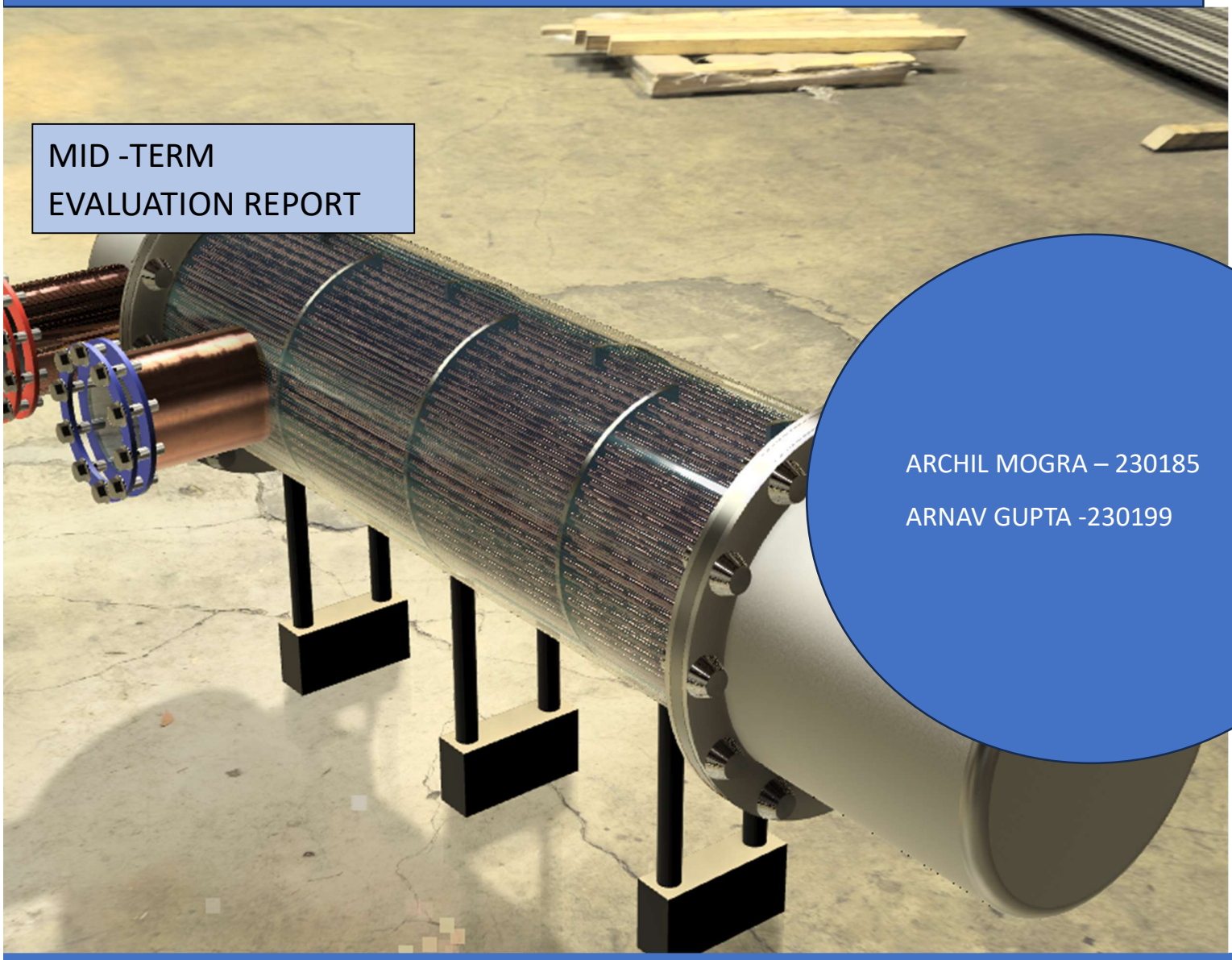
MID -TERM
EVALUATION REPORT



ARCHIL MOGRA – 230185

ARNAV GUPTA -230199

Shell & Tube

HEAT EXCHANGERS

Index

Ans. (3) **Application of Our Heat Exchanger:**

Oil and gas industries: These are widely used in the oil and gas industries involving processes like heating, cooling, evaporating, condensing and generally for high pressure applications. It is essential in **natural gas liquefaction (LNG)** plants, where gas is cooled to sub-zero temperatures. It also recovers heat in oil refining and petrochemical processes, reducing energy consumption.

Power Generation: A most common use of shell and tube heat exchangers are in transferring heat between steam and cooling water as it is cost effective and easily scalable to meet the changing needs of the processes. Integral to **nuclear power plants**, where they transfer heat from the reactor core to secondary systems for generating steam.

Chemical Processing: Used in transferring heat between two fluids such as liquid and gases, that are separated by solid barrier, and because of its structure, it is a good choice for handling toxic chemicals and gases. It works by allowing fluid or gas to flow through a set of tubes enclosed in a metal shell. The fluid or gas is chosen based on the corrosiveness of the substance and the state of the finished product. Heat exchangers are vital in **fractional distillation columns**, **alkylation units**, and **hydrocrackers**. Utilized for cooling and condensing vapors in chemical reactions such as **catalytic cracking** and **reforming**.

Metals and mining: Mining industries also use these because of its efficiency, durability, versatility, material friendliness, and wide coverage of fluids handling.

Food and Beverage Industry: Ensures hygienic heating and cooling during food processing, pasteurization, and sterilization. Used in brewing, dairy production, and beverage carbonation systems.

Pharmaceutical Industry: Maintains specific reaction temperatures for drug synthesis. It Provides controlled heating and cooling in fermentation and distillation processes. Also play a role in maintaining sterility and preventing cross-contamination during heat transfer.

Renewable Energy: Transfer heat in **solar thermal power plants**, connecting solar collectors to steam turbines. Integral to **geothermal energy systems**, where they transfer heat from hot water or steam to turbines. Applied in **biodiesel production**, facilitating transesterification reactions by maintaining optimal temperatures.

SPECIFIC APPLICATION OF OUR INTEREST (MECHANICAL INDUSTRIES)

Cooling Hydraulic Fluids: Widely used to cool hydraulic oils in heavy machinery like cranes, excavators, and industrial presses. Prevents overheating, ensuring optimal performance and extending equipment lifespan.

Lubricating Oil Cooling: Cools lubricating oils in mechanical systems such as turbines, compressors, and gearboxes. Maintains viscosity and reduces wear on moving components.

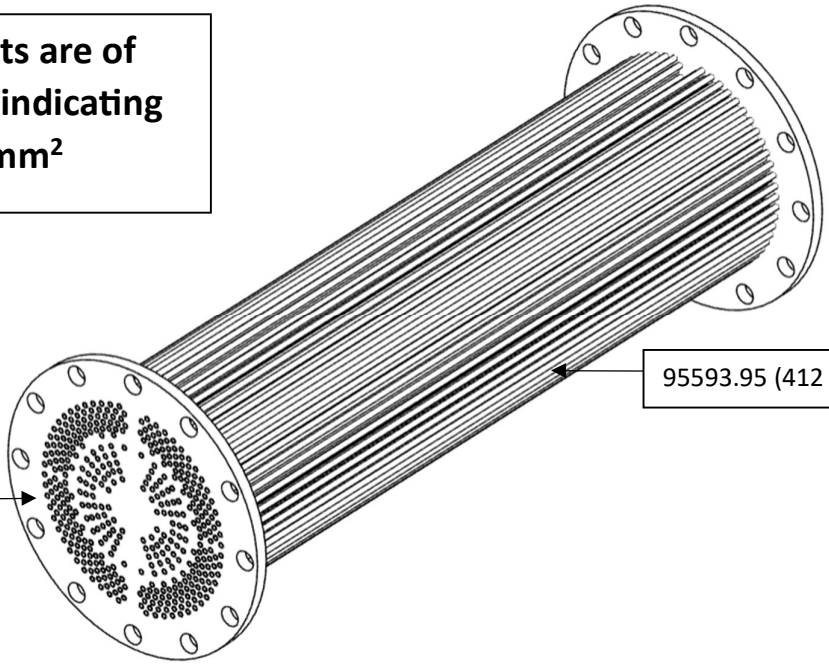
Casting and Foundry Operations: Manages heat in casting molds to achieve uniform cooling and reduce the risk of defects like cracks or voids. Ensures dimensional stability in metal components.

Cooling Engine Jackets: Applied in large industrial engines for cooling jacket water, ensuring engines operate within safe temperature ranges. Extends engine life and reduces the risk of thermal damage.

Also, it has wide range of applications, its not possibe to describe them all here

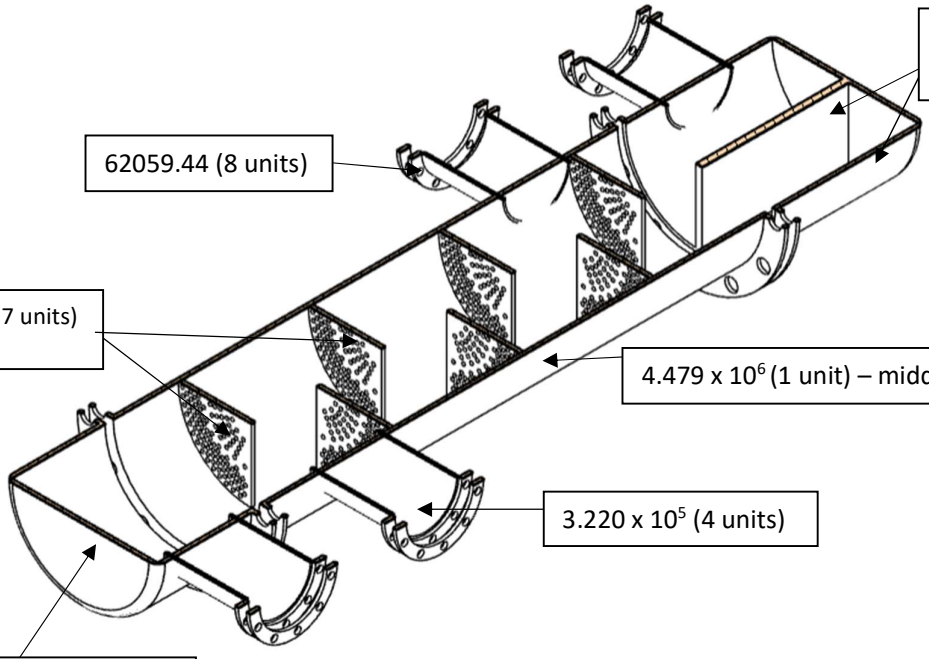
Ans. (4)

All measurements are of surface areas of indicating components in mm^2



95593.95 (412 units)

8.371×10^5 (2 units)



2.270×10^6 (1 unit) (including separator)

62059.44 (8 units)

2.025×10^5 (7 units) (Baffles)

4.479×10^6 (1 unit) – middle section

3.220×10^5 (4 units)

1.391×10^6 (1unit)-left section

TOTAL SURFACE AREA = Tubes + Shell = $(3.868 + 1.182) \times 10^7$ mm^2 = 50.5 m^2

TOTAL VOLUME OF HEAT EXCHANGER = $(4.179 + 5.34) \times 10^7$ mm^2 = 0.0951 m^3

Ans.5 MATERIAL SELECTION JUSTIFICATION:

TUBES (COPPER) : Copper is widely used in making of the tubes of heat exchanger because of its certain outstanding properties , Copper Tubes heat exchangers are important in solar thermal heating and cooling systems because of copper's high thermal conductivity, resistance to atmospheric and water corrosion, sealing and joining by soldering, and mechanical strength.

So, lets sum up some of its qualities which we considered in our manufacturing:

- Malleability and formability
- High durability in high pressure systems
- High thermal conductivity
- Corrosion Resistance

STAINLESS STEEL (MAIN BODY): Stainless steel is widely used in making of main body of the heat exchangers. Stainless steel can fight corrosion like no other alloy. With more than 10% chromium, it is one of the most sought-after alloys to choose for long-term investment in components like heat exchangers. It is also a known fact that stainless steel is comparatively easy to clean thus it explains its wide usage in other industries like power generation and architecture.

Since stainless steel is easier to clean than aluminum and copper it decreases maintenance and increases its lifespan. Moreover, stainless steel is a highly durable and strong material they are less likely to break down thus, justifying the investment made on heat exchangers. Therefore, we used stainless steel in large quantity for the main body of H.E.

- Resisting corrosion by Cooling down the temperature of the water and other chemical fluids
- Preventing oxidation by maintaining higher resistance in temperature.
- Maintaining excellent heat transfer capabilities

- Preventing the material to break down because of excellent corrosion-resistant properties
- The product or process is not contaminated by corrosion
- Compared to aluminum and copper it doesn't leave behind debris and thus is easiest to clean.

BAFFLES (ALUMINUM): Baffles are generally manufactured by aluminium because of its lightweightness which makes it easy to handle and install. we used aluminium to make baffles because of its other qualities also such as:

- Versatility
- Aesthetic Feature
- Low maintenance
- High strength etc.

FRAMES AND OTHER STRUCTURES (CARBON STEEL): We used carbon steel in other joint and supporting structures as it is strong cost effective and has a very good tensile strength. It also maintains the mechanical integrity very well, some of our major considerations were:

- Descent thermal conductivity
- Better heat distribution
- Suffers harsh climatic conditions very well etc.

FASTENERS (TITANIUM and nickel alloys): We majorly used titanium for fasteners because it has high flexibility and plasticity and has a fantastic combination of strength plus corrosion resistance. Another major factor is that it has high resistivity to fouling.

We have also used nickel alloys for some fasteners because of its high **MECHANICAL STRENGTH** which increases its durability and longetivity.

Ans. (6) Our whole manufacturing process can be classified into 4 phases:

MACHINE AND DRILLING OPERATION PHASE: Tube sheets can be plates or forgings depending on thickness, which are then machined and drilled. Flanges are usually hot forged rings that are then machined and drilled. Baffles are plate materials, cut into circles before being machined and drilled.

Then we can mark the baffle sequence number and set number in this phase only which proves to be efficient in the forecoming processes.

Also, we will ensure the proper drilling of holes of supporting frames and also on the sheets of inlet and outlet pipe openings.

Reasoning: This will be our very first approach to avoid any mistake further and heading towards a seamless flow.

WELDING AND FORMING PROCESS: This phase includes shaping the components, such as bending tubes and forming plates, followed by welding to assemble the parts. Now, various techniques can be used in this phase but we will use the best and cost effective.

Shell and tubes are welded primarily generally from the rolled plates. Techniques like TIG (Tungsten Inert Gas) and MIG (Metal Inert Gas) welding are commonly used for their precision and strength, so we can go with either of them.

Then we will apply heat treatments to improve the mechanical properties of the materials, such as annealing to relieve stress and increase ductility.

Reasoning: We will ensure that our welding technique is up to the mark so that we will not encounter any manufacturing failure in the future.

BUNDLE ASSEMBLY PHASE: A bundle of straight tubes is connected between the two tubesheets and contain baffles to direct liquid flow around the tubes to facilitate the required heat transfer. This is the last second step before the final assemble phase.

All our components like tubes, baffles, plates, frames, supporting structures, tubesheets, etc. will be assembled in the complete bundles and will be ready for the final assemble.

Reasoning: We will follow this process because it will give us a complete insight of our final piece, if any replacement has to be made, we can make it here as we don't want to take any chance with our procedure.

FINAL ASSEMBLY PHASE: In this phase we will put all the components together, bundle is pushed into the shell giving it a final touch ensuring proper alignment and secure connections.

Once the heat exchanger has passed all verification and testing procedures, it can be transported to the final location where it will be installed. During transportation, the heat exchanger must be carefully handled to prevent damage to flanged sealing surfaces, exposed tubes (in case of bundles), and fins (air coolers). Often, operational and spare parts like gaskets and bolting are included or shipped loose.

3rd party on-site inspections and field crews typically perform inspection and installation and are responsible to ensure the heat exchanger is installed correctly and is operating safely and efficiently. This may involve checking for leaks, verifying the fluid flow rates and temperature differences, and monitoring the overall performance of the heat exchanger.

Ans. (7) Firstly we will calculate the material costs:

MATERIALS	MATERIAL COST /KG	MASS OF MATERIAL USED	TOTAL COST
Stainless Steel	200 Rs.	342.8 kg	**68,560 Rs.**
Copper	860 Rs.	230.72 kg	**1,98,419.2 Rs.**
Aluminium	243 Rs.	32.9 kg	**7,994.7 Rs.**
Carbon Steel	170 Rs.	138.648 kg	**23,570.16 Rs.**
Titanium + Nickel alloys	5500 Rs. (Titanium) 1356 Rs. (Nickel)	8.32 kg	**19,569.92 Rs.**

TOTAL MATERIAL COST = 3,18,113.98 Rs.

Now we are into the manufacturing costs:

Firtly the labour costs which includes:

Design and planning: 80 hours for 1000 Rs. / hour = **80,000Rs.**

Assembly costs: 252 hours for 500 Rs. / hour = **1,26,000 Rs.**

Welding and installation: 280 hours for 1500 Rs. / hour = **4,20,000 Rs.**

TOTAL MANUFACTURING COSTS = 6,26,000 Rs.

OVERHEAD USAGE and (other) COSTS **= 1,23,000 Rs.**

Testing and Final Inspection cost **= 1,35,000 Rs.**

So, TOTAL COST ESTIMATION = 12,02,113.98 Rs. ~ 12 LAKHS (INR)