Energy Efficient Management of Compressed Air Systems in Forging Industries

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Abstract – *The industrial sector alone accounts for about 50% of the commercial energy. When it comes to a pneumatic operated forging industry the major share of energy consumption is by the compressor units that are used to provide compressed air to the hammers. From the study conducted in such an industry it was found that the majority of losses occurred due to the* ***improper management of the equipment's and*** *machines. The end tools were provided with compressed air than the rated requirement which leads to excessive consumption of air. This paper explains about the areas where the energy losses are concentrated like large amount in the compressed air systems, reduction in the capacity of the compressors than the rated value, losses due to the unload running of the compressors in the plant and monetary losses occurred due to that. It also explains some suggestions like use of VSD for speed control operation, installing automatic moisture drains to remove condensate and supplying the hammers with compressed air at required pressure.*

Key Words: Compressors, VSD, Hammer and Forging

1. INTRODUCTION

Energy is an area of concern nowadays. The number of industries has increased which in turn lead to the development of countries but on other side there is a rising problem of energy crisis. This has made the efficient operation of machines and tools necessary to reduce energy consumption. The industrial sector alone accounts for about 50% of the commercial energy [1].

1.1 Forging

Forging is a process of shaping a metal to desired shape first by soaking it at high temperature and shaping it to different shapes by hammering it at a large force. Mostly all the forging industries are pneumatically operated. The end tools i.e. the hammers are operated with compressed air. The shape of the material would be decided by the die used in the forging process. After forging is done the material would undergo heat treatment process and some quality analysis test.

1.2 Compressors

Compressors have an important part in the forging industry. They provide the compressed air for the operation of hammers. The compressors used in this industry are positive displacement reciprocating type compressors. They are run using induction motors. Study shows that around one third of the total energy charges per month in the industry are due to the operation of the compressors. The compressors are associated with its distribution system and there are losses occurring in the compressed air distribution systems due to its improper management. The air distribution system in the plant has a ring main system with an extension taken when a new hammer was installed. The compressors used in the plant are of 1000 cfm rated capacity and are designed to operate at maximum rated pressure of 10kg/cm^2.

Fig -1: Double Stage Reciprocating Compressor

2. AREAS OF CONCENTRATION

Some of the areas of concentration of the study was the capacity assessment of compressors in the plant, finding the pressure requirements at each hammer and modifications, estimation of energy loss due to unload operation of compressors, monitoring condensate level at moisture drains and its reasons, and heat exchange performance of intercoolers and after-coolers.

2.1 Capacity Assessment

Capacity assessment of the compressors were done using the receiver filling method

$$Q = \frac{P_2 - P_1}{P_0} \times \frac{V}{T}$$

P_2 = Final pressure after filling (kg/cm²)
P_1 = Initial pressure (kg/cm²)
P_0 = Atmospheric Pressure (kg/cm²)
V = Storage volume in m³
T= Time take to build up pressure to P_2 in minutes

Table -1: Measured Capacity

Compressor	C_2	C_3	C_5	C_7	C_8
Q (m³/ min)	24.36	24.63	24.09	26.08	26.71

It was found that there was a reduction in the capacity in the compressors.

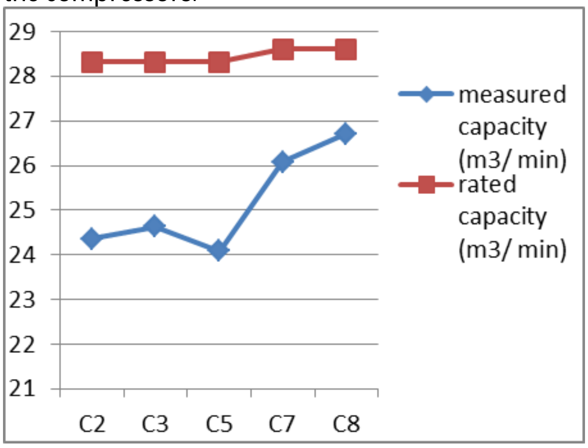

Chart -1: Variation in the Compressor Capacity

2.2 Estimation of Energy Loss

There were losses occurring in the compressor due to the unload operation and loss were calculated after monitoring the compressor operation for a time period.

Table -2: Estimated Losses

Day	1	2	3	4	5
loss per hour(Rs.)	52.60	50.49	47.70	49.96	49.79
unload running time per hour	9:00 min	8:50 min	8:35 min	8:30 min	8:30 min

To reduce unload running losses it was recommended to use VSD [2]. Variable speed operation could reduce the energy consumption in the plant due to unwanted compressor operation.

2.3 Moisture Content and Relative Humidity

The presence of moisture was found in the plant in a large amount and to find the reason of this relative humidity was calculated at the plant premises using sling psychrometer [3].

Table -3: Wet Bulb and Dry Bulb Temperature

Day	Dry bulb temperature T_d (°C)	Wet bulb temperature T_w (°C)	$\Delta t = T_d - T_w$ (°C)
1	34	30	4
2	33	30	3
3	35	31	4
4	31	27	4
5	33	29	4

The temperatures were used for the calculation of relative humidity and it was found to be around 70% during summer.

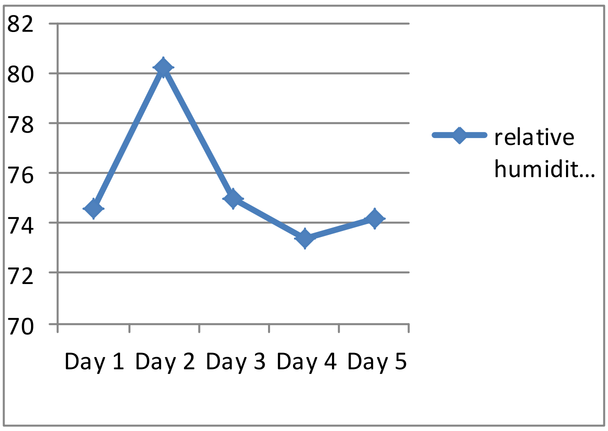

Chart -2: Variation in humidity

2.4 End Tool Pressure Requirement

Here in the plant the compressed air is supplied at unified pressure even though different hammers are operated at different pressures. This can cause more energy consumption as higher the pressure higher would be the energy requirement to compress the air to that pressure.

Table -4: Pressure Requirement

Details	Hammers		
	6 Ton	10 Ton	16 Ton
Pressure required (Kg/cm^2)	5-7	7.23-9.3	6.12-7.14

So when operated at higher pressure there are chances of leakage at the demand side. In two of the hammers compressed air is received at a pressure higher than the maximum rated pressure. So here there is possible chance of energy conservation by supplying air at minimum possible pressure so that the hammer can be operated with ease. It was recommended to reduce the pressure by sectioning the distribution system with the help of actuator butterfly valves.

Fig -2: Butterfly Valve with Actuator

2.5 Inlet Outlet Air Temperature

The temperature of air at the inlet is an important factor in the deciding the efficiency of the compressor. Lower the air temperature lower would be the energy consumption. The other important factor is the heat removal from the compressed air at the aftercooler. Scale formation can sometimes cause imperfect cooling that can reduce the air quality and allows more moisture in the compressed air which can cause corrosion.

3. CONCLUSIONS

Here at this industry study was done on the compressors and its distribution systems. Some areas of energy loss was identified mainly due to unload operation of compressors, supply of compressed air at a higher pressure than that required, excessive amounts of condensate collected at the moisture traps which are not removed periodically and reduction in the capacity of the compressors. To reduce these losses and to ensure efficient operation, some proposals like sectioning the present system using butterfly valves, use of VSD to reduce the energy consumption by speed control and use of automatic moisture drains to periodically drain moisture without air loss are suggested. This would ensure a better efficient operation of the plant and can reduce the energy consumption

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BIOGRAPHIES

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