Vol. 12 No. 5 A Chary Publication ₹ 100

Cooling India

December 2016

India's foremost Monthly dedicated to the growth of HVACR Industry

Improving Efficiency in Ice Cream Plant

The plant owner wanted to update plant for higher efficiency and safety with moderate investment in steps. Many a time plant upgrade or modernization leads to complete change of plant that involves heavy investment and ROI on such investments exceed three to four years…

The paper presents a case study of improving plant efficiency and safety at medium scale ice cream manufacturing unit. The plant is in Cuttack near Bhubaneshwar, Orissa. The plant produces 10 MT of ice-cream every day and supplies to Orissa and nearby states. The plant owner wanted to update plant for higher efficiency and safety with moderate investment in steps. Many a time plant upgrade or modernization leads to complete change of plant that involves heavy investment and ROI on such investments exceed three to four years. Hence, it was decided that plant upgradation should be carried only where necessary and to achieve highest efficiency and safety. The target was to keep ROI less than one year and achieve minimum 15% energy savings. The refrigerant used for plant is Ammonia which is natural choice because of the plant size and temperature requirement. The natural (gravity) feed system is used in plant for refrigeration.

We followed system approach to achieve our target. The first step was to study and prepare HAZOP report and find out the problems in operation of plant on day to day basis. We started recording plant operation parameters and work hours. After detail study, following problems were observed:

1. The cold storage and freezer rooms are not able to achieve desired temperature inspite of long running hours of compressors
2. All compressors including standby compressor was required to run the plant
3. The compressors were running at full load all the time
4. The compressor suction pressure and plant evaporating temperatures do not correlate. The suction pressure was much lower than the corresponding room temperature
5. The compressor discharge pressure was very high considering the ambient conditions
6. Complete plant was under manual operation
7. The cold rooms and freezer rooms were full with frost
8. The cold room and freezer rooms were designed for -25°C room temperature however, were never able to achieve below -14°C
9. The defrosting system was manual and was never able to defrost the coils completely.
10. Plenty of oil was getting accumulated in ACU or freezer coils.
11. Plant safety was totally bypassed
12. The level control system was bypassed and operators were manually throttling the valves on receiver supply line.
13. Thus, ACU or freezer coils were starving for liquid and operators were afraid of liquid stroke to compressor.
14. Operators were always busy with operating various valves and running around to check operation, temperature and liquid level.
15. Due to small leakages through flange joints plant had ammonia smell continuously.
16. The cold rooms and freezer rooms were located around the plant and many times the loader was trapped in the room. The trapped person was not able to communicate to plant operators.

All these conditions were leading to high energy consumption and loss of production. Overall plant was not able to perform at rated conditions.

Considering the budget availability, we decided to concentrate on achieving desired room temperature, increase plant efficiency and improving plant safety. We had limited to time to conduct all these activities.

Another constraint was limited availability of highly skilled and certified man power to operate the plant. Hence it was required to provide operating system which regular plant operators could handle and need of specialized manpower would be eliminated.

We decided to update following:

1. Install safety valves with dual manifold on all pressure vessels with suitable rating. We have selected resettable safety valves.
2. The compressor safety cut out were calibrated, repaired and re-connected for safety
3. Easy to use Automatic Compressor control system with energy monitoring was installed on each compressor

Plant discharge pressure before plant modification

Plant discharge pressure after plant modification

Fully automatic air purger in operation

Ammonia Leak detection system

Easy to use compressor automation system

Data monitoring system with web based operation and mobile application to monitor plant performance online anywhere in world

Cold room Safety Alarm system

Automatic liquid level control, temperature control and hot gas defrosting system

Plant piping before modification

Plant piping after modification

4. Fully automatic air purger installed on condenser and receiver
5. Automatic hot gas defrosting system installed to replace existing manual defrost system on all cold rooms and freezer rooms.
6. Temperature monitoring and control system was installed for all cold rooms and freezer rooms.
7. The automatic level control system was serviced and put into use.
8. The reflex type level gauges were installed instead of glass tubes.
9. The automatic ammonia leak detection system was installed
10. The flange type valves were replaced with 40 bar weld in line valves. The valves were chosen with back seating facility.
11. The cold room alarm system within built battery back was installed to located doors for trapped loader and generate alarm in plant room. The unit was provided with inbuilt battery backup so that it can work independently in case of electricity failure.

These all activities were complete in 10 working days with help of plant operators and only one welder, without distributing the regular plant operations.

The results observed after the modifications are:

1. The compressor discharge pressure reduced significantly to 160 PSI from 220 PSI
2. The automatic operation compressor removed operator interference and smooth loading or unloading compressor and overall energy requirement for compressor was reduced significantly
3. The safety valve and release system ensured increased safety at plant and no discharge of ammonia in plant incase safety valve pops up.
4. The automatic ammonia leak detection and alarm system increased plant safety and operator had more confidence in working around the plant
5. The automatic hot gas defrost system replaced manual defrost operation
6. The defrost time was reduced to 15 minutes instead of 45 minutes
7. The increase in cold room or freezer room temperature during defrost reduced to 2°C from 10°C
8. The cold room or freezer room design temperature of -25°C was achieved.
9. The time required for freezer operation reduced 25%
10. The number of compressors required reduced. The standby compressor remain as standby, was never required to operate
11. This reduced compressor running hours by 25%
12. The automatic level control system made sure that ACU or Freezer coils are flooded and no liquid is allowed on compressor.
13. The automatic level control system avoided operator's interference by throttling valves on receiver supply line.
14. The accumulation of oil in ACU and freezer units was eliminated
15. Frosting on ACU & freezer units eliminated
16. The online datalogging and remote monitoring system installed helped customer to monitor the plant on mobile phone while travelling abroad and enjoy his holidays.
17. The temperature control system made sure that required temperatures are maintained continuously. No under shooting / overshooting observed. All temperature were maintained within ±2°C
18. The weld in lines valves eliminated the leakages through flange joints of the valves and thus total number of flange joints in flange reduced to few.
19. The back seating facility in the valve assured operators that now they don't have to run around in tightening of valve glands.

Thus, over all plant performance improved by:

1. Reducing the plant operation time
2. Improving plant temperature
3. Operating at optimum suction and discharge pressure
4. The ammonia smell from plant room vanished
5. Increase plant safety
6. The automation of compressor, defrost system, liquid level control and plant monitoring generated comfort for operators and they could address other maintenance issues.

After observing plant operation for one year we observed 30% energy saving and improved product quality and production capacity as compared to last year.

Even though improved plant safety cannot be calculated in investment, the overall investment was recovered in 4 months. ■

Anand Joshi
Partner
Manik Engineers
Pune