The Right Cooling Solution... at Last!

By Prakash K. Sathe
Technical Advisor

Selecting the right cooling system for a small department store may sound simple but it turned out to be a painful and expensive experience as this one customer found out too late. Much depends on the experience, foresight and integrity of the sales engineer, who must understand the operation and maintenance problems his selection may cause in future to the customer.

When the first fully-air conditioned, two-storied, multi-commodity department store opened in Bombay about 20 years ago, it was the talk of the town. Since most of us were new to the concept of colorful, multi-product lifestyle stores, this one stood out and was a crowd-puller from day one.

This city has changed a lot since then, with many new stores and large shopping malls mushrooming all over. Nonetheless, the two branches of this store are respected landmarks of the city even today.

Recently, in the course of my work as a technical advisor for ACR systems, I was approached by the management of this department store. They had a problem of inadequate cooling in one of their branches and wanted me to suggest a suitable solution to either replace or modify the existing AC plant. It was here that I realized the importance of selecting the right AC system and how a wrong choice can lead to difficulties in maintenance and very high running costs for a mid-size store such as this. In this article, I will try to explain this case study.

The Store

The store is housed in a building with a glass façade on the front and is spread over two levels, with a central atrium. The total floor area for the two levels put together is approximately 10000 sq. ft., with individual departments for

About the Author

Prakash K. Sathe holds a diploma in production engineering from Fr. Agnels, Mumbai. He has 23 years experience with Blue Star Ltd. at the Thane factory, in the manufacture of heat exchangers and absorption chillers. He is a member of ISHRAE.

cosmetics, children's wear, women's wear, men's wear, home appliances, food (no fresh fruits and vegetables), furnishings, electronic goods and office furniture. The terrace is kept exclusively for locating the air-conditioning system.

The occupancy levels, including staff vary from about 50 persons to a maximum of 120 persons during peak hours (typically between 6 pm to 9 pm) and week-ends. Based on this, I calculated a cooling load of approximately 87 tons.

The Air Conditioning System so Far..

When the store first started operation in 1983, the air conditioning system consisted of a central chilled water plant made up of two water-cooled reciprocating chillers, each of 40 tons, connected by a common header to two air handling units. Each of the AHUs catered to one-half of the store. The chillers, AHUs, cooling tower, condenser and chiller pumps and piping were located on the terrace. A group of operators was appointed to run the AC plant and look after its day-to-day maintenance. The management was quite satisfied with the smooth functioning of the plant and except for a small nagging worry about the electricity consumption costs, things were hunky dory.

Somewhere in 1999, natural gas as an alternate source of fuel was introduced in Mumbai and some companies started aggressively marketing the concept of gas-fired absorption machines to all AC users in Mumbai, including this store. The huge electricity bills due to air conditioning were already weighing heavily on the management's mind. The prospect of operating the AC plant on cheap gas instead of expensive electricity was too good to ignore. As a result, the decision to replace the reciprocating chillers with gas-fired VAMs was taken almost immediately, helped, I suspect, to a large extent by the pressure of a sales engineer.

Limitations of an Absorption Chiller

It is important to understand the basic features of absorption machines and their limitations. These machines use water as refrigerant. They do not have a compressor and work on the absorption cycle. Condenser, evaporator and a generator are some of the major components. They undoubtedly offer the advantages of economic operation, low machine noise levels and lower dependence on electric power. However there is a practical catch. Unlike the simple split or package units, absorption chillers are complicated in construction. It is not very easy to understand the operation of an absorption machine and specially-trained operators are required to run the plant. It uses water as refrigerant and a negative pressure must be maintained with the help of a vacuum pump for the system to operate satisfactorily. Failure of the vacuum pump can cause severe problems like crystallization of the lithium bromide solution and this can cause complete failure of cooling. Spares such as complete heat exchangers are expensive and tubes are not easily available.

The part load performance (which is so important for a department store) is dismal, to say the least and they cannot be operated below a certain level of part load. I feared that these very factors had caused the present problem.

My doubts were confirmed, when I discussed in detail with the maintenance and operation team, and they admitted that they found the absorption machines more difficult to operate. Moreover, it was almost impossible to run the absorption machines during part loads. To add to their woes, one of the absorption machines failed totally because of a leak in a lithium bromide heat exchanger and the entire load therefore fell on a single machine.

The cost of repairs as quoted by the supplier was enormous and the management felt it prudent to take a second independent opinion to find a solution, and thus my involvement.

The Management's Requirements

I proceeded to have a detailed discussion with the stores' management team to find out their concerns and expectations, and they were:

a) The rectification/ replacement was to be carried out on the high-side (chilling plant side) of the system, without disturbing the existing ducting and interiors. Their logic was, that the system was running fine when the earlier reciprocating chillers were in operation, and hence the air-side was totally healthy.

b) One of the absorption machines was totally non-functional and the chilling plant capacity had to be somehow augmented.

c) The twenty year old cooling tower fan and pump supports had become corroded and were causing heavy vibrations in the building structure which had to be rectified.

d) In the present situation, more than anything else, their focus was on getting the air conditioning started. Though they did not say so directly, it was obvious that they wanted improved economics on part load performance, since the AC system would be operating on part load at most times. I also considered this as one of the most important criterion while proposing a solution.

e) Given the small setup, it was hardly possible for them to deploy specialized manpower for operation and maintenance of the plant. Therefore,

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simplicity of operation and ease of maintenance of the AC system was of prime importance.

Armed with these requirements, I set about recommending a solution.

My Solution

I studied the situation carefully and then worked out a proposal for the management's consideration:

a) I was in agreement with the management's view that the ducting was healthy and decided to leave it untouched.

b) The vapor absorption machines and AHUs would be removed all together. The AHUs were corroded and the cost of repairing the faulty VAM was too high.

c) The new system would consist of multiple air-cooled ducted split units. I was convinced that with water getting scarcer by the day, there was no point in having a water-cooled system for such a small plant. The savings made due to lower power consumed by the water-cooled machine would be offset by the increased running and capital cost of pumps, cooling towers, piping as well as water costs.

d) By introducing an air-cooled DX system, I succeeded in eliminating the entire series of pumps and cooling tower and hence a major source of noise and vibrations.

e) The air-cooled DX units would be modular, (2 x 17 tons + 1 x 8.5 tons) x 2 i.e. a total of 85 tons. This modular arrangement would ensure efficient part load operation.

f) The AC system should be under a maintenance contract (preferably with the original supplier) and the coils and filters should be cleaned regularly as part of preventive maintenance. Split units, being simple machines can be easily operated by regular operators and they can also carry out simple preventive maintenance procedures such as filter cleaning.

The management was pleased with my solution and implemented all my suggestions, and thus the story had a happy ending. In my mind, however, I could not help thinking that they could have been saved a lot of trouble and expense had they received proper guidance at the very initial stage.

Lessons for Mid-Size Department Stores

In my opinion, prospective owners of small and mid-size stores need to keep the following in mind when they select an air conditioning system:

a) Heat load depends largely on occupancy and the fresh air required for ventilation, which in turn can fluctuate widely. It is therefore necessary to have a system with good part load performance, preferably a modular system.

b) Sophisticated machines like VAMs require specially trained engineers for operation and maintenance. Such machines are viable and indeed advisable (due to their low electric power consumption) for large factories, offices, hotels or multiplexes, which have dedicated engineering and maintenance departments.
For a small department store, it is neither feasible nor economical to employ a dedicated engineering team for the sake of a small AC plant. Hence it is advisable to go for a simpler equipment technology that does not need skilled operators for the daily plant operation.
Power costs are no doubt important, but so are capital costs and hassle-free plant operation.

c) The plant should not be bulky, since space is always at a premium in today's times.

d) In most cases, an air-cooled DX system is the best choice for this range since it eliminates the need for pumps, piping, insulation and cooling tower, besides removing dependence on water, which is difficult to obtain today, expensive and hardness levels require water treatment. ❖