Design of Liquid Air Cooler for Radar and Other Aviation Equipment's

Riyaz Ahmed Shaikh ,Lalchadi Mohammed Akram, Sajiya Zahir Khan, Pratiksha Vasant Dudhane.
Mechanical Department , AIKTC School of Engineering and Technology
New Panvel , Navi Mumbai 410206
shaikhriyazahmed05@gmail.com ,
akramlalchadi@gmail.com ,sajiyazahirahmedkhan@gmail.com ,dudhanepratiksha2234@gmail.com

Abstract—An air cooler is used for efficient heat transfer from one particular medium to another medium. For separation of media, a solid wall is used so that they never mix, or they may be in direct contact. A cross flow heat exchangers are widely used in Aviation sciences, Automobile industries ,oil refineries and other large chemical processes.This type of heat exchanger is chosen because of Work load efficiency, it has comparatively high values. Its unique compactness adds a reason for its selection. Because of its compactness it has attribute of mobility. The other characteristics are less strain on pocket and the most dignified attribute , operational safety.
For designing of the apparatus, various parameters are taken into consideration. Temperature difference being the most important characteristic which is required for proper heat transfer. Flow rate of the fluid flowing through the pipes of the cooler is also of great significance. The heat transfer in the air cooler is also dependant on the pressure of fluid flowing through the pipes and the overall heat transfer coefficient of a liquid in application . Material of the pipes also affects the heat transfer occuring in the pipes.This paper throws light on the view that keeping all consideration in mind the standard design procedure can be followed the values which has been calculated is being drafted into three dimensional model using suitable drafting softwares so that the model can be analysed to validate various thermal structural parameters.

Keywords—Heat Exchanger,Cooler,Radar,Liquid air cooler, Design procedures.

I. INTRODUCTION

A air cooler is used for efficient heat transfer from one particular medium to another medium. For separation of media, a solid wall is used so that they never mix, or they may be in direct contact. Air coolers are widely used in

interstellar heating, aviation technology , air conditioning, refrigeration, petrochemical plants, power plants,

chemical plants, petroleum refineries,

natural gas processing, sewage treatments and cryogenics applications . One common example of a air cooler is the automobile radiator, in which the heat source is a hot

engine-cooling fluid, coolant, transfers heat to air flowing around the radiator.

The air cooler accepts two or more streams,

which may flow in perpendicular or parallel directions to

one another.In parallel flow , the direction of stream can be altered as per the requirements. Thus we

can think of three primary flow arrangements:

a) Parallel flow

b) Counter flow

c) Cross flow

Thermo- dynamically, the highest heat (or cold) recovery is provided by the counter flow arrangement, while the parallel flow geometry gives the lowest. The cross flow

arrangement, gives medium thermodynamic

Performance and offers superior heat transfer characteristics with

easier mechanical layout attributes. Under certain circumstances, a

hybrid cross counter flow geometry provides greater heat

(or cold) recovery with superior heat transfer performance.

II. METHODOLOGY

Since for cooling purposes , a liquid cooler which is being designed is of type one fluid unmixed and other fluid mixed cross flow heat exchanger. In the above the cooling air is a mixed fluid and the fluent flowing through pipes is unmixed. A cooler comprising an outer structural frame, a multiplicity of channels longitudinally aligned in parallel spaced relation to form first fluid passageways within the channels, and a multiplicity of wall projection portions formed from the channel side walls and extending outwardly with load bearing end segments of adjacent side walls abutting and transferring the channel load to the outer structural frame, the channels and wall projection portions arranged for flowing a second fluid normal to and in the space between adjacent channels, and fins extending from the channel edge walls having surface distortions and the entire assembly should be mounted on a trolley to make system portable.

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- THERMAL DESIGN
- MECHANICAL DESIGN
- Thermal design of cross flow heat exchanger includes the determination of :
- Heat Transfer Area
- Rate of heat transfer
- Over all heat transfer coefficient
- Tube Length and Diameter
- Tube Layout
- No.of passes

III. DESIGN PROCEDURE

Mechanical design of liquid air cooler includes various standard parts as per the available standard

DESIGN CONSIDERATION:

The below inputs and the size constraint taken into consideration for designing of liquid air cooler are

as follows :

Flow rate .

Maximum working temperature

Speed of fan

Desired cooling temperature

Design procedure:

STEP 01: Calculation of required heat transfer rate , unknown temperatures mass flow rate etc.

Q = Heat Transfer Rate

STEP 02: Selection of material for tubes, trolley, matrix and wheels .

Tubes - Copper, Aluminium etc.

Matrix shell - Sheet metal.

Trolley wheels - Caster.

STEP 03:

Major component of RCT:-

Air to liquid heat exchanger with fan.

Quick release coupling.

Trolley stand.

Caster wheel.

Electrical switches & sensors.

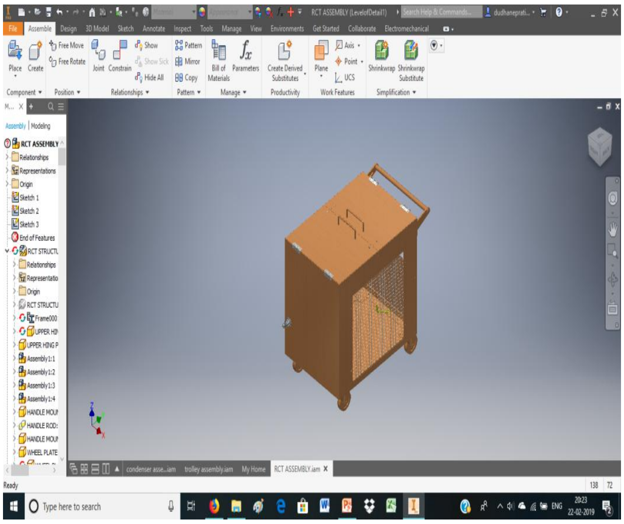

Figure 1. 3D drafted model of a external trolley.

Step 04: Overall heat transfer coefficient:

selected std. value of overall heat exchanger coefficient (U) from previous chart.

for Air cooled heat exchangers cooling of light hydrocarbons

U =400-550 W/m2 .k

Step 05: LMTD (logarithmic mean temp. difference) :

$$LMTD = \frac{(Th1 - Tc2) - (Th2 - Tc1)}{\ln\left(\frac{Th1 - Tc2}{Th2 - Tc1}\right)}$$

LMTD for cross flow (ΔTm) = (LMTD) $_{counter\ flow}$ * F

where , F =correction factor.

$$R = \frac{(T_1 - T_2)}{(t_2 - t_1)}$$

R=0.5

$$S = \frac{(t_2 - t_1)}{(T_1 - t_1)}$$

from std. chart available ; F is selected

STEP 06 : Surface Area and heat transfer Area :

$Q = U * A * LMTD_{cross\ flow}$
where ; A = heat transfer Area
Surface Area (A0) = π * D0* L
from BWG & SWG chart

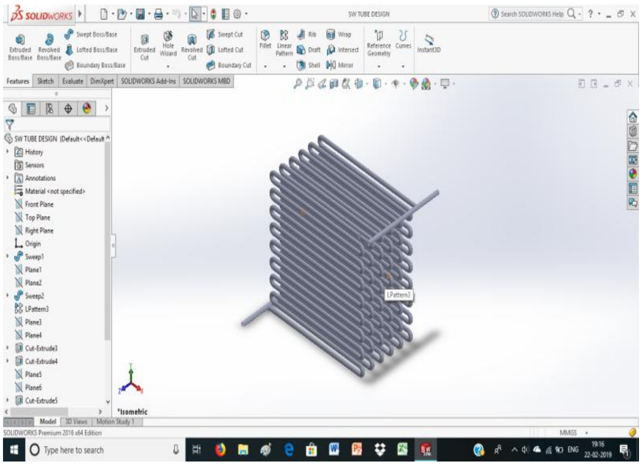

Figure 2. 3D drafted model of a Coil

STEP 07 - No. of passes(n):
No. of passes(n) = A / A0

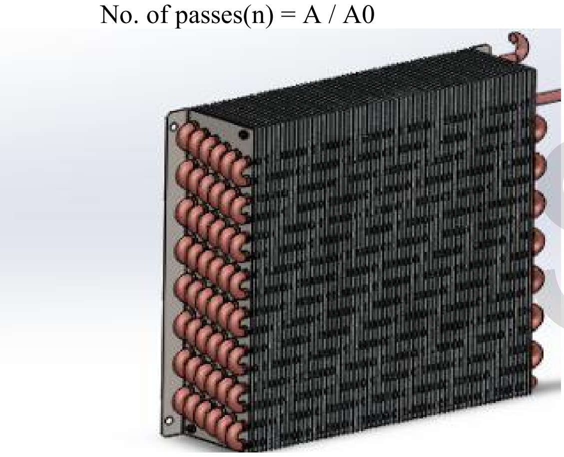

Figure 3. 3D drafted model of a Liquid air cooler

IV. CONCLUSION

- Various methods are available in the books of Heat Transfers but we selected a method which is
- formed by combining the standards available. We came to conclusion that the design of Liquid Air
- Cooler is independent of the methods used. This design was for lower temperature difference but it
- had a scope of further improvements since the method used is a amalgam. To use the design for a
- greater temperature difference one can increase the number of passes or decrease the temperature
- of cooling air or increase the volume flow rate of air as well as of the fluid flowing through the pipe.
- To improve a heat transfer by the liquid air cooler, one can experiment with the materials of the flow pipes to get the suitable output. The core classification for designing are:

V. RESULT:

We can finally say that the targeted temperature difference can be provided by the above design procedures. The condition for physical constraints is also fulfilled by the above procedures. Physical constraints include portability of the system and the Dimensional parameters for its attribute of compactness. The safety constraints of operational and handling safety are also met by this design procedure. The design also emphasize on the optional cost product while fabricating.

VI. FUTURE SCOPE :

According to the approach that is selected their are chances of enhancing the method which is described previously.
Can increase efficiency of heat exchangers .
Reduce the size of heat exchanger in order to use less material and make it compact for the same efficiency.
Further research can be done for simplification of solution to the problem given.
Apart from the standard procedures of TEMA, one can design heat exchanger by using non standard procedure and can come to same result.

VII. REFERENCES

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