iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.43392

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Design of Shell Tube Heat Exchanger Using Vibration Analysis

Maruti Kamble[1], Dr. A. D. Desai[2]
[1]Student, [2]Professor Department of Mechanical Engineering, Shree Ramchandra College of Engineering, Pune-412207.

Abstract: The condenser with BXM configuration in manicoy and Agatti plant worked well without any accident, but the condenser with BXV configuration in karavati plant failed six times in a year. The vortex shedding, elastic instability and accoustic vibration of the tube bundle this parameter are analyzed. And further modes of vibration and fundamental are studied with parameters like tube pitch, span and cross flow velocity were made. Optimum tube pitch for allowable cross flow velocity, minimum amplitude of vibration short span lengths for vibration free heat exchanger are determined. Vibration analysis results find for BHM to BXM type heat exchange installed in Minicoy and Agatti Desalination Plants. Shell and Tube Heat exchangers are with TEMA configuration BHM in Minicoy and Agatti desalination plants and BXM in Kavaratti with fresh nominal water generation capacity is 100 m3/day.
Keywords: Heat Exchanger, vibration, tube, span length, pipe, Temperature.

I. INTRODUCTION

The plant for low-temperature thermal desalination (LTTD) works on the principle of flash distillation, in which warm seawater (at around 28 °C) evaporates in a chamber kept under vacuum (at around 27 mbar abs) and the resulting vapor is then in a condenser is liquefied. A shell and tube heat exchanger (STHE) in which 12°C cold deep sea water flows within the shell and tube was selected considering its various advantages such as low pressure drop, multiple tube pass arrangement, easy maintenance and robust mechanical construction. The heat exchanger contains 90/10 cupro-nickel tubes enclosed in a SS-304L shell in which steam flows. The pipes are exposed to high vibration bending stresses and corrosives that can lead to pipe failure (Jahangiri, 2011). Corrosion can be mitigated by proper shell and tube bundle material selection, while vibration can be mitigated by proper design against tube failure, so flow induced vibration is considered an integral part of thermal design. Fluid elastic instability, random excitation or turbulent buffeting, vortex shedding or periodic wake shedding, and acoustic resonance lead to tube vibrations in shell and tube heat exchangers (Pettigrew and Taylor, 2003a and b). Among these excitation mechanisms, the most severe vibration mechanism is fluid elastic instability, which may cause tube damage after few hours of operation and buffeting due to flow-turbulence causes very little vibration, which causes tube wall thinning, due to fretting, such causes of vibration must be avoided (Goyder, 2003 and Price, 2001). For closely spaced tube arrays with pitch ratio less than 2, the vortex shedding degenerates into broadband turbulent eddies resulting in turbulent buffeting (Blevins, 1990). Due to cross flow, turbulence increases in tube bundles as the fluid flows across the array geometry and, as such, the tubes are subjected to turbulent buffeting (Polak and Weaver, 1995). Shell and tube heat exchanger design can be optimized by changing the tube length which shows influence of shell acoustic frequency, tube natural frequency, bundle cross flow, critical velocity, and vortex shedding ratio (Gawande, et al.,2011). All the above studies are based on fundamental frequency only; there may be influence of higher modes on vibrations. A detailed analysis was carried out for flow induced vibrations due to fluid elastic instability, vortex shedding and acoustic resonance of the tube bundle along with the fundamental and higher modes of vibration by changing various parameters such as span, tube pitch and cross flow velocity.

II. PROBLEM STATEMENT

The heat exchanger is the most important concept in the thermal field and also vibration is always associated with it, so analyzing the vibration state of the heat exchanger is challenging. A mathematical model to minimize the annual costs incurred in operating a heat exchanger needs to be formulated and optimized. The thermal and physical properties of the two fluids at the inlet conditions are known. The heat exchanger is an integral part of its thermal design. A proper design is absolutely secure against tube failure due to flow induced vibration. Most sophisticated thermal design software packages perform vibration analysis as a routine part of thermal design. This is important because during thermal design the geometry of a heat exchanger is ultimately established and that same geometry along with flow, physical and property parameters will determine whether the given heat exchanger is safe from tube failure due to flow induced vibrations.

Flow induced vibration is a very complex subject and involves the interaction of several parameters, many of which are not very well known.

Although many cases of tube failure due to flow-induced vibration have been reported in recent years, an understanding of the factors responsible for these failures leaves much to be desired. The literature reveals several interesting studies on specific facets of the vibration problem; however, very little research has addressed the specific problems associated with shell and tube heat exchangers.

It is desirable that the heat exchanger be designed for given outlet temperatures of both the shell-side and tube-side fluids. The heat transfer area and pump power required to achieve the desired temperature conditions were calculated as a function of the design variables. The objective function is a function of the effective heat transfer area and the pumping power required to overcome the pressure drop.

III. LITURATURE REVIEW

A. Durgesh Bhatt, Priyanka M Javhar-2012

Durgesh Bhatt, Priyanka M Javhar conducted a Shell and Tube Heat Exchanger Performance Analysis It is observed that by changing the value of one variable the by keeping the rest variable as constant we can obtain the different results. Based on that result we can optimize the design of the shell and tube type heat EXCHANGER. HIGHER THE THERMAL CONDUCTIVITY OF the tube metallurgy higher the heat transfer rate will be achieved. Less is the baffle spacing , more is the shell side passes, higher the heat transfer but at the cost of the pressure drop.

B. Vindhya Vasiny Prasad Dubey, Raj Rajat Verma-2014

Dubey and Verma conducted a Performance Analysis of Shell & Tube Type Heat Exchanger under the Effect of Varied Operating Conditions and concluded that It may be said that the insulation is a good tool to increase the rate of heat transfer if used properly well below the level of critical thickness. Amongst the used materials the cotton wool and the tape have given the best values of effectiveness. Moreover the effectiveness of the heat exchanger also depends upon the value of turbulence provided. However it is also seen that there does not exists direct relation between the turbulence and effectiveness and effectiveness attains its peak at some intermediate value. The ambient conditions for which the heat exchanger was tested do not show any significant effect over the heat exchanger's performance.

C. Dawit Bogale-2014

Dawit Bogale conducted a experiment on shell and tube heat exchangers showing optimization and redesign of the machine is done for both mechanical and thermal designs and the simulation for the heat transfer between the two fluid is analyzed using the concept of CFD (Computational Fluid Dynamics) using Gambit and Fluent software's. The final result of the STHEx in HBSC which is the redesigned STHEX can achieve or efficiently work to achieve the required outlet temperature 340˚C the temp at which the beer is ready for customer for use.

IV. ADVANTAGES

1) The Design of Shell and Tube Heat Exchangers is very compact.
2) It capable to handling with High Pressure.
3) It less expensive too.
4) Can be used in systems with higher operating temperatures and pressures Pressure drop across a tube cooler is less Tubular coolers in refrigeration system can act as receiver also. Using sacrificial anodes protects the whole cooling system against corrosion Due to the pressure differential use coolers may be preferred for lubricating oil cooling

V. LIMITATION

1) It is very tough to readily analyze the shell side of the tubes for scaling or tube damage.
2) Less efficiency in Heat Exchanger Cleaning and maintenance is Problematic since a tube cooler requires enough clearance at one end to remove the tube nest.
3) It cannot be increased the capacity of tube cooler.
4) It requires more space for drop it at one place.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

VI. FUTURE SCOPE

We could not scale up our project due to limitations and limitations of knowledge. Although the heat pipe heat exchanger is a successful project, some improvements are needed. Our focus was to make the project easy and not very expensive. So that it benefits society and can be easily bought. It can also be used in cars. Heat pipe heat exchangers in thermal conductivity are highly effective. Heat pipes do not require any other source of energy such as electricity, they simply work with a working fluid in the heat pipe and heat is absorbed in the evaporator section and then transferred to the condenser where the vaporized liquid then condenses and releases the heat to the refrigeration section. This idea or project can be of great appeal to society as it is eco-friendly.

REFERENCES

[1] Pal, A., Joshi, Y., & Wenger, T. (2001). Design and Performance Evaluation of a Compact Thermosyphon. Retrieved on Sept 15, 2019 from https://pdfs.semanticscholar.org/bfaa/438800fd68aa238cc05a2ab3e540630b1b5a.pdf
[2] Howell, D., (2019). Thermosyphons. Retrieved on Sept 22, 2019 from https://www.sciencedirect.com/topics/engineering/thermosyphons
[3] Streicher, W.,&Soteris, A. (2016). Thermosiphon System. Retrived on Oct 01,2019 from https://www.sciencedirect.com/topics/engineering/thermosiphon-system
[4] Abdullahi, B., Raya, K., &Sa'ad, M. (August 7, 2019). Thermosyphon Heat Pipe Technology. Retrieved on Oct 01, 2019 from https://www.intechopen.com/books/recent-advances-in-heat-pipes/thermosyphonheat-pipe-technology
[5] Lamaison, N., Marcinichen, J., Szczukiewicz, S., & John, R. (January, 2016). Passive Thermosyphon Cooling System for High Heat Flux Servers. Retrieved on Oct 03, 2019 from https://www.researchgate.net/publication/301238878_Passive_Thermosyphon_Coolin g_System_for_High_Heat_Flux_Servers