Regeneration of Lubricating Oil Vented from Oil Vapors from the Main Oil Tank of Industrial Power Turbines

Aamir Ibrahim
Department of Mechanical Engineering
National Institute of Technology Srinagar
Srinagar, India

Hakim Shahid Bashir
Department of Mechanical Engineering
National Institute of Technology Srinagar
Srinagar, India

***Abstract*— Vaporization of lubricating oil over the Main oil tank is very commonly noticed problem which results in frequent top ups for maintaining the oil level .These top-ups seemingly small at first actually amount to a significant value overtime resulting in huge economic losses. This paper focuses on developing a regeneration mechanism for recovery of this oil in order to minimize oil wastage hence resulting in a more efficient power production mechanism which is of utmost value in the present scenario of energy crisis.**

Keywords—Power Turbine, bearings,Oil Storage Tank,Vapour exhauster, Compressor, Heat exchanger, Double acting Compressor, Surface Condenser.

I. IDENTIFICATION OF THE PROBLEM

The lubricating oil which is fed to various bearings of an industrial power turbine gets heated up due high relative motion between the rotating shaft and the bearings. To maintain the temperature of the lubricating oil for requisite viscosity the oil is circulated through different cooling schemes depending on the design and the availability of the resources. For sustaining any fluctuating demands of oil, like during hydraulic barring wherein the demand of oil increases due to opening of barring gear, an Oil Storage tank is necessarily provided in the system. This also caters to oil loss due spills and vaporization.

Vaporization of oil over the Main oil tank is very commonly noticed problem which results in frequent top ups for maintaining the oil level. The vapors are led out of the tank by means of vapor exhauster fans, provided in pairs for redundancy, and are vented into the atmosphere.

II. ESTIMATED COST OF TOP-UPS

Let the number of turbines in a power plant be ‘x_1’

Let the number of main oil tanks for each turbine be ‘x_2’

Let the number of barrels topped-up per month be ‘x_3’

Let the cost per barrel of oil be ‘C’

Hence the estimated cost of top-ups per month = $C.x_1.x_2.x_3$ .... (1)

And the estimated cost of oil per year = $365.C.x_1.x_2.x_3$ .... (2)

If we think of a power plant with three turbines where each turbine has three main oil tanks. In such a plant, a top-up of one barrel is usually required per oil tank. This implies a top-up of 9 barrels per month and that’s about 1890L of oil topped-up per month which is quite a significant amount. This quantity of oil in India would cost about Rs.150000 and amount to a yearly loss of about Rs.1.8 million.

III. MAKING THE PROPER DESIGN CHOICE

To condense the oil vapours we may employee of the following mechanism:

1. The vapours can be passed through a surface type condenser which will lead to condensation of vapours, but may require a large condensing surface due to lower specific volume of the vapour and also the cooling water so required will be appreciable that renders this design inefficient. [2]

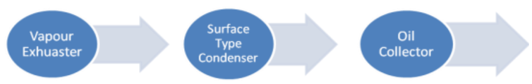

Figure 1: Schematic flow diagram for design 1

2. The vapours may be compressed first and then passed through a heat exchanger to condense the Oil Vapours. The design will have low space requirements with much higher efficiency.

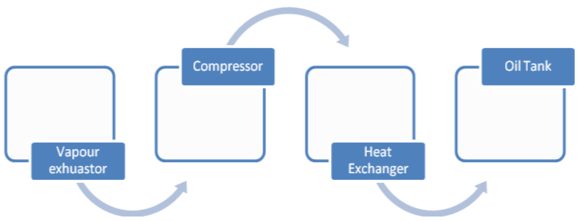

Figure 2 : Schematic flow diagram for design 2

IV. PRINCIPLE BEHIND THE PROPOSED DESIGN

Increasing the pressure of a Fluid increases its saturation temperature. If Pressure of a fluid is increased at constant temperature, at a particular pressure the fluid will change its state form gaseous to Liquid. [1]

ISSN: 2278-0181
Vol. 3 Issue 12, December-2014

Capitalizing on this principle if the vapors from the Main Oil Tank are compressed to a certain pressure at which it remains liquid at room temperature, the vapors can very well be converted into liquid again. This will require a heat exchanger just at the outlet of compressor so that the temperature of the compressed vapors is brought below the condensation temperature.

V. THE FINAL PROPOSED DESIGN

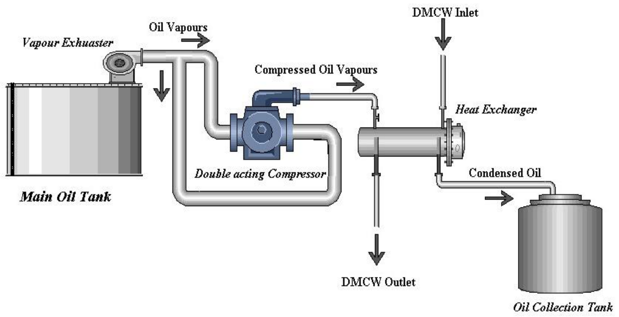

Figure 3: Proposed condenser-heat exchanger mechanism for condensation of oil vapors

A simple design that is proposed for the problem involves a compressor and heat exchanger. The vapours vented through the main oil tank are first passed through a double acting compressor in order to increase their pressure at the given temperature to their critical pressure at room temperature. A double acting compressor is employed to make the design more efficient. [3]Then the pressurized oil vapours are passed through a counter-flow heat exchanger to cool them to room temperature which results in their liquefaction. This liquefied oil is collected in another storage tank which can be utilized for further use.

VI. CONCLUSION

The proposed design with certain considerations like the number of turbines in the plant , number of top-ups required per month and the cost of those top-ups as given by equation (1) taken into account can prove to be good value in saving oil wastage and hence reducing economic losses.

REFERENCES

1. Michael J. Moran, Howard N. Shapiro, Fundamentals of Engineering Thermodynamics,6^{th} ed.,Wiley,2007.
2. Jack Philip Holman,Heat Transfer,10^{th} ed.,Tata-Mcgraw-Hill Education.
3. H Cohen, GFC Rogers, HIH Sarvanamuttoo, Gas Turbine Theory, 4th ed., Longman Group Limited