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STUDY OF AIR COOLED HEAT EXCHANGER

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Abstract

Today our country is passing through a critical stage employment is very scarce, growing number of educated people remain unemployed for long time. Our government is trying to do its best to provide employment, but the government has its own limitation. So self-employment is very important aspect according to present situation. To provide one with suitable guidance in this direction, project work has been included in our curriculum of the final year of master course. This project work reflects the theoretical and practical knowledge gained by the student during their studentship in the institute. It deals with an important aspect in the curriculum of a student in that the student should be able to design on his own the whole aspects of the component taken at hand and be able to suggest new ideas to manufacture a given component on the basis of economically justified ground in the light of improved techniques.

Being a student of final year Mechanical Engineering we have selected “AIR COOLED HEAT EXCHANGER” unit which is used in Home automation system ,with the above ends in views. This subject has a unique importance in the field of electronics

1. INTRODUCTION

Air Cooled Heat Exchangers are designed and constructed so that the hot process fluid to be cooled flows through a tube while the cooling air flows across the outer surface to remove heat. The cooling air is propelled by fans in either a forced draft or induced draft configuration. These Heat Exchangers can be Cover Plate / Plug Box and pipe bend models. Tube materials can be carbon or low alloy steel, stainless steel, copper, copper alloys and nickel alloys. Fin materials which are attached to the outer surface of tubes in order to create large surface area, can be of Carbon steel, Aluminum, Marine grade Aluminum and Copper Materials. Fin Type can be Plain or Crimped with Type, Extruded or Embedded. Special imported heavy-duty fans & motors are fitted for outdoor applications. Designing is done considering fouling, condensation, velocity of the airflow and enhanced tube surface area being provided by fins. The mechanical design of the exchanger takes utmost care of the process conditions including pressure, temperature, corrosively and ease of maintenance.

Air Cooled Heat Exchangers are commonly used in industrial applications where a reliable source of water is not available as a cooling medium. These heat exchangers find favor with industry for economic and operational reasons since they eliminate need of any kind water cooling systems as well as water conditioning systems thereby reducing capital requirements, as well as operating and maintenance costs.

Air Cooled Heat Exchangers are made to be used throughout the oil and gas industry including refineries and petrochemical plants, under severe conditions including high pressure and temperature, as well as corrosive fluids and environments. Air cooled steam condensers are a special type of heat exchanger employed to condense steam at the exhaust end of steam turbines for both power generation and mechanical drive applications.

2. METHODOLOGY

The testing and inspection procedure are laid down in such a way that equipment manufactured by a passes though all the simulation test, which may out instrument be subjected to in actual use. After a careful study we have laid down the final tests.

1) VISUAL INSPECTION TEST

This test in a primary test to see the any physical damage.

1.1) PCL inspection

1.2) Mechanical strength

1.3) Input/ output connection scheme.

2) ASSEMBLY TEST

This test will cover all the functional test.

2.1) Components test

2.2) Circuit operation test using the test point signal.

3) FINAL TEST

This test will be carried out with the actual operation and conditions

4) MECHANICAL VIBRATION TEST

This test will be done on the batch samples only.

3. TESTING

Testing play a most important role in the manufacturing of any product, which defects the invisible defects and confirms the desired technical features of product.

During testing product is subject to various type of testing.

A) VISUAL CHECK

In this it is seen that all components of proper values are mounted to their respective polarities.

B) CRCUIT TESTING

In this circuit is given to the required supply and various parameters i.e. voltage current etc. are recorded and then is kept on for cycle operation that is for 24 hrs. and parameters are recorded after a certain intervals.

TYPES OF TEST

Generally this test is conducted on one prototype job which covers following stages :-

In this testing job is subjected to a wet atmosphere for one cycle at a designed temperature and afterwards immediately normal testing is conducted and observed that reading are in line with desired readings.

On completing the testing the various stages readings are completed with designed parameters for necessary approval

A model of a simple heat exchanger

A simple heat exchanger might be thought of as two straight pipes with fluid flow, which are thermally connected. Let the pipes be of equal length *L*, carrying fluids with heat capacity C_i (energy per unit mass per unit change in temperature) and let the mass flow rate of the fluids through the pipes be j_i(mass per unit time), where the subscript *i* applies to pipe 1 or pipe 2.

The temperature profiles for the pipes are $T_1(x)$and $T_2(x)$where *x* is the distance along the pipe. Assume a steady state, so that the temperature profiles are not functions of time. Assume also that the only transfer of heat from a small volume of fluid in one pipe is to the fluid element in the other pipe at the same position. There will be no transfer of heat along a pipe due to temperature differences in that pipe. By Newton's law of cooling the rate of change in energy of a small volume of fluid is proportional to the difference in temperatures between it and the corresponding element in the other pipe:

$$\frac{du_1}{dt} = \gamma(T_2 - T_1)$$

$$\frac{du_2}{dt} = \gamma(T_1 - T_2)$$

where $u_i(x)$is the thermal energy per unit length and γ is the thermal connection constant per unit length between the two pipes. This change in internal energy results in a change in the temperature of the fluid element. The time rate of change for the fluid element being carried along by the flow is:

$$\frac{du_1}{dt} = J_1\frac{dT_1}{dx}$$

$$\frac{du_2}{dt} = J_2\frac{dT_2}{dx}$$

where $J_i = C_i j_i$is the "thermal mass flow rate". The differential equations governing the heat exchanger may now be written as:

$$J_1\frac{\partial T_1}{\partial x} = \gamma(T_2 - T_1)$$

$$J_2\frac{\partial T_2}{\partial x} = \gamma(T_1 - T_2).$$

Note that, since the system is in a steady state, there are no partial derivatives of temperature with respect to time, and since there is no heat transfer along the pipe, there are no second derivatives in *x* as is found in the heat equation. These two coupled first-order differential equations may be solved to yield:

$$T_1 = A - \frac{Bk_1}{k}\,e^{-kx}$$

$$T_2 = A + \frac{Bk_2}{k} e^{-kx}$$

where $k_1 = \gamma/J_1$, $k_2 = \gamma/J_2$, $k = k_1 + k_2$ and A and B are two as yet undetermined constants of integration. Let T_{10} and T_{20} be the temperatures at x=0 and let T_{1L} and T_{2L} be the temperatures at the end of the pipe at x=L. Define the average temperatures in each pipe as:

$$\overline{T}_1 = \frac{1}{L}\int_0^L T_1(x)dx$$

$$\overline{T}_2 = \frac{1}{L}\int_0^L T_2(x)dx.$$

Using the solutions above, these temperatures are:

$$T_{10} = A - \frac{Bk_1}{k} \qquad T_{20} = A + \frac{Bk_2}{k}$$

$$T_{1L} = A - \frac{Bk_1}{k}e^{-kL} \qquad T_{2L} = A + \frac{Bk_2}{k}e^{-kL}$$

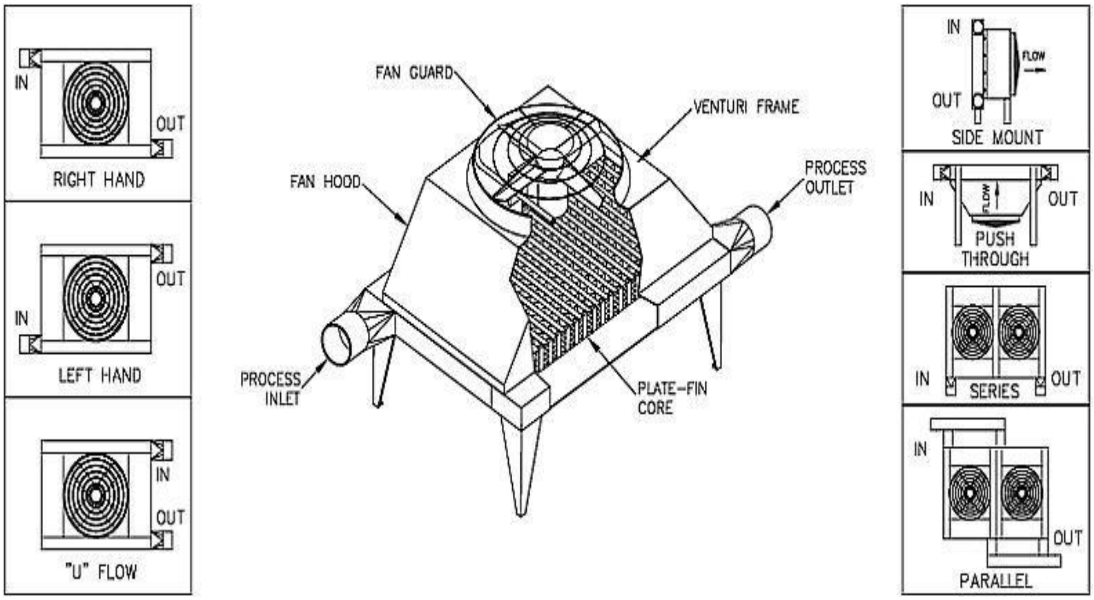
$$\overline{T}_1 = A - \frac{Bk_1}{k^2L}(1 - e^{-kL}) \qquad \overline{T}_2 = A + \frac{Bk_2}{k^2L}(1 - e^{-kL}).$$

Choosing any two of the above temperatures will allow the constants of integration to be eliminated, and that will allow the other four temperatures to be found. The total energy transferred is found by integrating the expressions for the time rate of change of internal energy per unit length:

$$\frac{dU_1}{dt} = \int_0^L \frac{du_1}{dt}\,dx = J_1(T_{1L} - T_{10}) = \gamma L(\overline{T}_2 - \overline{T}_1)$$

$$\frac{dU_2}{dt} = \int_0^L \frac{du_2}{dt}\,dx = J_2(T_{2L} - T_{20}) = \gamma L(\overline{T}_1 - \overline{T}_2).$$

By the conservation of energy, the sum of the two energies is zero. The quantity $\overline{T}_2 - \overline{T}_1$ is known as the "log mean temperature difference" and is a measure of the effectiveness of the heat exchanger in transferring heat energy.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PARALLEL

4.MONITORING AND MAINTENANCE OF HEAT EXCHANGERS

Online monitoring of commercial heat exchangers is done by tracking the overall heat transfer coefficient. The overall heat transfer coefficient tends to decline over time due to fouling.

$U=Q/A\Delta T_{lm}$

By periodically calculating the overall heat transfer coefficient from exchanger flow rates and temperatures, the owner of the heat exchanger can estimate when cleaning the heat exchanger will be economically attractive. Integrity inspection of plate and tubular heat exchanger can be tested in situ by the conductivity or helium gas methods. These methods confirm the integrity of the plates or tubes to prevent any cross contamination and the condition of the gaskets.

Mechanical integrity monitoring of heat exchanger tubes may be conducted through Nondestructive methods such as eddy current testing.

Fouling

A heat exchanger in a steam power station contaminated with macrofouling. Fouling occurs when impurities deposit on the heat exchange surface. Deposition of these impurities can be caused by:

Low wall shear stress

Low fluid velocities

High fluid velocities

Reaction product solid precipitation

Precipitation of dissolved impurities due to elevated wall temperatures

The rate of heat exchanger fouling is determined by the rate of particle deposition less re-entrainment/suppression. This model was originally proposed in 1959 by Kern and Seaton.

Crude Oil Exchanger Fouling. In commercial crude oil refining, crude oil is heated from 21 °C to 343 °C prior to entering the distillation column. A series of shell and tube heat exchangers is typically used to exchange heat between the crude oil and other oil streams, in order to get the crude to 260 °C prior to heating in a furnace. Fouling occurs on the crude side of these exchangers due to asphaltene insolubility. The nature of asphaltene solubility in crude oil was successfully modeled by Wiehe and Kennedy. The precipitation of insoluble asphaltenes in crude preheat trains has been successfully modeled as a first order reaction by Ebert and Panchal who expanded on the work of Kern and Seaton.

CONCLUSION

A thermal engineer involved in air-cooled heat exchanger design should read and evaluate the wealth of data and knowledge provided in kays & London's book. Most people just read the empirical data represented at the back of the book for design purpose, but the entire textbook should be considered. Even though the first edition was written almost fifty years ago, almost all - if not all- of the information is still very applicable in this high tech age.

REFERENCES

1. Heat exchanger- R.S. Khurmi
2. Fundamental of Heat exchanger-Rameshk.shah
3. Heat exchanger Design- Arthur. P.Frass