Air Conditioning a Diamond Processing Unit

How one company modernised its facility, installed a central AC plant and the thought process that went behind the design and selection of an efficient cooling system.

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The Indian diamond processing industry is a global supplier of small size diamonds that meet the quality standards of discerning buyers for colour, clarity, cut and carat (the "4Cs" of good quality). The state of Gujarat has the largest concentration of such processing units. Just a few years ago, international suppliers of rough diamonds from South Africa dumped low quality roughs on Indian companies and processing units had to be satisfied with very poor prices for their polished diamonds in the markets of USA and Europe. For this reason low grade buildings built for general purposes were used as factories for diamond cutting and polishing. To ensure security, such buildings were outfitted with strong rooms without proper ventilation and indoor temperatures often reached 50°C, even in a city like Surat where the ambient temperature rarely exceeds 38°C. Workers in such an environment had to work with bare minimum clothing. Absenteeism due to sickness was high, resulting in low quality and productivity.

To increase their market share some processing units started to deploy modern technology in the form of "laser" machines for diamond cutting, which require air conditioning as well as process-cooling. Window ACs did not work well because frequent clogging of cooling coils with diamond dust resulted in repeated failure of compressors. Package ACs did not fare much better.

After recognizing the potential of Indian diamond processors, international suppliers of rough diamonds later started to supply better quality diamonds and as a result, exporters were able to realise better value additions. This helped to convince the factory owners to set up better manufacturing facilities with greater emphasis on indoor air quality and comfort for the workers.

This is the story of one such company, *Facet Polishing Works*, a leading diamond processing unit that decided to set up an ultra modern factory in the heart of Surat city, the diamond hub of India.

About the Author

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The Building

With a constructed area of 160,000 ft^2, the factory cum office has a basement, ground and six upper floors. Framed in RCC with brick masonry, the roof of the building is insulated with 25mm thick Nitrile rubber. Building orientation and glass windows are designed to optimise solar gains. A 4000 ft^2 atrium with corridors around the atrium on all floors provides a touch of elegance and a sense of scale to the whole operation.

The first floor to the fifth floor is the factory area, housing various departments of diamond processing like planning, windowing, sawing, barrel preparation, bruting, polishing and grading. A total of 2800 persons work in the building at a time. The sixth floor houses the director's office and conference rooms. All utilities including the AC plant are located in the basement.

Photo 1 : Planning / Cleaving

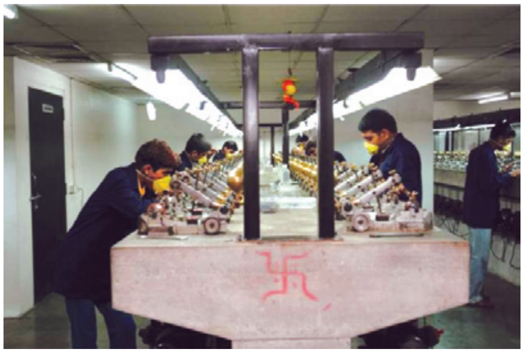

Photo 2 : Blade Sawing

Diamond Processing

Figure 1 presents the flow of work involved in processing diamonds and the various operations are explained below:

Planning / Cleaving

This is the process of splitting a diamond along a grain. Both manual as well as computerised cleaving is carried out in this department. Inside conditions are designed for comfort only.

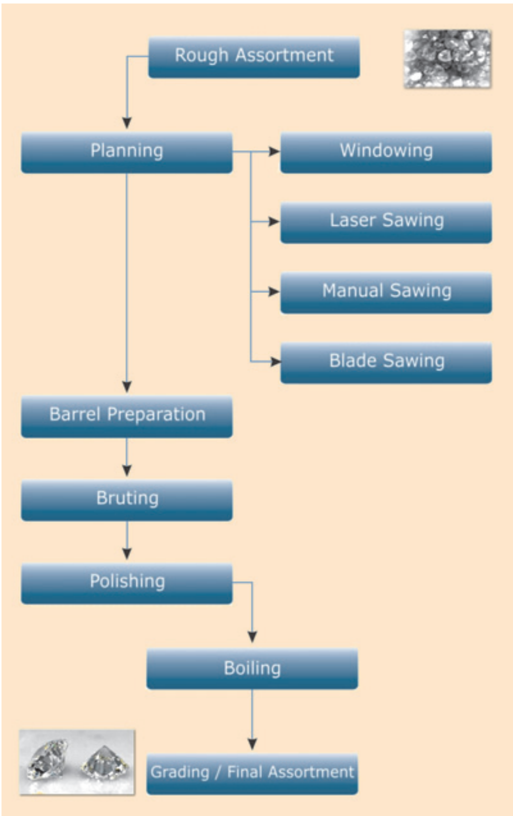

Figure 1: Diamond Process Flow

Windowing

The process involves marking of small facets polished on a rough diamond through its skin to allow a polisher to observe and map any internal feature of the diamond prior to cutting. Since the process generates heat and dust, a dust collection system and comfort conditions are required.

Sawing

It is the process of cutting a diamond into two pieces. The process can be manual or mechanised using a laser machine.

Laser Sawing

Here the diamond is cut in two pieces by focusing concentrated rays of laser in a CNC machine. Precise temperature control is provided for high tech machines. Chilled water required for process cooling (to cool the tooling and laser gun), is also provided through a secondary chilled water circuit.

Blade Sawing

In this process a diamond is cut on a sawing machine with a copper blade or a diamond blade as a cutting tool. Since the process generates heat and

Photo 3 : Barrel Preparation

Photo 4 : Bruting

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Photo 5 : Auto Blocking

Photo 6 : Polishing

dust, a dust collection system and comfort conditions are provided.

Barrel Preparation

Here the approximate diameter of a diamond is fixed by cutting sharp edges on the diamond. The diamond is cut with the help of another diamond and after this process it gets a barrel shape. Comfort conditions are provided.

Bruting

The process of rounding a diamond to form its griddle, customarily done by grinding one diamond against another on a rotating and sliding spindle is called "bruting". Close temperature control is provided.

Auto Blocking

Nowadays, auto blocking machines, which are a combination of mechanical and electronic systems are used for rough faceting of a diamond to give mass production while maintaining all parameters within a tolerance. Close temperature control is provided.

Polishing

In diamond manufacturing, polishing can refer to the grinding of facets onto a partially made rough diamond. Since the process also generates heat and dust, a dust collection system and comfort conditions are provided.

Grading

The process of appraising a diamond and allocating grades to it with the help of instruments like Calorimeter, Microscope, Fluorescence meter etc. is termed as "grading". Comfort conditions are provided.

The System

A detailed site study of the operations of various departments was carried out at the design stage and existing conditions as well as future requirements were discussed with the owner and respective department heads. The heat load pattern that emerged could be classified into three categories:

- Departments running 24 hrs a day
- Departments running 12 hrs a day
- Departments or a space that were used occasionally

Table 1 provides a summary of heat loads for these three categories.

The total present air conditioning load is approximately 700 tons. However the load pattern is

Sr. No.	Sys. No.	Air Qty Cfm	TR	Running In Day Time	Running 24 Hrs.	Running Occasionally
1	B 1-2	11760	21.81	21.81		
2	G-1	6940	17.06	17.06		
3	G-2	13530	39.30	39.30		
4	G-3-1	6325	14.00			14.00
5	G-3-2	6325	14.00			14.00
6	G-4	4860	12.00			12.00
7	G4-1	1200	3.00	3.00		
8	G-4-2	800	2.00			2.00
9	F1-6	16185	40.00	40.00		
10	F5-6	15750	39.25	39.25		
11	F2-3	13223	40.00	40.00		
12	F4-3	12777	40.00	40.00		
13	S1-6	15835	34.40	34.40	34.40	
14	S5-6	17000	40.00	40.00		
15	S2-3	15111	35.00	35.00		
16	S4-3	14530	35.70	35.70		
17	T1-6	13350	31.63	31.63	31.63	
18	T5-6	15800	35.58	35.58		
19	T2-3	7400	22.59	22.59	22.59	
20	T4-3	6865	21.50	21.50	21.50	
21	FT2-3	7400	22.59	22.59	22.59	
22	FT4-3	6865	21.50	21.50	21.50	
23	ST-3	4500	12.99	12.99		
24	ST-6	4500	12.99	12.99		
25	ST-1A	4835	9.61	9.61	9.61	
26	ST-9A	5290	10.88	10.88		
27	ST-10	1700	4.15	4.15		
28	Conference	6000	10.00	10.00		
29	Laser M/C		60.00	60.00	60.00	
	GRAND TOTAL		703.53	661.53	223.82	42.00

Table 1: Summary of heat loads for three categories of load.

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scattered in such a way that to satisfy the cooling needs of the building a high efficiency centrifugal chiller of 375 ton capacity was installed along with natural stratification type chilled water thermal energy storage tank system with a storage capacity of more than 1000 ton hours. The system also has primary and secondary pumping stations operating on VFDs controlled by BMS. All air handling units are designed with direct coupled plug fans driven by VFDs.

Salient Features of the Air Conditioning System

Chiller

A three-stage high efficiency centrifugal chiller with a capacity of 375 TR working on refrigerant R-123 with a power consumption of 0.514 IkW/TR is installed.

Thermal Energy Storage (TES) Tank

This system uses the sensible heat of water to store cooling. The thermal energy is stored in the form of low temperature chilled water in a tank. In chilled water storage, natural stratification has been the preferred approach because of its low cost and superior performance.

A thermal energy storage tank system with a storage capacity of 850 TRH (ton hours) has been installed. The chilled water tank is made of RCC and insulated with high density EPS (expanded polysytrene) material.

The tank has a capacity to store approximately one million litres of chilled water and consists of five different tanks in tandem (such that the outlet of one tank is connected to the inlet of the next one). The five compartments of the tank have been connected by specially designed "diffusers" to transfer chilled water into and out of the TES tank.

The tank water once charged (chilled), can supply the chilled water to the load, thus eliminating the need to run the chiller till the tank is discharged completely. While the tank is getting discharged, the chiller as well as the pumps (primary & condenser) can be switched off along with the cooling tower fans.

Photo 7 : Thermal Energy Storage Tank

Diffuser

The tank has specially designed diffusers to transfer chilled water in to and out of the TES tank at a low velocity to create almost laminar flow in the tank. The mixing is minimised by maintaining a low velocity at the outlet as well as water flow in sub-headers of diffusers. The diffuser is made of hot dipped galvanised piping with holes drilled in a specific pattern.

Diffusers are designed in such a way that low temperature chilled water enters tank-1 from the bottom and rises to the top gradually charging the tank. In tank-2 the chilled water enters from top and leaves the tank from the bottom. Again, in tank-3 chilled water enters the tank from bottom and rises to the top gradually charging the tank. In tank-4 the chilled water enters from top and leaves the tank from bottom. Finally in tank-5 chilled water enters the tank from bottom and rises to the top gradually charging the tank.

Chilled Water Pumps

The system has a primary and secondary pumping station. The secondary CHW pump operates on VFD controlled by BMS. The speed of the motor of the secondary CHW pumps is controlled by a differential pressure sensor installed at each of the four vertical CHW shafts distributing CHW to various air handling units on different floors.

Air Handling Units

A total 28 double skin type draw through AHU'S are installed presently for air conditioning of the building. Fans for the AHUs are direct driven plug type controlled by VFD driven motors. High efficiency bag type filters are used to arrest dust generated during the diamond polishing process to ensure a healthy environment.

Dust Collection System

The dust collection system is attached to the polishing mills, which collect the diamond powder generated during the process, avoiding inhaling of the dust by operators and maintaining the inside air quality.

Photo 8 : Dust Collection System

Building Management System

The integrated building manage-

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ment system controls and monitors the following equipment

A. Air Handling Units (AHU's) : There are 28 AHU's each having a two-way CHW valve which is closed if the AHU is not running, thus reducing the flow demand in the secondary circuit. Continuous modulation of CHW valves enables us to maintain the return air temperatue (RAT) near its set value. As the RAT is achieved, the CHW valve throttles down to a semi-closed position which also reduces the flow demand in the secondary circuit. Thus reducing the energy consumed. When the RAT is maintained at the setpoint and if the CHW valve is closed more than 50%, the Variable Frequency Drive (VFD) is used to lower the supply fan speed. This reduces the CFM of the AHU which further contributes to energy savings. The BMS generates a "dirty filter alarm" when the filters get clogged. This is monitored with the help of a DP (differential pressure) switch mounted across the filter. The weekly time scheduler enables the user to programme the automatic operation of the AHU's.

B. Ventilation Fans : There are 6 ventilation fans. Five fresh air fans are used for providing the fresh air for the AHU's and the kitchen area and one exhaust fan is used to extract the fumes from the kitchen area.

C. Elevators : There are two lifts which are being monitored under BMS. The monitoring is done for the various parameters such as Direction of Travel, Lift Position at individual floor and Run Status. This enables the user to track and analyse the lift movenment. This is of prime importance since these lifts are used to carry diamonds within the building.

D. Water Management : There are three overhead tanks namely - RO overhead tank, SMC overhead tank and Bore Water overhead tank located on the terrace. Each of these three tanks is split into two separate tanks with an equaliser line. There are in addition three storage tanks namely RO storage tank, SMC storage tank and Bore Water storage tank located in the basement. An individual pump is provided for each of these storage tanks which can pump the water to its respective overhead tank. The BMS monitors the levels of each of these tanks and the pump is controlled based on the same. For example the RO pump runs when the RO overhead tank is low and it automatically stops when the tank becomes full. In case if both the RO storage tank and RO overhead tanks are low, then the BMS cannot run the RO pump (to avoid a dry run) and hence generates the alarm as well as sounds the hooter. The hooter is located in the security cabin. Similar logic is applied for the SMC and Bore Water tanks/pumps. This ensures smooth and unattended auto operation of the water management system.

E. UPS : The BMS monitors various parameters of UPS such as Battery Voltage, Inverter Fail-to-start Alarm & Battery Load etc.

F. Intergration with Energy Meters : There are about 25 energy meters, which are BMS compatible and integrated with the BMS. The meters measure power consumption of various utilities such as HVAC, elevators, water management and lighting etc. In addition to the power, other parameters such as pf, frequency, KVAR, line voltages and current etc. are also monitored. The BMS generates utilitywise power consupmtion data which represents the consumption pattern on a monthly basis. Historical trends are also made available for the user to analyse the data in graphical formats.

G. Integration of Chiller : The chiller is integrated with the building management system which enables the monitoring and trending of important chiller parameters such as - chiller and condenser inlet / outlet temperatures, evaporator and refrigerent temperature / pressure, percentage of "chiller load and chiller power", etc. These paramters are of prime importance while sequencing of the chiller in various operating modes.

H. Variable Air Volume System : Air handling units for the director's floor have been provided with VAV systems . Air flow to the area is varied depending on room temperature and speed of the fan motor is varied accordingly.

Graphics

The state-of-the-art three dimensional animated colour graphics of Intelligent Building Management System makes the front end very attractive and user friendly. The control and monitoring of the building plant makes it as easy as the click of a mouse with well guided navigation tools. The system also provides the password protection with the desired levels of authority to various users.

Operation Philosophy

The chiller plant consists of one centrifugal chiller having an installed capacity of 375 TR. The present total load is approximately 700 TR. In order to cater to the varying load pattern, a storage tank has been provided. The tank has a capacity to store one million litres of chilled water and it consists of five different tanks in tandem. The tank has specially designed diffusers to transfer chilled water in to and out of the TES tank at a low velocity. The mixing is minimised by maintaining low velocity.

The tank water once charged (chilled), can supply the chilled water to the load. Thus eliminating the need

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to run the chiller till the tank is discharged completely. While the tank is getting discharged the chiller as well as the pumps (primary and condenser) can be switched off along with the CT fans.

This contributes substantially to energy savings. Further, under partial load conditions, the chiller can still be run at full capacity and part of chiller capacity (in excess of the load) can be used for charging the tank.

Chiller efficiency is better when it runs at a capacity of 60% or higher. It enables the chiller to produce maximum TR per kW input of electrical power. These factors contribute greatly to energy savings. In order to achieve this designed functionality, an Intelligent Building Management System is used to control the chiller plant.

The laser cooling systems and seven AHUs for related areas run round the clock. Other 17 AHUs are normally operating in the general shift i.e. 8.30 am to 6.00 pm. Four AHUs catering to areas like gym, atrium etc. run occasionally.

The total peak air conditioning load works out to 703.53 TR (refer *Table 1*). During off peak times the load remains around 223.82 TR (refer *Table 1*). The air conditioning systems along with the TES system can be operated in five different modes depending upon the load characteristic.

Charging Mode

Under this mode, the chiller is used to charge the TES tank. In this case, the building cooling requirement is nil and the secondary system is switched off. The entire energy produced by the chiller primary circuit is used to charge the thermal storage tanks. The stored energy can then be used for cooling at a later period of time. As the load pattern changes, the BMS will shift from this mode to any of the below mentioned modes as per the load condition.

Direct Cooling Mode

This mode is selected by the BMS when the load demand is more than 80% of chiller capacity (i.e. 300 TR). In this mode, no charging takes place of the thermal storage tank. Both primary and secondary chilled water pumping is ON, the speed of the secondary pumps is very low as there is no tank pressure drop. This is done by a VFD through differential pressure sensors across supply and return headers by BMS, resulting in energy saving.

There are two motorised butterfly valves (MBV's) across the inlet and outlet of the tanks, which are used to isolate the tanks during this mode. The entire capacity produced by the chiller caters to the demand of the low side. As the load starts dropping, the two-way chilled water valves on the AHU's start closing. This results in increase of CHW supply header pressure which in turn is used to lower the secondary pump frequency. Thus lowering the CHW flow of the secondary circuit. When the load drops below 70%, the sequence automatically shifts to the Combined Cooling & Charging mode which is explained below.

Discharge Mode

Once the tank is charged, the BMS automatically

Mode	Mode	V1	V2A	V2B	V3	V4	V5	PR PUMP	SEC PUMP
Mode – 1	**Only Charging Mode**	**Closed**	**Open**	**Open**	**Open**	**Open**	**Open**	**ON**	**OFF**
Mode – 2	Direct Cooling Mode	Open	Open	Open	closed	Open	Closed	ON	ON
Mode – 3	Direct discharge Mode	Closed	Closed	Closed	Open	Closed	Open	OFF	ON
Mode – 4	Combined Cooling & Discharge Mode	Closed	Open	Open	MODULATE	Open	MODULATE	ON	ON
Mode – 5	Combined Cooling & Charging Mode	Closed	Open	Open	MODULATE	Open	MODULATE	ON	ON

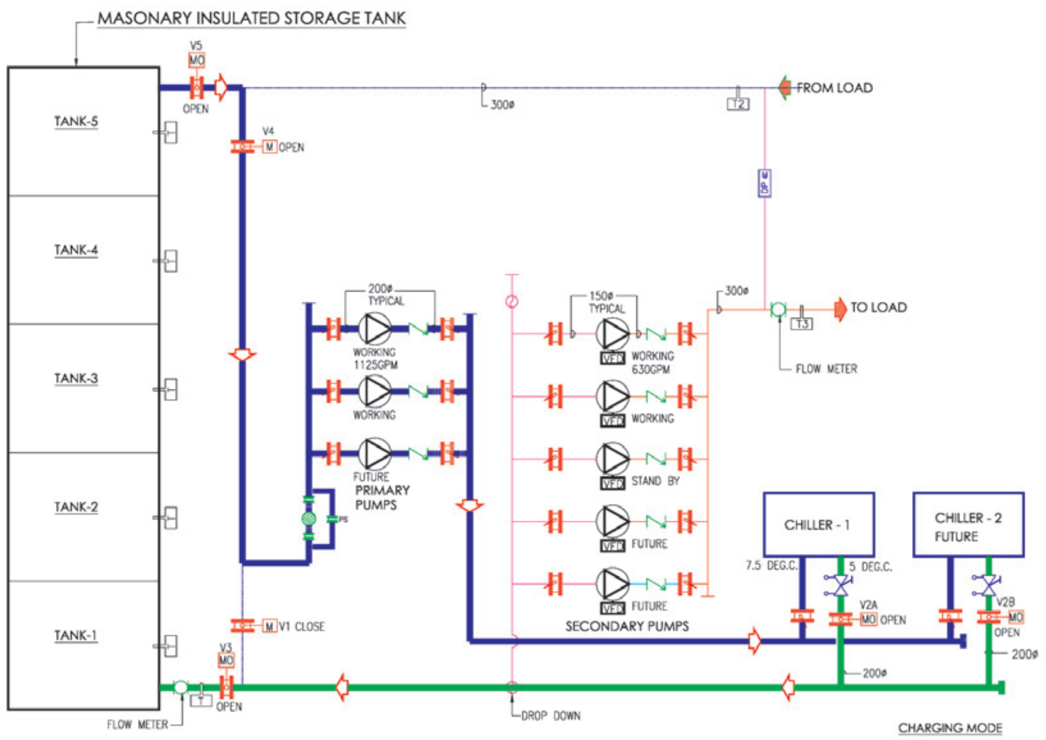

Figure 2 : Charging Mode.

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shifts to this mode of operation. In this mode, equipments such as chiller, primary pump, condenser pump and CT fans are switched-off. The storage tank isolation MBV's are opened and the secondary pumps are used to deliver the required CHW to the low side according to the load demands. This continues till the storage tanks are fully discharged. This is monitored with the help of a CHW temperature sensor mounted at the outlet of the tanks. As this temperature rises beyond the desired set value, the BMS automatically shifts the operating mode back to direct cooling mode. This cycle repeats automatically with a round the clock and unattended operation by the BMS until the load demand is zero. Under zero load demands, the system is switched over to the Charging mode.

Type of Chiller	Centrifugal Chiller	Screw Chiller	Reciprocating Chiller
Installed Capacity	375 TR	375 TR	375 TR
Tonnage at 80 % loading	300 TR	300 TR	300 TR
Power consumption at 80 % loading	154.20 kW	234.00 kW	267.00 kW
Excess power consumption over centrifugal chiller	-	79.80 kW	112.80 kW
Excess power consumption per day	-	1197.00 kWh	1692.00 kWh
Excess energy charges per day @ Rs.5.25/kWh		Rs. 6,284/-	Rs.8,883/-
Savings in annual power consumtion @ 300 days per annum		Rs.18,85,200/-	Rs.26,64,900/-

Table 2 : Comparision of energy consumption between conventional chiller systems v/s centrifugal chiller with thermal energy storage system.

Combined Cooling & Discharging Mode

When the peak load is more than the installed capacity of chiller, both the chiller and the TES tank are used to meet the cooling requirement of the building. In this case, the chiller, primary and secondary pumps are all ON.

The tank isolation MBV's are opened, so that the secondary circuit draws flow from primary as well as the storage tank as per the required load condition. This mode ensures that the chiller runs at full capacity (which gives better efficiency) plus the excess energy required is drawn from the charged storage tank. If the load drops and when the tank gets discharged, the BMS changes this mode of operation to Combined Cooling and Charging mode as explained below.

Combined Cooling and Charging Mode

The chiller is used partially to offset the building load and partially to charge (store) the TES tank. In this case also, the chiller, primary and secondary pumps are all ON. The tank isolation MBV's are opened, so that the excess flow of chilled water from the primary circuit is fed to the thermal storage tanks. The secondary circuit draws flow from primary as per the required load condition. This mode ensures that the chiller runs at full capacity (which gives better efficiency) plus the excess energy produced is used to charge the thermal storage tank which can be used at a later period of time. If the load drops further and when the tank gets charged, the chiller starts unloading its capacity. When the chiller capacity drops below 70%, BMS changes this mode of operation to Discharge mode as explained above.

Benefits from the System

Following are the tangible benefits the customer avails out of the installation :

Tonnage required for process cooling for each laser machine	2.5 TR
Power consumption of dedicated air cooled chiller @ 1.6 ikW / TR	4 kW
Power consumption for process cooling using high efficiency central plant @ 0.75 ikW / TR	1.875 kW
Saving in power consumption	2.125 kW
Saving in energy tarrif per hour @ Rs.5.25 / kWh	Rs.11.16 / hour of operation.
No of hours of operation per annum @ 24 hrs /day for 300 days per annum	7200 hrs
Saving in energy tarrif per annum per laser machine	Rs. 80,352 /-
No of laser machines	30 Nos.
Total saving in energy tarrif per annum	Rs. 24,10,560 /-

Table 3 : Comparison of energy consumption between conventional small air cooled chillers v/s new central plant for laser process cooling.

Chiller

Presently the chiller and TES system are operated through a BMS in the following modes during daily operation :

3.00 am to 12 noon – Discharge Mode
12.00 noon to 7.00 pm – Direct Mode
7.00 pm to 3.00 am – Combined Cooling & Charging Mode

The chiller runs round 15 hrs a day at an average load of 80% or more in either direct cooling mode or combined

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cooling and charging mode to achieve higher efficiency of chiller operation. The chiller stays off completely for 9 hrs.

The comparison of energy conservation by using high efficiency centrifugal chiller operating on or near full load in tandem with TES system is shown in *Table 2* with respect to other types of chillers such as screw / reciprocating compressor.

The power consumption for chillers @ 80 % load is considered as under-

1) Centrifugal Chiller – 0.514 ikW / TR
2) Screw Chiller – 0.78 ikW / TR
3) Reciprrocating Chiller – 0.89 ikW / TR

Laser Process Cooling System

In the earlier set up, a dedicated low efficiency (1.6 ikW / TR) air cooled chiller of 2.5 - 3 TR was installed per laser cutting machine and a crude tank and coil arrangement was carried out for the process cooling circuit.

In the new set up, chilled water from a secondary chilled water circuit is directly used for process cooling, reaping the advantage of using a high efficiency chiller with over all consumption of 0.75 ikW / TR. See *Table 3* and *Table 4* for details of power savings between the two types of process cooling systems.

Comparision of Energy Conservation Between Conventional Water Cooled Package System v/s Centrifugal Chiller with Thermal Energy Storage System

It is a normal trend in the region to provide water cooled package units. The annual power consumption for such a system is illustrated in *Table 5*.

	Departments Running 24 Hrs/Day	Departments Running 10 Hrs/Day	Departments Running Occassionaly
Cooling capacity required in TR	163.82 TR	437.71 TR	42 TR
Diversity of load considered	50 %	50 %	80 %
Power consumption per Hr @ 1.23 ikW / TR	100.75 kW	269.19 kW	41.32 kW
Operating hours per day	24 Hrs	10Hrs	3 Hrs
No. of days of operation per annum	300 Days	300 Days	50 Days
Power consumption per annum	7,25,400kWh	8,07,570 kWh	6198 kWh
Cost of power @ Rs. 5.25/ kWh per annum	Rs. 38,08,350/-	Rs.42,39,742/-	Rs.32,539/-
Total cost of power consumption per annum	**Rs. 80,80,631/-**		

Table 5 : Cost of power consumption using water cooled package units.

Tonnage required for process cooling for each laser machine	2.5 TR
Power consumption of dedicated air cooled chiller @ 1.6 IkW / TR	4 kW
No of laser machines	30 Nos
Power consumption @ 24 hrs per day 300 days per annum & 70 % diversity	6,04,800 kWh
Cost of energy per annum @ Rs. 5.25 / kWh	Rs. 31,75,200/-

Table 4 : Cost of power consumption using small air cooled chillers for laser process cooling.

We also have to include cost of power consumption for chillers for cooling of laser machines, which is required to be installed in case of package units. Cost of power consumption for the chillers is as under :

As calculated above, total cost of power consumption in case of water cooled package units and air cooled chillers for laser machines is approximately Rs. 1.12 crore per annum.

While in the case of existing system of high efficiency centrifugal chiller with thermal storage system, cost of power consumption is around Rs. 67 lacs per annum(375TR × 0.75 ikW/TR × 15 hrs × 300 days × Rs.5.25 / kWh) This is a substantial saving.

Secondary Chilled Water Pumps

Presently, by controlling the speed of the pump motor to maintain a constant differential pressure across the supply and return CHW headers , motors run well below the synchronous speed (@ 35 Hz) resulting in reduction in power consumption.

Air Handling Units

Two-way chilled water valves controlled by room temperatures vary the flow demand in the secondary circuit. This reduces the speed of secondary CHW pumps resulting in energy conservation.

VAV Systems

Air flow to various offices on director's floor is controlled by a VAV system. This modulates AHU fan motor speed and power consumption is reduced .

Building Management System

Energy Conservation

It is a known fact that the BMS helps in reducing the energy consumption. Installtion of such a system not only saves energy but records the savings. The recorded trends / historical data helps quantifying the savings as well as provides a means to optimise on such savings potential.

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Sr. No.	Thermal storage with chilled water	Thermal storage with phase change material
1	Uses water as medium of storage	Uses brine to solidify phase change materials
2	Due to water, the chiller efficiencies can be higher. (Lower IkW/TR)	Due to brine, chiller efficiencies are lower. (Higher IkW/TR
3	Does not require interim heat exchangers for large systems.	Requires interim heat exchanger for larger system to minimize brine charge.
4	Simpler technology, manufactured at site.	Factory made

Table 6: Comparison of thermal storage using chilled water v/s phase change material.

Manpower Savings

Automated control and monitoring of the building utilities results in a minimal requirement of manpower. The BMS system automatically generates the desired reports, history and all types of system logs.

Automated Execution of Complex Logics

The complex work logics are difficult or impossible to manage manually. The BMS once programmed, keeps executing the large complex logics automatically. The system also takes the necessary corrective actions as programmed. For example - when a working pump trips, the stand-by pump automatically takes over. The system can also report any critical alarms to a remote alarm device or pager/mobile.

Weekly Time Schedules with a Facility to Programme Exceptions

BMS operates the various utilities on different weekly time shcedules. There is also a provision available in the system for the user to programme the exceptional time schedules, which means that the system can start or stop with an execption. This time scheduler logic allows the user to programme the annual holidays or overtimes.

Seamless Integration with 3rd Party Systems

Seamless integration with all 3rd party systems enables the user to have a single window approach to the system monitoring and control. It results in a common database for all the systems and maintenance becomes easier.

An Overall Effective Management of the Building Assets

All the building utilities are preciuos assets of the plant engineer. The BMS tracks run hours of each of the equipments and automatically generates a maintenance schedule thereby reducing the down time. Automated sequencing of various equipment results in longer life cycles of such equipment.

Thermal Storage System

The major advantage of this system as compared to the thermal storage with phase change material is shown in *Table 6*.

Conclusion

Installation of a TES system with chiller has reduced the connected electrical load of the building by 150 kW, reducing maximum demand cost by Rs.2,70,000/- per annum.

The payback period of such a system is excellent incase of dual tarif on electrical power.

The system works on simple principles blended with high efficiency chiller and BMS . The diffuser design is also simple and this can be made at site by a piping contractor.

As the connected load is reduced, over all power generation capacity of power plant is also reduced. If such sytems are installed on a large scale in the area ,it will certainly control carbon emission in the environment. Furthur, use of refrigerant R-123 reduces emission of fluorocarbons.

The owner's support and design team's commitment to design an efficient building was the key ingredient for the success of this project. ❖