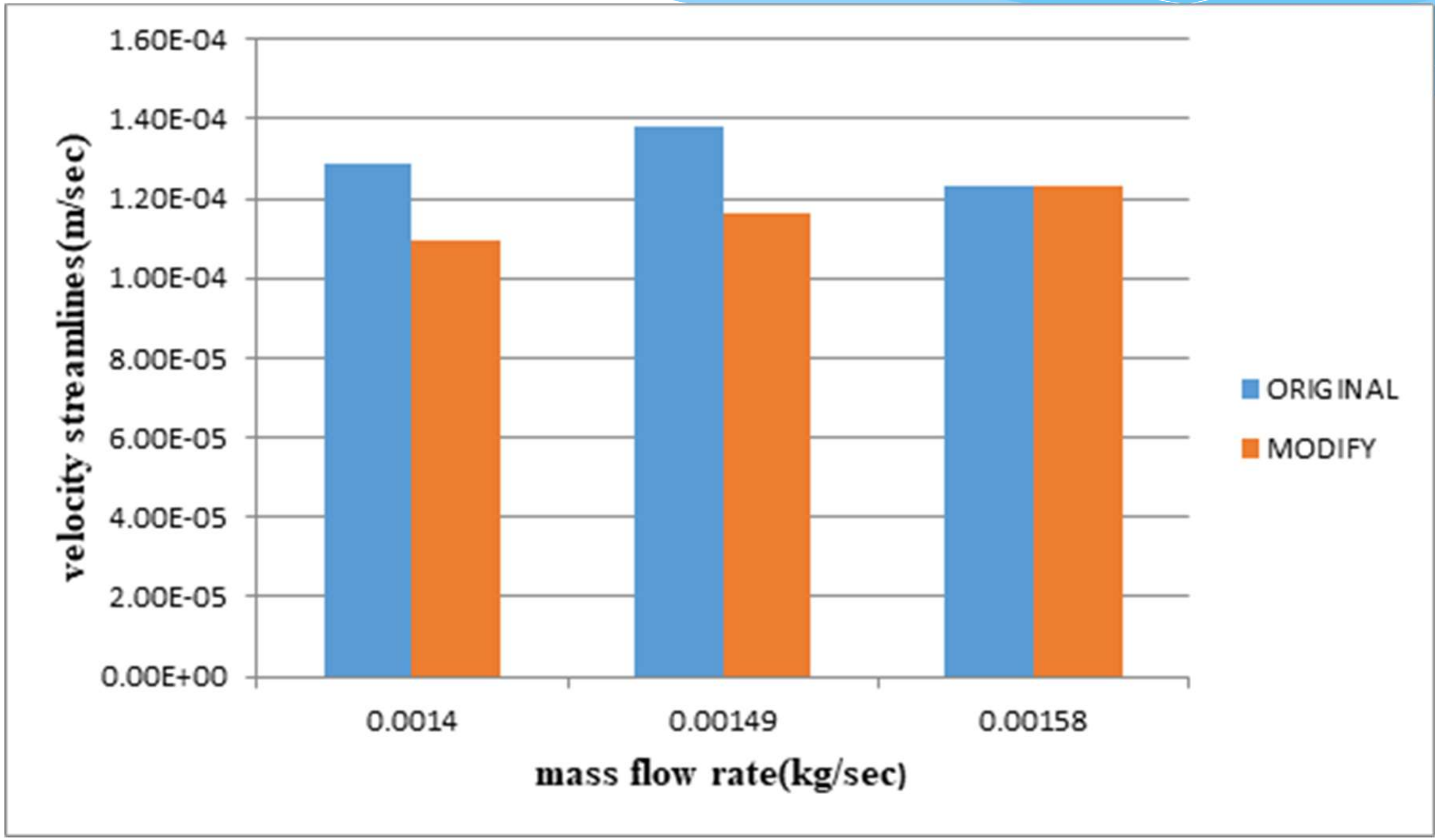

CONCULSION

- Here in this thesis the objective of the thesis is to enhance the heat transfer of hydraulic oil cooler. By this thesis, we can show the development for oil cooling for various application used in chemical industries.

- For the development of oil cooling different profile shapes are being estimated and different flow rates are considered here by verifying in ANSYS software using fluid analysis. For the modeling of the oil cooler Catia is used here.

- As if we verify the results obtained from the tabular form here we could clearly observe that the pressure is being decreased for the modified model.

- we verify for the three different mass flow rates the pressure is also being decreased for the modify model. And the stress is almost no difference between the models

- The temperature and wall shear stress has been increased for the modified model. This indicates there is a better heat transfer rate when compared with the original one

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THANK YOU