Efficient Operation of Compressed Air System by Using Inter and After Cooler

VIKASH KUMAR[1], M S ABDAHEER[2]
[1, 2] *Shekhawati Engineering and institute & Technology, Sikar*

Abstract- This paper present the working of air compressor and how the air compressor efficiency increase with the help of inter cooler and after cooler and in this paper discussion of compressed air system component intake air filter, inter stage cooler, after cooler, air drier, receiver.

Indexed Terms- air compressor, inter-cooler, after-cooler

I. INTRODUCTION

Air compressor account for significant amount of electricity used in Indian industries. Air compressor are used in a variety of industries to supply process requirement, to operate pneumatic tools and equipments, and to meet instrumentation needs. Only 10 to 30 % of energy reach the point of end use, and balance 70 to 90 % of energy of the power of prime mover being converted to unusable heat energy and to a lesser extent lost in form of friction, misuse and noise.

II. COMPRESSED AIR SYSTEM COMPONENTS

Compressed air system consist of the following major components; intake air filter, inter stage cooler, after cooler, air drier, receiver, piping network, filter, regulator and lubrication

- Intake air filter; Prevent dust from entering compressor, dust causes sticking valves, soured cylinder, excessive wear etc.
- Inter stage cooler; Reduce the temperature of air before it enter the next stage to reduce the work of compression and increase the efficiency. They are normally water cooled.
- After cooler; the objective is to remove the moisture in air by reducing the temperature in a water cooled heat exchanger.
- Air dryer; the remaining trace of moisture after cooler are removed using air drier because air for instrument pneumatic equipment has to be relatively free of any moisture.
- Receiver; Air receiver are provided as storage and smoothing pulsating air output reducing pressure variation from the compressor.

III. EFFICIENCY OF INTER AND AFTER COOLER

Efficiency is an indicator of heat exchange performance – hoe well inter cooler and after cooler are performing. Inter cooler are provided between successive stage of multi stage compressor to reduce the work of compression – by reducing the specific volume through cooling the air- apart from moisture separation .

Ideally the temperature of inlet air at each stage of multi stage machine should be same as it was at first stage. This is referred to as “perfect cooling” or isothermal compression. Hence in actual practice, the inlet air temperature at subsequent stage are higher than normal levels resulting in higher power consumption, as a large volume is handled for the same duty

Details	Imperfect cooling	Perfect cooling (Base value)	Chilled water cooling
First stage inlet temperature(˚c)	20.2	20.2	20.2
Second stage inlet temperature(˚c)	24.4	20.2	14.8
Capacity(Nm^3/min)	13.2	13.4	13.8
Shaft power(KW)	73.1	71.7	70.4

Specific energy consumption(KW/N m^3/min)	4.2	4.0	3.88
Percentage change	+1.9	Reference	-1.9

It can be seen that in table an increasing of 4.2 ˚c in the inlet air temperature to the second stage result in 1.9% increase in the specific energy consumption. Use of water at lower temperature reduces specific power consumption. However very low cooling water temperature could result in condensation of moisture of air, which if not remove would lead to cylinder damage.

Similarly, inadequate cooling in after- coolers (due to fouling, scaling etc), allow warm, humid air into the receiver, which cause more condensation in air receivers and distribution lines, which in consequence, leads to increased corrosion, pressure drops and leakages in piping and end- use equipment. Periodic cleaning and ensuring adequate flow at proper temperature of both inter cooler and after coolers are therefore necessary for sustaining desired performance.

IV. CONCLUSION

From the different inter-cooling processes carried out in two stage reciprocating air compressor, it can be concluded that the isothermal work required to compress the air has been reduce. So the power required to drive the reciprocating compressor has also reduced by 1-2% with respect to normal inter-cooling. From all the results of inter-cooling processes, it can be concluded that the radiator coolant inter-cooling and mixture of ethylene glycol with water inter-cooling result in better volumetric efficiency as compared to other type of inter-cooling. It is possible that when costs of different coolants are not considered, in operation of two stages reciprocating air compressor can be used.

REFERENCES

[1] James D. Van de Ven, Perry Y. Li, "Liquid piston gas compression" Applied Energy (2009), pp1-9.

[2] B. G. Shivaprasad "Regenerating heat transfer in reciprocating compressor", pipe line industry, (2003), pp1-12.

[3] T. Armaghani, S.A.R. Sahebi and H. Goodarzian, "The first law simulation and second law analysis of a typical reciprocating air compressor", Indian Journal of Science and Technology, Vol. 5, (2012), pp-2390-2395.

[4] Jeng-Min Huang , Chung-Ping Chiang , Jiing-Fu Chen, Yung-Lo Chow , Chi-Chuan Wang, "Numerical investigation of the intercooler of a two- stage refrigerant compressor", applied thermal engineering 27 (2007), pp- 2536–2548.

[5] David Kim, Jack Mamiye, Kyle Burns, Torie Rose, Joseph Zavodny, "Improving Rutgers' air compressor system's efficiency and performance", Rutgers University Center for Advanced Energy Systems, (2008), pp 1-15.

[6] P. Grolier, "A method to estimate the performance of reciprocating compressors", International Compressor Engineering Conference, Paper 1510, (2002), pp 1-9.

[7] J. A. McGovern and S. Harte, "An exergy method for compressor performance analysis", international journal of refrigeration, Vol. 18, No. 6, (1995), pp. 421-433.