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Presentation on Detailed Energy Audit findings – S 14 Block

Syngene International Limited, Bommasandra, Bengaluru

Thursday, 6 September 2019

Project Code.
2019IB16

Facility energy consumption summary

Source	Year 2018-19	
	kWh/year	Lakh Rs./year
Electricity from Grid	6924794	557.45
Electricity from Diesel Generator	326299	Rs. 47.25

- Cost of Electrical Energy : 8.34 Rs. / kWh

Areas Covered

- Electrical Systems
- Electrical Drives
- HVAC
- Compressed Air
- Blowers, Fans and Vacuum Pumps
- Steam Utilization and distribution.

Methodology - Instrumented study

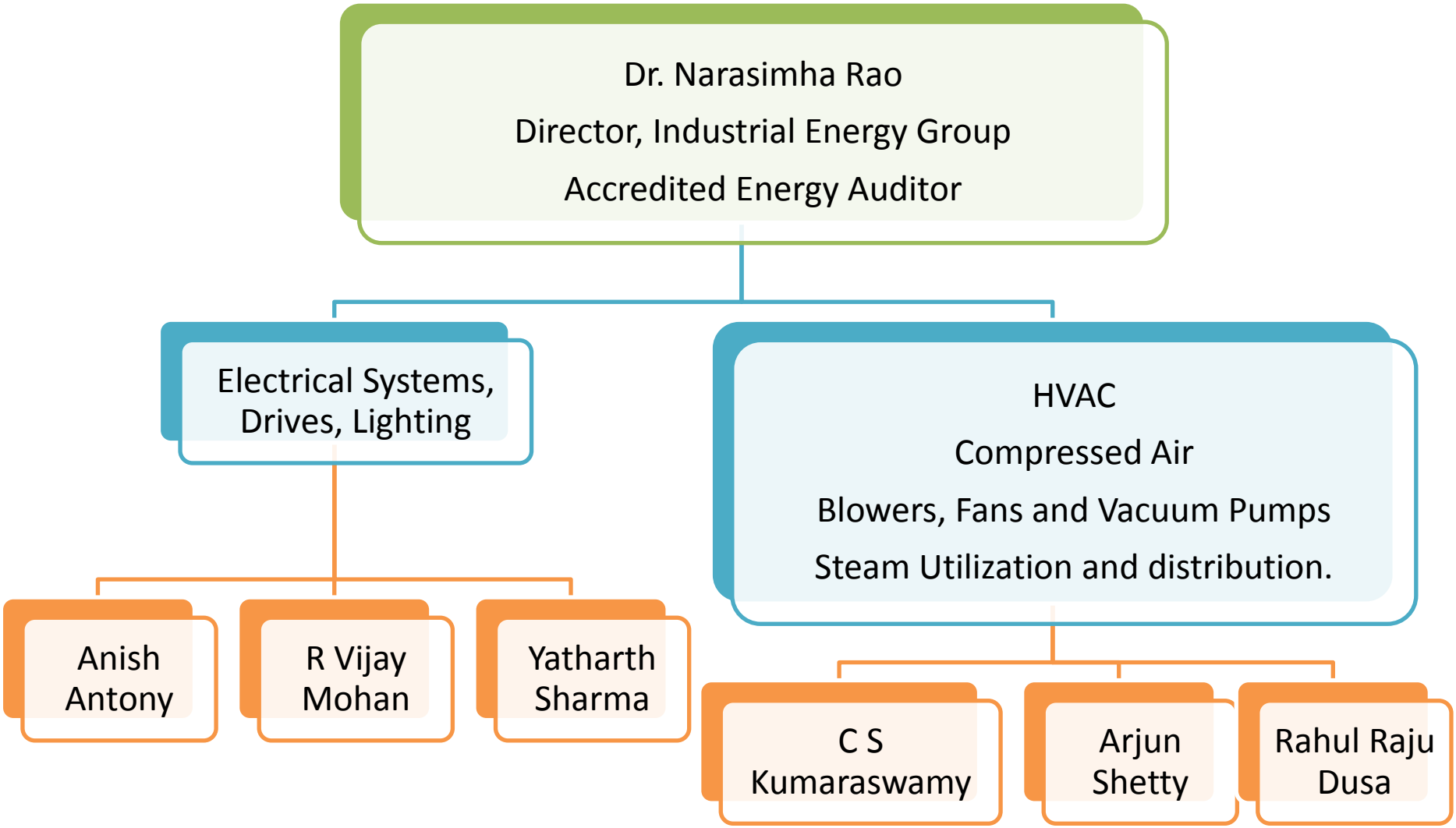




- Power analyzers (Krykard ALM 32, ALM 10, Fluke 41B)
- Anemometer
- Multi-fuction kit
- Ultrasonic water flow meter
- Infra-red thermohunter
- Thermograph
- Lux meter

Energy Audit Team

Team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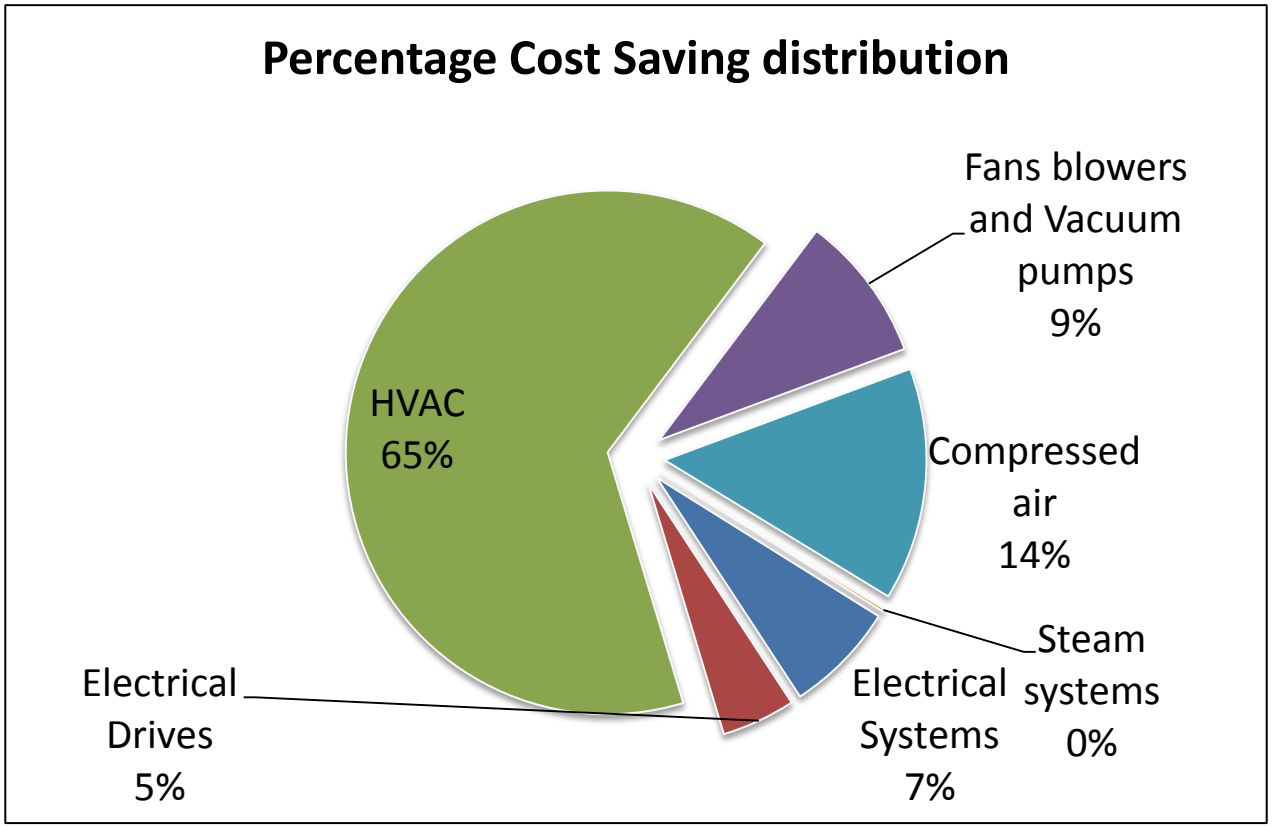
Energy Saving Recommendations

Summary

Type of Recommendations	No. of Recommendations	Annual energy saving potential	Annual Saving Potential,	Cost of Implementation,	Payback Period, Years
		Lakh kWh (kg steam)	Rs. Lakh	Rs. Lakh	
Short term investment, payback less than I Year	12	9.52 (5468.2)	79.63	18.59	0.2
Medium investment, payback between 1- 3 years	2	2.25	18.77	36.24	1.9
Long investment, payback more than 3 years	4	2.67	22.30	79.82	3.6
Total	**18**	**14.45 (5468.2)**	**120.69**	**134.65**	**1.1**

Summary



- Energy savings : 19.92% of total energy consumption
- Steam savings : 1.4% of total steam consumption
- Cost savings : 19.48% of total energy cost

Electrical Systems, Drives and Lighting

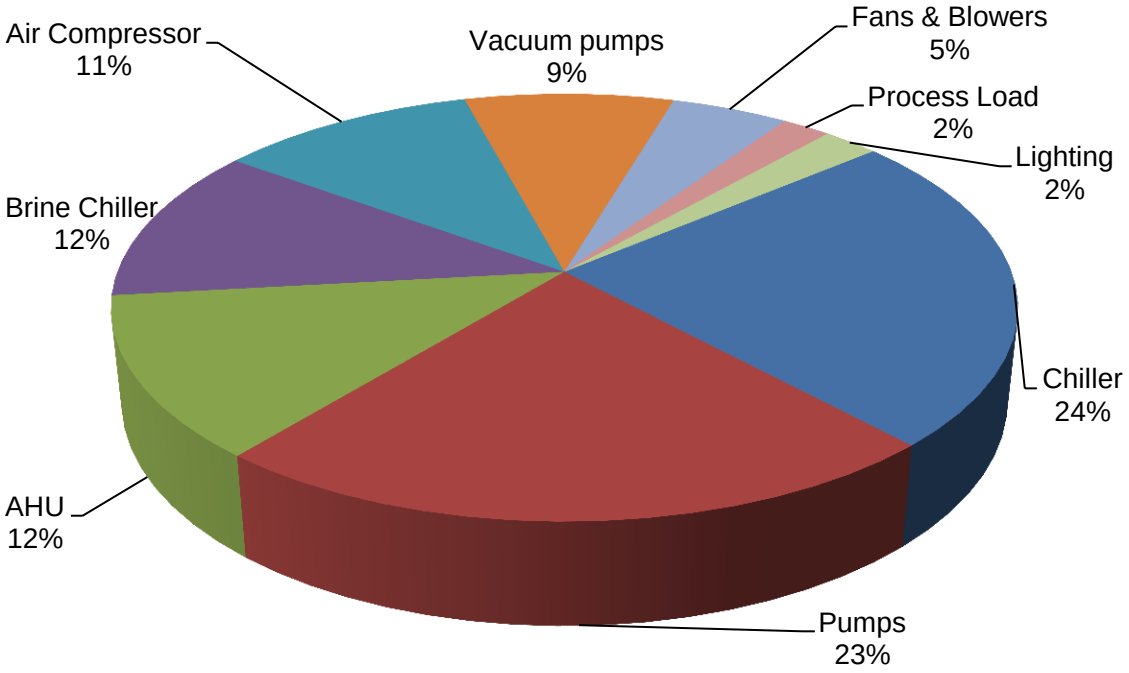
Introduction

- Source of power to S-14 block is from S11 Substation.
- S11 substation receives electricity from Syngene central utility and Biocon substation at 11kV. Stepping down to 433V is carried out by three 2.5 MVA transformers.
- The average load on S14 Block is around **1.2 MW (Total load of 7 feeders of S14 block).** The average energy consumption per day is around **21000 kWh.**
- Power factor maintained in the range of **0.88 to 0.99 lag** .
- **Electrical Parameters Studied**: Voltage, Current, Voltage and Current harmonics, % Unbalance of voltage and current, Power (kW, kVA, kVAr) and Frequency.

Measured load of S14 feeders

Feeder	Load (kW)	PF
S14 PCC2	101	0.98
S14 Ph-1 Sub PCC	129	0.98
S14 Ph-2 Chiller Panel	169	0.99
S14 Ph-2 Sub PCC	177	0.98
S14 Utility MCC	144	0.93
S14 Ph-1 MCC2	132	0.93
S14 PCC1	347	0.88
Total	**1199 kW**	

Load breakup of S14 Block



Description	Load (kW)
Chiller	237
Pumps	224
AHU	120
Brine Chiller	115
Air Compressor	106
Vacuum pumps	86
Fans & Blowers	48
Process Load	20
Lighting	23
Total	979

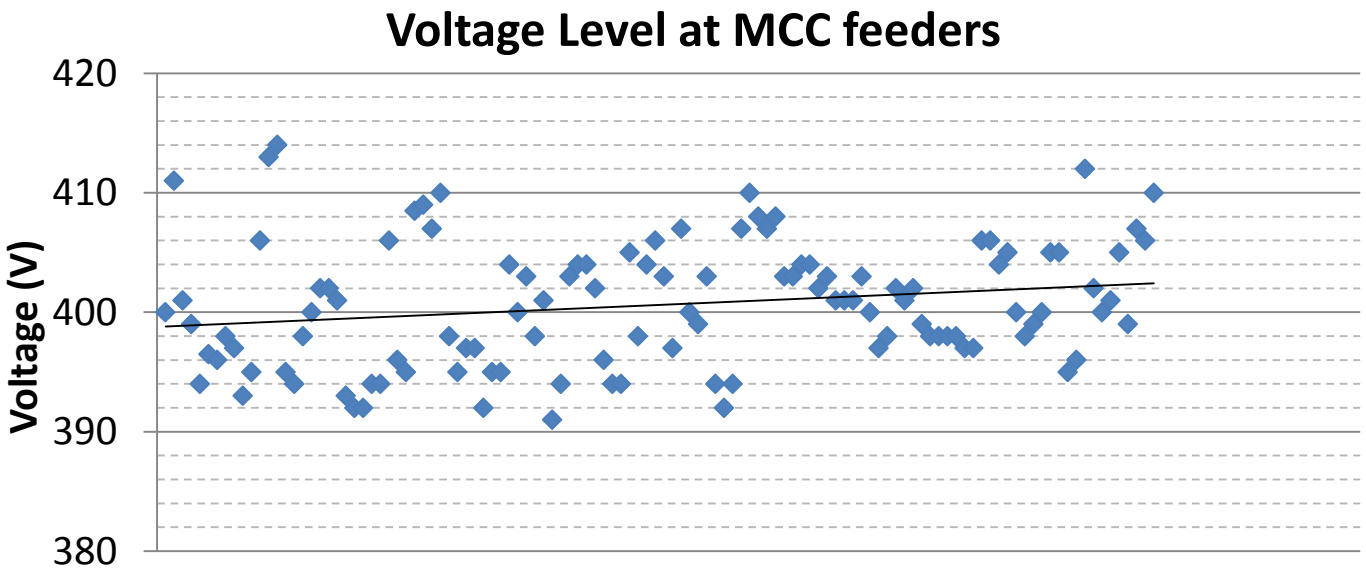
Summary of Potential savings – (Electrical systems, Drives and Lighting section)

Sl. No.	Description	Electricity, Lakh kWh	Value, Rs. Lakh	Rs. Lakh	Years
SHORT TERM MEASURES					
	Electrical Systems				
1	Improve the Distribution voltage level at MCC panels by raising the tap position in distribution transformers	0.7	5.84	Nil	Immediate
LONG TERM MEASURES					
	Electrical Systems				
2	Provide additional run of cables for the identified feeders	0.3	2.46	7.44	3
	Electrical Drives				
3	Application of Energy Efficient motors	0.66	5.51	17.29	3.1
	Sub total	**1.66**	**13.81**	**24.73**	**1.79**

1. Improve the Distribution voltage level at MCC panels by raising the tap position in distribution transformers.

- More than 90% of the plant load is consumed by induction motors. The designed system voltage of electrical drives is 415V (±10%).
- **Overvoltage causes saturation of the motor iron core and thus wasting the energy due to magnetisation losses such as eddy current losses and hysteresis losses.** Also, the overvoltage stress will reduce motor lifetime.
- **Under voltage supply to an induction motor, will slightly affect the motor speed-torque characteristics due to an increase in slip.** If the motor loaded more than 70% and operating at under voltage will result in reduced torque and motor will end up drawing more current and power.
- From the motor drives measurement, the loading of the motors is more than 75% in the majority. The measured supply voltage of each motor drive at MCC panels is illustrated in the figure given below.

Proposals – Syngene S14



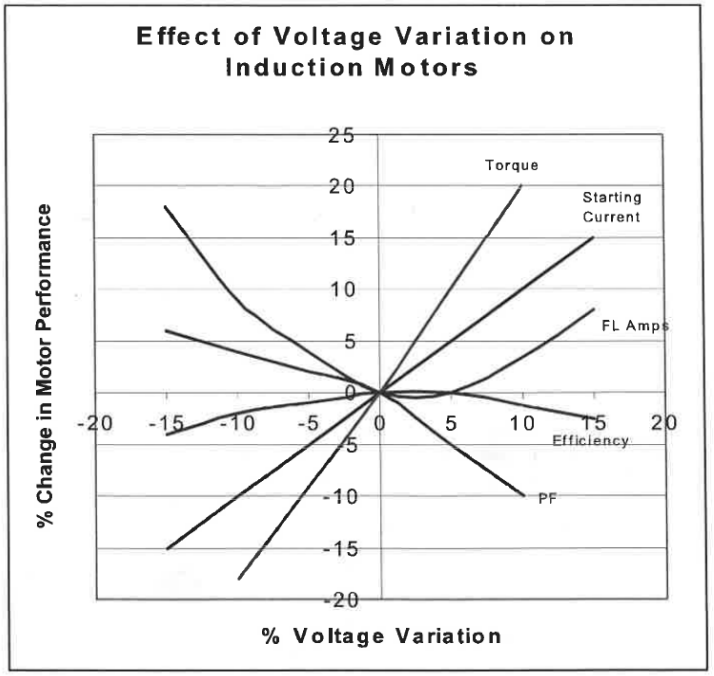
Estimated energy saving is 8~10kW.

Techno-economic

Annual energy savings	:	70080 kWh
Annual cost saving @ Rs. 8.2 /kWh	:	Rs. 5.74 lakh
Cost of implementation	:	Nil
Simple Payback	:	Immediate

Suggestion

Voltage Variation	110%	90%
Starting & Max. torque	Increase by 21%	Decrease by 21%
Synchronous speed	No change	No change
% slip	Decrease by 17%	Increase by 23%
Full load speed	Increase by 1%	Decrease by 1%
Full load efficiency	Increase by 0-1 point	Decrease by 1-3 points
Full load PF	Decrease by 2-8 points	Increase by 1-3 points
Full load current	Decrease by 0-7%	Increase by 10-12%
Locked rotor current	Increase by 10-14%	Decrease by 10-12%
Temp. rise @ full load	Decrease by 4-6^{o}C	Increase by 4-8^{o}C
Max. Overload capacity	Increase by 21%	Decrease by 19%
Magnetic noise (No load)	Increase slightly	Decrease slightly



2. Provide additional run of cables for the identified feeders.

Background

Feeder/ Equipment	Cable details		
	Size	Runs	Length (km)
200TR King Air Chiller	300 sqmm	1	0.05
300TR Chiller	300 sqmm	2	0.05
Air Compressor-2	300 sqmm	1	0.03
Phase1 MCC-2	400 sqmm	1	0.45
Chiller panel Phase 2	240 sqmm	3	0.45

2. Provide additional run of cables for the identified feeders.

Recommendation

Feeder/ Equipment	Cable details				Operating parameters				Proposed runs of cable
	Size	Runs		Ω/km	kW	kVA	Amps	PF	
200TR King Air Chiller	300 sqmm	1		0.13	153	183	260	0.84	2
300TR Chiller	300 sqmm	2		0.13	125	151	213	0.83	3
Air Compressor-2	300 sqmm	1		0.13	104	116	170	0.90	2
Phase1 MCC-2	400 sqmm	1		0.11	132	147	140	0.90	2
Chiller panel Phase 2	240 sqmm	3		0.16	169	188	270	0.90	4

2. Provide additional run of cables for the identified feeders.

Energy Savings

Present distribution losses per annum	: 80875kWh
Reduction in cable losses by providing adequate runs	: 29511kWh
Annual cost saving @ Rs. 8.2 /kWh	: Rs. 2.42 lakh
Cost of implementation	: Rs. 7.44 Lakh
Simple Payback	: 3.1 Years.

Electrical Drives Proposals – Syngene S14

1. Application of Energy Efficient motors

Motor ID/Code	Motor Rating			Operating parameters of present motor			Proposed Motor			Reduction in losses (kW)	Energy saving (kWh)	Monetary saving (Lakh INR)	Investment (Lakh INR)	Payback (Year)
	kW	RPM	Eff. (%)	kW	Eff. (%)	Loss (kW)	kW	RPM	Eff. (%)					
300TR Secondary pump-3	18.5	1475	91%	18	91.2%	1.58	22.0	1475	93.0%	0.36	3154	0.26	1.48	5.7
Chilled water circulation pump-02	22	2950	90%	7.2	85.3%	1.06	22.0	2950	93.0%	0.29	2513	0.21	1.76	8.5
210TR Primary Pump-1	15	2905	89%	14.6	89.3%	1.57	18.5	2905	92.4%	0.48	1452	0.12	1.2	10.1
King air Primary Pump-1	15	2905	89%	15.3	89.2%	1.65	18.5	2905	92.4%	0.52	1563	0.13	1.2	9.4
Phase 1 &2 Chilled water circulation pump-01	22	2950	87%	18.5	85.0%	2.78	22.0	2950	92.7%	1.46	12777	1.05	1.76	1.7
Phase 1 &2 Chilled water circulation pump-02	22	2950	87%	18.3	87.3%	2.32	22.0	2950	92.7%	1.02	8901	0.73	1.76	2.4
CT Fan-03	9.3	570	89%	9.8	86.0%	1.37	15.0	990	91.9%	0.56	4893	0.40	0.744	1.9
CT Fan-04	9.3	570	89%	9.9	89.1%	1.08	15.0	990	91.9%	0.27	2330	0.19	0.744	3.9
CT Fan-02	9.3	570	89%	9.6	89.2%	1.04	15.0	990	91.9%	0.25	2150	0.18	0.744	4.2
Process CT Pump2	15	2930	88%	14.6	87.8%	1.78	18.5	2930	92.4%	0.69	6069	0.50	1.2	2.4
Brine Chiller ph2 Secondary Pump-1	7.5	2870	85%	4.1	83.4%	0.68	7.5	2870	90.1%	0.23	1989	0.16	0.6	3.7
Brine Chiller ph2 Primary Pump-1	3.7	2870	80%	5.18	79.3%	1.07	3.7	2870	87.1%	0.38	3348	0.27	0.296	1.1
Brine chiller phase 1 Secondary pump-1	7.5	2900	88%	5.2	88.0%	0.62	7.5	2900	90.1%	0.11	957	0.08	0.6	7.6
HVP-04 Booster pump	3		80%	3.1	81.8%	0.56	3.0		87.0%	0.19	1695	0.14	0.24	1.7
VP-03 phase 1	22	2950	87%	17	87.2%	2.17	22.0	2950	93.0%	1.00	8779	0.72	1.76	2.4
VP-3 (Utility MCC panel)	15		89%	14	89.3%	1.50	15.0		91.9%	0.39	3457	0.28	1.2	4.2
Total											**66027**	**5.41**	**17.29**	**3.19**

Compressed air

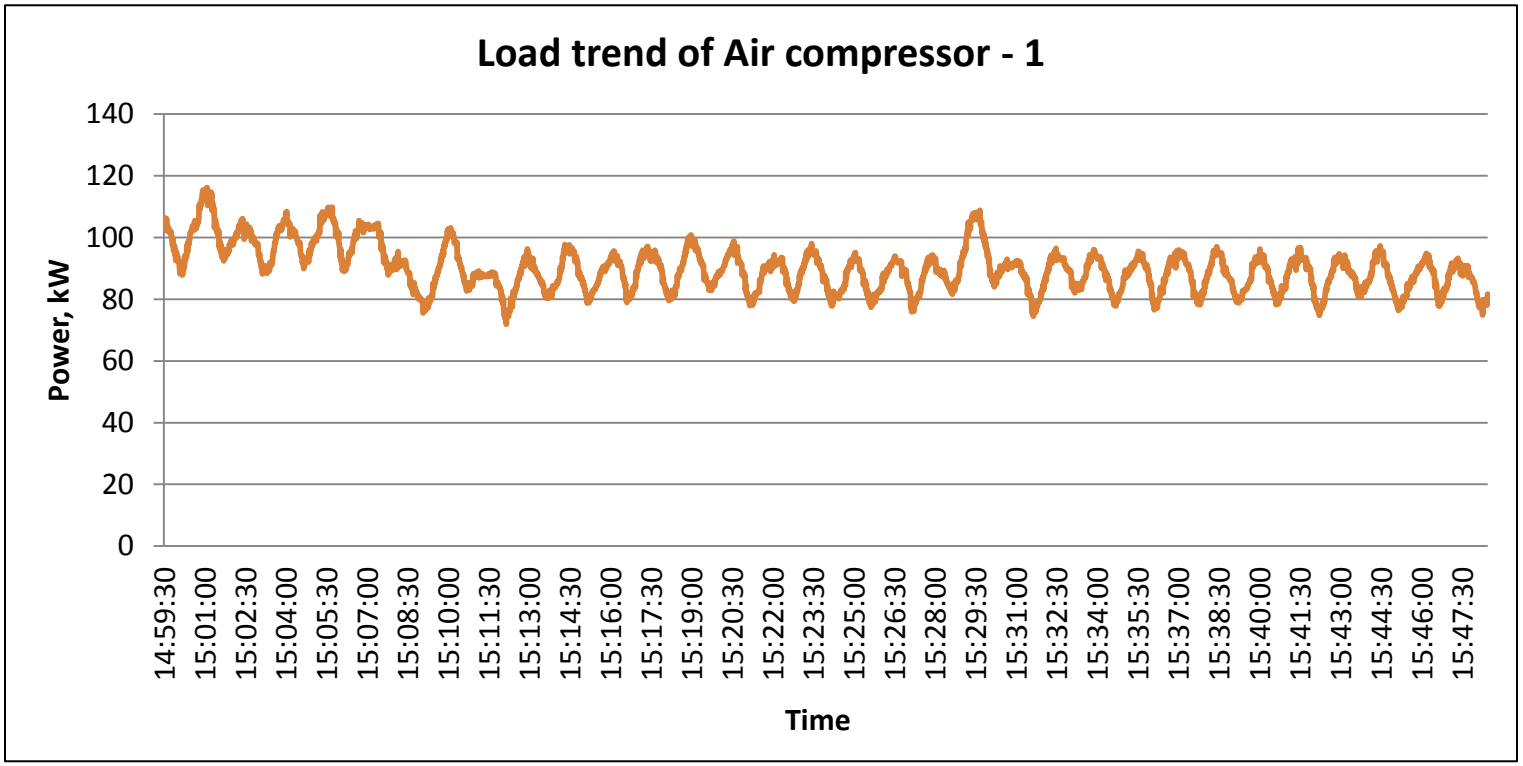
Compressed air system

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Overhaul Air compressor – 2	1.56	13.03	1	0.1
	Sub-Total	**1.56**	13.03	1	0.1
LONG TERM MEASURES					
2	Use low pressure air compressor for process air	0.52	4.32	20	4.6
	Sub-Total	**0.52**	4.32	20	4.6
	Total	**2.08**	**17.35**	**21.00**	**1.2**

Compressed air system

Description	Unit	Air compressor
Make		Atlas copco
Model		ZT -90- FF VSD
Type		Air cooled, Screw type, Oil free
Free Air Delivery	cfm	492
Pressure	kg/cm^2	9.0
Motor	kW	90
Installed numbers	Nos.	2

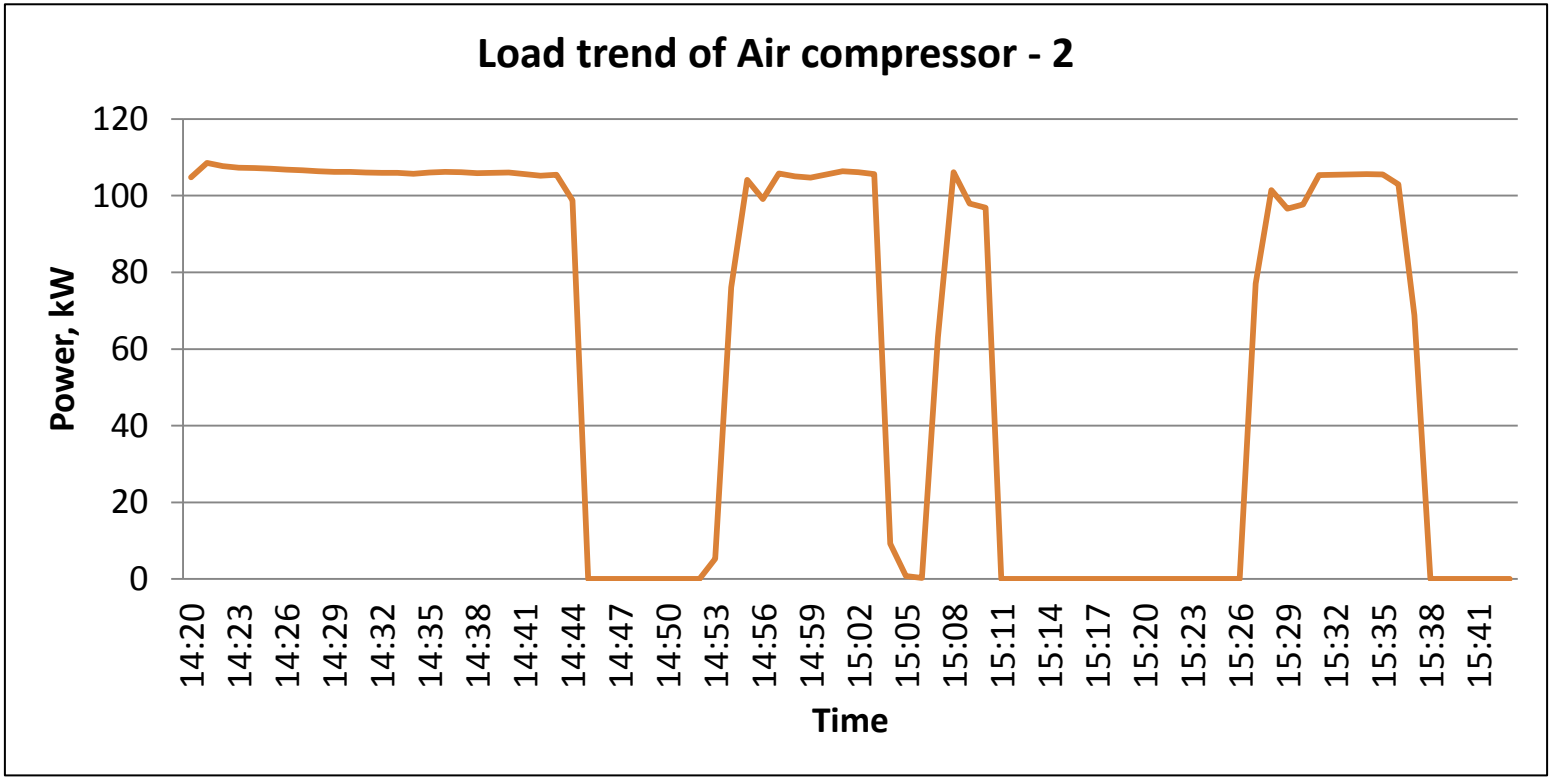
Energy Conservation Measures - Air compressors



Power consumption – 71kW to 116kW

Average power consumption : 90kW

Energy Conservation Measures - Air compressors



Average power consumption : 116kW

Energy Conservation Measures - Air compressors

Overhaul Air compressor – 2

Background :Specific Energy Consumption of Air compressor – 2 is 0.22kW
Average Best SEC : 0.18kW/cfm .
Element 1 & 2 Air temperature was – 230 ^{0}C and 199 ^{0}C
Element temperature should be less than 180 ^{0}C.
Recommendation : Overhaul air compressor 2 immediately, until it is serviced operate air compressor 1

Description	Unit	Value
Free Air Delivery (FAD) of air compressed air - 2	cfm	494
Power consumption of air compressor - 2	kW	107
Operating Specific energy consumption (SEC)	kW/cfm	0.22
Average Best SEC of similar rating air compressor (at 7bar pressure)	kW/cfm	0.18
Reduction in SEC by overhauling	kW/cfm	0.04
Energy Savings	kWh	18.08
Annual operating hours (360days X24 hours)	hours	8640
Annual Energy Savings	kWh	156211
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	13.03
Investment (for overhauling)	Rs. Lakh	1
Payback period	Years	0.1

Use low pressure air compressor for process air

Background :

Nitrogen plant & Instrument Air – 7.0bar, SEC 0.18kW/cfm

Process Air – less than 4 bar, SEC 0.14kW/cfm

Recommendation : Use separate air compressor for low pressure application & High pressure application

Description	Unit	Value
Estimated compressed air demand for process	cfm	200
Present SEC of air compressor	kW/cfm	0.18
SEC of low pressure air compressor	kW/cfm	0.15
Reduction in SEC by replacing with low pressure air compressor	kW/cfm	0.03
Energy Savings	kWh	6
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	51840
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	4.32
Investment for low pressure air compressor	Rs. Lakh	20
Payback period	Years	4.6

Plug compressed air leakages

Background :

During the study period it was observed that air leakages mainly found in hose pipe joints, air regulators and pipe joints. Hence it is to carryout compressed air leak test on every 4 months once

Recommendation : Plug compressed air leaks, Wherever possible use welding for plugging, as it is a good practice and should be preferred over threaded connection

HVAC

HVAC

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Replace existing primary and secondary pump with single optimum sized chilled water pump	0.83	6.92	2.4	0.3
2	Provide dedicated cooling water pump for Trane chiller	1.81	15.13	1.44	0.1
3	Replace primary chilled water pump of Diakin make chiller with optimum size pump	0.61	5.12	1.0	0.2
4	Replace secondary chilled water pump of Diakin make chiller	1.56	12.97	3.6	0.3
5	Improve Diakin chiller SEC by installing online condenser cleaning system	1.91	15.89	7.5	0.5
6	Install Variable Speed Drive for Cooling tower fans and operate with leaving water temperature	0.43	3.58	1.65	0.5
	Sub-Total	**7.15**	**59.61**	**17.59**	**0.30**

HVAC

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
MEDIUM TERM MEASURES					
7	Technology upgradation to Electronically Commutated (EC) fan motors for the AHUs	1.3	10.84	24.24	2.2
8	Avoid operation of chilled water transfer pump by shifting Diakin Chiller to second floor roof top	0.95	7.93	12	1.5
	Sub-Total	**7.15**	**59.61**	**17.59**	**0.30**
	Grand Total	**9.40**	**78.37**	**53.83**	**0.7**

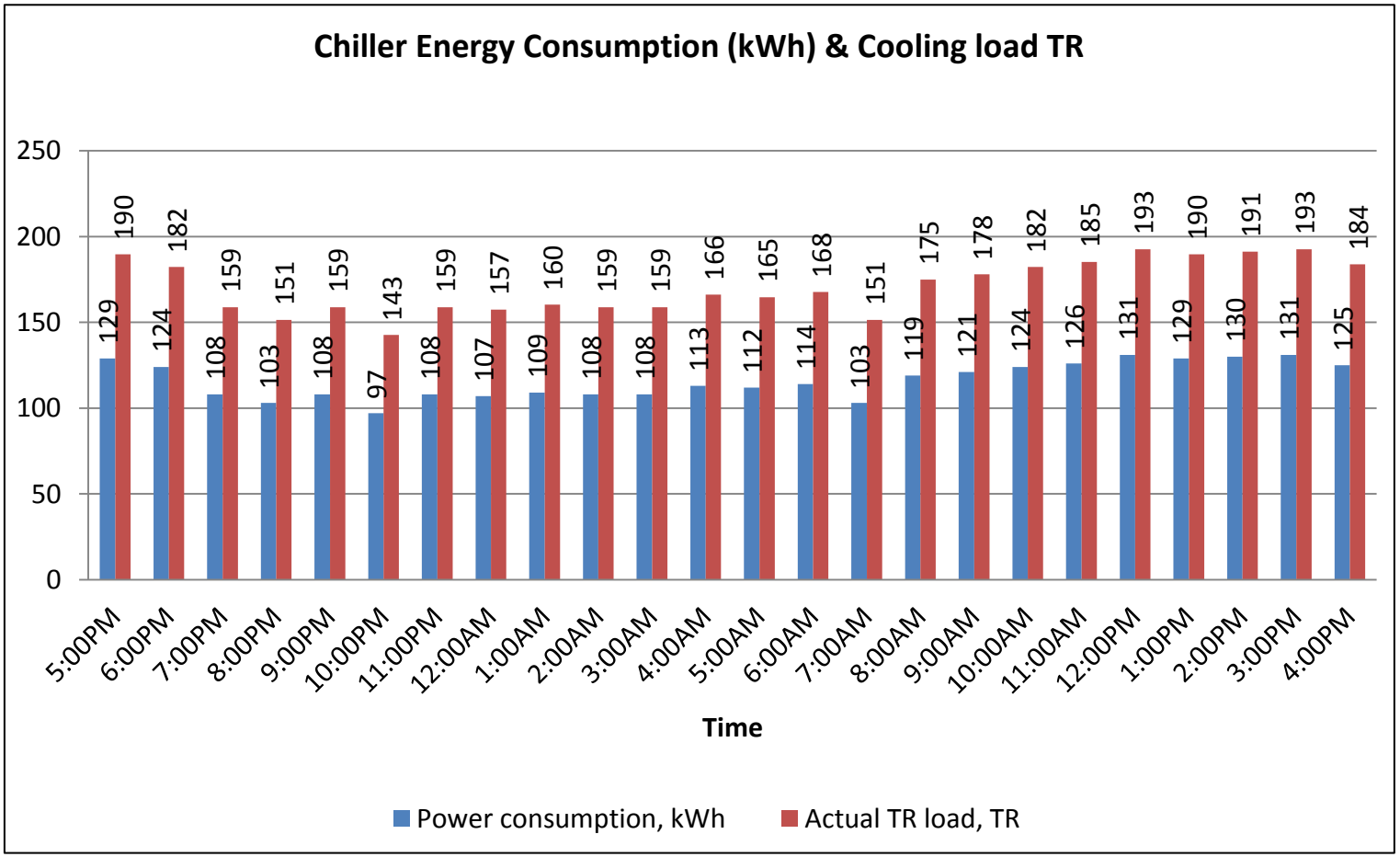
HVAC

Description	Unit	2nd floor			3rd floor
Make		Trane (307TR)	King Air – 1 (200TR)	King Air – 2 (200TR)	Daikin (202TR)
Type		Water cooled rotary screw compressors			
Refrigerant		R 134A			
Evaporator water flow		186	101	101	109
Entering water temperature (EWT)	^{0}C	11	11	11	12.2
Leaving water temperature (LWT)	^{0}C	6	5	5	6.6
Differential Temperature	^{0}C	5	6	6	5.6
Condenser water flow		214	121.2	121.2	136
Entering water temperature (EWT)	^{0}C	30	29.4	29.4	29.4
Leaving water temperature (LWT)	^{0}C	35	35	35	35
Differential Temperature	^{0}C	5	5.6	5.6	5.6
Cooling Capacity	TR	**307**	**200**	**200**	**202**
Power input to chiller compressor	kW	183.89	153	153	130.1
Specific Energy Consumption	kW/TR	**0.60**	**0.76**	**0.76**	**0.64**

Performance – Trane make Chiller

Particulars	Units	Design Parameters	Operating Parameters
Make			**TRANE**
Refrigerant		R134a	
Evaporator water flow	m^3/h	186	**145**
Entering water temperature (EWT)	^0C	11	11.6
Leaving water temperature (LWT)	^0C	6	7.6
Differential Temperature	^0C	5	4
Condenser water flow	m^3/h	214	234
Entering water temperature (EWT)	^0C	30	29.7
Leaving water temperature (LWT)	^0C	35	32.7
Differential Temperature	^0C	5	3
Cooling Capacity	TR	307	192
Power input to chiller compressor	kW	183.89	131
Specific Energy Consumption(only chiller compressor power)	**kW/TR**	**0.6**	**0.68**
Condenser water pump power	kW	NA	36
Condenser Fan Power	kW	NA	15.5
Chiller System Specific Energy Consumption (Includes chiller auxiliary equipment power)	kW/TR	NA	**0.95**

Energy and cooling load trend - Trane make chiller

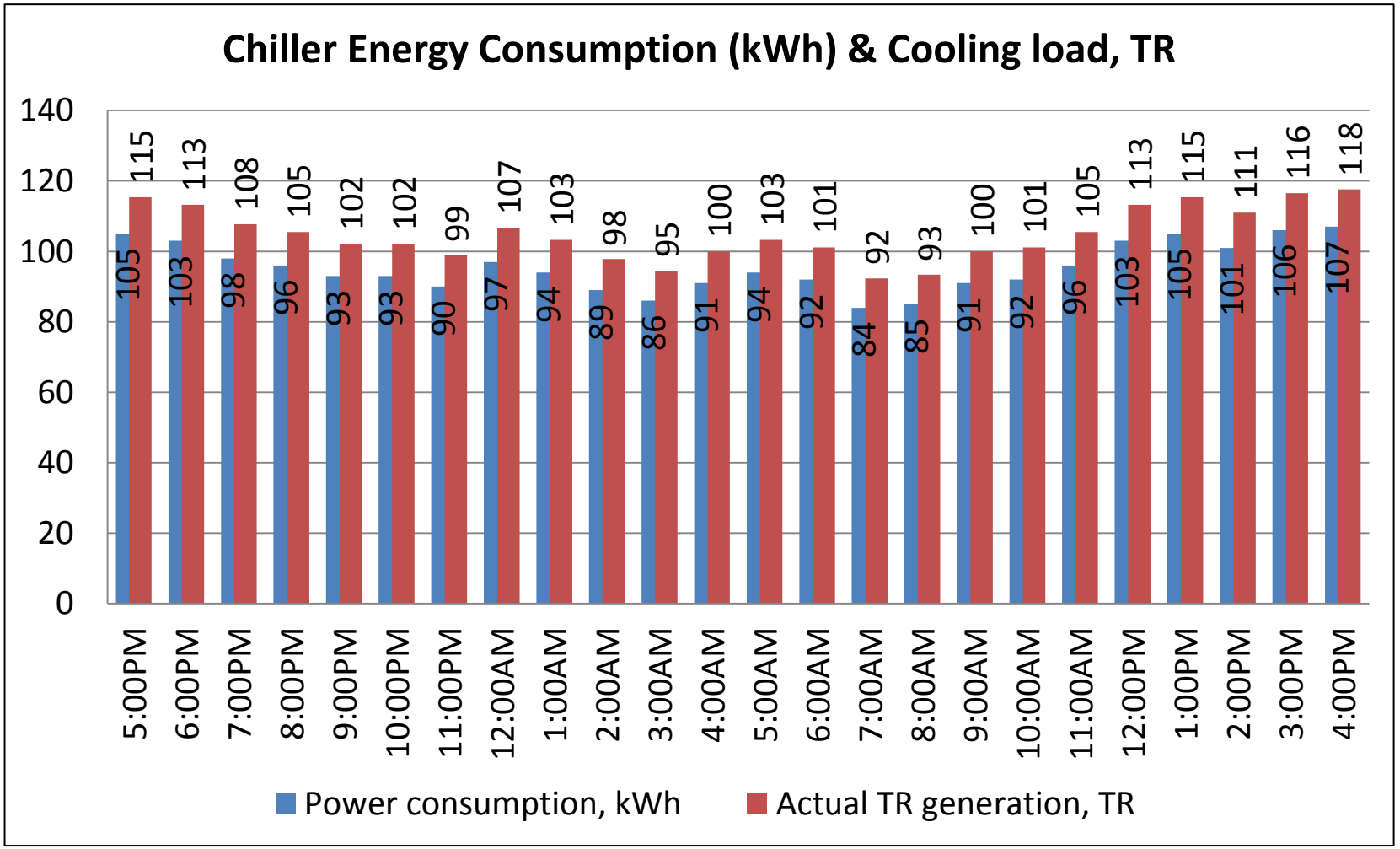


Performance – Daiken make Chiller

Particulars	Units	Design Parameters	Operating Parameters	
Make		**DAIKIN**		
Refrigerant		R134a		
Design Parameters			18th June	22nd June
Evaporator water flow	m^3/h	109	134	134
Entering water temperature (EWT)	^0C	12.2	9.05	9.3
Leaving water temperature (LWT)	^0C	6.6	6.58	6.5
Differential Temperature	^0C	5.6	2.47	2.8
Condenser water flow	m^3/h	136	103	120
Entering water temperature (EWT)	^0C	29.4	27.83	27.5
Leaving water temperature (LWT)	^0C	35	30.35	30.3
Differential Temperature	^0C	5.6	2.52	2.8
Cooling Capacity	TR	202	109	124
Power input to chiller compressor	kW	130.1	100	102
Specific Energy Consumption	**kW/TR**	**0.64**	**0.91**	**0.82**
Condenser water pump power	kW		16	18
Condenser Fan Power	kW		7.3	8.2
Chiller System Specific Energy Consumption (Includes chiller auxiliary equipment power)	kW/TR		1.13	1.03

Condenser approach – 5.6 ^0C & 4.3 ^0C

Energy and cooling load trend - Daiken make chiller



Performance – King Air make Chiller

Particulars	Units	Design Parameters	Operating Parameters
Make		**KING AIR**	
Refrigerant		R134a	
Design Parameters			
Evaporator water flow	m^3/h	101	102
Entering water temperature	^0C	11	9.2
Leaving water temperature (LWT)	^0C	5	6.1
Differential Temperature (EWT)	^0C	6	3.1
Condenser water flow	m^3/h	121.2	107
Entering water temperature (EWT)	^0C	29.4	29.3
Leaving water temperature (LWT)	^0C	35	33
Differential Temperature	^0C	5.6	3.7
Cooling Capacity	TR	200	105
Power input to chiller compressor	kW	153	132
Specific Energy Consumption	**kW/TR**	**0.76**	**1.26**

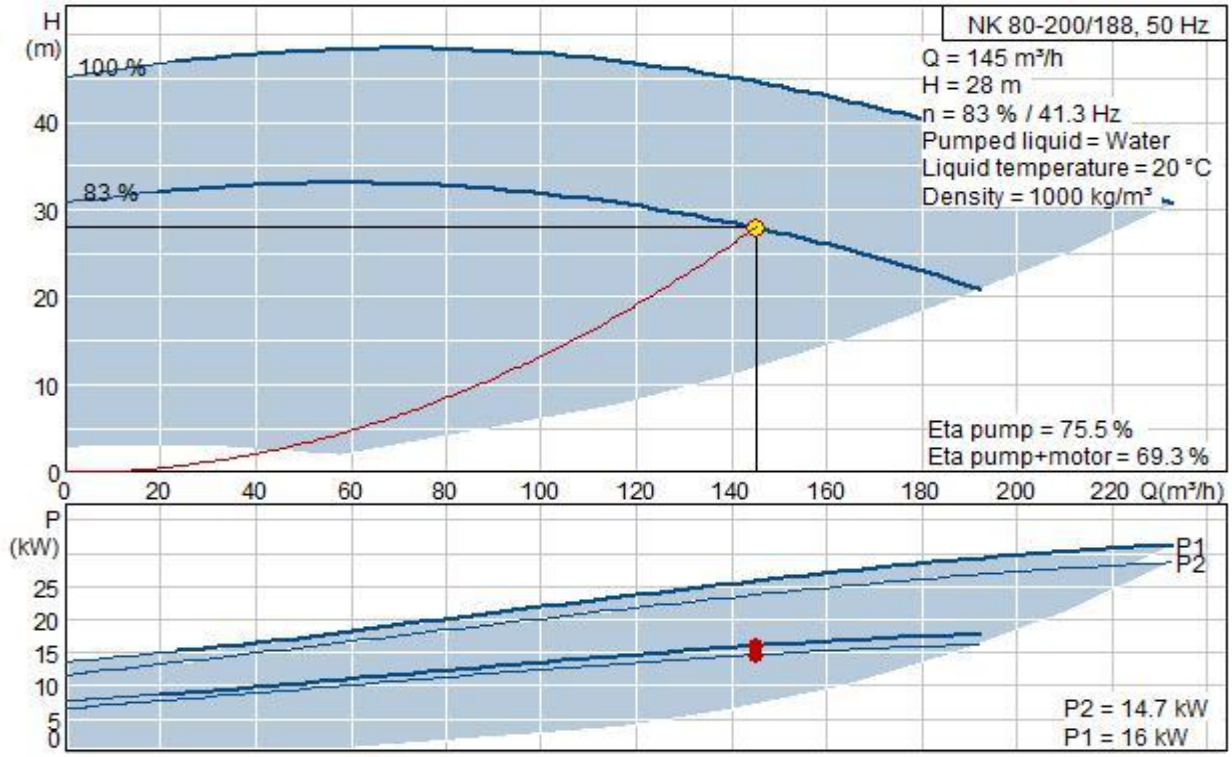
Condenser Approach temperature – more than 7.5^0C

Energy Conservation Measures - Chillers

1. Replace Trane make chiller, primary & secondary chilled water pumps with optimum size single pump

Background :Mismatch in chiller capacity Vs installed primary & secondary pumps .

Recommendation : Replace primary and secondary pumps with optimum size Pump



Energy Conservation Measures - Chillers

1. Replace Trane make chiller, primary & secondary chilled water pumps with optimum size single pump

Background :Mismatch in chiller capacity Vs installed primary & secondary pumps .

Recommendation : Replace primary and secondary pumps with optimum size Pump

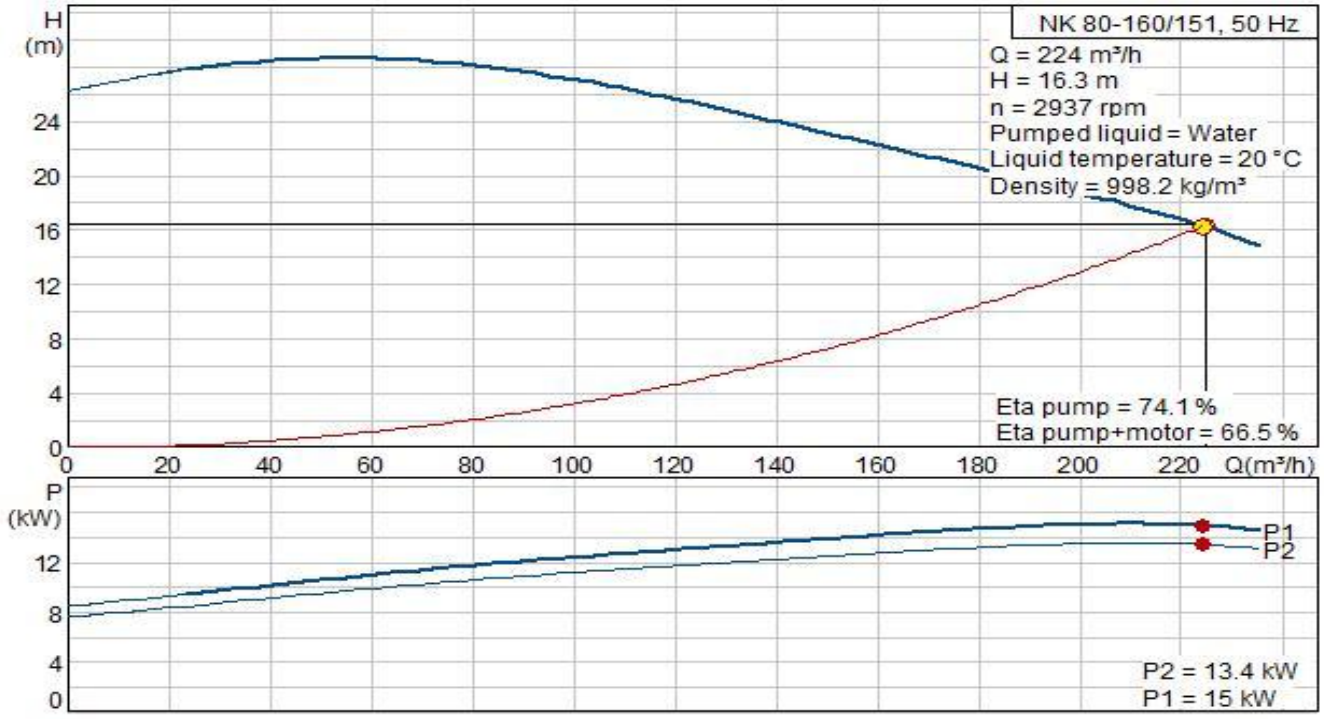
Description	Unit	Value
Power consumption of primary chilled water pump	kW	7.6
Power consumption of secondary chilled water pump	kW	18
Total power consumption towards chilled water pumps	kW	25.60
Power consumption of single proposed pump	kW	16
Energy Savings by new pump	kW	9.60
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	82944
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	6.92
Investment (for new pump)	Rs. Lakh	2.4
Payback period	Years	0.3

Energy Conservation Measures - Chillers

2. Provide dedicated cooling water pumps for Trane chiller condenser cooling

Background : Pump design head is high – 35 meters . Actual pump head required for Trane make chiller is 15meters. Forced to operate at 23 meters head to meet water demand for daiken and brain chiller

Recommendation : install new optimum size pump for Trane make chiller condenser cooling



Energy Conservation Measures - Chillers

2. Provide dedicated cooling water pumps for Trane chiller condenser cooling

Background : Pump design head is high – 35 meters . Actual pump head required for Trane make chiller is 15meters. Forced to operate at 23 meters head to meet water demand for daiken and brain chiller

Recommendation : install new optimum size pump for Trane make chiller condenser cooling

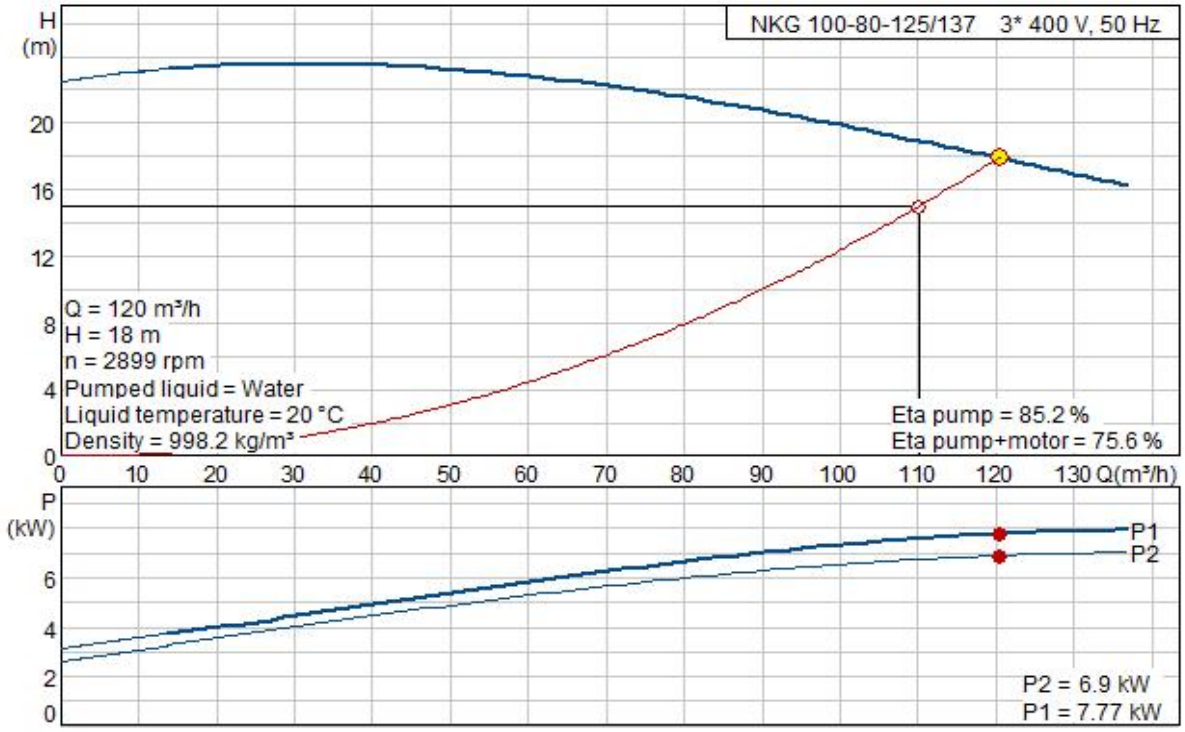
Description	Unit	Value
Power consumption of condenser cooling water pump	kW	36
New optimum size pump power	kW	15
Energy Savings by new pump	kW	21.00
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	181440
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	15.13
Investment (New condenser cooling water pump)	Rs. Lakh	1.44
Payback period	Years	0.1

Energy Conservation Measures - Chillers

3. Replace Daiken make chiller, primary chilled water pump with optimum size pump

Background : primary chilled water pump is operating at 42% efficiency. Less operating pump efficiency is mainly due to miss match in installed pump and chiller capacity.

Recommendation : Replace existing pump with new optimum size pump



Energy Conservation Measures - Chillers

3. Replace Daiken make chiller, primary chilled water pump with optimum size pump

Background : primary chilled water pump is operating at 42% efficiency. Less operating pump efficiency is mainly due to miss match in installed pump and chiller capacity.

Recommendation : Replace existing pump with new optimum size pump

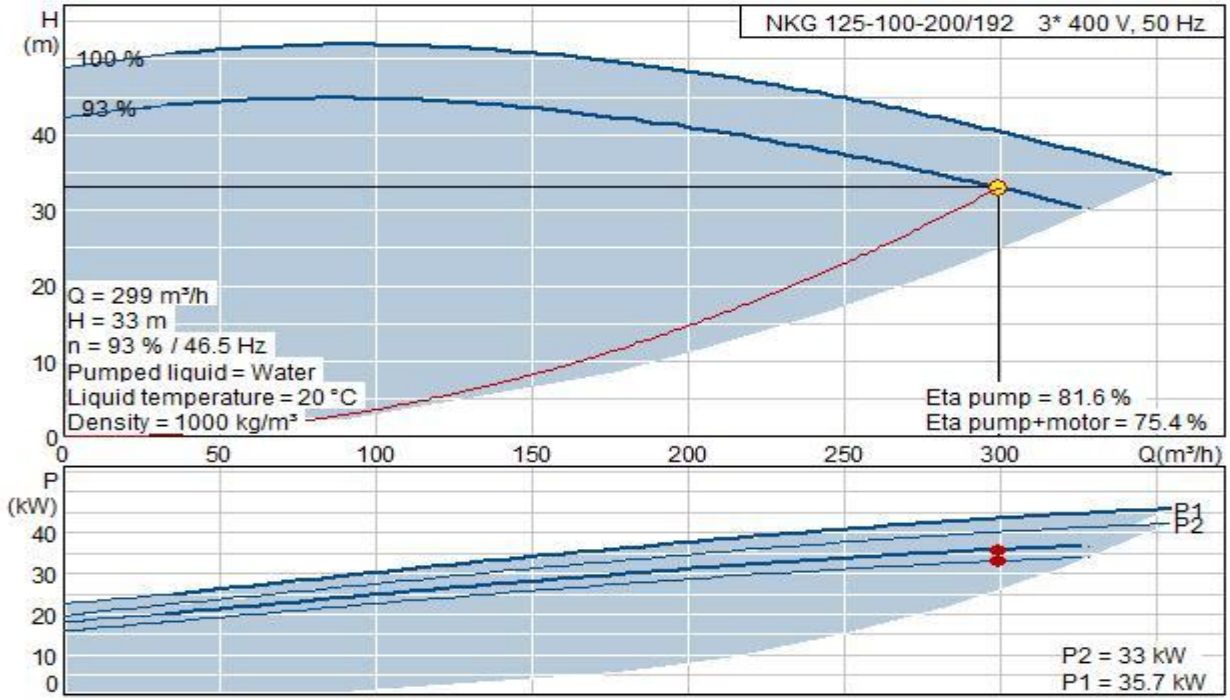
Description	Unit	Value
Power consumption of primary chilled water pump	kW	14.6
New optimum size pump power	kW	7.5
Energy Savings by new pump	kW	7.10
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	61344
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	5.12
Investment (New primary chilled water pump)	Rs. Lakh	1.00
Payback period	Years	0.2

Energy Conservation Measures - Chillers

4. Daiken make chiller, secondary hilled water pump with optimum size pump with VSD

Background : chilled water pump combined operating efficiency was 44%. Less operating pump efficiency is mainly due to high design Head pump (55meters) operating at 32 meters with VSD.

Recommendation : Replace existing pumps with new optimum size pump with VSD



Energy Conservation Measures - Chillers

4. Replace Daiken make chiller, secondary hilled water pump with optimum size pump with VSD

Background : chilled water pump combined operating efficiency was 44%. Less operating pump efficiency is mainly due to high design Head pump (55meters) operating at 32 meters with VSD.

Recommendation : Replace existing pumps with new optimum size pump with VSD

Description	Unit	Value
Power consumption of Secondary chilled water pump (2nos)	kW	54
New optimum size single pump power (With VSD)	kW	36
Energy Savings by new pump	kW	18.00
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	155520
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	12.97
Investment (New secondary chilled water pump)	Rs. Lakh	3.6
Payback period	Years	0.3

Energy Conservation Measures - Chillers

5. Provide online condenser cleaning system for Daiken make chiller to improve specific energy consumption

Background : Specific Energy Consumption is 0.91kW/cfm – Very High due to increase in condenser approach temperature. Condenser approach temperatures should be less than 3.0^0C. Higher condenser approach temperature indicates the fouled condenser tubes, which reduces the chiller efficiency

Recommendation : Provide online condenser cleaning system

Description	Unit	Value
Actual TR generation of Daiken chiller	TR	105
SEC of Daiken chiller compressor	kW /TR	0.91
Average best SEC of Chiller	kW/TR	0.70
Reduction in operating SEC	kW/TR	0.21
Energy Savings by overhauling and installing online condenser cleaning system	kW	22
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	190512
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	15.89
Investment (New condenser cooling water pump)	Rs. Lakh	7.5
Payback period	Years	0.5

Energy Conservation Measures - Chillers

5. Provide VSD for main cooling tower fans and operate with fans drive with cooling tower leaving water temperature

Background : Cooling tower fans are operated at full speed irrespective of climatic condition (ambient temperature) and cooling tower leaving water temperature
Recommendation : Provide VSD for CT fan drives and operate with CT leaving water temperature feedback

Description	Unit	Value
Power consumption of cooling tower fans (3 nos.)	kW	29.3
Calculated CT fan power by operating 6% less speed / Operating with LWT feedback control	kW	24
Energy saving by 6% less speed	kW	4.96
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	42888
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	3.58
Investment (VSD)	Rs. Lakh	1.65
Payback period	Years	0.5

Energy Conservation Measures - Chillers

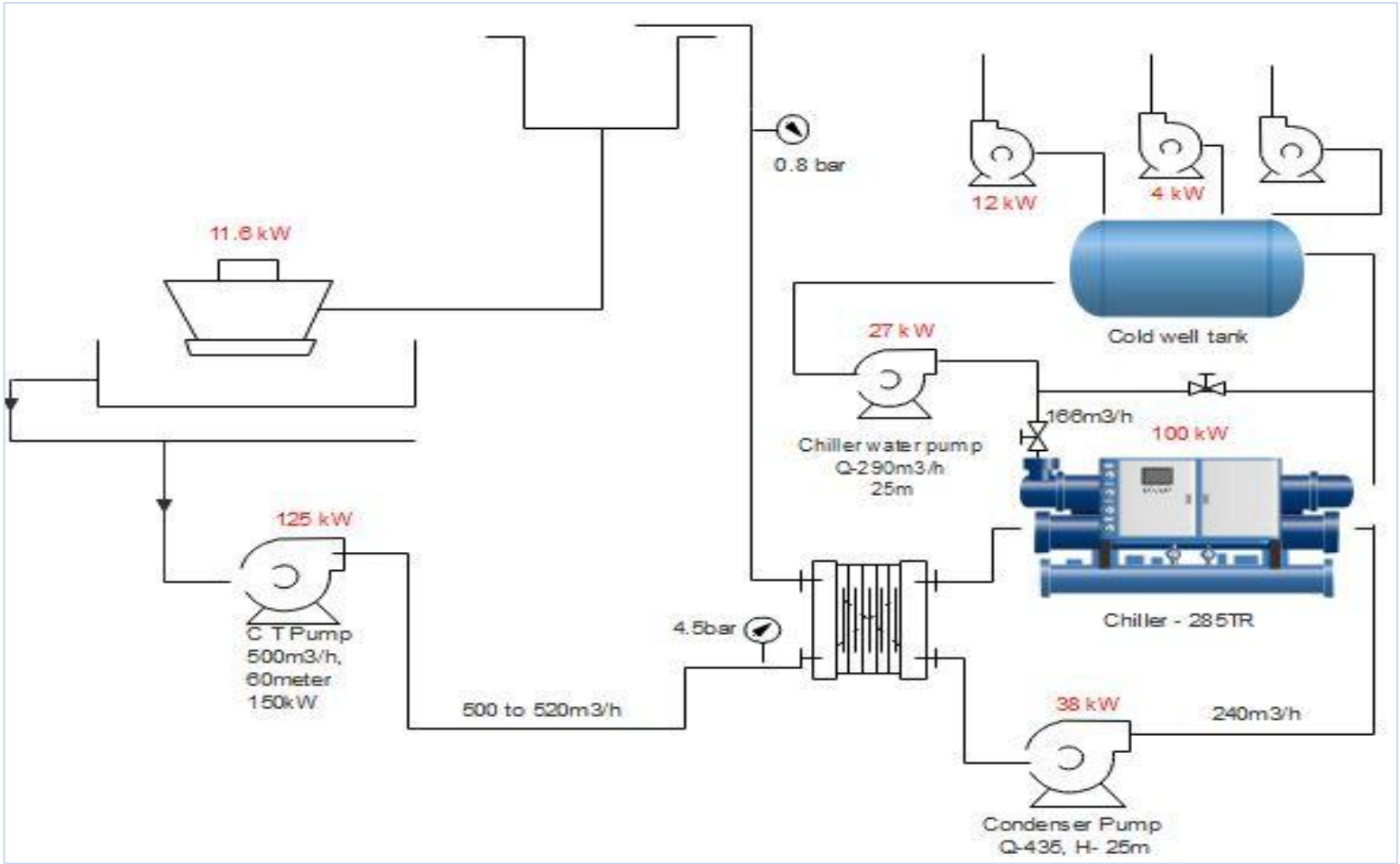
6. Avoid operation of transfer pump by shifting Daiken chiller to 2nd floor roof top

Background : Daiken chiller is installed in 3rd floor and part of secondary pump return chilled water comes to 2nd floor hot well tank and pumped back to 3rd floor hot well tank with transfer pump

cooling tower was installed at 2nd floor and chiller was installed at 3rd floor. This elevation difference forces the cooling water pumps to operate at 23 meters head

Description	Unit	Value
Energy consumption of transfer pump	kW	6
Present power consumption of cooling water pump	kW	18
Cooling water pump energy reduction by shifting chiller (new cooling water pump)	kW	11.00
Total energy savings	kW	13.00
Annual operating hours (360daysX24)	hours	8640
Annual Energy Savings	kWh	95040
Annual cost savings (Rs.8.34/kWh)	Rs. Lakhs	7.93
Investment (New condenser cooling water pump)	Rs. Lakh	12
Payback period	Years	1.5

Water cooled Chiller Compressor – 285TR with VSD



Chiller insulation suggessions

7. Technology up gradation to Electronically Commutated (EC) fan motors for the AHUs

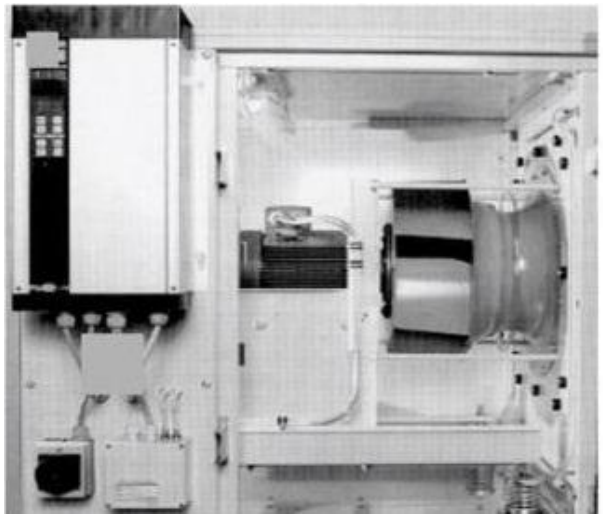
Background

- Plugged/pulley type driven fan motors at present with VFD.
- Frequencies set either auto or manual mode operation
- Based on user side pressure requirements

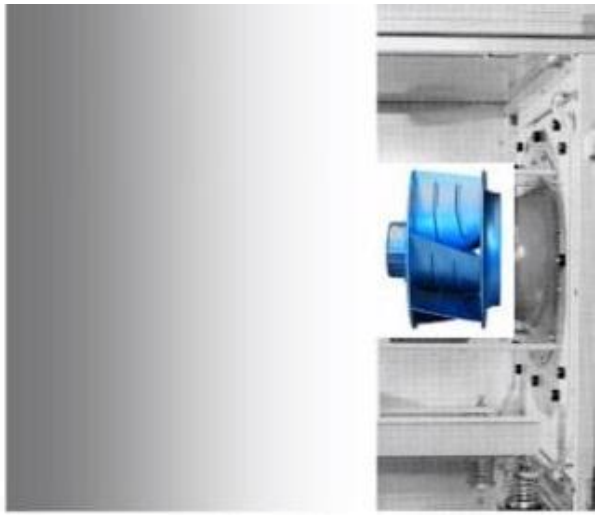
Recommendation

- Convert to direct coupled DC based brushless EC motor driven fans.
- Improved performance, higher efficiency, compact and reliable.

7. Technology up gradation to Electronically Commutated (EC) fan motors for the AHUs



Conventional motor-fan with VFD



EC motors

7. Technology up gradation to Electronically Commutated (EC) fan motors for the AHUs

Energy savings

Particulars	Units	Value
Present total power consumption of the AHUs	kW	77.27
Estimated power savings on technology up gradation	kW	15.454
Annual operating hours (24 hours x 350 days)	hours	8400
Annual energy savings	lakh kWh	1.30
Annual cost savings (Rs. 8.34/kWh)	Rs. Lakh	10.83
Total installed motor capacity	kW	110.2
Investment	Rs. Lakh	24.24
Payback period	Years	2.24

- 40% of actual verified savings with this technology up gradation.
- Only 20% considered as power consumption with VSD being considered as base case scenario.
- Data considered for evaluation are discussed detailed in the report.

8. Rectification of BMS control logics for AHUs and use of separate dehumidification system in the long run

Background

RH	T	CHW CV % open	HW CV % open
Constant	Increases	Increase	Close
Constant	Decrease	Decrease	Close
Increase	Constant	Increase	Increase
Decrease	Constant	Decrease	Decrease
Increase	Decrease	Decrease to min position 40%. Beyond control done by HV increase open	

- CHW and HW CV expected to operate on the above logic and maintain ~22^{0}C and < 65% RH at user end.
- But deviations observed.

8. Rectification of BMS control logics for AHUs and use of separate dehumidification system in the long run

Background

AHU no.	Return air		Set Return air parameters		Supply Air		Chilled water valve	Hot water valve
	RH, %	T, ^{0}C	RH, %	T, ^{0}C	RH, %	T, ^{0}C	% open	% open
1		23.5					100	NA
2	70.7	23.2	50	22			100	50
3	68.4	23.2	70	22			100	0
11	39.8	19	40	20			100	40
13	64.6	23	70	21			100	0
13 Trial 1	61.5	21.5	50	15			100	65
13 Trial 2	61.5	21.5	50	20			100	65
14 day 1	57.3	27.1	45	22			100	65
14 day 2	68.4	21.3	45	20			40	0
12		NA	50	21		21.4	100	
7	56.1	22.6	45	20		17.4	100	65
8	45.5	22.7	50	18		19.1	100	65
9	49.4	21.7	50	20		18.3	100	0
10	34.4	23.6	45	20			100	0
16	51.6	23.1	35	20			100	64.1

– Present system restricts optimal and efficient operations of the AHU system

8. Rectification of BMS control logics for AHUs and use of separate dehumidification system in the long run

Background

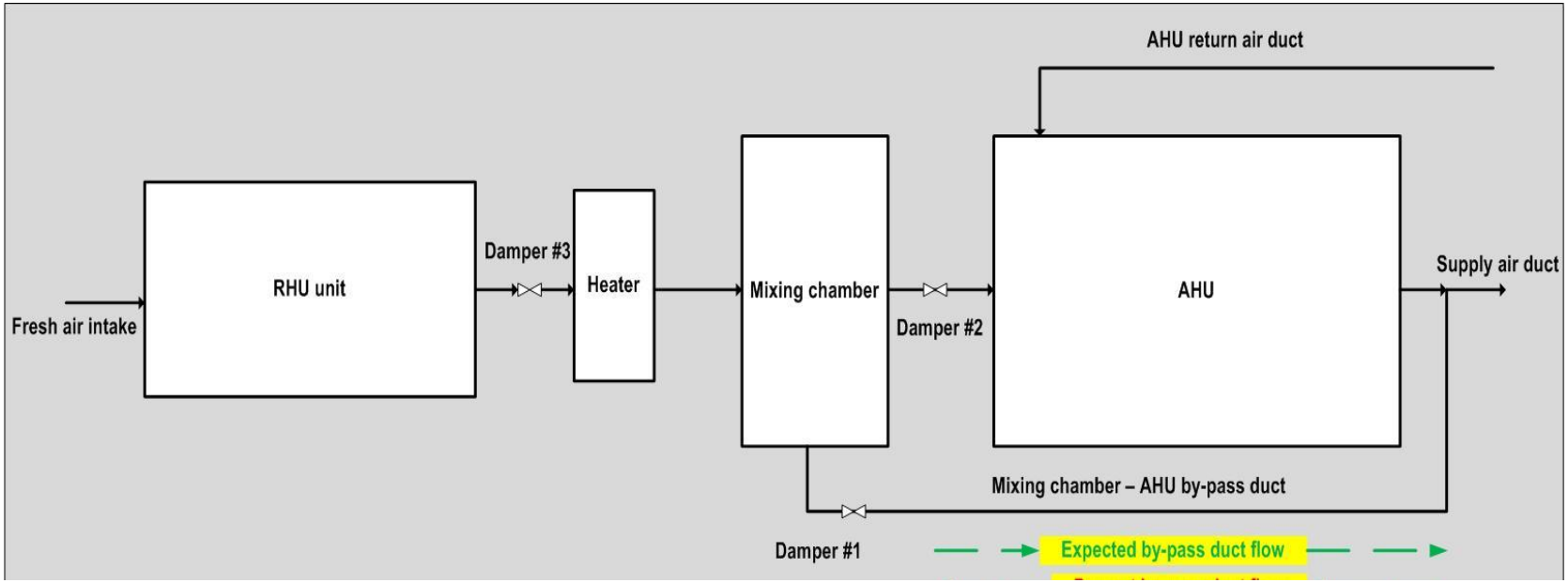
- RH is at times uncontrollable and is learnt to be suddenly rising
- Extreme set points as precautionary measure
- Reasons include cleaning schedules of reactor areas & moisture addition from VAU and fresh air to the user area.

Recommendation

- Standard communication between the floor personnel in the reactor area and the BMS personnel during such cleaning or other activities pertaining to sudden rise in RH levels shall be established.
- Long term plan to phase out integrated dehumidifiers and go for a separated dehumidifier units for better control over the air quality and causes relatively less hindrance to the AHU performances.

8. Rectification of BMS control logics for AHUs and use of separate dehumidification system in the long run

Recommendation



8. Rectification of BMS control logics for AHUs and use of separate dehumidification system in the long run

Energy Savings

- As it is a dynamic system, quantification of energy savings on such measures may not be possible. However effective operations shall lead to
  - Reduction in hot water and steam demand
  - Reduction in hot water and chilled water pumping power.
  - Reduction in cooling load demand at the chiller end

Fans, Blowers and Vacuum pumps

Fans, Blowers & Vacuum pumps

S.No	Energy Conservation Measures	Annual Energy Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		Electricity, Lakh kWh	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Avoid idle running of VP 16, 17	0.10	0.84	Minimal	Immediate
	Avoid unwanted openings of scrubber hoses at process areas	0.01	0.09	Nil	Immediate
	Sub-Total	**0.11**	**0.93**	**0**	**Immediate**
LONG TERM MEASURES					
2	Technology upgradation to Electronically Commutated (EC) fan motors for EAUs and VAUs	1.2	10.01	35.09	3.5
	Sub-Total	1.2	10.01	35.09	3.5
	Total	**1.31**	**10.94**	**35.09**	**3.2**

Vacuum pumps

1. Avoid idle running of VP 16, 17

Background

- Catering to Nutch Filteration area.
- Filteration process not in operation during study period but associated VP running.

Recommendation

- Interlocking with buffer timer control

Energy Savings

Parameters	Unit	Value
Vacuum pump power consumption during idle running	kW	7.5
Considered non-operating hours per week (3 days x 8 hours)	hours per week	24
Annual non-operating hours	hours	1344
Total energy savings	kWh	10080
Annual cost savings (@Rs. 8.34 /kWh)	Rs. Lakhs	0.84
Investment cost	Rs. Lakhs	Minimal
Payback	years	Immediate

- Above value indicative
- The idle operation was observed for three consecutive days during the study period

Blowers and Fans

2. Avoid unwanted openings of scrubber hoses at process areas

Background

- Reasons for openings
  - To prevent risk of harmful gases accumulating in the region
  - To enable continuous exhaust of harmful gases during the process operations.
  - Forgot to close when not in need

Recommendation

  - Hose points were not connected to the reactors nor placed near by.
  - Methanol and other harmful gases lighter than air. Place the points appropriately such that
    - Efficiently and quickly remove these gases from the working environment.
    - Prevent Loss of power by the scrubbers due to unwanted flow
    - Prevent Loss of cold conditioned air to the atmosphere

Blowers and Fans

2. Avoid unwanted openings of scrubber hoses at process areas

Energy Savings

Particulars	Units	Values
No. of scrubber hose points open	no's	3
flow	m3/h	152.68
Power loss for the said flow on blower side	kW	0.25
Cooling load loss	TR	0.18
Equivalent power loss	kW	0.13
Total power loss	**kW**	**0.38**
Operating hours (12 hours x 250 days)	hours	3000.000
Annual Energy loss	kWh	1124.672
Annual cost savings	Rs.	9379.762
Investment	Rs.	Nil
Payback period	years	Immediate

- Above value indicative with 3 sample points. The number of openings and duration may vary time to time.
- Indoor air quality shall not be compromised.

Blowers and Fans

3. Technology up gradation to Electronically Commutated (EC) fan motors for the EAUs and VAUs

Background

- Plugged/pulley type driven fan motors at present with VFD.
- Frequencies set either auto or manual mode operation
- Based on user side pressure requirements

Recommendation

- Convert to direct coupled DC based brushless EC motor driven fans.
- Improved performance, higher efficiency, compact and reliable.

Blowers and Fans

3. Technology up gradation to Electronically Commutated (EC) fan motors for the EAUs abd VAUs

Energy savings

Particulars	Units	Value
Present total power consumption of the AHUs	kW	71.62
Estimated power savings on technology up gradation	kW	14.32
Annual operating hours (24 hours x 350 days)	hours	8400
Annual energy savings	lakh kWh	1.20
Annual cost savings (Rs. 8.34/kWh)	Rs. Lakh	10.01
Total installed motor capacity	kW	159.5
Investment	Rs. Lakh	35.09
Payback period	Years	3.5

- 40% of actual verified savings with this technology up gradation.
- Only 20% considered as power consumption with VSD being considered as base case scenario.
- Data considered for evaluation are discussed detailed in the report.

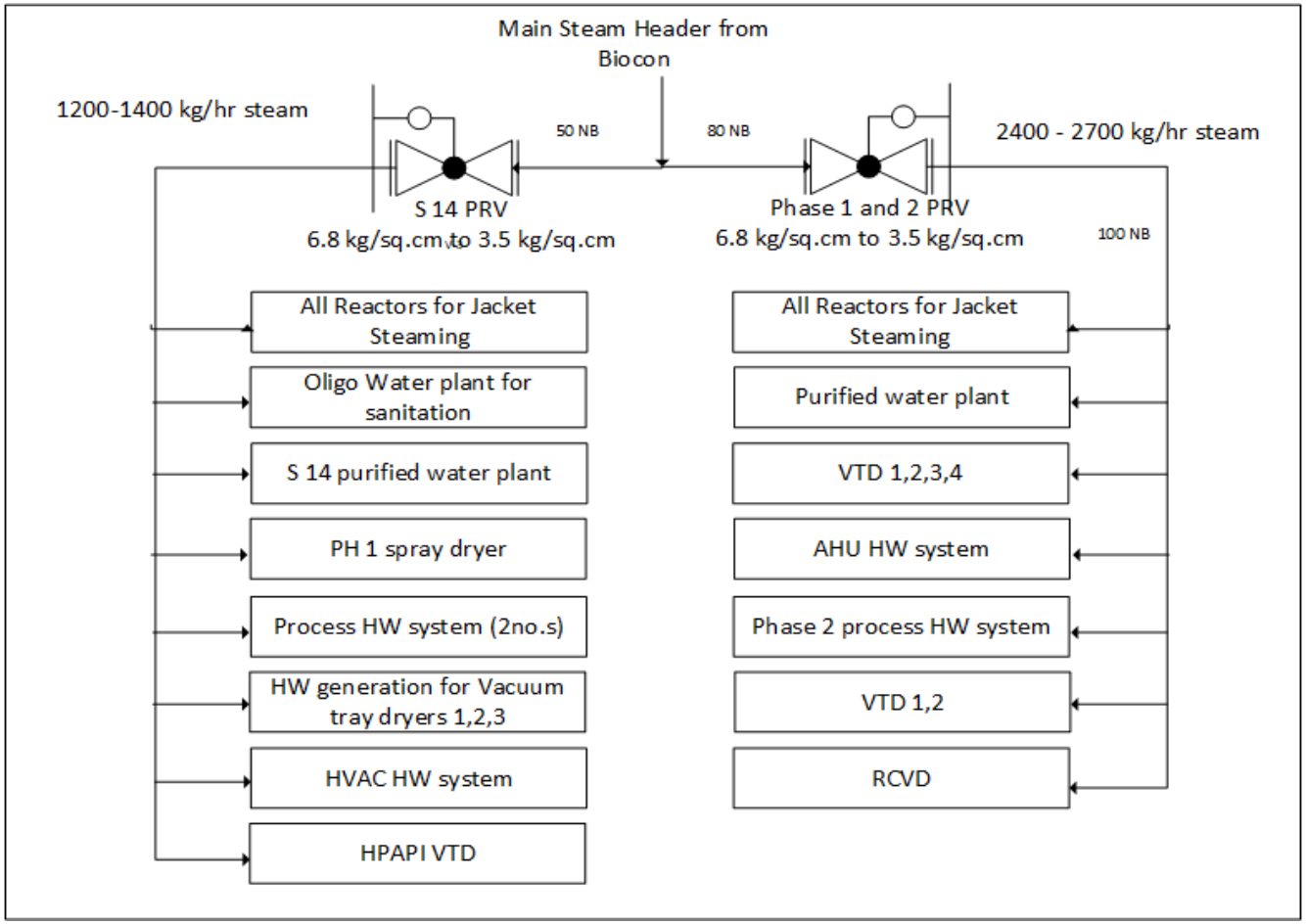
Steam System

Steam systems

S.No	Energy Conservation Measures	Annual Steam Savings Potential	Annual energy cost Savings,	Investment, Cost	Simple payback period
		kg	Value, Rs Lakh	Rs Lakh	Years
SHORT TERM MEASURES					
1	Exploring options of direct injection of steam to the hot water generation tanks	1825	0.07	Minimal	Immediate
	Following optimal set points for hot water generator operations	3643.2	0.14	Nil	Immediate
	Sub-Total	**5468.20**	**0.21**	**0**	**0.0**
	Total	**5468.20**	**0.21**	**0**	**0.0**

Steam system

Steam Distribution



Steam system

Hot Water consumption

Make up water for Hot water	Units	S14	Phase 1	Phase 2
Daily max	kL	12.5	1.6	6.4
daily average	kL	0.7	0.2	1
Monthly total	kL	21	7.2	28.6

Steam consumption

Steam consumption	Units	S14	Phase 1	Phase 2
Daily max	kg	3600	8917	
daily average	kg	2263.9	8073.9	
Monthly total	kg	70181	250265	

1. Exploring options of direct injection of steam to the hot water generation tanks

Background

- Indirect heating using steam via plate heat exchanger at present
- CV with tank temperature feedback for HW.
- Condensate collected sent back to central utility.

Recommendation

- Opt for direct injection
- Heat content of the condensate return is not wasted and completely utilized.
- Reduction in equivalent steam consumption.
- Reduction in make-up water consumption as the steam condensate is of high quality standards.

Steam system

1. Exploring options of direct injection of steam to the hot water generation tanks

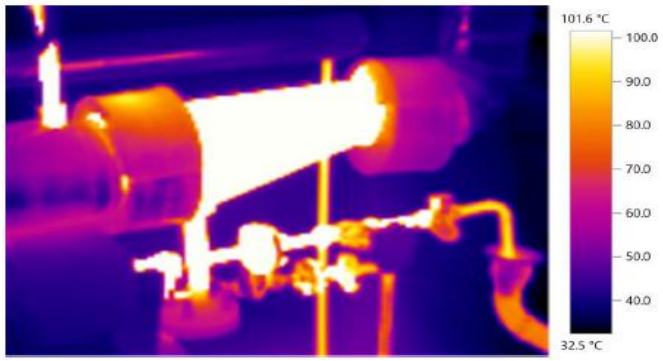
Energy savings

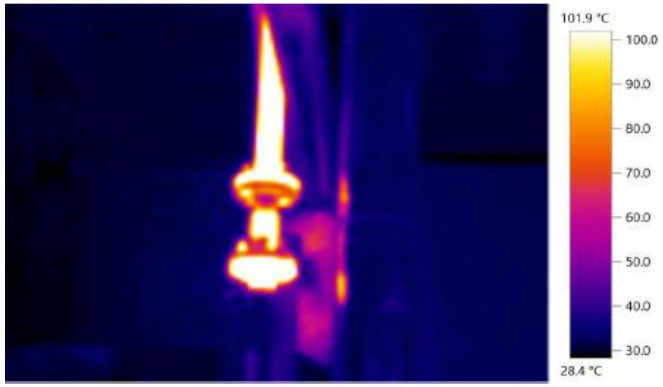
Particulars	Units	Value
Make up water temperature considered	deg. C	25.00
Generated hot water temperature	deg. C	30.00
Daily average make up water to be heated	kL/day	1.90
Operating hours (24 hours x 330 days)	hours	7920.00
Energy loss through saturated condensate rejection	kcal	939641.80
Equivalent Annual steam savings	kg	1825.51
Annual cost reduction on steam (Rs. 3.85/kg steam)	Rs. Lakh	0.07
Annual cost reduction on make-up water (Rs. 90/kL)	Rs. Lakh	0.01
Total cost reduction	Rs. Lakh	0.08
Investment cost	Rs. Lakh	Minimal
Payback period	years	immediate

- Water treatment costs have not been included.
- The heat pump option for the said quantities was not feasible

2. Rectifying insulation of steam and hot water lines

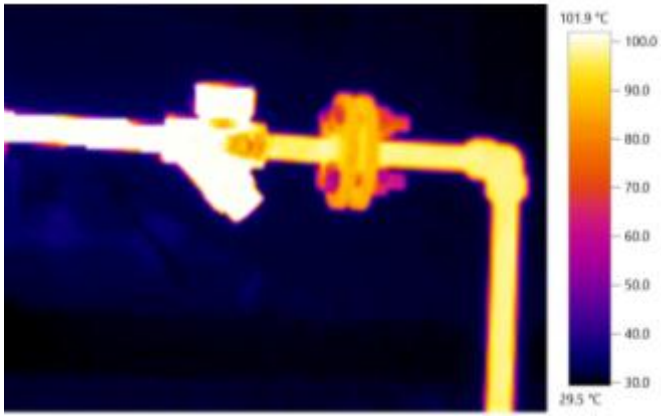
Background





2. Rectifying insulation of steam and hot water lines

Background



3. Following optimal set points for hot water generator operations

Background

- Deviations from the logic for the control valves to operate in maintaining the hot water temperatures

Parameter	Unit	Values				
Ambient RH	%	40-49	49-59	79-89	59-69	69-79
Ambient T	^{0}C	20-30	20-30	15-25	15-30	15-30
Set HW T	^{0}C	26	27	31	29	29

- Example
  - Ambient RH: 51.8%, T: 29^{0}C => Expected HW set temperature T: 27^{0}C
  - But actual set T : 30^{0}C
- Leads to increase in steam consumption
- Practice followed as preventive measure to tackle sudden indoor T, RH changes.

3. Following optimal set points for hot water generator operations

Recommendation

- Avoid unwanted additional heating of hot water.

Energy Savings

Particulars	Units	Value
Equivalent incremental heat energy required	kcal/hour	237.5
Equivalent steam required	kg/h	0.46
	Kg/year	3643.2
Hourly cost reduction on steam (Rs. 3.85/kg steam)	Rs./hour	1.78
Annual cost reduction	Rs. Lakh	0.14
Investment	Rs. Lakh	Nil
Payback period	years	immediate

- Above values are indicative as the set temperatures may always not be maintained at 30^0C




Thank You