Energy Conservation Opportunities in Electroplating Process – A Case Study from CII

Energy Conservation Opportunities

- Energy Efficient Rectifier System IGBT Vs SCR Vs Diode Based Rectifier
- Selection of Bus Bar Rating
- Automation of System
- Chemical Heating Electrical Vs Thermal Vs Solar
- Insulation of Tanks
- Pump selection and Control
- Agitation Compressed Air Vs Lube Blower
- Basic Designing of Agitation system
- Evaporation Losses

Replace Existing Diode Rectifier with IGBT Rectifier

Present System

- Diode base rectifier are used Electroplating
- Older technology

S.no	Name of Rectifier	Voltage	Current	Power	P.F	D.C Current	D. C. Volts	Rated Power in kVA
1	Anodizing	401	45.2	26.78	0.858	1000	40	40
2	Electro Polishing	402	14	8.1	0.84	500	30	15
3	Jig material Removing	401	7.1	4.3	0.88	500	12	6
4	Chrome	401	7.7	4.7	0.84	300	12	3.6
5	Plating-2	401	8	4	0.89	500	12	6
Total Power				**47.88**				**70.6**

Replace Existing Diode Rectifier with IGBT Rectifier

Rectifier Type	IGBT Based	SCR Based	Diode Based
Rating	12V 12000A	10V 10000A	12V 10000A
KW Capacity	144	100	120
DC voltage (V)	5.67	7.42	8.2
DC current (A)	7250	7250	7250
AC voltage (V)	420V/424V/422V	403V/411V/407V	418V/422V/421V
AC current (A)	74.73A/72.54A/72.83A	128.8A/152.6A/138.6A	112A/113A/112.3A
PF	0.99	0.92	0.96
KW	50.35	87.6	77.59
KVA	50.50KVA	95.46KVA	80KVA
% Efficiency	81.64	61.41	76.62
Start Time	1.57 PM	12.10PM	6.05PM
End Time	2.47PM	1.00PM	6.55PM
Duration	50M	50M	50M
Start KWH reading	588.3	525	647
End Time KWH reading	630.8	588.3	712.4
KW consumed in 50mi	42.5	63.3	65.4
KW consumed in 60 mi	51	75.96	78.48

Replace Existing Diode Rectifier with IGBT Rectifier

Proposed System

- IGBT rectifier for Electroplating
- Latest technology
- Lower Power consumption
- Potential of more than 35% of energy saving in this case
- Generally we have experienced saving in range from 20 – 50 % also

Replace Existing Diode Rectifier with IGBT Rectifier

Savings = 47.88 kW x 30% x 4500 hrs/Annum x Rs 8.70/ Unit

Annual Savings	**- Rs 5.6 Lakhs**
Investment	**- Rs 6.0 Lakhs**
Pay Back	**- 13 Months**

Selection of Bus Bar Size

Points to be Consider

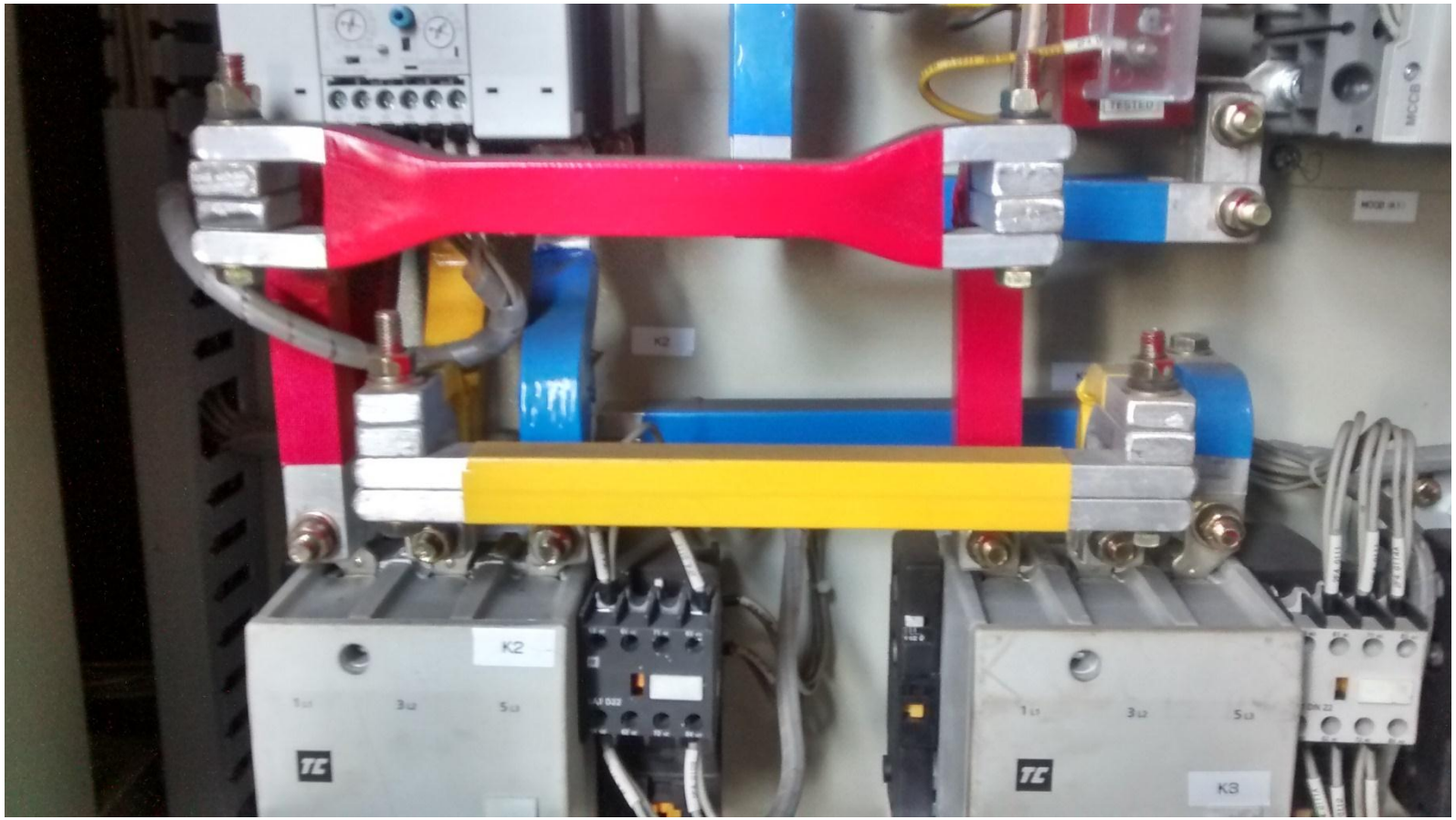
Material Mostly copper

- Current Density 1.6 A/mm2 – 2.0 A/mm2
- 2000 A Bus bar
- 1250 mm2
- 125 x 10 mm Copper bus bar

For Aluminium

- Current Density 0.8 A/mm2 – 1.0 A/mm2
- 2000 A Bus bar
- 2000 mm2
- 2 x 100 x 10 mm Aluminium bus bar

Losses due to overheating in Bus Bars



Use Thermal Heating in place of Electric heating

Present System

- Electric Heaters are installed in several areas for water heating, chemical heating and space heating
- Power consumption in heaters are measured
- Cost Comparison of electric and Thermal heating is Analyzed

Use Thermal Heating in place of Electric heating

S.No.	Name of heater	Quantity	Measured(kW)	Rated (kW)
	Dipping Drying Room	11	2.7	2.7
plating -2	Cleaning Tank-1	1	2.1	2.5
	Cleaning Tank-2	1	2.6	2.5
	plating Tank	5	2.65	2.5
Plating-1	Cleaning Tank-1	2	2.1	2
	Cleaning Tank-2	1	2.1	2
	plating Tank	5	2.1	2
	Crome Tank	1	2.1	2
Anodizing Plant	Celing Tank	2	2.1	2
	Color Tank	1	2.1	2
	Casting tank	1	2.1	2
Nickel mate	Mate nickel Tank	3	2.1	2
	Cleaning	1	2.1	2
	MSL Cleaning tank	1	2.1	2
Black Tank	Anthracite	1	2.1	2
	ultrasonic	1	2.1	2
	cleaning	1	2.1	2
Anthracite	Anthracite Tank	2	1.5	2
	gold	1	2.1	2
	Cleaning	1	2.1	2

Use Thermal Heating in place of Electric heating

Comparison of Heating cost in NG fired HWG

- Electric Heating cost- 125 kWh x Rs. 8.70/unit
  = Rs 1087.50/ hr for 1 lakh kCal/hr

- Thermal heating cost – 100000 / 8500 x 80 % efficiency
  - 14.70 scm/hr
  - 14.70 scm /hr x Rs. 45 /scm
  - Rs. 661.50 /hr

Considering 10 kWh energy consumption

Saving Potential - Rs. 345/hr

Use Thermal Heating in place of Electric heating

Action Plan

- Install NG based HWG for heating purpose of water and chemicals
- Remove the electrical heaters

Paint Dryer

- Install hot water to air heat exchanger
- Install circulation blower for proper circulation of hot air in dryer
- Minimize hot air leakages and radiation losses if any
- Install air filter to provide fresh air in dryer

Use Thermal Heating in place of Electric heating

Saving = Rs 345/hr x 12 hrs/day X 300 Days/Annum

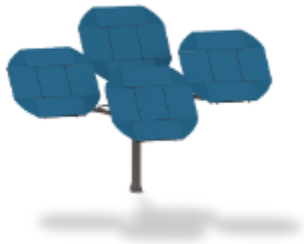
Annual Saving	**- Rs 12.42 Lakhs**
Investment	**- Rs 12.00 Lakhs**
Pay Back Period	**- 12 months**

Solutions Offerings

Heat

Power

Solar Field
For Industrial Process Heating Applications



SmarTree
For Smart Cities, Malls, Public Parks, Plazas, etc.

Smart Kitchen
For Industrial & Institutional kitchens

SmarTrack
For high yield offgrid & utility scale Power Plants

Redefining Industrial Energy Generation

SOLAR FIELD

Solar Field

For Reducing Fuel Consumption In Industries

Dishes take very small ground space

System Cost covered in less then 3 years

Can be retrofitted to any existing system

Fully automated systems

Can heat up to 400°C

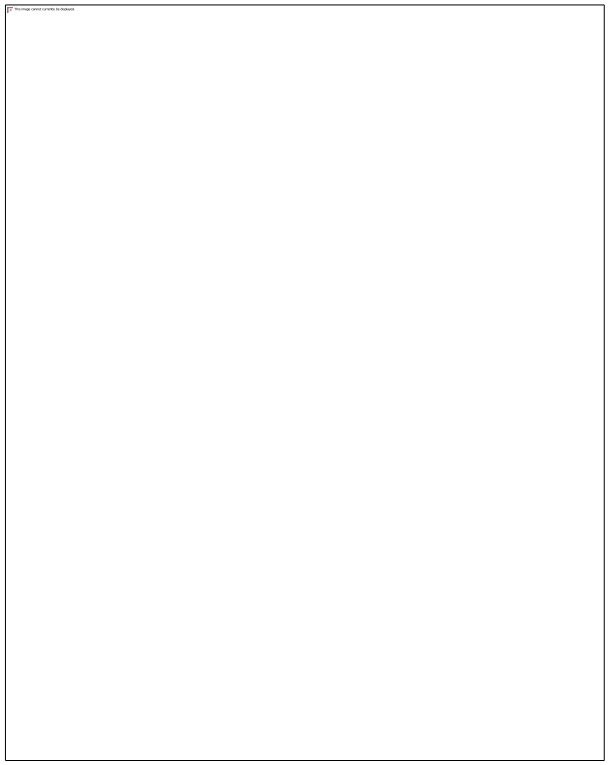
Reduces your carbon footprint emission

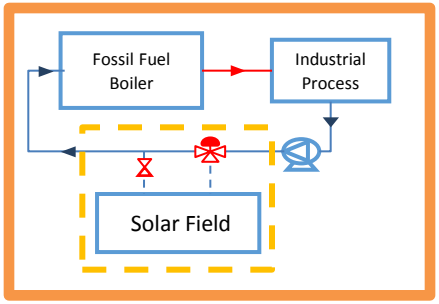
1. Incoming Solar Radiation gets concentrated by high efficiency Paraboloid Dish Concentrator onto a cavity receiver with minimum losses
2. The concentrated energy is heat-transferred to various working fluids like hot water, Thermic Oils, etc.
3. Piping system routes energy from each receiver to end application for integration
4. Entire process is fully automated and dish tracks the Sun in two axis all year long

Solar Field Solution – An Integrated Approach For Displacing Fossil Fuels For Thermal Energy

SOLAR FIELD

Solar Dish Concentrators





Process integration & Automation

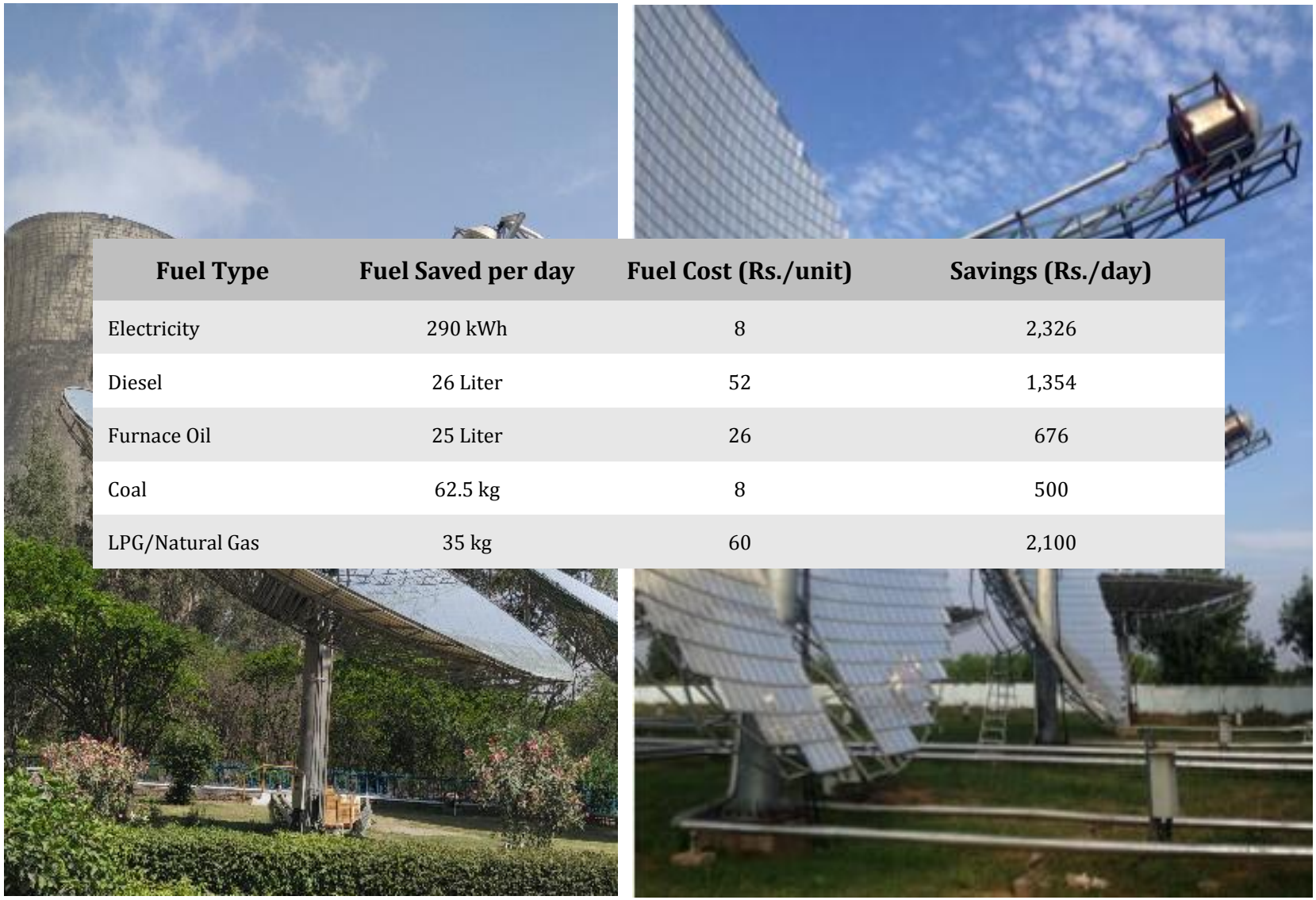
Instrumentation & Piping Network

THERMAL ENERGY

- Heating
- Cooling
- Cooking
- Power Generation

TO USER PROCESS

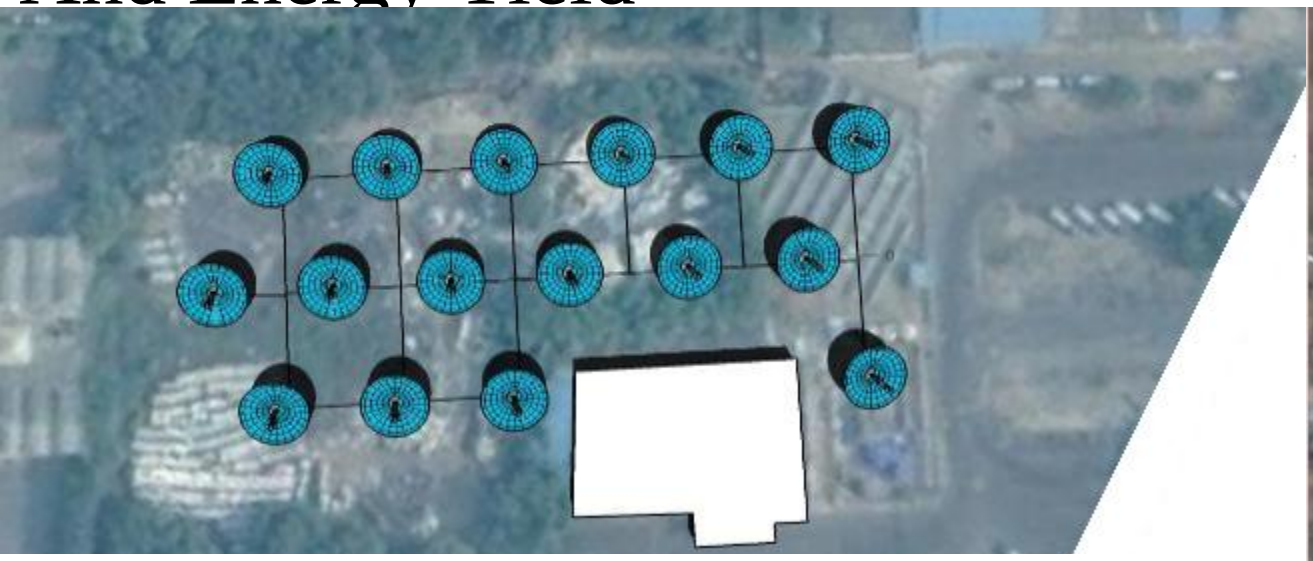
Equivalent Energy Output From Dish

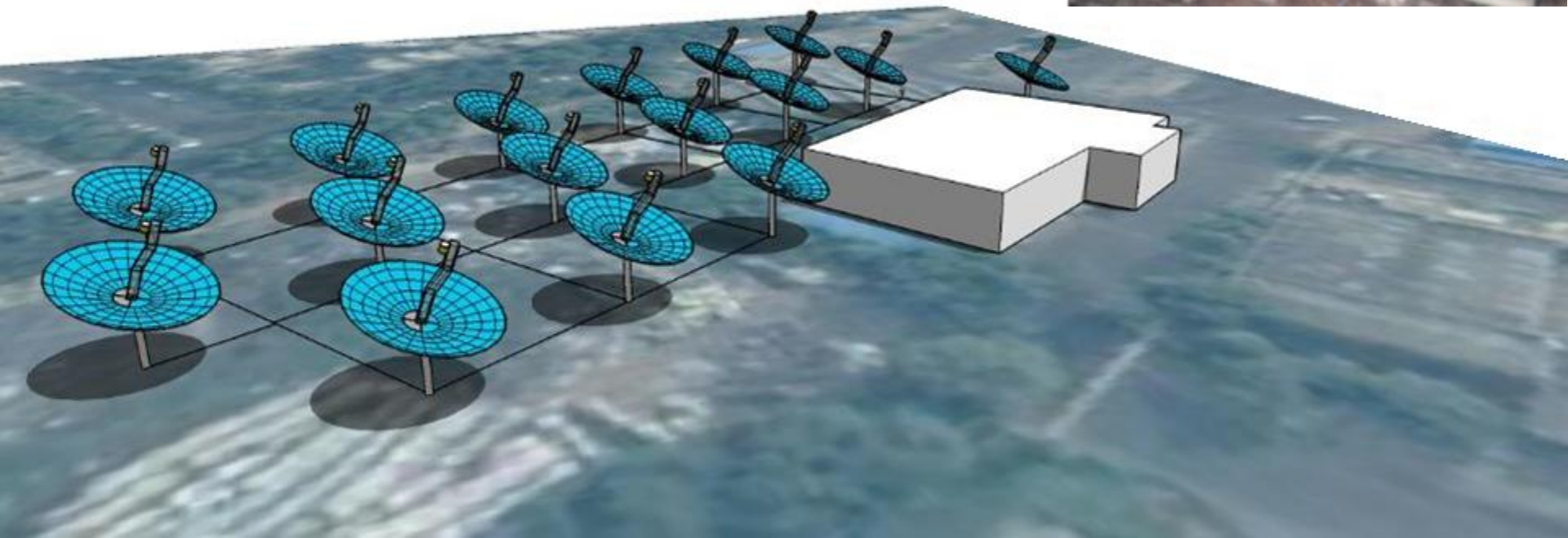


Fuel Type	Fuel Saved per day	Fuel Cost (Rs./unit)	Savings (Rs./day)
Electricity	290 kWh	8	2,326
Diesel	26 Liter	52	1,354
Furnace Oil	25 Liter	26	676
Coal	62.5 kg	8	500
LPG/Natural Gas	35 kg	60	2,100

Paraboloid Dish Concentrator: Peak Rating 40,000 kcals/hr.

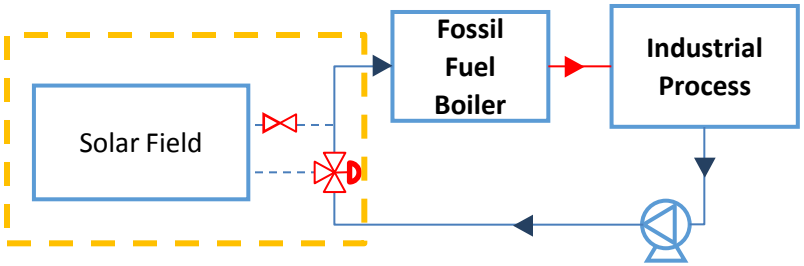
Shadow Analysis Tools For Optimized Layout And Energy Yield



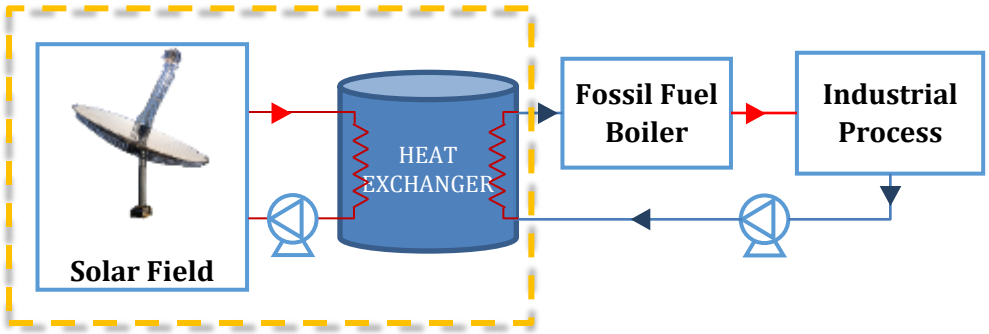


Solar Field Integration Is Seamless

MWS Solar Field for direct heat delivery



Field for indirect heat delivery



- No impact on customer processes
- Back-ended integration
- Full automation, controls and safety implemented in Solar Field

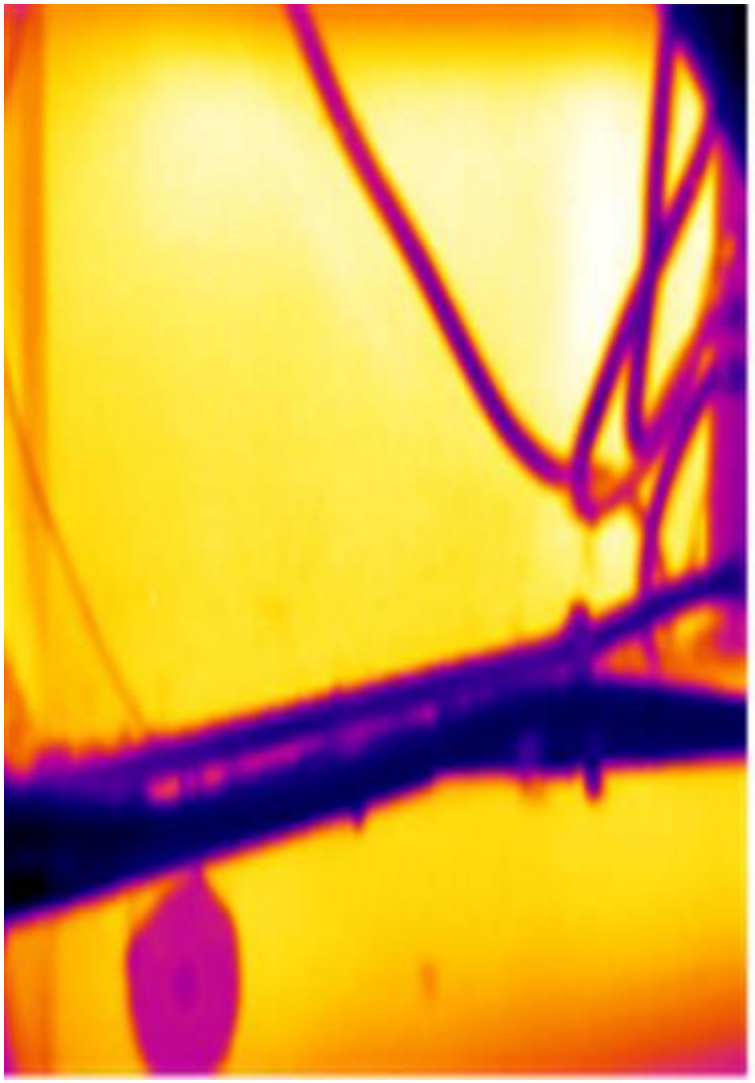
Industry	Working Fluids	Temperature Range
Pharmaceutical	Steam, Air	80°C - 230°C
Textile industry	Water, Steam	60°C - 150°C
Chemical Industry	Steam, Air	80°C - 320°C
Pulp & Paper Industry	Steam	Up to185°C
Food Industry	Steam Thermic Oil	80°C - 280°C
Automobile Industry	Water, Steam	60°C - 200°C
Air Conditioning (VAM)	Water, Steam	60°C - 150°C

Improve Surface Insulation to Reduce Radiation Losses of Tin Plating Tanks

Present System

- Thermal Imaging of tanks installed at Tin Plating Unit done for surface heat loss estimation
- Surfaces of tanks have high temperature
- Temperature range 70-80°C
- A part of useful energy goes into Waste
- It should be around ambient +10 Deg.
- Good potential of energy saving by reducing radiation losses

Thermal Imaging



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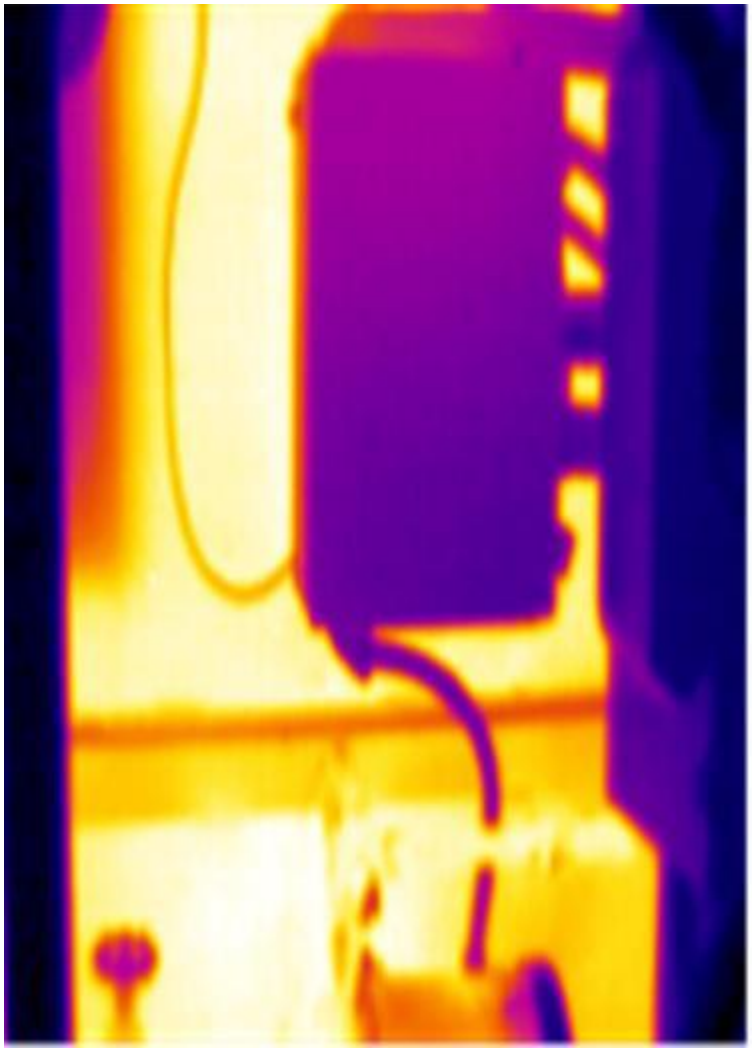

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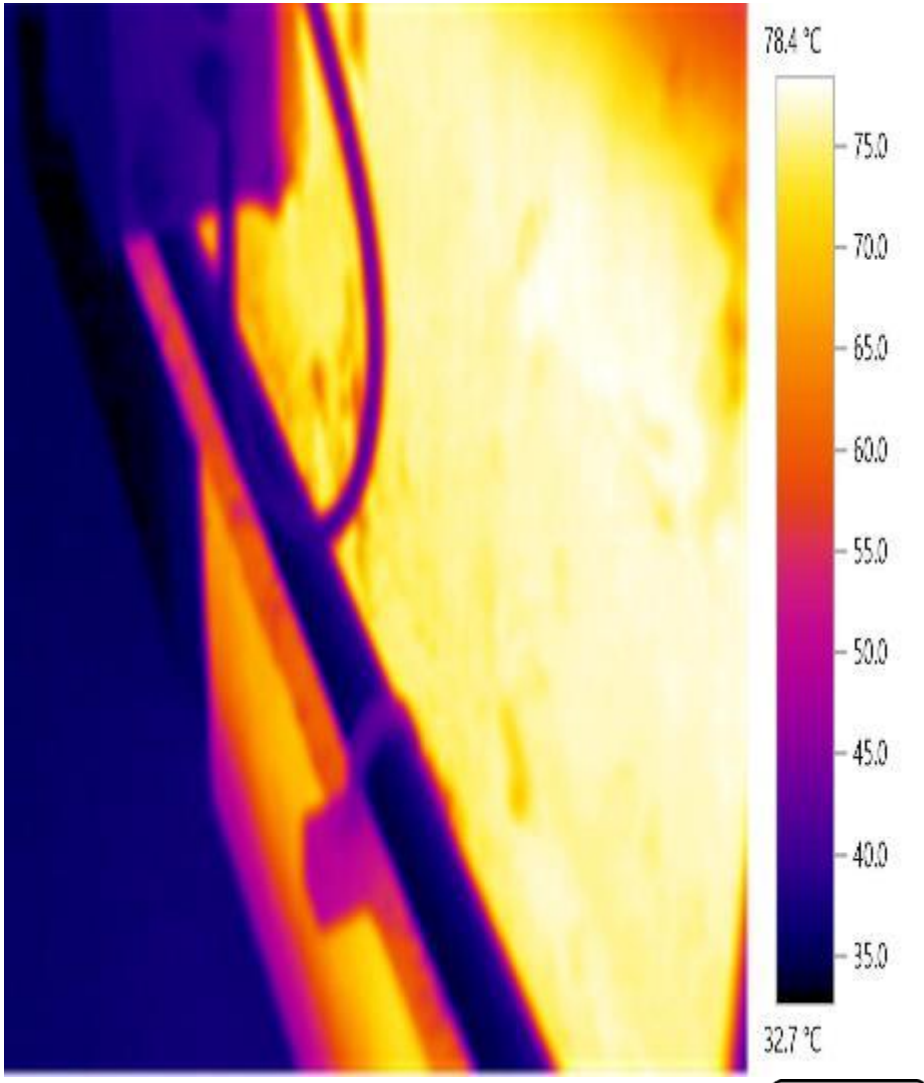

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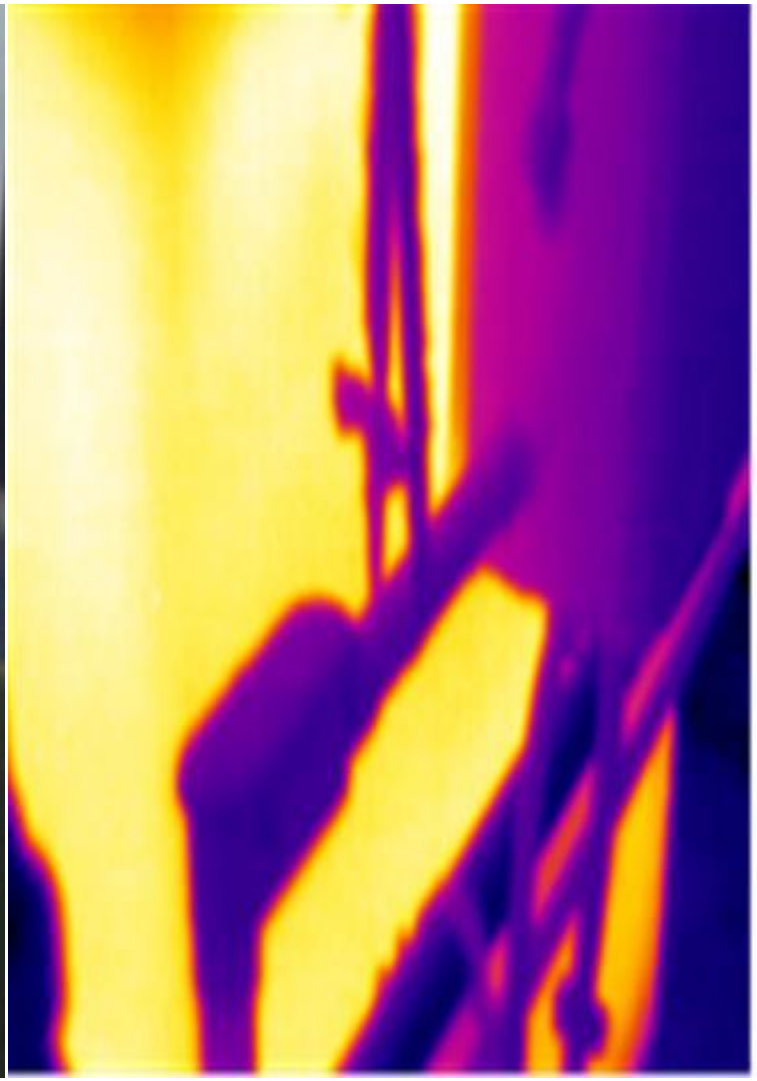

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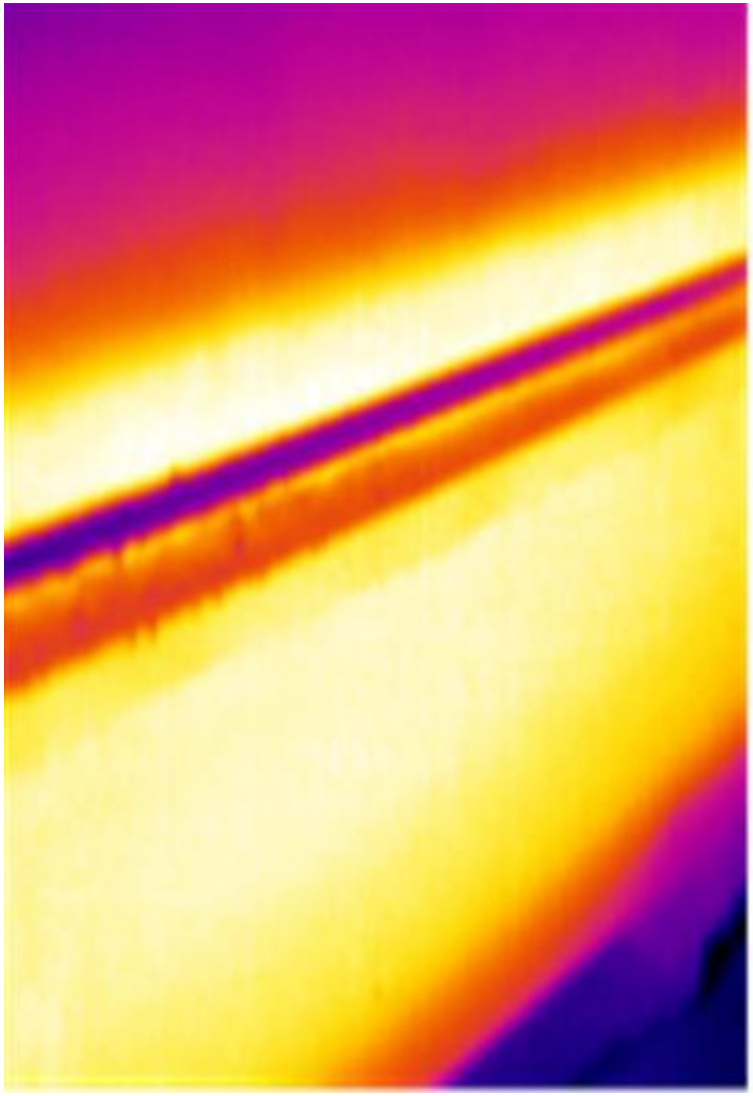


Improve Surface Insulation to Reduce Radiation Losses of Tin Plating Tanks

S N	Description	Before Insulation	After Insulation
1	Skin Tempreture (°C)	70	50
2	Surface Area (m^2)	15	15
3	Ambient Temperature (°C)	35	35
4	Average Operating (Hours/ Yr)	8500	8500
5	Heat Loss Due To radiation (kCal/ Hr)	6169	2419
6	Annual Heat Loss(kCal/ year)	52434375	20559375
7	Heat Value of one unit of Energy (kCal/kWh)	860	
8	Annual Unit loss/ Year	60970	23906
9	Annual unit Saving (kWh/ Year)	37064	
10	Unit Rate (Rs/unit)	7.50	
11	**Annual Saving (Rs. Lakh/ Year)**	**2.78**	
12	**Investment (Rs. Lakh) @Rs.2000/sqm**	**0.30**	
13	**Simple Pay Back Period (Months)**	**2**	

Improve Surface Insulation to Reduce Radiation Losses of Tin Plating Tanks

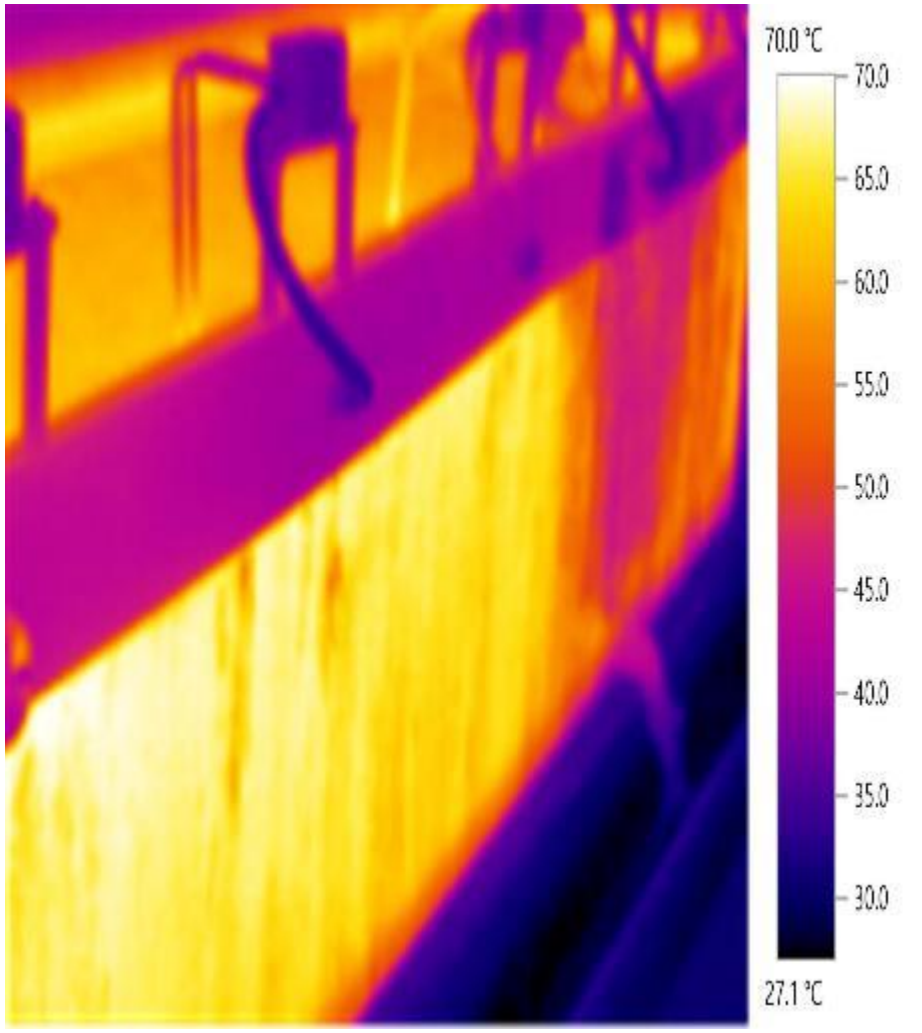
Annual Savings	**- Rs. 2.78 Lakhs**
Investment	**- Rs. 0.30 Lakh**
Payback Period	**- 2 Months**

Improve Surface Insulation to Reduce Radiation Losses of Tanks

Present System

- Thermal Imaging of tanks installed at Tanks done for surface heat loss estimation
- Surfaces of tanks have high temperature
- Temperature range 65-75°C
- A part of useful energy goes into Waste
- It should be around ambient +10 Deg.
- Good potential of energy saving by reducing radiation losses

Thermal Imaging



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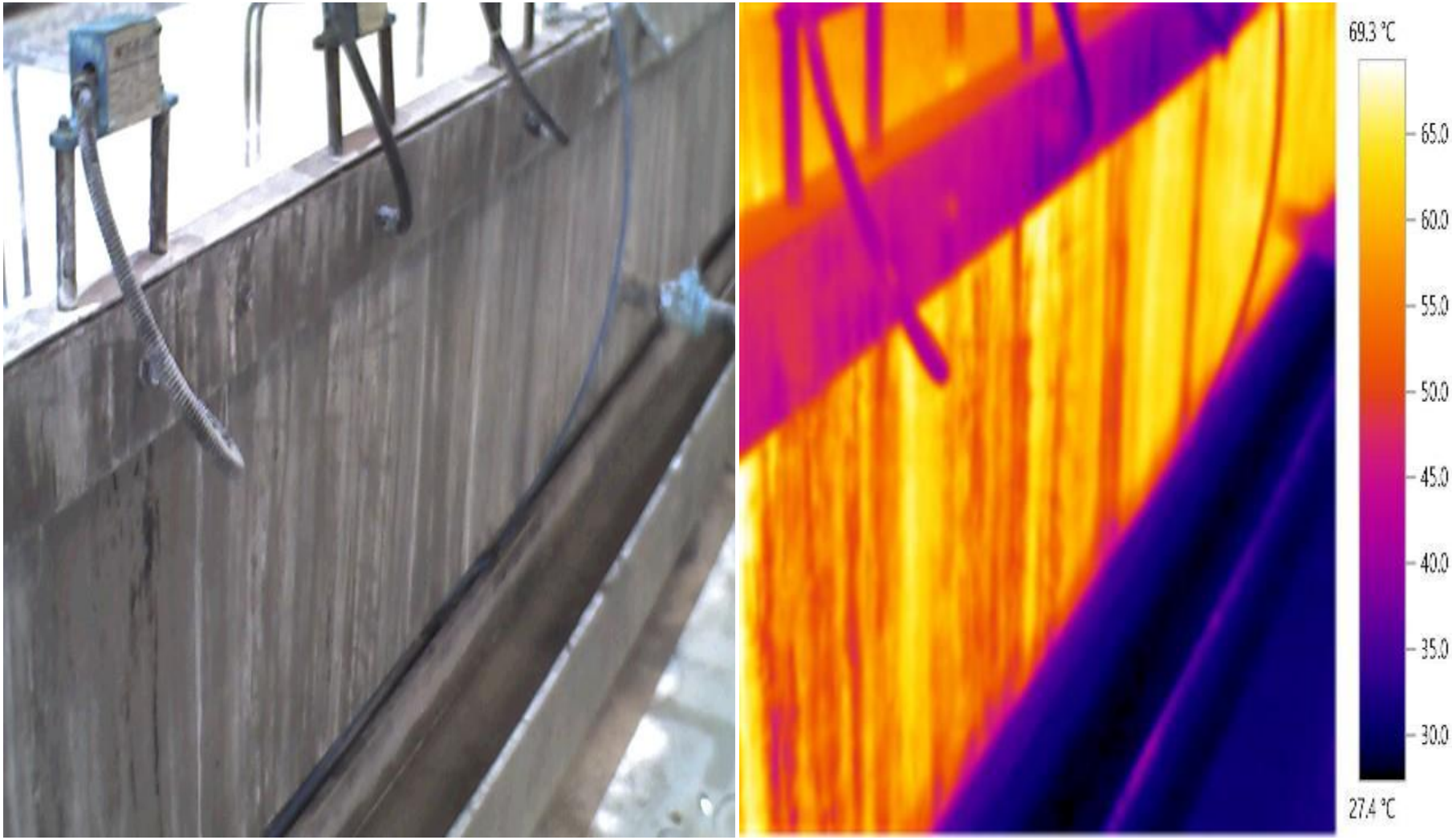

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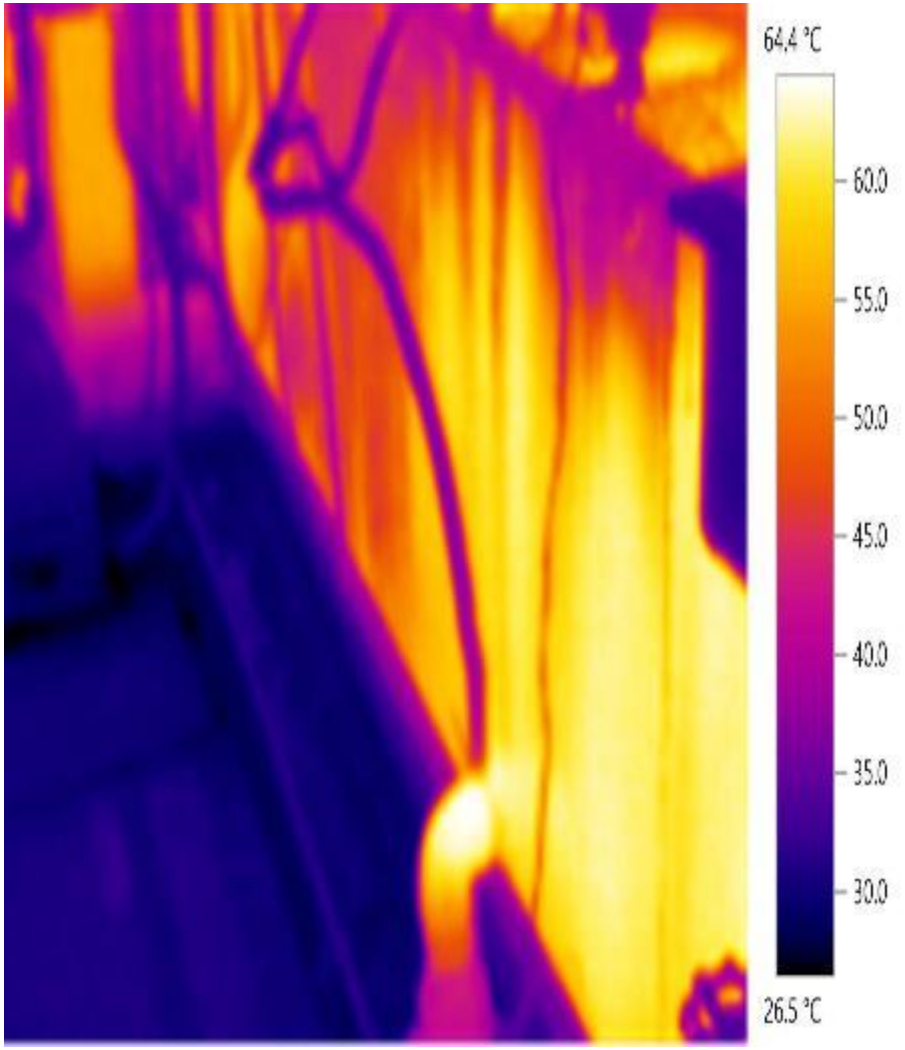


Improve Surface Insulation to Reduce Radiation Losses of Tanks

S N	Description	Before Insulation	After Insulation
1	Skin Tempreture (°C)	65	50
2	Surface Area (m^2)	10	10
3	Ambient Temperature (°C)	35	35
4	Average Operating (Hours/ Yr)	8000	8000
5	Heat Loss Due To radiation (kCal/ Hr)	3450	1613
6	Annual Heat Loss(kCal/ year)	27600000	12900000
7	Heat Value of one unit of Energy (kCal/kWh)	860	
8	Annual Unit loss/ Year	32093	15000
9	Annual unit Saving (kWh/ Year)	17093	
10	Unit Rate (Rs/unit)	7.50	
11	**Annual Saving (Rs. Lakh/ Year)**	**1.28**	
12	**Investment (Rs. Lakh) @Rs.2000/sqm**	**0.20**	
13	**Simple Pay Back Period (Months)**	**2**	

Improve Surface Insulation to Reduce Radiation Losses of Tanks

Annual Savings	**- Rs. 1.28 Lakhs**
Investment	**- Rs. 0.20 Lakh**
Payback Period	**- 2 Months**

Replace Pneumatic pump with centrifugal pump for Pre conditioning in Crome Plant

Present System

- Presently pneumatic pumps is used for Pre Conditioning in Crome Plant
- Present flow around 50 cfm
- Specific power consumption: 17 kW/100 cfm
- Present Power consumption- 8.5 kW
- As a standard practice centrifugal pump should be used for such application
- Excellent saving potential

Replace Pneumatic pump with centrifugal pump for Pre conditioning in Crome Plant

Replace Pneumatic pump with centrifugal pump for Pre conditioning in Crome Plant

Action Plan

- Install Centrifugal pump with Titanium Coated Impeller
- 0.5 kW pump will be operated
- Saving of 8 kW can be achieved

Replace Pneumatic pump with centrifugal pump for Pre conditioning in Crome Plant

Saving = 8 kW x 24 Hr/ Day x 305 Days/ Yr x Rs. 8.14/ Unit

Annual Savings	**- Rs. 4.7 Lakhs**
Investment	**- Rs. 0.50 Lakh**
Simple payback	**- 2 months**

Install Centrifugal blowers in place of compressed air for agitation

Present System

- Presently compressed air is used for agitation
- Total number of points around - 3
- Present flow around 20 cfm of each
- Specific power consumption: 17 kW/100 cfm
- Present Power consumption- 10.2 kW
- As a standard practice root blowers should be used for such application
- Excellent saving potential

Install Centrifugal blowers in place of compressed air for agitation

Action Plan

- Install Centrifugal blower
- 2.5 kW Blower will be operated
- Saving of 7.5 kW can be achieved

Install Centrifugal blowers in place of compressed air for agitation

Saving = 7.5 kW x 24 Hr/ Day x 305 Days/ Yr x Rs. 8.14/ Unit

Annual Savings	**- Rs. 4.48 Lakh**
Investment	**- Rs. 1.0 Lakh**
Simple payback	**- 4 months**

Installation of Efficient Agitation System

Present System

- Presently Compressed air and lube blower are used
- Compressed Air Inefficient way of operation
- Efficient Agitation System available

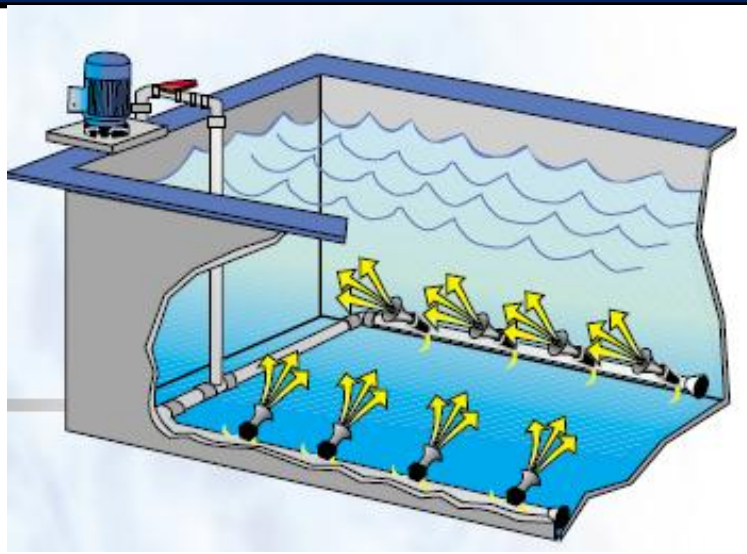
Installation of Efficient Agitation System

Installation of Efficient Agitation System

- Permit to increase current density for faster plating
- Reduce metal consumption that’s to a better thickness distribution
- Reduce Heating
- Reduce Air borne fume emission

Installation of Efficient Agitation System

- EDUCTOR provide agitation of solution by the use of a centrifugal pump and a series of Eductors placed into the tank in a way similar at air agitation system.
- Each eductor increases 5 times input pump flow rate and therefore it permits to use a relatively small
- pump to recirculate a large volume of solution in the tank.



Avoid Damper Control & Install VFD on Identified Blowers

Present System

- Installed Blowers were studied
- Some of the blowers were damper controlled
- 20 - 50 % closed damper position on 3 nos of Blowers
- Inefficient way of flow controlling
- A part of energy goes into waste
- Cause low operational efficiency

Avoid Damper Control & Install VFD on Identified Blowers

Avoid Damper Control & Install VFD on Identified Blowers

Present System

S. No	Blower	Power Consumption (kW)	Damper Controlling %
1	FMUT – 26	11.34	50 %
2	FMUT – 27	8.9	50 %
3	FMUT - 28	21.30	30 %
	Total Power Consumption (kW)	**41.60 kW**	

Avoid Damper Control & Install VFD on Identified Blowers

Proposed System

- Install VFD on Identified blowers
- Keep open loop feed back system
- Set the frequency according to flow requirement
- Operate the fans at full damper opening
- On conservative basis at least 8.50 kW of power will be saved

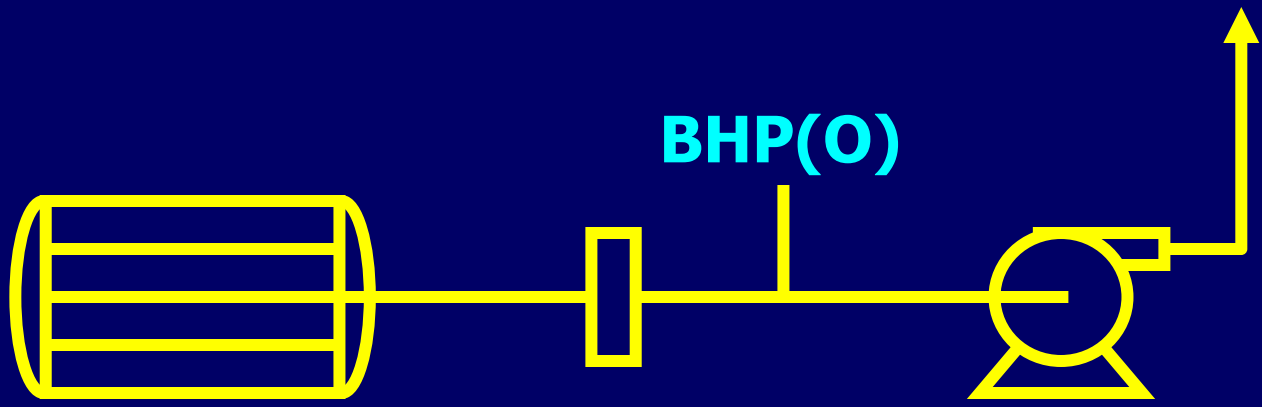
Avoid Damper Control & Install VFD on Identified Blowers

Saving = 8.5 kW x 12 hrs/day x 300 Days/Annum x 8.7 Rs/Unit

Annual Saving	**- Rs 2.67 Lakhs**
Investment	**- Rs 2.00 Lakhs***
Simple Payback	**- 9 Months**

* For 3 no. VFD for Blowers @ Rs.5000/kW

Efficiency



$$\text{Pump } \eta\,(\%) = \frac{\text{Pump output}}{\text{Input to pump [BHP(O)]}}$$

$$\text{Pump } \eta\,(\%) = \frac{\text{Flow (lps) x Head (m) x Sp. Gr.}}{102 \times \eta\,(\text{motor}) \times \text{kW (I)}}$$

Efficiency Measurement of Pumps

Optimise Flow of RO Plant High Pressure by VFD & Avoid Valve Control

Present System

- High pressure water pump at RO Plant studied in detail
- Operational parameter measured
- Capacity control methods were observed

Optimise Flow of RO Plant High Pressure by VFD & Avoid Valve Control

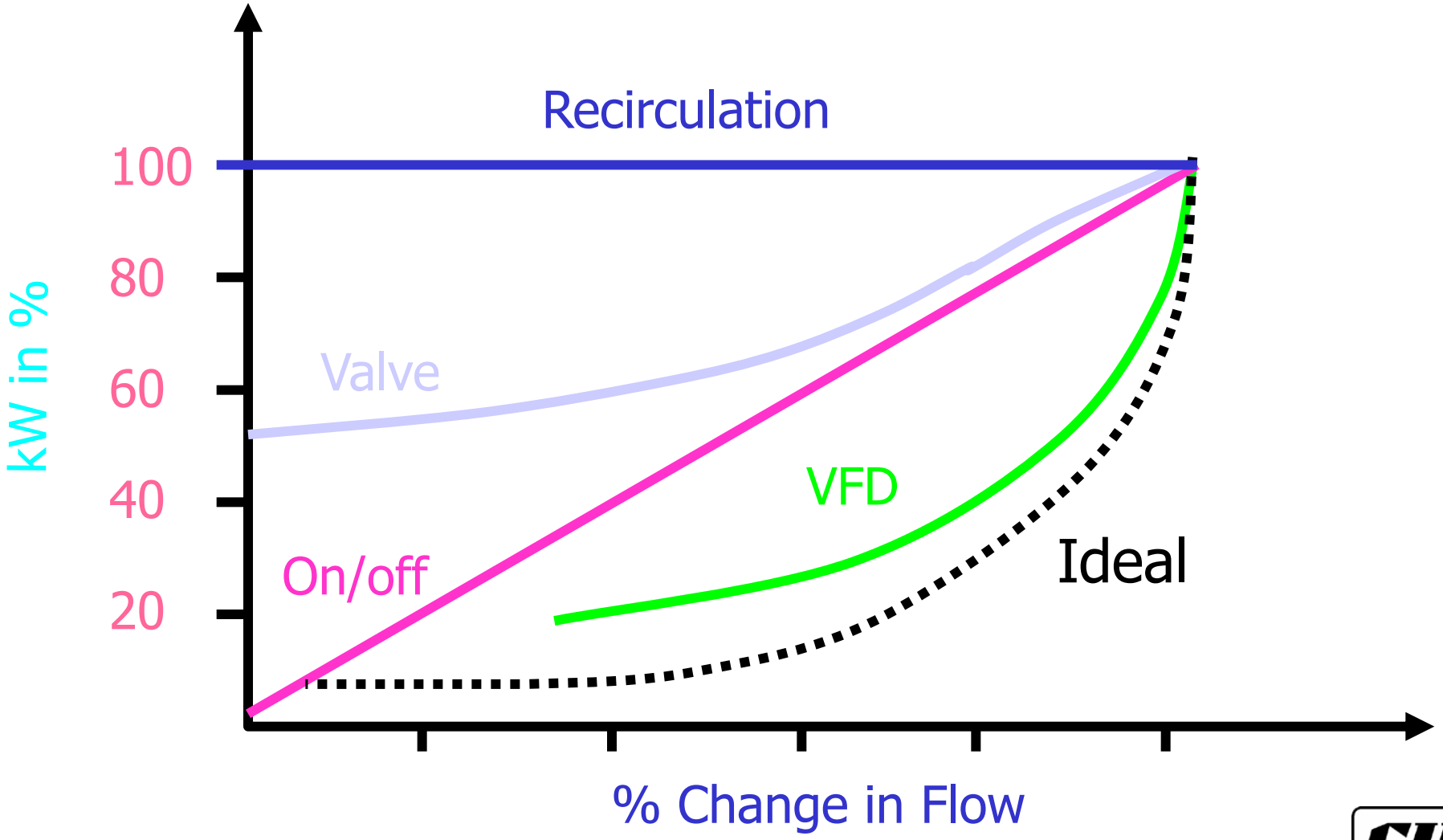
Present Concern Area

- Discharge of HP pump was throttled to about 50%
- Power Consumption – 4.70 kW
- Flow delivered – 4.0 m3/hr
- Pressure drop across valve is very high
- Inefficient method of flow controlling
- A major part of energy goes into waste
- Cause low operational efficiency

Valve Controlling RO Plant High Pressure Pump

Valve Controlling

Optimise Flow of RO Plant High Pressure by VFD & Avoid Valve Control



Optimise Flow of RO Plant High Pressure by VFD & Avoid Valve Control

Proposed System

- Install VFD on RO high Pressure Pump
- Set the frequency according to flow requirement
- Operate the pump at full valve opening
- At least 2.20 kW of power will be saved

Optimise Flow of RO Plant High Pressure by VFD & Avoid Valve Control

Saving = 2.20 kW x 12 hrs/day x 300 Days/yr x 8.70 Rs/Unit

Annual Saving	**- Rs 0.69 Lakh**
Investment	**- Rs 0.20 Lakhs**
Pay back	**- 4 Months**

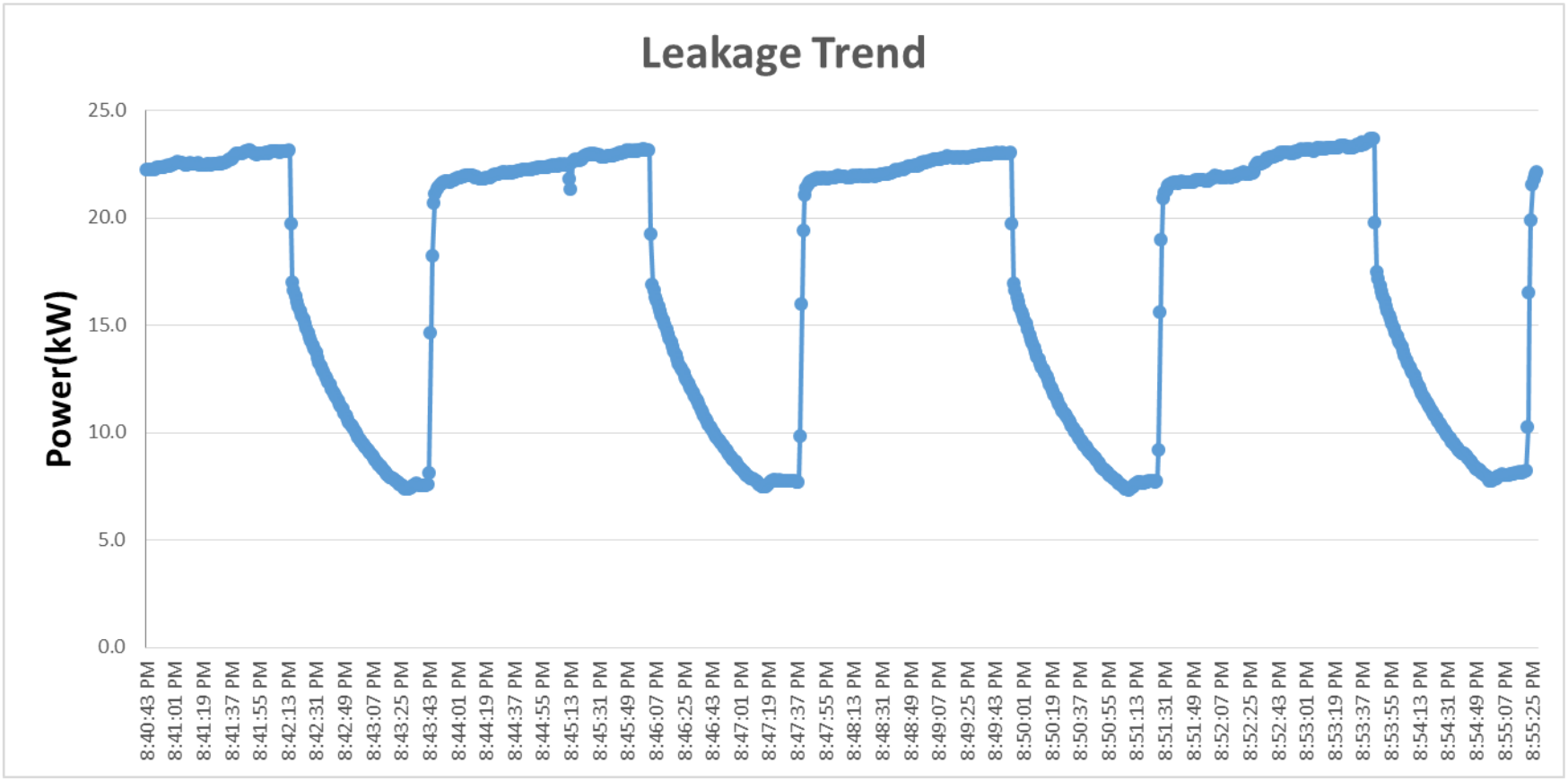
Minimise compressed air leakages in plant by rigorous maintenance

- Compressed air leakage – common in any industry
- But how much?
- Leakage is very tricky
  - ❖ Higher the pressure – More will be the leakage
  - ❖ More the leakage – Higher the pressure drop at the farthest user
- Leakage test conducted
- Compressed air leakage - Avoidable loss
  - ❖ Within a limit

Minimise compressed air leakages in plant by rigorous maintenance

- Total compressed air generation – around 300 – 350 cfm
- Estimated leakage – 60 cfm
  - Percentage leakage – around 20%
- Benchmark for air leakage
  - Leakage should not exceed 5-7% of generation
  - US and Europe benchmark 6%
- At least 40 cfm should be arrested
- Good potential for saving
- Involvement of all departments

Minimise compressed air leakages in plant by rigorous maintenance



Minimise compressed air leakages in plant by rigorous maintenance

- Maintenance & Production team to take initiatives
- Put tags on air leaking areas
- Maintenance team to arrest the leakage and remove the tags

Minimise compressed air leakages in plant by rigorous maintenance

- Bring down the leakage to 5 % in next 2-3 months
- Arrest leakage at war foot
- Conduct leakage test every week – For next2-3 months
- Make weekly report –
  - Reduction in percentage leakages
  - Number of tags put and removed
  - Reduction in number of tags in consecutive weeks

Minimise compressed air leakages in plant by rigorous maintenance

Savings = 7.20 kW x 12 Hours/Day x 300 Days/Annum x Rs. 8.70/Unit

Annual Savings	**-**	**Rs 2.25 Lakhs**
Investment	**-**	**Rs 0.50 Lakhs (for maintenance)**
Payback	**-**	**3 Months**

CII Experience of Similar Industries

- Omax Group
- Shriram Pistons
- Federal Mogul
- Indeutsch
- Hero Cycles and Supplier
- Yerik International
- FMI
- Nirankari Industries
- Lumax
- Max India
- Avon Cycle Suppliers
- Uniparts Group
- Yamaha, Bajaj
- Many More

Thank You