Energy Audit Report

Client: Rubber based medical accessories manufacturing company

Energy Audit Conducted by

SAS Powertech P Ltd.

Pune

Audit Period: MAY 2018

Major observation Reg Energy Scene at XXX

From Energy infrastructure point of view,

XXX Pune is a well designed, Well erected and well maintained Plant. Sufficient care has been taken to optimize energy consumption.

Now the plant is more than 5 years OLD. This is the time when

- Routine maintenance
- SOPs for operating the equipment efficiently
- Monitoring product wise specific energy consumption with at most accuracy
- Continual benchmark comparison

will help XXX to offer consistent energy performance.

Processes and products

XXX manufactures various plastic based consumables used in hospitals for medical treatment..

The processes involved are

- Plastic injection molding.
- Steel needle manufacturing.
- Assembly of disposable syringes.
- Cannula, AVF, IV Port, Blood tubing Manufacturing.
- Dialyzer manufacturing.

Utilities

The plant activity being manufacturing of medical consumables, entire manufacturing activity happens in clean and humidity controlled air conditioned environment.

Main utilities are

- ✓ Boilers (HSD / Biodiesel operated) for steam generation
- ✓ Compressors to generate compressed air.
- ✓ Chillers for generating chilled water for air conditioning and cooling in injection molding machine.
- ✓ Cooling towers for chillers and compressors.

AVG monthly quantities Manufactured

Details of monthly production figures Removed from this presentation

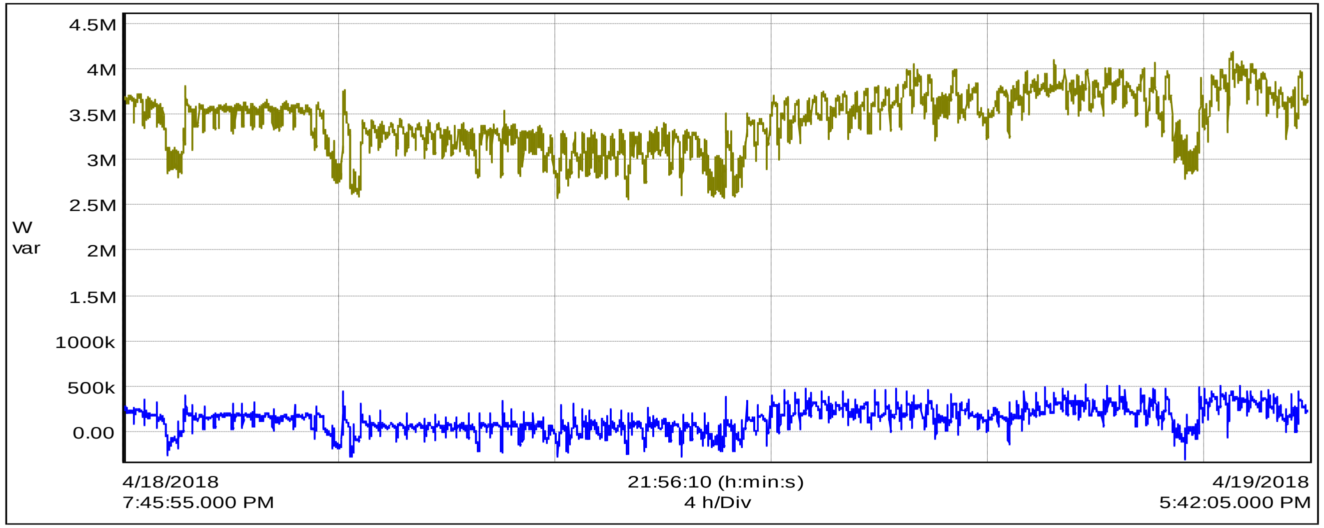
Energy forms used and consumption.

Monthly Energy Consumption

Electricity - 64%, Thermal – 36%

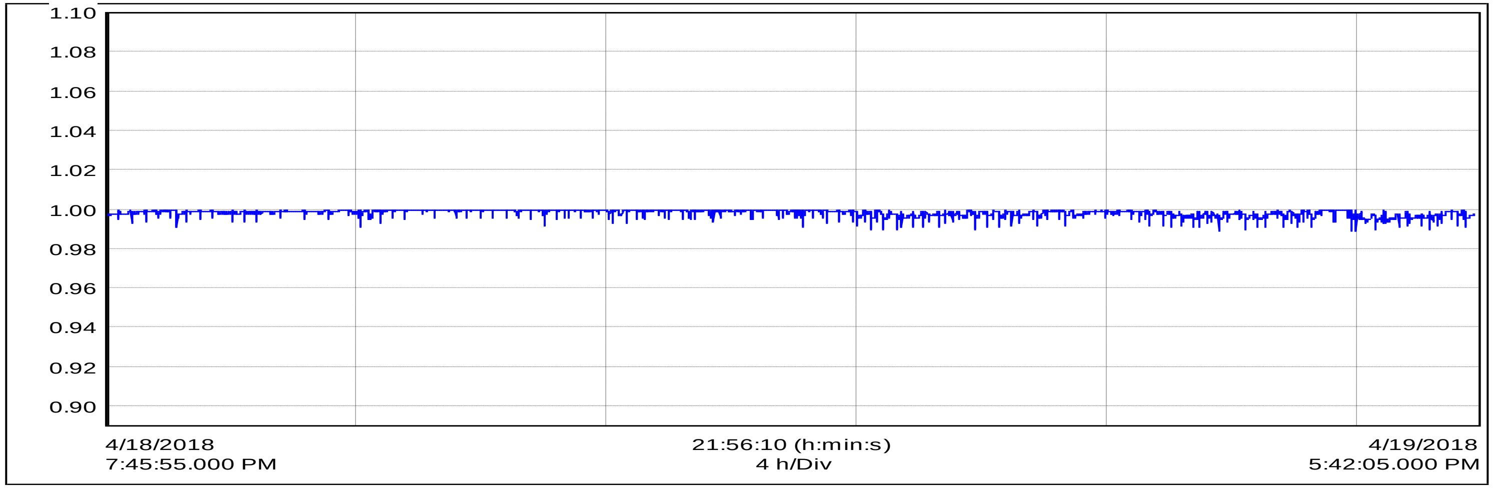
Form of energy	Qty	Cost Rs
Electricity Kwh	2200000	17600000
HSD / Biodiesel Ltrs	150000	9750000

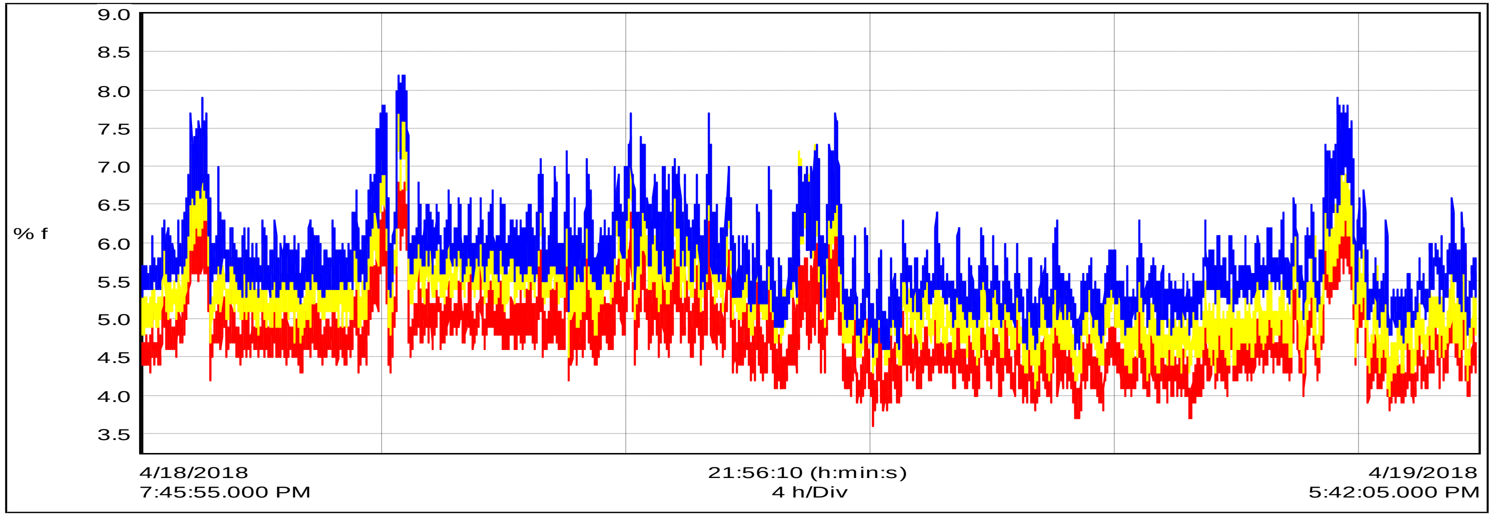
Electricity consumption pattern over 24 Hours



Daily PF / Harmonics trend at 11KV Level

PF and harmonics trend at 11KV Level – Typical day 24 hours





Electrical Infrastructure

Electrical System at XXX

- Electricity is received at 132 KV.
- 132 KV is stepped down to 11KV using a 12MVA transformer.
- XXX does not have any HT loads at present.
- 11KV is then stepped down to LT 433V through 12 transformers installed in plant.
- Plant has DG sets which are connected at 11KV level.
- Present peak plant load is 4.2MW.
- Lot of expansion work is in progress.

Transformer Loading and vital Power quality Parameters.

Electrical Loading and PQ

TR	KV Ratio	kVA	Load	Max Amps	AVG KW	THDI%	PF
TR 132	132/11	12500			4000	7%	1
Tr11	11/433	1000		310	160	38%	1
Tr12	11/433	2000					
Tr13	11/433	1000		263	230	39%	0.97
TR 21	11/433	630		372	140	50%	1
TR22	11/433	400		180	85	28%	1
TR31	11/433	1250		450	250	27%	0.98
TR32	11/433	1250		625	430	2.70%	1
TR33	433/210	300					
TR41	11/433	1000		300	170	28%	0.97
TR42	11/433	1500		700	400	10%	0.95
TR43	433/210	300					
TR51	11/433	2000	Chiller	350	240	6%	1
TR52	11/433	2000	Chiller	650	400	3.50%	1
TR53	11/433	2000	Compressor	1800	1000	3.50%	0.98
TR SS	11/433	200					
					3505		
Data blank - Not recorded.							
Voltage distortion observed at all transformer secondaries is <3%							

Transformer Loading and vital Power quality Parameters contd..

Electrical Loading and PQ - Comments

Observations and comments.

a. Tr 32, Tr 42, Tr 52 and Tr 53 form more than 50% Load.
b. Tr 11, Tr 13, Tr 21, Tr31, Tr 41 handle more harmonic currents. Total load on these transformers is around 950KW.
c. Transformer loading being less, above current harmonics do not produce objectionable voltage harmonics.
d. Billing power factor must be almost unity.
e. All reactive power control panels are of “Detuned type” and are **contactor based.** The loads (Except utility loads) are of fluctuating type, so it is advised that these panels may be retrofitted with thyristor switching so that dynamic power factor will be maintained at unity for each transformer. This may be done for transformers in b above initially. Each of these transformers may be provided with 100A active harmonic filter.
f. Modifications as in e above will reduce harmonic currents handled by these transformers and improve and maintain good power quality. Reduction in transformer losses will not be measurable and visual payback establishment will be difficult.
g. As per information shared Proposed major new load will be HT compressors. This will need major change in reactive power compensation as the same will have to provided on HT side.

Boiler Performance assessment

Boiler performance

Boiler	Fuel	Efficiency		Excess Air		Combustion efficiency	
		Direct	Indirect	Observed	Ideal	Observed	Ideal
A and D	Biodiesel	75.70%	86.64%	22 to 34%	10 to 20%	84 to 87%	90 to 93%
B and C	Biodiesel	78.32%	85.83%	15 to 56%	10 to 20%	85 to 88%	90 to 93%
A and D	HSD	82.24%	85%	20 to 38%	10 to 20%	85 to 89%	90 to 93%
B and C	HSD	78.53%	85.38%	17 to 66%	10 to 20%	85 to 88%	90 to 93%

Actual S/F ratio			
Biodiesel boiler A & D	Biodiesel boiler B & C	HSD boiler A & D	HSD boiler B & C
13.06	**13.51**	**14.54**	**13.87**

There are no direct steam purging applications and special efforts are taken to recover condensate. The recovery is above 80%.

By frequent fine tuning of burners, controlling excess air and proper preventive maintenance as a very conservative estimate it is possible to save around Rs.10 Lacs per year. (Detail calculations and measurements are available in separate excel sheets. We will submit them in report)

Sample boiler assessment

Biodiesel Boilers A and D		
Sr.No	**Description**	**Steam Generator (Boiler)**
	Boiler A	**Master (Two nozzles on)**
	Boiler D	**Backup (One nozzle on)**
1	Make	M/S Thermax Ltd, Pune, India.
2	Model	SM-20 DL / 10.54 / 41-44
3	Type	Shellmax,3 pass,wet back,fire tube.
4	Capacity, kg/hr	2000
5	Connected load, kW	26.5
6	Year of Mfg.	2011
7	Fuel	HSD - Biodiesel-LHMC oil (Light heavy mixed chemical oil)
8	Net Calorific value, Kcal/Kg	9800
9	Density of biodiesel, kg/m3	0.831
11	Observations	
12	Steam working pressure,kg/cm2(g)	9
13	Steam temp observed,°C	179.06
14	Steam discharge line size,inch	3
15	Steam blowdown line size,inch	1 1/2
16	Blow down frequency	Once in a shift
17	HSD day tank,size,mtr x mtr x mtr	1 x 1 x1.30
18	Capacity, Kl	1.3
19	Bio diesel tank,size,mtr x mtr x mtr	3.25 x 2.30 x1.60 ht (Single
20	Capacity, Kl	12
21	Bio diesel tank volume in Lit per cm ht.	75
22	Trial start time,pm	4:30
23	Trial end time,pm	7:30
24	Initial biodiesel tank dip level,mm	440
25	Final biodiesel tank dip level,mm	370
26	Initial steam generation for boiler A,kg	3046331
27	Initial steam generation for boiler D,kg	624078
28	Final steam generation for boiler A,kg	3050631
29	Final steam generation for boiler D,kg	625475
30	During trial,Biodiesel consumption,Lit	525
31	During trial,Total steam generated,kg	5697
32	Heat supplied by biodiesel,kCal/kg fuel burned	4275495
33	Feed water temp,°C	95
34	Enthalpy of steam generated,kCal	663.1
35	**Boiler efficiency by Direct method,% as per BEE standards.**	**75.70**

Equipment code: Steam Generator (Boiler) A&D			
Capacity: 2 TPH			
Indirect efficiency calculations.			
Sr.No	**Description**	**Observations**	
1	**Flue gas analysis**		
	Steam Generator - Boiler A	**High Mode**	**Low mode**
	Oxygen %	4.20	5.50
	Flue gas temp,°C	246	185.00
	Carbon monoxide %	0.018	0.02
	Carbon dioxide %	12.23	11.27
	Excess air %	23.53	33.54
	Dry flue gas losses %	7.64	5.77
	Hydrogen in fuel loss %	6.85	6.57
	Moisture in combustion air loss %	0.61	0.46
	Total heat loss %	15.10	12.80
	Overall combustion efficiency %	**84.90**	**87.20**
2	**Flue gas analysis**		
	Steam Generator - Boiler D	**High Mode**	**Low mode**
	Oxygen %	4.00	4.10
	Flue gas temp,°C	236	207.00
	Carbon monoxide %	0.024	0.044
	Carbon dioxide %	12.34	12.25
	Excess air %	22.65	23.79
	Dry flue gas losses %	7.20	6.19
	Hydrogen in fuel loss %	6.80	6.67
	Moisture in combustion air loss %	0.58	0.50
	Total heat loss %	14.58	13.36
	Overall combustion efficiency %	**85.42**	**86.64**

Compressor performance assessment.

Compressor assessment

Compressor No.	Unit	1	2	3	4	5	Total
Working pressure,	kg/cm²(g)	8.4	8.2	8.3	8.2	8.3	
Loading Pressure,	kg/cm²(g)	7.6	7.6	7.6	7.6	7.6	
Unloading Pressure	kg/cm²(g)	8.6	8.6	8.6	8.6	8.6	
Loading %		60.39	62.76	74.74	66.19	59.96	
FAD with present density difference	CFM	1253.67	1311.67	1317.54	1252.11	1291.84	6426.84
Actual Specific Consumption	KW/CFM	0.174	0.165	0.159	0.168	0.169	
Std Specific Consumption	KW/CFM	0.156	0.156	0.156	0.156	0.156	
% increase in power consumption		11.82	6.39	2.50	7.85	8.52	
Power measured	KW	218	217	210	210	218	1073
ACTUAL TOTAL FAD = 6427 CFM							
ACTUAL DEMAND AS PER DATA PROVIDED = 5071 CFM							
THIS INDICATES ABOUT 22% LEAKAGE (Actual leakage not measured)							

Arresting 50% leakage will conservatively save 75KW. (Calculations show saving of 104KW). Improving specific energy consumption by proper maintenance and discharging exhaust outside the room may save another 75 KW.

Possible yearly saving = 150KW x 0.5 x 20 x 8 x 300 = Rs.3600000

(Detail calculations and measurements are available in report)

Sample compressed air assessment

Compressor No.	1	2	3	4	5
Make	Atlas Copco	Atlas Copco	Atlas Copco	Atlas Copco	Atlas Copco
Type / Model	Oil free, water cooled, Screw compressor ZR 200	Oil free, water cooled, Screw compressor ZR 200	Oil free, water cooled, Screw compressor ZR 200	Oil free, water cooled, Screw compressor ZR 200	Oil free, water cooled, Screw compressor ZR 200
Mfg.year	2011	2011	2011	2011	2011
Capacity,cfm	1286.16	1286.16	1286.16	1286.16	1286.16
Max.inlet temp. °c	45	45	45	45	45
Motor,kw/HP	200	200	200	200	200
RPM	2960	2960	2960	2960	2960
Rated Dis. Pressure , bar	8	8	8	8	8
Serial No.	PNA 117727	PNA 117761	PNA 117726	PNA 117728	PNA
Observations					
Status	On	On	On	On	On
Working pressure,kg/cm²(g)	8.4	8.2	8.3	8.2	8.3
Loading Pressure,kg/cm²(g)	7.6	7.6	7.6	7.6	7.6
Unloading Pressure,kg/cm²(g)	8.6	8.6	8.6	8.6	8.6
Loading Hours,hr	18424	19173	21439	20000	14411
Running hours,hr	30509	30552	28685	30215	24034
Unloading hours,hr	12085	11379	7246	10215	9623
Unloading %	39.61	37.24	25.26	33.81	40.04
Loading %	60.39	62.76	74.74	66.19	59.96
Ambient Air Temp,°c	36	36	36	36	36
Discharge Air Temp,°C	33	32	31	31	33
Power taken ,kW	218	217	210	210	218
Oil pressure,bar	2.33	2.59	2.55	2.5	2.42
Compressor outlet air discharge temp,°C	33	32	31	31	33
Screw element 1 outlet temp,°C	195	197	193	191	192
Screw element 2 outlet temp,°C	183	186	183	188	187
Suction inlet size,Height mm	580	580	580	580	580
Suction inlet size,Width mm	93	93	93	93	93
Area of suction inlet,sq.ft	0.58	0.58	0.58	0.58	0.58
Suction air velocity,fpm	3570, 3340, 3130, 3230, 3090	3690, 3140, 3270, 3420, 3670	3400, 3390, 3430, 3470, 3430	3440, 3280, 3170, 3270, 3040	3580, 3480, 3270, 3310, 3110
Avg.Suction air velocity,fpm	3272	3438	3424	3240	3350
Free Air Delivery, cfm @ suction conditions	1898.77	1995.10	1986.97	1880.20	1944.03
FAD with present density difference	1253.67	1311.67	1317.54	1252.11	1291.84
Actual Specific Consumption in kW/cfm	0.174	0.165	0.159	0.168	0.169
Standard Specific Consumption in kW/cfm	0.156	0.156	0.156	0.156	0.156
% increase in power consumption	11.82	6.39	2.50	7.85	8.52

Application wise Approximate Cost of compressed air use per day

Compressed air use

Section wise compressed air usage analysis revoved from this presentation.

Cooling tower performance assessment.

Cooling tower for compressor after coolers

Compressor CTs								
CT ID	Capacity TR	Delta T deg C	Approach	Effectiveness %	FAN MOC	Cooling duty measured Kcal/hr	% Utilization	
1	50	5	12	29.41	FRP	99500	65.8	
2	50	7	9.5	42.42	FRP	109200	72.22	
3	50	6.5	9.5	40.62	FRP	157495	100	
4	50	5.5	9.5	36.66	FRP	133045	87.99	
5	50	7	9.5	42.42	FRP	136150	90.04	
Cooling tower Fan / Pump performance								
CT ID	Fan KW			Pump KW	Flow M3 per hr	Observed Pressure Kg/cm2	Overall Pump efficiency	Possible saving in Lac Rs per year
1	0.985			2.23	21.07	1	25.70	0.43
2	1.41			2.76	28.5	1	28.00	0.38
3	0.541			2.74	23.29	1	23.00	0.59
4	1.17			2.732	23.7	1.25	32.00	0.29
5	1.275			2.53	22.5	1.25	30.00	0.31
Total	5.381			12.992				2

Overall Pump efficiency appears to be quite low. Excessive pressure drops in aftercooler and piping should be avoided. Possible yearly saving is around Rs. 2 lac. Cooling tower fans may have reliable sump water temperature based ON/OFF control in typical Pune weather to save energy. (Detail calculations and measurements are available in report)

Cooling tower performance assessment.

Cooling tower for Chillers

Cooling tower performance								
CT ID	Capacity TR	Delta T deg C	Approach	Effectiveness	FAN MOC	Cooling duty measured Kcal/hr	% Utilization	
1	589	2.5	13.5	15.62	Aluminium	556000	31.72	
3	589	4	9.5	29.62	FRP	904000	50.75	
4	589	4	8	33.33	FRP	915160	51.38	
5	589	5	10	33.33	FRP	1143950	64.22	
Cooling tower Fan / Pump performance								
CT ID	**Fan KW**			**Pump KW**	**Flow M3 per hr**	**Observed Pressure Kg/cm2**	**Overall Pump efficiency**	**Possible saving in Lac Rs per year**
1	10.6			39.97	452	1.5	46.00	1.81
3	5.5							
4	6.9			39.08	458	1.25	40.00	3.75
5	6.9							

Overall Pump efficiency appears to be low. Excessive pressure drops may be reduced by descaling. Possible yearly saving is around Rs. 5.56 lacs. Cooling tower fans may have reliable sump water temperature based ON/OFF control in typical Pune weather to save energy. (Detail calculations and measurements are available in report)

Chiller Performance. Comparison with commissioning conditions

Chiller performance assessment.

Parameter Description	Audit Trial	@ commisioning	Audit Trial	@ commisioning
Observed Operating Parameters	Chiller no.5	Chiller no.5	Chiller no.3	Chiller no.3
Oil level	Sufficient	3/4 visible	Sufficient	3/4 visible
Suction Pressure,kpa	276	251	267	265
Discharge Pressure,kpa		797	788	729
Oil supply pressure,kPa	788	NA	769	NA
Diffrential Oil Pressure,kpa	512	NA	501	NA
Evap.chilled water inlet temp, ° C	9.9	10.1	10	10.3
Evap.chilled water Outlet temp,° C	7.2	7	7	6.9
Chilled water Delta T,°C	2.7	3.1	3	3.4
Evaporator approach,°C	0.1	1.5	0.5	0.3
Evaporator inlet chilled water pressure,Kg/cm2	3.75	NA	3.75	NA
Evaporator Outlet chilled water pressure,Kg/cm2	2.5	NA	2.5	NA
Delta P across Evaporator,Kg/cm2	1.25	1.7	1.25	1.7
Condenser inlet cooling water pressure,Kg/cm2	1.25	NA	1.5	NA
Condenser Outlet cooling water pressure,Kg/cm2	0.25	NA	0.25	NA
Delta P across Condenser,Kg/cm2	1	1.2	1.25	1.2
Condenser CTW entering water temp,°C	32.1	30.8	31.4	28
Condenser CTW leaving water temp,°C	34.8	33.7	34.4	31.6
Condenser sat.refrigerant temp,°C	31.25	NA	30.75	NA
Condenser approach,°C	3.55	2.3	3.65	2.5
Observed Compressor power,Kw	235		212	
Observed Flow,Cu.mtr/hr	299.13		269.32	
Existing Heat load ,TR	267.08		267.18	
Capacity Utilization,%	54.99%		55.01%	
Kw/TR	0.880		0.793	
Coefficient of Performance	3.996		4.432	

Chiller performance performance assessment.

Energy saving opportunities in chillers

Observations and Recommendations for energy saving opportunities in chillers	
Sr.no.	**Observations**
1	Chiller no.5,3 needs effective evaporator descaling on priority basis,as pressure drop across evaporator is towards higher side i.e more than 1.0 kg/cm2(g).
2	Chiller no.5,3 needs effective condenser descaling on priority basis,as condenser approach observed is more than 3.
3	Observed Specific power consumption is at higher side i.e 0.79 to 0.88 with compared to rated 0.65.
4	With proper overhauling of chiller units which includes descaling of condenser unit,evaporator unit,checkup of primary refrigerant quantity in the system,we can practically able to achieve SEC upto 0.65 Kw/TR for the chiller
5	For chiller no.5,by reduction in specific energy consumption from present to 0.75 kw/TR practically,we can save upto ,34.69 kw*24hr *350 days*0.40*rs.7.5 per unit charges = 8.74 Lacs per annum.
6	For chiller no.3,by reduction in specific energy consumption from present to 0.75 kw/TR,we can save upto ,11.62 kw*24hr *350 days*0.40*rs.7.5 per unit charges = 2.92 Lacs per annum.

CHW Primary Pump performance assessment.

Energy saving opportunities in CHW Primary Pumps

CHW Primary Circulation Pump Details		
Chiller ID	CHPP 5	CHPP 3
Make	ITT	ITT
Type	Centrifugal	Centrifugal
Capacity M3/hr	330	330
Head Mtr	20	20
RPM	1468	1468
Motor Kw	22	22
Discharge pressure,Kg/cm2(g)	4.00	4.25
Suction pressure,kg/cm2(g)	2	2
Net resultant discharge pressure,kg/cm2(g)	2	2.25
Flow observed,Cu.mtr/hr	299.13	269.32
Observed Motor Power , Kw	24.2	24.27
Motor Loading %	97.90	98.18
Hydraulic power,Kw	16.30	16.51
Shaft power,Kw	21.54	21.60
Pump efficiency %	**75.69**	**76.45**

These pumps are operating at "Practical Optimum efficiency"

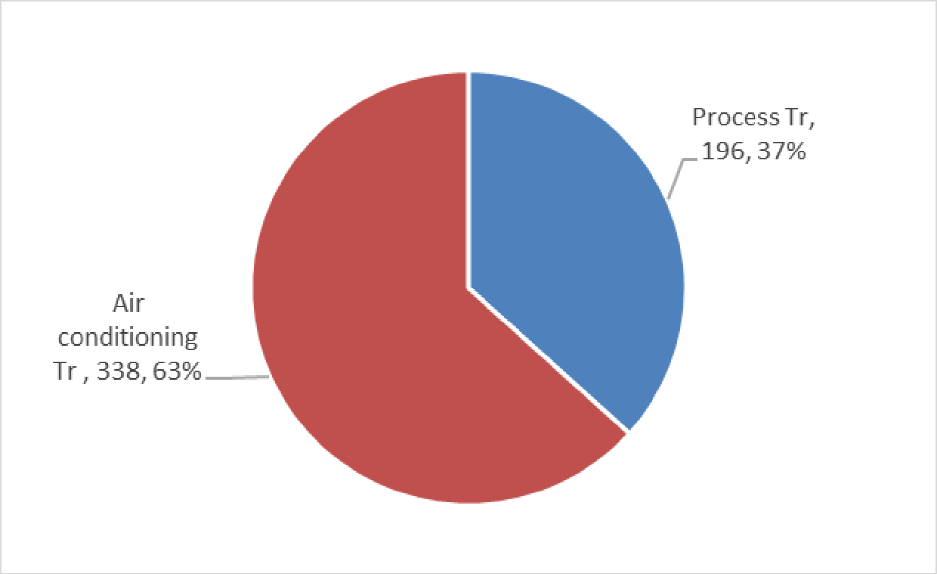
Division of heat load on HVAC system

Approximate division of heat Load.

Present heat load taken by chilled water from process PHE:

Chilled water flow observed	- 179.89 m3/hr
Chilled water inlet temp°C	- 7
Chilled water out let temp°C	- 10.3
Heat load handled, kCal	- 5,93,637
TR	- 196.30

Total Tr generated as per chiller assessment done - 534 Tr.



Sample assessment of AHUS

Sample Assessment of AHUs

Description -	Machine room 3 - AHU - S-1-3	Machine room 3 - AHU - S-1-1
Make	VTS TF Air systems P Ltd	VTS TF Air systems P Ltd
Rated Capacity CMH	40500	40500
Capacity TR	NA	NA
Motor Kw/HP (no.of blower 4 nos.@ 7.5kW each),VFD operated,direct coupled type	30 / 40	30 / 40
Yr.mfg.	2011	2011
Coil details	Not available	Na
Fan model	VS 560	VS 560
Total static pressure mm WG	150	150
Fresh air supply,%	6 to 10 %	6 to 10 %
Use of treated air	Syringe moulding section	Syringe moulding section
End user temp conditions,C°	23±2	23±2
Chilled water inlet pressure,kg/cm2(g)	3.25	3.25
Chilled water outlet pressure,kg/cm2(g)	3.00	2.50
Chilled water inlet temp,°C	8.6	8.4
Chilled water outlet temp,°C	12	11
Atm air Dry bulb temp,°C in m/c room	31	31
Atm air Wet bulb temp,°C in m/c room	23	23
No.of Pre filters, suction side	12	12
Type of filter	Felt cloth	Felt cloth
Micron size	10	10
Pre Filter size , mm x mm x mm	592 x 592 x 150	592 x 592 x 150
Area of single filter ,m2	0.350	0.350
No. of filters	12	12
Total volumetric flow,cu.ft/min	22716.51	25895.02
Before cooling coil,condition of air		
WBT of recirculating air,°C	16	16
DBT of recirculating air,°C	25	26
After cooling coil,condition of air		
WBT of recirculating air,°C	12	10
DBT of recirculating air,°C	15	12
Observed power,Kw @ 36.5 Hz	4.3	3.770
Density of air ,kg/m3 @ 25°C	1.1839	1.1822
Total air flow observed through AHU unit,m3/hr	38623	44027
Enthalpy of air at Heat exchanger inlet, h in kJ/kg	45	45
Enthalpy of air at Heat exchanger outlet, h out in kJ/kg	34	29.5
Refrigeration effect,Q e kJ/hr	502977.91	806749.11
Refrigeration effect in TR	**39.81**	**63.85**

Observations on AHU Assessment

Sample assessment of AHUS

- AHU 1 and AHU 3 of machine room 3 were assessed to check delivered TR.
- It is observed that HEPA filters are removed from supply plenum, as such to control air flow as per requirement, VFD frequency is adjusted to around 36 HZ. This has resulted into drastic reduction in energy consumption. 7.5KW x 4 blowers now consume only 4KW.
- We were informed by XXX team that this has been done on 7 main AHUS.
- On same VFD setting, AHU 3 delivers 40Tr, while AHU 1 delivers 64Tr. – both deliver air in same area. This suggests choking of suction felt filters for AHU3.
- With removal of HEPA filters, it is advised that Indoor air quality with respect to particulate matter may be checked against Sop requirements.

Use of balancing valves in place of ON/OFF valves for AHUs..

Comment on Chilled water distribution to various areas

It is observed at present that AHUs receive chilled water through temperature control operated ON – OFF valves. The process heat load must be fluctuating type as this is a batch production process. Envelop load changes in Pune area substantially between 24 hours of a day and also seasonally.

Use of mechanically operating balancing valves will help in rationalizing chilled water demand and may result in reducing the same. This will reflect in modulating existing chillers as each chiller has three compressors which internally have facility to modulate and deliver exact requirements. This will also help in improving indoor air quality requirements in all areas.

It is very difficult to predict actual savings due to this unless detail demand analysis is carried out.

Installing BMS for HVAC system.

Installing BMS

HVAC being a major area of energy consumption, a dedicated BMS with sensors for energy input as well as operating parameters would help exercising good control.

Thermography of heat Insulation and checking of steam use:

CHW & Steam Lines Insulation check

Thermography of heat insulation was carried out on sample basis for boiler house, overhead steam supply lines, headers etc.
IR Phographs, CCD Photographs, loss calculations are included in report.

Observation:

- Insulation of Mezzanine floor steam supply lines found damaged at certain places. It is very difficult to attend such issues at Mezzanine floor.
- This may be difficult for Compressed air and chilled water lines as well.
- Sectiontion A – uses steam based radiators just bellow chequered plate flooring. The insulation of steam line there was seen to be damaged. This contributes in releasing heat in that area and adds to HVAC heat load. This needs to be attended on priority as at times the temperatures there cross acceptable limits.

Monitoring Product wise specific energy consumption

Product wise specific energy consumption monitoring

XXX spends **INR 550000 to INR 600000 per day or INR 20Crs per year on supplying utilities** like chilled water, Steam and compressed air to various product lines in the plant.

Lot of complex machines are involved in manufacturing process which use these utilities.

All the ESOs suggested in this report and those XXX may generate in future, will optimize cost of generating these utilities. **However the utilization may generate some inefficiencies or wastages from time to time.** So monitoring product wise specific energy consumption will be of great help to generate specific alerts.

Implementation of ISO 50001 will bring in continual control on these consumptions. All this will need some investment in instrumentation. Considering quantum of energy used, Auditors strongly recommend this instrumentation and implementation of ISO 50001. This will also be a step towards **INDUSTRY 4.0**

Suggested savings in this audit

Savings

Suggested savings in this audit

Tr53 Load distribution	Rs.1Lac
Boilers:	Rs.10Lacs
Air compressors:	Rs.36Lacs
CT – Air compressors:	Rs.2Lacs
CT – Chillers:	Rs.5.56Lacs
Chiller – 5:	Rs.8.74Lacs
Chiller – 3:	Rs.2.92Lacs
Canteen Air conditioning:	Rs.1.73Lacs
Total:	**Rs.67.95Lacs**

Most of the above savings require low or medium cost majors with around 1 year payback.

XXX may think about chiller - condenser descaling systems as a permanent solution. Payback will be more as it is an asset based modification, but will help in optimizing energy performance and enhancing life of the equipment.

To do List

ESOs.	Priority 1	Priority 2	Priority 3
Electrical			
Tr53 Load to be distributed on Tr51,52,53	■		
Harmonic Mitigation at Tr 11,12,13,21,31,41		■	
Assess PF and Harmonic situation with expansion load		■	
Compressed Air			
Confirm Leakage by lekage qualification test	■		
Locate leakage by physical leak detection		■	
Act on minimizing leakages		■	
Compressor CT ESOs - Pump efficiency improvement and Automatic Fan control	■		
HVAC			
Descalling	■		
Installation of automatic ONLINE descalling Equipment			■
Chiller CT ESOs - Pump efficiency improvement and Automatic Fan control	■		
AHU maintenance to ensure same capacity AHUs should deliver same Tr fpr same fan speeds		■	
Consult HVAC expert to quantify savings - if balancing valves are used.			■
Boiler			
Burner fine tuning and controlling excess air - Adj Cam. Water side descaling 6months. Fire side tube cleaning with flex grinder - bimonthly	■		
inclusion of Instrumentation to assess utility consumption by each product line			■