In House Manufactured Mechanical Water Separator

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Abstract: In the current scenario, all manufacturing and service industries are fighting for their survival, and it depends on their product quality and price of the product. Both depends on the way to manufacture the product, if there is any deficiency in manufacturing process, it will reflect both the quality and price of the product. For this purpose, various machines are used and these machines are controlled through pneumatic system which intern work by compressed air. Havells India Ltd Alwar plant is facing a problem of moisture in compressed air at the machine ends which limits the machine parts efficiency and cable quality. Moisture in compressed air used in a manufacturing plant causes problems in the operation of pneumatic systems, solenoid valves and air motors and can adversely affect the process or product being manufactured. Havells India Ltd. Desire to control the amount of moisture generated in compressed air. To arrive at a solution, a moisture separator is manufactured and fitted at the machine ends. The effect of it on compressed air quality is observed.

Key word: Moisture in Compressed Air, Cable and Wire Manufacturing Plant, Compressed air system for machines, Refrigerant circuit

I. INTRODUCTION

Compressed air is a fundamental source of energy for the large majority of industrial processes. Industrial plant use compressed air throughout their production operations, which is produced by compressed air units ranging from 5hp to over 50,000 hp [1]. Pneumatic systems used extensively in industry and factories are commonly plumbed with compressed air. This is because a centrally located and electrically powered compressor that powers cylinders and other pneumatic devices through solenoid valves can often provide motive power in a cheaper, safer, more flexible, and more reliable way than a large number of electric motors and actuators. Condensation in the tank and air lines is a natural occurrence when compressing air [2]. Most common problems caused by water in compressed air systems is washing away of required lubrication, increased maintenance, sluggish pneumatic equipment, rust, instrumentation clogs, paint spotting, airline freeze-up and dramatically shortened tool life. There’s no way to compress air without compressing water along with it. The hotter the air is, the more water it can hold. The vapor form of water doesn’t cause problems for the most part unless it’s cooled down to a temperature at which it condenses into a liquid. Unfortunately, every time compressed air is expanded through an orifice – like the throttle of an air tool, or a control valve or a spray gun, or after a long run of pipes, it experiences some cooling. If it’s cooled enough, liquid occurs in air. The aim of this project is to find a solution of problem of moisture after long run of pipes. The practical approach is done in Havells India Ltd., a cable manufacturing plant located in Alwar district in Rajasthan. The problem observed in this company is moist air at the machine end. This project is oriented towards find a cheap solution to minimise water particles in compressed air at machine ends.

II. COMPRESSED AIR SYSTEM FOR MACHINES

Cable manufacturing machines uses compressed air to operate pneumatic valves and cylinders to perform various functions like holding wire bobbins, braking arrangement, give air to remove moisture on cable surface after extrusion, etc. Havells India Cable manufacturing plant is divided in four sections for manufacturing HT (high tension) cable, LT (low tension) cable, control cable and Domestic or house wire. We consider two section containing HT and control cable manufacturing equipment in which following machines are used. The complete arrangement of compressors is shown in the figure 1. Here notation R1 and R2 stands for receiver 1 and 2 and D1, D2 and D3 Stands for Driers 1,2,3 respectively. From this figure, it is clear that compressed air after compressor kept in compressed air tank which has an auto drain valve to drain condensate from coming out of compressors and this dry air goes into receiver D1, D2 and D3 Stands for. Compressor having 1000 CFM works regularly and in case of its breakdown, other two compressors run simultaneously. Three dryers are fitted for drying compressed air which is coming out of compressors and this dry air goes into receiver tank which has an auto drain valve to drain condensate from moist air.
As we know, one 100 CFM compressor operating at 100 PSI will generate 18 gallons per day at 90° F and 50 percent RH. Therefore, for 1000 CFM compressor, the amount of water generated is 180 gallons for the above conditions. About 60 percent of this moisture is removed by the after cooler. The remainder passes through the centralized dryer which has a capacity to handle 1500 CFM air. Here we see that at the compressor end the air is moisture less hence dry air is ensured. This air before passing through the dryer, kept into receiver tank where its pressure is around 7 kg/cm². Each receiver capacity is 3 m³ and test pressure is 10.3 kg/cm². This high pressure dry air is sent to machines after passing through driers through distribution GI pipes where the actual twist comes. Here Elgi refrigerated air drier remove moisture by cooling the compressed air to a temperature of 3°C. the air to the drier should be sufficiently cool (25 Deg. C to 40 Deg. C) to get the best performance, so an after cooler is necessary. The Elgi dries include separate circuits, a compressed air circuit and refrigeration circuit.

2.1 Compressed air circuit:

The compressed air drying circuit uses an air-to-air exchanger, which acts as a pre-cooler/ re-heater, and an air-to-refrigerant heat exchanger. Both heat exchangers use the lease tube in tube design that gives superior heat transfer. The tubing in both heat exchangers is copper to increase heat transfer, better service life and reduce corrosion. Warm, saturated air first enters the air-to-air heat exchanger where it is precooled. By precouling the incoming air, energy is saved through reduction of the heat load imposed on the refrigerant compressor and condenser. Saturated air then enters the air to refrigerant heat exchanger further reducing the air temperature to specified dew point 3 °C water is condensed as the air is cooled to the specified dew point. The cold air then re-enters the air-to-air heat exchanger where it is reheated. Reheating of air does not affect the dew point of air [3]. The incoming air flows through the air-to-air heat exchanger in an opposite direction.

2.2 Refrigerant circuit:

The gaseous refrigerant from the evaporator is ducked by the refrigeration compressor and pumped into the condenser. It is then cooled and liquefied by the motor driven fan. The liquid refrigerant feeds into evaporator after passing through the drier/ filter and thermostatic expansion valve. Because of the thermal exchange with the compressed air which passes through the evaporator in an up stream direction, the refrigerant vaporises and returns to the compressor to restart a new cycle [4]. All of the 71 machines require compressed air for performing various function, hence a network of GI pipe line is laid in an area of 4000 Square feet. Compressed air is distributed to all machines via these GI pipe line. Main header pipe line from compressor or supply end is 1” GI pipe and then ½” GI pipe lines are attached to the main header line to the machines. Hence two phenomenon occurs in these pipe lines, one is the pressure drop across the length of the pipe line and the second is the condensation of water particles in air. Here the pressure drop in the pipe line is around 0.5 kg/cm² and the required pressure in the machine is 3 kg/cm² to perform its function properly therefore sufficient pressure is available on the machines. Now comes to the second thing, condensation of moisture after this long run of pipes. Every machine is fitted with FRL unit which separate the oil and water particle from the compressed air but the maximum capacity of these FRL unit is limited to certain grams of moisture [5].

The second option here is to use mechanical water separator. These water separators work efficiently but the filter element has to be changed after some time depends upon the moisture present.

III. FABRICATED WATER SEPARATOR

3.1 Need for in fabricated water separator

It is essential to fit a filter/separator at the places where there is a chance of moisture in air like after a long run of pipes. In the Havells company, around 300 machines are connected through airline one option is to fit coalescence filter to fit on each machine before regulator so that only dry air goes into the machine but the life of filter element is not more than 4 months, it also depends on the incoming air moisture. House water separator as shown in figure 2. The other way finds out is to make in house water separator in which filter element or replaceable parts should not be used or if used than the cost of replaceable filter element should be very low. It should also be cheaper and the quality of air should be sufficient enough means water droplets should not go into the machine parts. Since water particles corrode the cylinder and valve seal parts. This result is not only in part cost but also the production loss and man power consumed to repair/ replace cylinder/ valve.

![Fig 2: In house water separator](image-url)
Having these things in mind, Havells engineers team developed a mechanical water separator at their own in which the basic design consists of GI pipe 8" in diameter. Three half round plates (cut from the GI sheet) are fitted in this pipe at an angle to make an obstacle in the flow of air. Three to four strips of GI sheet are also welded in each half round plate in vertical position to make an obstruction in air flow. Air supply is given through a ½" pipe opening at the bottom of the vessel with a nozzle to increase air velocity. This air after impacting bottom of the vessel, rises upward and passes through half round plates and obstruct by the obstacle made in the half round plates. And in process of impacting these obstacles, moisture particles separate from the air. To drain moisture, gate valve is fitted at the bottom of the vessel.

IV. RESULT AND DISCUSSION

A complete analysis is done on three machines in HT section of Havells India Ltd to compare the moisture content before using moisture separator and after using moisture separator. Data recording for the year 2017 is taken by the help of dew point meter. Results are shown in the form of graphs below in Figure 3, Figure 4, and Figure 5.
Fig. 5: Moisture comparison before and after Separator-Extruder Sio plas

The observations from this analysis are listed below:

1) From the various tables and chart data, it can be concluded that by installing the moisture separator, there is a reduction in the dew point temperature and subsequently in the reduction in the moisture content of the compressed air quality.

2) The reduction in dew point varies from 0.6 to 1.7°C

3) Reduction in moisture content varies from 0.36 to 1.2 gm/mn^3

Since as per quality class, the moisture content for the pneumatic cylinder should be as minimum as possible, therefore the quality of the compressed air is not fall under any of the quality class and continuous improvement is needed. But the way to reduce moisture is indeed positive and modification is needed to enhance the performance of the moisture separators.

V. CONCLUSION

Auto drain valve in place of ball valve to separate moisture immediately will be more effective.

Reason- Ball valve has to be opened partially always to remove moisture, otherwise separated moisture from baffle plates will be mixed in incoming air thus the purpose of this separator will not fulfilled. In this process air pressure and CFM generated is lost considerably without providing useful work to the machine. Auto drain valve will be opened automatically when a certain amount of moisture collected in the separator so air pressure and CFM loss will be minimum. A filter element may also be provided to enhance efficiency. Reason- Compressed air cannot get dry completely after striking on baffle plates. In this project the result shows that the after using moisture separator, dew point temperature reduces by 0.6 to 1.7°C as compare to compressed air supplying on machine without using moisture separator and therefore moisture content in compressed air reduces by 0.36 to 1.2 gm/mn^3 after passing through moisture separator. Filter element will further reduce the moisture content in air. Pipe lines should be insulated Reason- When high temperature compressed air runs in GI pipes, pipe surface cooled with outside low temperature air and moisture generated.

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