Technical Paper on ISSUE 30 – Building Sector

This is a joint paper by Mr. Narendra Mohan Majhi

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Designing of Energy Efficient Buildings
&
Retrofitting of Buildings for energy Efficiency in India

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1. Introduction:

In the competitive business environment, energy conservation is need of the hour for sustaining business success in addition to contributing protection of our environment and mother earth. Each energy conservation activity results in economic development and environment protection as well.

There exists energy conservation potential in buildings both through:

Improvement in design

Retrofitting of existing buildings

This article is for energy conservation in commercial buildings, office buildings and ancillaries, Guest Houses and group housing societies. The article covers **success stories**, **suggestions** and **strategies for harnessing renewable energy** for conserving energy in buildings.

2. Areas of energy consumption in buildings:

The areas of energy consumption in buildings in descending order of amount of energy consumed are indicated below:

i) Air Conditioning
ii) Supply of hot water in canteen / building
iii) Lighting and Fan

3. Success Stories on retrofitting of Air Conditioning in buildings:

3.1 Use of vapour absorption system for air conditioning:

Guwahati Refinery has installed vapour absorption air conditioning system for Quality Control Laboratory building instead of conventional window air conditioners in the year 2000. The system is working satisfactorily since then. The scenario of this oil refinery was shortage in power generation and surplus in steam.

Gujarat Refinery has installed vapour absorption air conditioning system for Control Room of LAB Unit instead of conventional power based air conditioning system. The system is working satisfactorily. The scenario of this oil refinery was surplus in low pressure steam.

4. Suggestions on retrofitting

4.1 Use of vapour absorption refrigeration for air conditioning in one Office Building:

The technical building of one of the Oil Refinery has about 100 offices in the building.

Air Conditioning:

The numbers of air conditioners (window AC and split AC) installed are about 100 numbers.

Average power consumption: 2 kWh per AC

Total power consumption: 200 kWh

Number of working days in a year: 300 days
Operating hours per day : 10 hours
Annual power consumption : 600 MWH

The power requirement is supplied from own generation through gas turbines (three GTs) and and one steam generators. The average fuel consumption for generation of one MWH of power within this oil refinery is 0.28 SRFT (Standard Refinery Fuel in MT) per 1000 kWh of power generation.

Average fuel consumption : 0.28 SRFT / MWH
The annual power consumption for air conditioners is : (600 * 0.28) = 168 SRFT per year.

The cost of equivalent fuel oil is about Rs 26000 per MT, i.e. if the fuel is not burnt, the same can be sold in market as fuel oil.

The value of fuel consumed for air conditioning is = (168 * 26000/100000) = Rs 43.68 lacs.

Suggestion for vapour absorption Air Conditioning System:

It is proposed to utilize surplus steam for installation of vapour absorption refrigeration system for generation of chilled water and use of this chilled water for air conditioning of the building.

1	Space to be air conditioned						
	Floor	Wing	Length(Mtr)	Widht (Mtr)		Area in Sq. Mtr	
	Ground Floor	Left wing	50	30		1500	
	Ground Floor	Right wing	50	30		1500	
	Fist Floor	Left wing	50	30		1500	
	Fist Floor	Right wing	50	30		1500	

	Second Floor	Left wing	50	30		1500	
	Second Floor	Right wing	50	30		1500	
	Area for front block					7500	
	Area of rear block is similar as above					7500	
	Total surface area					15000	
	TR per Square meter for large buildings					0.04	TR/Sq mtr
	TR required for total building					600	TR
	Contigency @ 25%					150	TR
	Total TR required					750	TR

2 Benefits of installing vapour absorption chiller for centralised air conditioning

A.	Fuel Consumption for vapour absorption chiller		
	Power consumption for vapor copression chiller	2.5	kWh/TR
	Power consumption for vapor copression chiller	1875	KWh
		1.875	MWH
	Average fuel consumtion SRFT / MWH	0.28	SRFT/MWH
	Onstream days	300	days
	Operating hours per day	16	hours
	Fuel consumtion per year	1344	SRFT per year
B.	Fuel Consumtion for vapour absorption chiller		
	Heat requited for vapour absorption chiller	2575	Kcal / TR
	Heat requited for vapour absorption chiller	1931250	Kcal/hour
	Steam required		
	Enthalphy of steam at 10 kg/cm2	730	Kcal/kg
	Enthalhy of condensate at saturation temp	180	Kcal/kg
	Enthalphy per kg of steam	550	Kcal/kg
	MP steam required	3511.4	kg/hr
		3.511	MT/hour

i)	Benefits of converting WASTE TO WEALTH by using this waste steam:		
	Steam consuption per year considering 16 hours operation per day	16854.55	Mt/year
	Steam fuel ratio	14	
	Fuel savings	1203.896	MT/year
	Annual fuel saving	1300	MT per year
	Average fuel cost	18000	Rs/MT
	Financial savings	**234**	**Lacs per year**
ii)	Savings due to stopage of existing window Acs / Split Acs subsequent to installation of vapour absorption chiller		
	Total equivalent window AC numbers of Acs/ Split Acs	100	
	Power consumtion per AC	2	kWh
	Total power consumtion	200	kWh

	Onstream days	300	
	Power Consumption per anuum considering 10 hours / day	600	MWH
	Average fuel consumtion SRFT / MWH	0.28	SRFT/MWH
	Fuel saving per year	168	SRFT/Year
	Annual fuel saving	200	MT per year
	Average fuel cost	18000	Rs/MT
	Financial savings	**36**	**Lacs per year**

iii)	Total fuel savings	1500	MT per year
	Average fuel cost	18000	Rs/MT
	Financial savings	**270**	**Lacs per year**

Remarks:
1. It is suggested to use low pressure steam at about 5 kg/cm2 for vapour absorption chiller instead of using MP steam directly. Low pressure steam has higher latent heat and delta temperature between saturation temperature of LP steam and media to be heated.

2. The data on TR/square meter of lage building and heat required /TR for vapour absortion chiller system has been taken from standard reference books.

Conclusion on retrofitting:

On Air Conditioning:

Industries may look into steam power balance and may switch over to vapor absorption refrigeration system in place of conventional power based refrigeration system wherever economics is viable.

4.2 On Lighting:

The extent of use of CFL lamp in office buildings is still far from desired level. The use of energy efficient tube lights is also not yet popular in domestic sector.

Industries use such lamps through contracts. Industries may be advised to use only CFL lamps and energy efficient lights in all buildings for office, residential colonies and guest houses. Such items may be built in contracts awarded by buildings of Industries.

4.3 Supply of hot water

The canteens of industrial installations require hot water for cooking and washing of dishes. In most of the places conventional electricity is used for generation of hot water. In some cases steam is used for cooking purpose but condensate is not recovered.

In guest houses of many installations, conventional geyser is used for supply of hot water.

i) Solar water heater

It is proposed to install SOLAR WATER HEATER for canteens and guest houses for supply of hot water instead of geysers which consumes electricity i.e. fuel.

a) Suggestion on solar water heater in Technical building and Canteen

Geysers are used for supply of hot water to bath rooms, meals canteen and canteen in training centre at Gujarat Refinery. Electricity is consumed for this purpose. Meals canteen has provision of steam heater in addition to geyser.

It is proposed to install integrated solar water heater at the roof of Technical building for supplying hot water to technical building, meals canteen and training centre. The economics is given as under:

- Reduction in electrical energy consumption
- Use of renewable energy – solar energy
- Savings in consumption of fuel oil / fuel gas being used for generation of electricity
- Reduction in CO2 emmission
- Estimated fuel saving is 76 SRFT per year

Benefits of installing Solar water heater in Technical Building
for supply of hot water to Technical building, meals canteen and Training Centre

Electricity consumption for all geysers	75	kWh
Operating hours per day	8	hours
Operating days	300	days
Total eclectricity consumption	180	mWh
Average power energy factor	0.25	SRFT / mWh
Fuel consumtion	45	SRFT per year
Cost of fuel	26000	Rs/SRFT
Savings	11.70	Rs in lacs per year
Reduction in steam consumption	50.00	kg/hour
Operating days	365.00	days
Reduction in steam consumption	438.00	MT per year
Steam fuel ratio	14.00	
Reduction in fuel consumtion	31.29	MT per year
Savings	8.13	Rs in lacs per year
Total savings	19.83	Rs in lacs per year
Investment required		
Solar water heater system	15.00	Rs in lacs (Aprox)

Pipes and fitting	7.00	Rs in lacs
Total investment	22.00	
Annual maintenance cost	2.92	
Pay back period	1.30	Years

b) Suggestion on solar water heater in Tapti Guest House

There are 24 rooms in Tapti guest house. The numbers of rooms in hostel are 58. There are two kitchens (one for Tapti and other for mess). There also common bath rooms. Each room has one geyser in addition to common toilet. Total numbers of geysers are about 84. At present electricity is being used for supply of hot water to bath room and kitchen.

It is proposed to install integrated solar water heater at the roof of hostel for supplying hot water to all rooms in Hostel and Tapti guest house. The benefits are as under:

- Reduction in electrical energy consumption in hostel and Tapti guest house
- Use of renewable energy – solar energy
- Savings in consumption of fuel oil / fuel gas being used for generation of electricity
- Reduction in CO2 emmission
- Estimated fuel saving is 62 SRFT per year

Benefits of installing Solar water heater in Hostel and Tapti guest house

Number of geysers	86	numbers
Electricity consumption	1.5	kWh
Operating hours per day	8	hours
Operating days	240	days
Total eclectricity consumption	247.68	mWh
Average power energy factor	0.25	SRFT / mWh
Fuel consumtion	61.92	SRFT per year
Cost of fuel	26000	Rs/SRFT
Savings	16.10	Rs in lacs per year
Investment required		
Solar water heater system	10.00	Rs in lacs (Aprox)
Pipes and fitting	5.00	Rs in lacs
Total investment	15.00	

Annual maintenance cost	2.92	
Pay back period	1.14	Years

5. Improvement in design

The followings are proposed for improvement in design for improving energy efficiency of buildings. The areas covered are as under:

- Air Conditioning
- Hot water supply
- Lighting
- Water proofing
- Emissive coating

5.1 Solar steam generator for Air Conditioning and Cooking

It is suggested to install “SOLAR STEAM GENERATOR” for generation of low pressure steam. This low pressure steam can be used for:

- Vapor absorption refrigeration for generation of chilled water for air conditioning of large buildings.
- The low pressure steam can be used for cooking in canteens of industrial units and large community canteens.

The success story is excellent functioning of large scale solar water steam generating system at “SHANTIVAN” of Bramhakumari’s institute at Abu Road, District- Sirohi, Rajasthan. The low pressure steam generated is being used for cooking where foods for about 5000 to 15000 persons are being cooked with excellent hygienic condition.

5.2 Solar Water Heater

It is suggested to install “Solar water heater” for all buildings being constructed now. In fact, Housing Development Authorities and Government Authorities may be requested to make it mandatory for installing such system at the time of approval of construction of any building.

5.3 Energy efficient lamp

In spite of lot of effort put by all concerned, use of energy efficient lamps is yet to gear up in India. The followings are suggested:

- It may be made mandatory for Corporate Sector to include it in their contracts as all of such jobs are executed through annual maintenance contract.
- Awareness campaign in domestic sector

5.4 Insulation of Roof and Water proofing

It is suggested to have insulation at roof of buildings i.e. additional heat protective layer on the roof. This may be followed by water proofing of all roofs of buildings.

5.5 Emissive Coating

Emissive coating may be applied at the surface of walls of building for minimizing heat absorption and radiation by walls.

5.6 Glass Window with heat seal

Glass windows with heat sealing may be provided for minimizing heat ingress to building.

6. Barriers

The barriers on the suggestions are:

- Low awareness on benefit of energy efficient lamp in domestic sector particularly in rural areas.
- Low response to Solar Water Heater by some Corporate Sector due to failure of such system at there first installation.
- High maintenance prone of solar water heating system as conceived by some of the corporate sector
- Lower rate of acceptance of new ideas like generation of low pressure steam through solar water heater.
- Low awareness on energy efficiency of buildings.
- Energy efficiency of buildings are rarely monitored as Corporate Sectors deal with energy saving opportunities of large areas.

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Building industry is in India is doing well, there is lot of scope for energy saving in Building, demand for buildings is expected to more in future also and customer has now lot of choices for selection of buildings. Builders are facing the challenge of designing of Energy efficient Buildings, which consume less energy, which is a major component.

Technical experts/ specialist are already doing research work in bringing more efficient technology for building. However, efforts are required to cut down the energy consumption in this sector. We like to know what efforts builders, architects are doing in this direction, send details about your efforts, success stories, failure, barriers, your suggestion, your area of concern, support required. These are some of the issues we wish to discuss with industry members. We are organising workshops for Building Sector in under Life Long Learning (3L) Programme to discuss and share the knowledge.

Please submit your technical paper on the above topic to us by **9th May 2010**. We will award best 6 papers Rs. 10,000/- each and further out of 6 selected papers, 2 best technical paper writers will be invited to present their paper in any workshop. A lump sum fee of Rs. 15,000/- towards travel expenses/ honorarium will be paid to the presentators.

Submit your technical papers by **9th May 2010** to info@energymanagertraining.com