Capacity Building workshop

Energy efficiency improvements in compressed air and cooling water systems

27th February 2018 at Indore

Under the project
Capacity Building of Local Service Providers (LSPs)

Supported by
GEF-UNIDO-BEE Project
Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

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Workshop summary

Overview of workshop

Capacity Building workshop of Local Service Providers (LSPs) on Energy efficiency improvements in compressed air systems and cooling water systems was organized by TERI on 27th February 2018, Tuesday in association with IIF Indore Chapter under GEF-UNIDO project. Total 22 participants were present during the workshop and for the industry visit, which was organized after the workshop. Agenda of the workshop and list of participants are attached in the annexure 1 and annexure 2 respectively.

Summary of points discussed in the meeting

Mr. Nilesh Shedge welcomed the participants and thanked all the participants. He briefed about the topics which were going to be presented during workshop.

Mr. C Harinarayan also welcomed the participants and TERI team. He mentioned that, after induction furnace, air compressor and cooling water systems consumes most of the power in a typical foundry and most of the power and energy losses are observed in these systems. He encouraged participants to take advantage of TERI experts during workshop, which are made available by UNIDO for capacity building of LSPs.

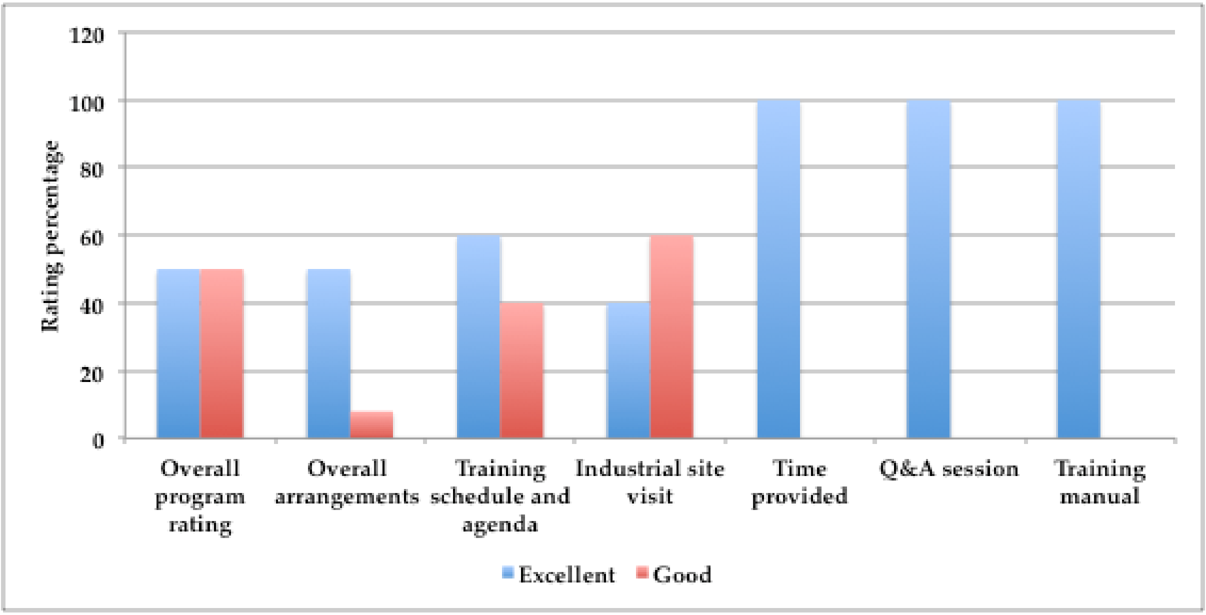
Mr. Vivek Sharma gave descriptive presentation on cooling water systems in induction furnace and how the losses occur in the pumps. He shared his experiences in Rajkot foundry cluster and gave examples of successful case studies in pumping system. He talked about the maintenance check points for cooling water circuit. He also introduced new technologies available in pumps and cooling towers and encouraged participants to adopt these technologies to achieve significant energy savings.

Mr. Nilesh Shedge gave detailed presentation on air compressor systems and shared actual case studies of implementation of new technologies in air compressors done by TERI in foundries. He talked about the different components of compressed air systems like dryers, air piping, receiver tanks and their significance in the overall system efficiency. He highlighted that air compressors are the most inefficient systems and proper sizing of the machines along with regular checks on air leakages in the plants are important points to avoid losses.

After the lunch, plant tour through the M/s Pioneer Engineering Industries was arranged, so that on site discussion about the presented systems can be done with the participants to enhance the learning experience. Workshop went in a very interactive way, participants asked many questions and TERI team as well as LSPs present satisfied those queries. In the end, Mr. Nilesh Shedge gave vote of thanks and expressed his gratitude to M/s Pioneer Engineering for offering their facility for workshop. He also thanked all the participants for taking a day for the workshop. Selected photos of the workshop and visit are attached in the annexure 3.

Feedback forms

Based on the analysis of the feedback forms received from the participants, it is observed that workshop was well received by the participants and 100% participants were satisfied with Q&A session and training module provided to them. Around 50% of participants rated training schedule and industrial site visit as "Excellent". More than 40% participants have rated overall program as "Excellent" while rest of them have rated it as "Good". About 60% of participants were satisfied with arrangements made and have rated industrial visit as "Good". Few sample feedback forms are attached in the annexure 4.



Analysis of feedback forms

Suggestions by participants

Some participants have made suggestions as follows;

1) Training modules in local language like Hindi
2) More videos should be included in presentation

Learning's by participants

Some of the topics learned by the participants and mentioned by them are listed below;

1) Sizing of air receiver
2) Air pipe selection
3) Latest technologies in air compressor and pumps
4) Importance of air dryer and its sizing
5) Significance and losses occurring due to air leakages
6) Air pressure reduction
7) Energy monitoring is equally important

Annexures

Annexure 1: Agenda of the program

Capacity building workshop

Energy efficiency improvements in compressed air and cooling water systems

Tuesday, 27 February 2018

Pioneer Engineering Industries, 75/8-9, Industrial Area, Maxi Road, Ujjain

Under the project:

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Agenda

10:00 – 10:30	**Registration**
10:30 – 10:40	**Welcome Address** Mr C Harinarayan, Chairman, IIF-Indore Chapter
10:40 – 10:50	**GEF-UNIDO-BEE project and initiatives in Indore cluster** Mr Prabhat Sharma, UNIDO Cluster Leader - Indore
10:50 – 11:50	**Energy efficiency improvement opportunities in induction furnace cooling water system** Mr Vivek Sharma, TERI
11:50 – 12:50	**Energy efficiency improvement opportunities in compressed air system** Mr Nilesh Shedge, TERI
12.45 – 13:00	**Q&A**
13:00 – 14:00	Lunch
14:00 – 16:00	**Site Visit / On-site training** Visit to Pioneer Engineering Industries
16.00 – 16:30	Feedback from participants
16:30 – 16:45	**Vote of thanks**

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Annexure 2: List of participants

S. No	Name	Organization	Mobile No	Email ID
1.	Ranjeet Yadav	pioneer engineering Ujjain	9630089074	
2.	Sunil Soner	Agaitic Group	9589444534	Suneelsoner007@gmail.com
3.	Sugash Pandey	Jash Engineering Limited	9039512126	
4.	Vijay Verma	Jash Engineering Limited	9929291092	
5.	Sangram Patil	Jash Engineering Limited	7869962233	sangram@jashindia.com
6.	Jay Singh	Jash Engineering Limited	8975003057	
7.	A N Pandey	pioneer engineering	7389941905	Anpandey1963@gmail.com
8.	Charnjeet Singh	pioneer engineering	9630079099	pioneerujain@gmail.com
9.	L D Amin	Jash Engineering Limited	9755416000	lda@jashindia.com
10.	Hari Narayan	Pioneer engineering Ujjain	9630079091	pioneerengg@gmail.com
11.	Vikas Sharma	RCS Indore	9431334442	
12.	Suresh Upadhyay	Resource Combine, Indore	9303234414	sureshupadhyay@gmail.com
13.	Aniya Kumar	Hira Industries	8109226468	
14.	Abdul Khan	Talati Tools	9993655886	abdulkhan@talatitools.co.in
15.	Mukesh K	Talati Electric	9993688866	mukesh@talatitools.co.in
16.	Rajdeo Sah	Infinite Solutions	9583182981	rajdeo@infisolutions.org
17.	Saji Joy	JMA Alloys	9826305078	jmaiyn@gmail.com
18.	Sanjay S	PIE	7389941902	
19.	Dharmendra Sharma	Emerald Indra	9926067886	
20.	Prabhat Sharma	GEF-UNIDO-BEE	7470379107	cl.indorecluster@gmail.com
21.	Vivek Sharma	TERI	9850366248	Vivek.sharma@teri.res.in
22.	Nilesh Shedge	TERI	9978601047	Nilesh.shedge@teri.res.in

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Capacity building workshop

Energy efficiency improvements in compressed air and cooling water systems

27 February 2018, Pioneer Engineering Industries, 75/8-9, Industrial Area, Maxi Road, Ujjain

S. No	Name	Organization	Mobile No	Email ID	Signature
1.	RanJeet Yadav	Pioneer Engg. Ujjain	9630089074		[signature]
2.	Suneel Soner	Ajitik Mkt. co.	9589444534	suneelsoner007@gmail.com sales1@ajaitikgroup.com	[signature]
3.	Suyash Pandey	Jash Engg Ltd.	9039512126		[signature]
4.	VIJAY VERMA	Jash Engg. Ltd.	9929291092		[signature]
5.	Sangram Patil	Jash. Eng. Ltd.	7869962233	sangram@jashindia.com	[signature]
6.	JAY SINGH	JASH Engg. LTD.	8975003057		[signature]
7.	A.N. Pandey	Pioneer Engg. Ujjain	7389941905	anpandey1963@gmail.com	[signature]

S. No	Name	Organization	Mobile No	Email ID	Signature
8.	Charanjeet Singh	Pioneer Engg Ind.	9630079099	pioneerengin@gmail.com	[signature]
9.	L. D. Amin	JASH Engineering Ltd	9755416000	lda@jashindia.com	[signature]
10	Hari narayan	Pioneer Engg Ind	9630079091	pioneerengin@gmail.com	
11	Vikash Sharma	RCS Indore	9431334442		[signature]
12	SURESH UPADHYAY	Resource Combine Indore	9303234414	suresupadhyay@gmail.com	[signature]
13	ANIYA KUMAR	HIRA INDUSTRIES	8109226468.		[signature]
14	Abdul Khan	Talati (Ingersoll Rand)	9993455888	abdulkhan@talatitools.co.in	[signature]
15	Mukesh Katiyar	Talati Electric	9993688866	mukesh@talatitools.co.in	[signature]
16	Rajdeo Sah	Infinite Solutions, Indore	9583182981	rajdeo@infisolutions.org	[signature]
17	Saji Joy	JMA Alloys	9826305078	Jmaayn@gmail.com	[signature]

S. No	Name	Organization	Mobile No	Email ID	Signature
18	Sanjay Sahni	PIE	7389941902		[signature]
19	Dharmendra Shar	Emerald Infra	9926067886		[signature]
20	Prabhat Sharma	GEF-UNIDO-BEE	7470377107	Chindore cluster@gmail.com	[signature]
21	Vivek. Sharma	TERI	9850366248	vivek.sharma@teri.res.in	[signature]
22	Nilesh. Shedge	TERI	9978601047	nilesh.shedge@teri.res.in	[signature]
23					
24					
25					
26					
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Annexure 3: Selected photographs of the event




Annexure 4: Sample feedback forms

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Capacity building workshop

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Tuesday, 27 February 2018

Pioneer Engineering Industries, 75/8-9, Industrial Area, Maxi Road, Ujjain

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Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India

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Evaluation Sheet for Participants

Feedback Form for Participants			
Parameter	*Feedback*		
	Excellent	Good	Average
How would you rate the overall programme?	✓		
How would you rate overall arrangements?	✓		
How was the training schedule and agenda?	✓		
How was the industrial site visit?	✓		
Do you think that adequate time was provided for each topic?	Yes [✓]	No [ ]	
Do you think that satisfactory answers were given to your questions during the training programme?	Yes [✓]	No [ ]	
Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
Suggestions & Recommendations for improvement:			
I am Sustificaton in your Structure and roduction, your air leagur, Power consuption I am full fill satisfied. Thank you sir.			
Name two learning, which from this programme you will be able to implement in your plant?			
I am thinking and proper way. Changing System. and Power Consuption Reduces			
Signature:	Amiyakumarpanda.		
Name of participant:	AMIYA KUMAR PANDA.		
Organization:	(UJJAIN) HIRA INDUSTRIES (6/9/Industrial area)		
Mobile No:	+91-810922 6468.		
Email ID:			

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	

Suggestions & Recommendations for improvement:

This is the vary Helping program. I was enjoy this program.

Name two learning, which from this programme you will be able to implement in your plant?

Signature: M Katiya

Name of participant: Mukesh Katiya

Organization: Talati Electric works

Mobile No: 9584240254

Email ID: mukesh@talatitools.co.in

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	
Suggestions & Recommendations for improvement:			
Name two learning, which from this programme you will be able to implement in your plant?			
Compressore air pipe line Looping (cloping system)			
Signature:	[signature]		
Name of participant:	A.N. Pandey		
Organization:	Pioneer Engg. Ujjain. M.P		
Mobile No:	7389941905		
Email ID:	anpandey1963@gmail.com		

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Do you think that the background training manual is informative and useful enough?	Yes [✓]	No [ ]	
Do you think that the discussion on EE/RE will help you in your work?	Yes [✓]	No [ ]	

Suggestions & Recommendations for improvement:

please provide some calculation in training manual.

Name two learning, which from this programme you will be able to implement in your plant?

i) Optimize the Compressor efficiency.
ii) Selection of pump. according to head and flow rate not on H.P (power rating)

Signature: Suyash
Name of participant: Suyash Pandey
Organization: Jash Engineering ltd.
Mobile No: 9039512426.
Email ID: SuyashPandey86@gmail.com.

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Annexure 5: Copy of presentations

Energy efficiency improvement opportunities in induction furnace cooling water system

Capacity building workshop

Energy Efficiency and Renewable Energy Technologies

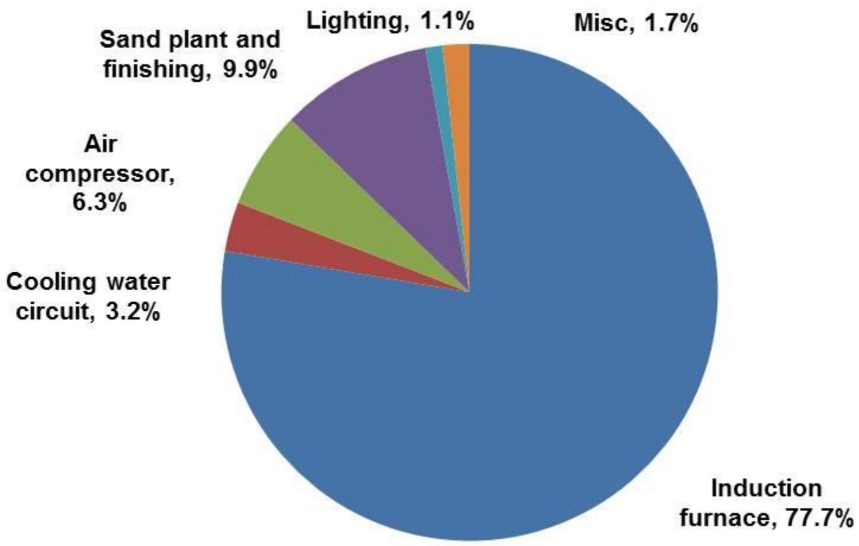
Tuesday, 27th Feb 2018

Indore

The Energy and Resources Institute

MSME Foundry

Creating Innovative Solutions for a Sustainable Future



Pump and pumping system

Power consumption (kW)

- Usually lower than rated power
- Near to or higher than rated if re-winded

Flow rate (cu.m/hour)

- Most cases it was lower than design, few cases < 60% of design flow rate

Head (m)

- Most cases pressure gauges found not functioning

Optimizing piping design

- Water velocity ~ 1.8 – 2.0 m/s

3

Approach

- Design data
  - ✓ Flow rate, m^3/hour
  - ✓ Design head, m
  - ✓ Rated power, kW
- Performance assessment
  - ✓ Estimation of hydraulic power
  - ✓ Efficiency of pump

Approach

- Hydraulic power
- Overall system efficiency= Hydraulic power, kW/ motor power, kW
- Pump efficiency, %=Overall efficiency/motor efficiency
- Operating point on the Pump system curve

Pumping system

- Parameters to be measured/monitored
  - Suction head and discharge head (Pressures), bar
  - Pump motor power, kW
  - Water flow, m^3/hr
  - Frequent check of impeller and motor bearings

Pumping system

❑ Instruments needed for in house monitoring

- ➢ Ultrasonic flow meter
- ➢ Pressure gauges for discharge and suction pressures, bar
- ➢ Single phase power meter, kW

Selection and sizing – Before installation

Pump specification
- Flow rate, lpm (litres per minute)
- Head, m
- Power rating, hp / kW
- Pump-motor set efficiency, %
  - 34%, 37%, 40%, 47%, 59%

Piping
- To minimize friction loss
- Water velocity typical design 1.8 – 2.0 m/s
- Based on economics

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Selection and sizing – Before installation

1.Each centrifugal pump has a BEP at which its operating efficiency is highest and its radial bearing loads are lowest.
2.At or near its BEP, a pump operates most cost effectively in terms of both energy efficiency and maintenance
3. Selecting a pump with a BEP that is close to the system's normal operating range can result in significant operating cost savings.

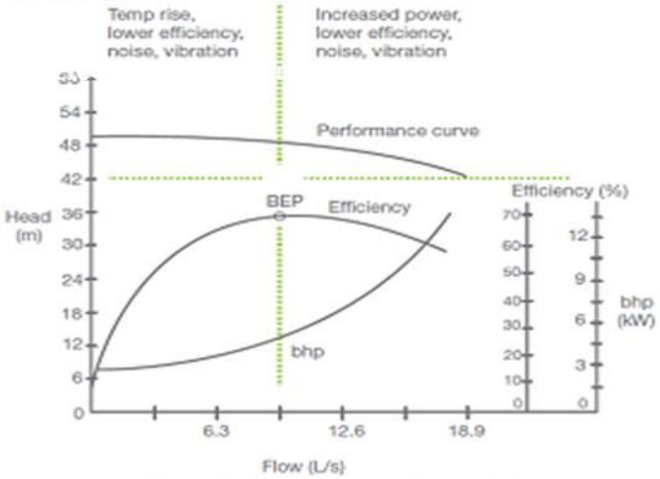
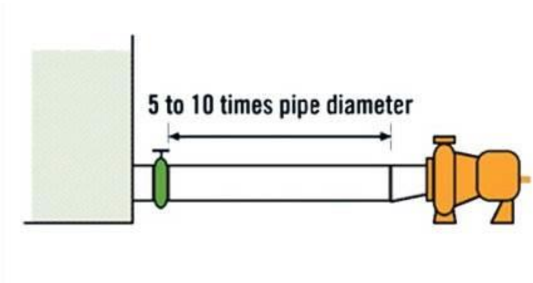


Figure 3.1.1 Pump operating point

Selection and Pipe sizing – Before installation

1. KEEP SUCTION PIPING AS SHORT AS POSSIBLE



2. PIPE DIAMETER ON SUCTION SIDE SHOULD BE EQUAL OR ONE SIZE LARGER THAN PUMP INLET

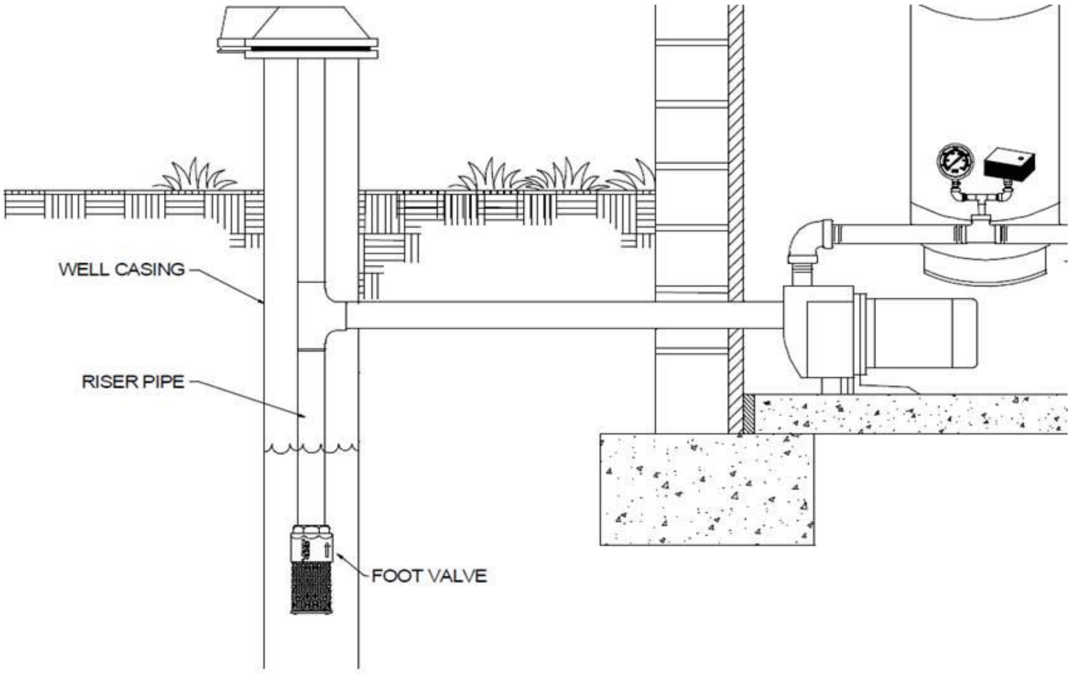
Selection and Pipe sizing – Before installation

3.ELIMINATE ELBOWS MOUNTED ON OR CLOSE TO THE INLET NOZZLE OF THE PUMP (I.E TO AVOID BENDS IN SUCTION PIPES TO ELIMINATE PRESSURE DROP)

Pumping System

Pressure guage for pressure indication

Selection and Foot valve – Before installation



Selection and Foot valve – Before installation

Foot Valve Location

Foot Valve Location	Recommended Foot Valve Installation:
Max. 25 feet or less below pump suction inlet	Install Foot Valve in a vertical position for best and most efficient operation.

Pumping System

- Eliminate unnecessary uses

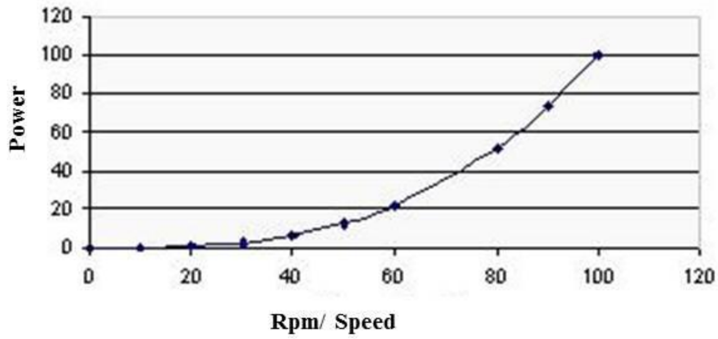
Energy Efficiency Measure	Typical % improvement in energy efficiency over current Pump system efficiency practice		
	% Improvement over LOW eff. base case	% Improvement over MED eff. base case	% Improvement over HIGH eff. base case
Use pressure switches to shut down unnecessary pumps	10.0%	5.0%	2.0%
Isolate flow paths to nonessential or non-operating equipment	20.0%	10.0%	5.0%

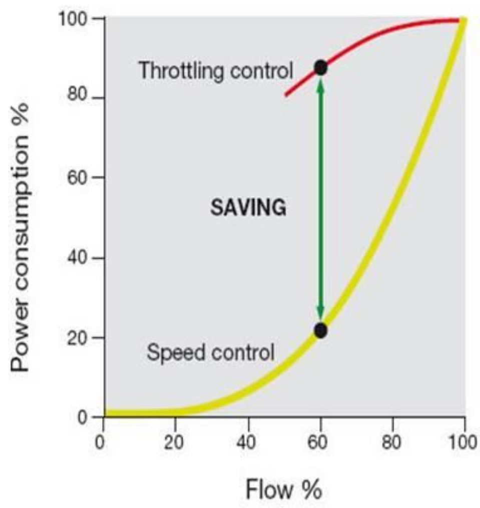
Pumping system

- Upgrade System Maintenance

Energy Efficiency Measure	Typical % improvement in energy efficiency over current Pump system efficiency practice		
	% Improvement over LOW eff. base case	% Improvement over MED eff. base case	% Improvement over HIGH eff. base case
Fix Leaks, damaged seals, and packing	3.5%	2.5%	1.0%
Remove scale from components such as heat exchangers and strainers	10.0%	5.0%	2.0%
Remove sediment/scale buildup from piping	12.0%	7.0%	3.0%

Pumping system





- ✓ For variable loading, like in case of pump with a variable load can reduce it flow by lowering its RPM and generate substantial saving

Pumping System

- Meet variable flow rate requirement w/o throttling or bypass

Energy Efficiency Measure	Typical % improvement in energy efficiency over current Pump system efficiency practice		
	% Improvement over LOW eff. base case	% Improvement over MED eff. base case	% Improvement over HIGH eff. base case
Install variable speed drive	25.0%	15.0%	10.0%
Replace pump with more energy efficient type	25.0%	15.0%	5.0%
Replace motor with more energy efficient type	5.0%	3.0%	1.0%
Initiate predictive maintenance program	12.0%	9.0%	3.0%

Pumping System

Common Problem	Potential Measures to Improve Efficiency
Unnecessary demand on pumping system	Reduce demand on system
Oversized pumps	Select pump that operates near to BEP Change impeller Trim impeller Fit multiple-speed pump Use multiple-pump arrangements Fit lower speed pump/ motor
Pump wear	Pump maintenance
Less efficient impeller	Change impeller
Inefficient pump throttling controls	As for oversized pumps Fit adjustable or variable-speed drive
Inefficient piping configuration	Change piping inefficiencies
Oversized motor	Change motor
Inefficient motor	Change to high-efficiency motor
Lack of monitoring and/ or documentation	Install monitoring and conduct survey

Pumping System

ECM:Replacement of monoblock pump with EE monoblock multistage pump for coil cooling

Recommended Pump Specification	Units	Coil cooling pump for Furnace
Flow rate	m^3/hour	14.4
Differential Head	m	40.0
Efficiency	%	51.1%
Power proposed pump	kW	3.07
Power saving	kW	1.43
Operating period	hour	4,800
Annual Energy saving	kWh/year	6,856
Cost saving		
Annual Monetary Saving	Rs lakh / year	0.42
Investment	Rs lakh	0.55
Simple Payback Period	years	1.3

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Pumping System

High efficiency Pump

Flow characteristic is improved and power consumption reduced

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Pumping System

17,280 kWh/year

0.45 Years Simple Payback Period

17.0 tCO_2/ year

Replacement of old single stage pump with new EE horizontal multistage pump

Pumping System

Old inefficient monoblock pump

Energy efficient multistage monoblock pump

Cooling Tower

Drift eliminators: These capture water droplets entrapped in the air stream that otherwise would be lost to the atmosphere.

Air inlet: This is the point of entry for the air entering a tower. The inlet may take up an entire side of a tower–cross flow design– or be located low on the side or the bottom of counter flow designs.

Louvers: Generally, cross-flow towers have inlet louvers. The purpose of louvers is to equalize air flow into the fill and retain the water within the tower. Many counter flow tower designs do not require louvers.

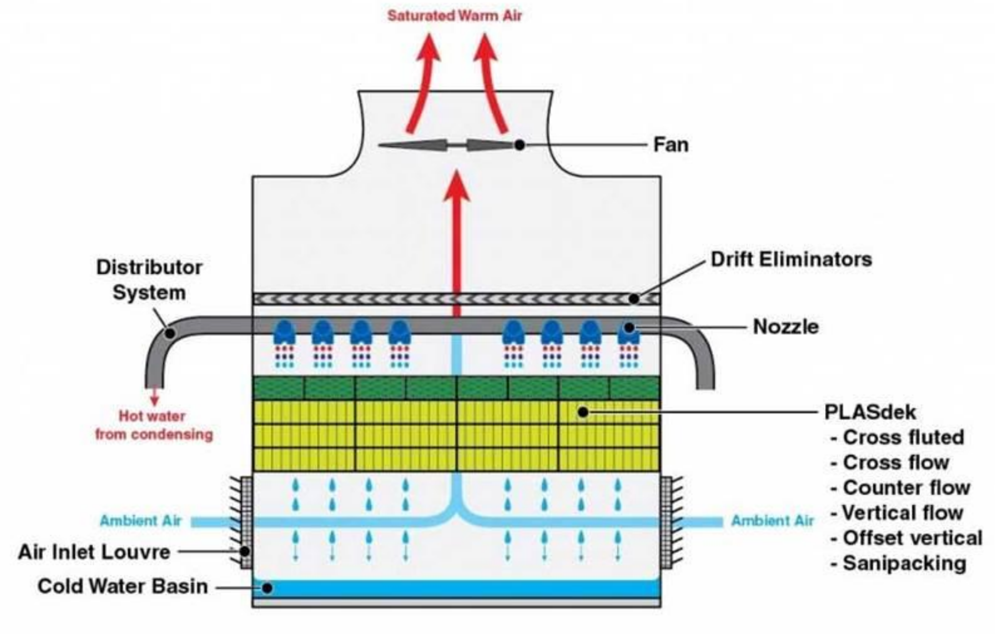
Nozzles: These provide the water sprays to wet the fill. Uniform water distribution at the top of the fill is essential to achieve proper wetting of the entire fill surface. Nozzles can either be fixed in place and have either round or square spray patterns or can be part of a rotating assembly as found in some circular cross-section towers.

Fans: Both axial (propeller type) and centrifugal fans are used in towers. Generally, propeller fans are used in induced draft towers and both propeller and centrifugal fans are found in forced draft towers. Depending upon their size, propeller fans can either be fixed or variable pitch.

A fan having non-automatic adjustable pitch blades permits the same fan to be used over a wide range of kW with the fan adjusted to deliver the desired air flow at the lowest power consumption.

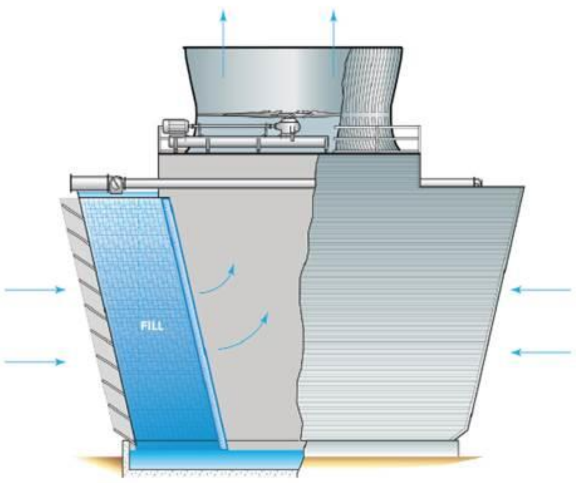
Automatic variable pitch blades can vary air flow in response to changing load conditions.

Cooling Tower

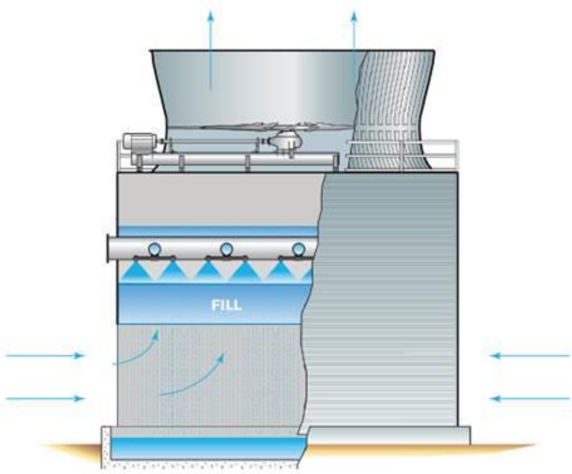


Counterflow Tower

Cooling Tower



Crossflow Design



Counterflow Design

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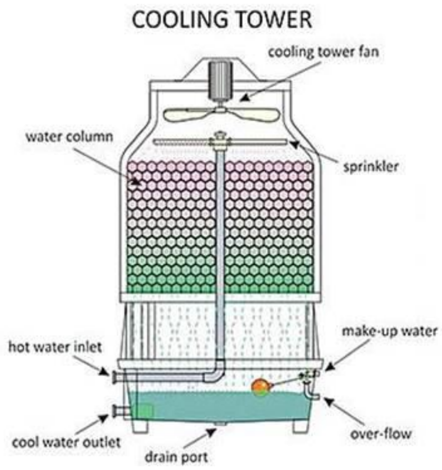
Cooling Tower

Operating Parameters of Cooling tower

S No	Parameter
1	Ambient dry bulb temperature (°C)
2	Ambient wetbulb temperature (°C)
3	Average Cooling water inlet temperature (°C)
4	Average Cooling water outlet temperature (°C)
5	Average Cooling duty water flow rate (m^3/hour)



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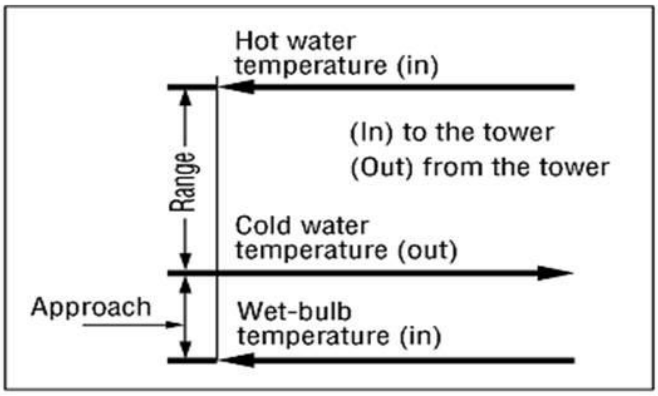
Cooling Tower

Performance assessment of cooling tower



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Cooling Tower

Range = Entering cooling water temperature(return from process) – Leaving water temperature (supply to process)
High range means good performance of cooling tower

Approach = Leaving cooling water temperature – Ambient wet bulb temperature
Low Approach means good performance of cooling tower

Effectiveness = Range /(Range+ Approach)
High effectiveness means good performance of cooling tower

Heat rejected in TR = (Mass flow rate x specific heat x range)/3024
High cooling capacity means good performance of cooling tower

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Cooling Tower

Energy efficiency opportunities in cooling tower

1.Selecting a cooling tower (Approach closer to WBT)
2.Fills
3.Pump and water distribution system
4. Fan and Motors

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Cooling Tower

1. The fill is merely a media by which more water surface is caused to be exposed to the air(increasing the rate of heat transfer), and which increases the time of air-water contact by retarding the progress of the water (increasing the amount of heat transfer).

2. Splash-fill causes the flowing water to cascade through successive elevations of parallel "splash bars." Equally important is the increased time of air-water contact brought about by repeated interruption of the water's flow progress.

3. Film-fill has gained prominence in the cooling tower industry because of its ability to expose greater water surface within a given packed volume.

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Cooling Tower

Energy Efficiency opportunities in cooling tower

Selecting a cooling tower

Depending on relationship between Approach and wet bulb temperature.
Use drift eliminators to minimise drift loss

Fills

	Splash Fill	Film Fill	Low Clog Film Fill
Possible L/G Ratio	1.1 – 1.5	1.5 – 2.0	1.4 – 1.8
Effective Heat Exchange Area	30 – 45 m^2/m^3	150 m^2/m^3	85 – 100 m^2/m^3
Fill Height Required	5 – 10 m	1.2 – 1.5 m	1.5 – 1.8 m
Pumping Head Requirement	9 – 12 m	5 – 8 m	6 – 9 m
Quantity of Air Required	High	Much low	Low

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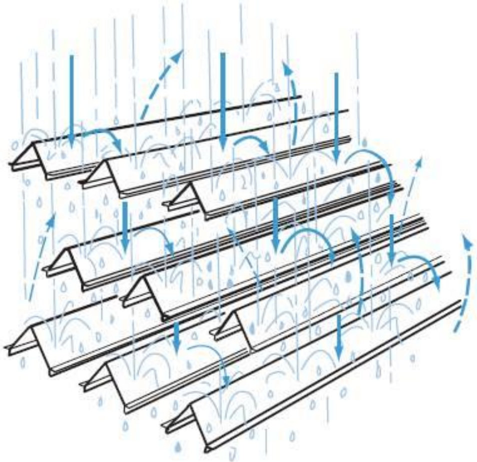
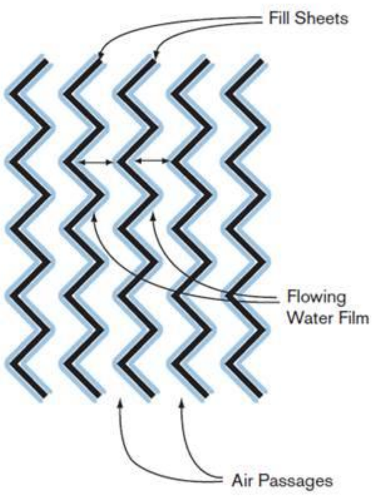
Cooling Tower



Splash Fill



Film Fill

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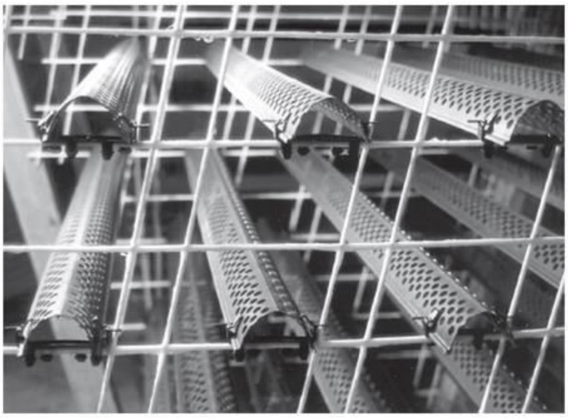
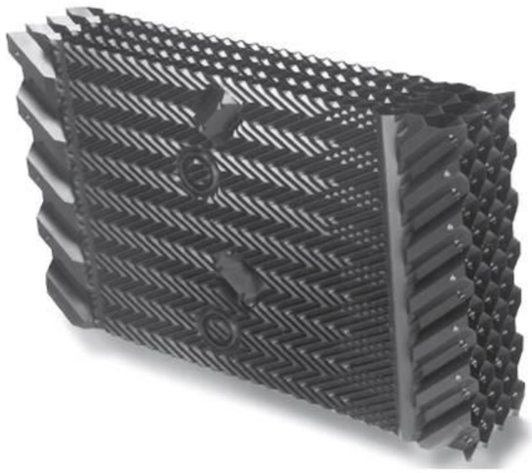
Cooling Tower



Splash Film Installed



Film Fill Installed

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Cooling Tower

Energy Efficiency opportunities in cooling tower

Fans and Motors

1.Fan must overcome system resistance, pressure loss : impacts electricity use

2.Fan efficiency depends on blade profile

Replace metallic blades with FRP blades (15-20% energy saving potential)

3.Use blade with aerodynamic profile (Fan efficiency 85-92%)

4.Use IE3 premiu standard motors for cooling tower fan motors (3-6% energy saving potential)

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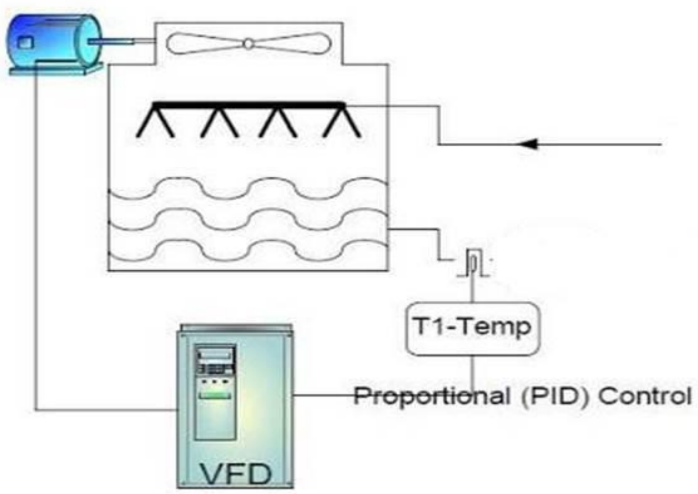
Cooling Tower



Temperature control automation for cooling tower

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Cooling Tower

Induced Draft Cooling Tower

Forced Draft Cooling Tower

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Be the change you want to see in the world

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Capacity building workshop
Energy efficiency improvements in compressed air systems

Wednesday 27th February 2018

Indore

Nilesh Shedge, TERI

The Energy and Resources Institute

Contents

- Understanding of air compressors
- Understanding of compressed air **system**
- Energy consumption & cost effectiveness
- Check points in compressed air system
- Energy savings best practices
  - Notes
  - Examples
  - Dos & Donts
- Select case studies

Introduction

Reciprocating air compressor

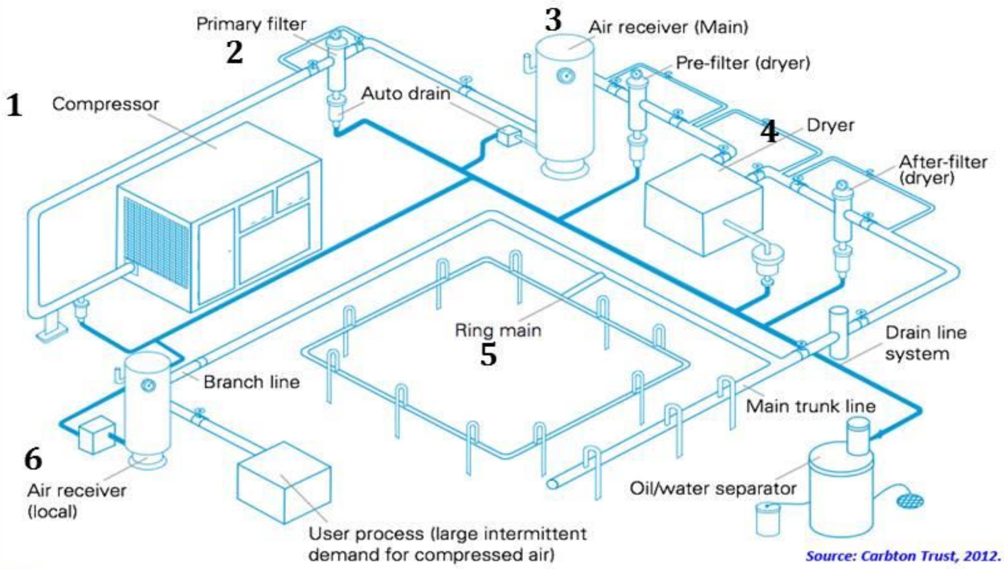
Compressed air systems are quite inefficient and only 10-30% of energy reaches the point of end-use

Source: Compressed air system, Bureau of Energy Efficiency

Type of air compressors

Screw air compressor

Components of compressed air system



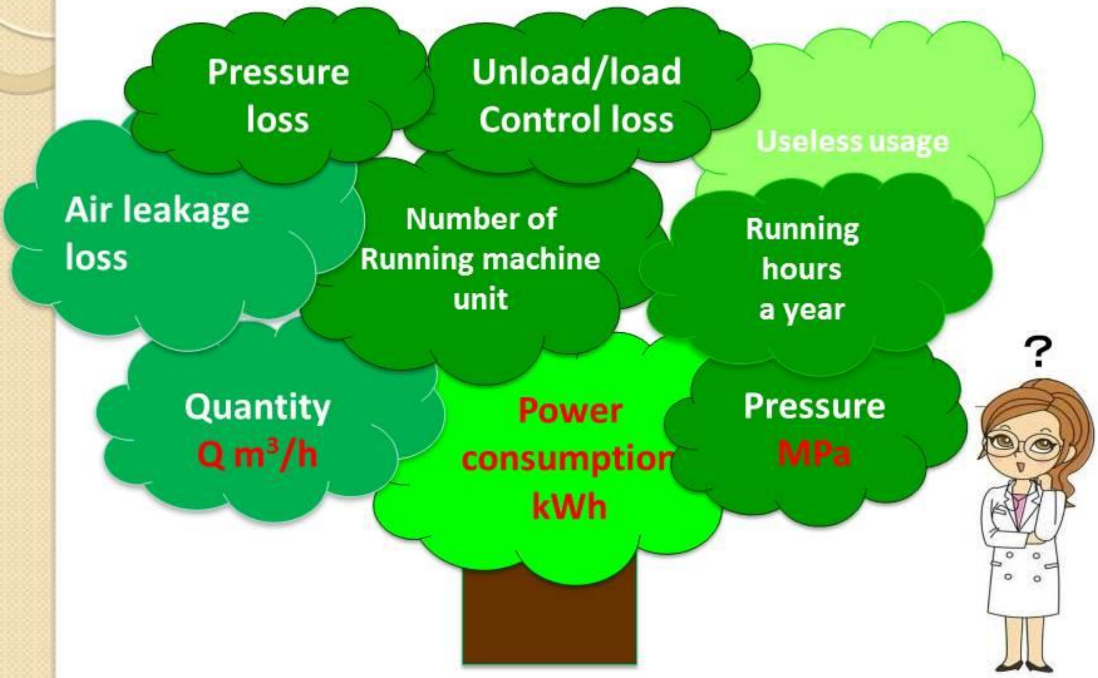
Source: Carbton Trust, 2012.

Summarizing understanding of compressed air system

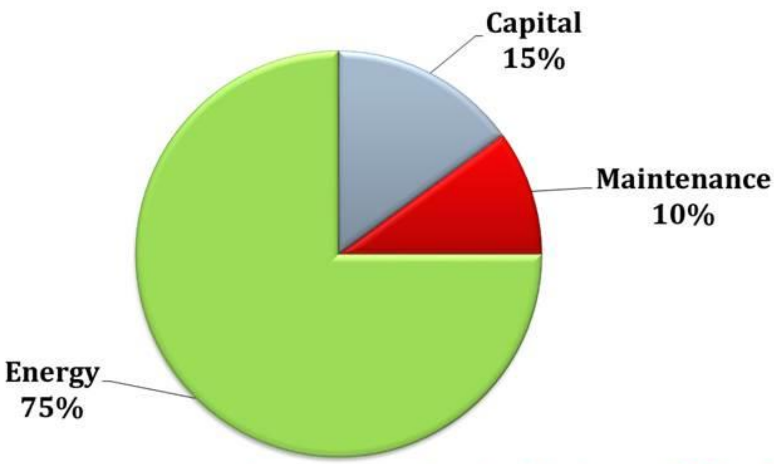
- Air compressor – converts atm air into pressurized air
- Receiver tanks – used for storage
- Dryers – used for removing water vapours
- Filters – used for cleaning or removing any particles
- Pipes – used for transporting
- Valves – used for control
- Pressure gauges – used for monitoring pressure levels
- Flow meters – used for monitoring volume

Presentation by Chetankumar Sangole, TERI

What is Energy consumption of air compressor?



Life cycle costing



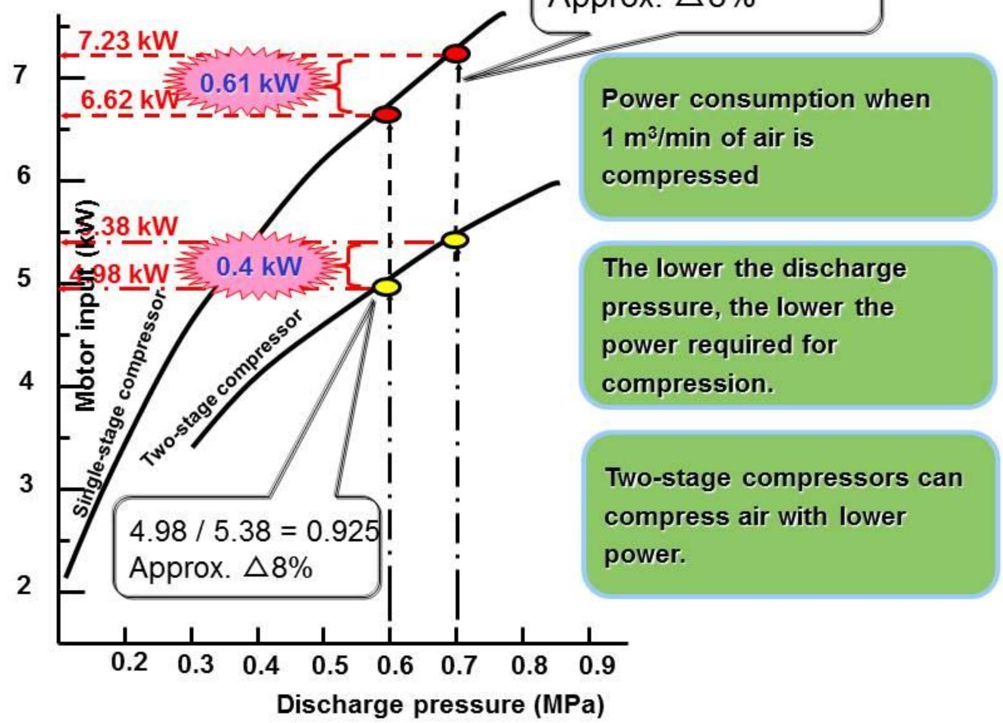
By proper management energy saving to the tune of 10 – 50% can be achieved in a compressed air system

Energy savings best practices

- Pressure settings for reciprocating, screw type (energy savings 8 to 16 %)
- Cool & fresh air at suction (energy savings 3%)
- Air leakages reduction (energy savings 10 to 40 %)
- Effective use of compressed air (energy savings 3 to 7%)
- Pipe sizing & design (savings 7 to 20 %)
- Type of air compressor and overall condition (savings 7 to 15 %)
- Inverter type (VFD driven) air compressor (savings 11 to 43 %)

Pressure setting optimization:

Characteristics of Air Compressor (positive displacement compressor)



Air compressor location

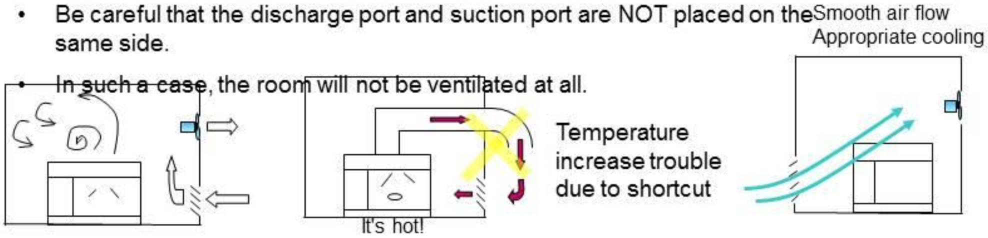
- Proper Ventilation
- Dust free location
- Platform for Machine

Presentation by Chetankumar Sangole, TERI

- Proper Ducts for machines
- Air filters on windows

Notes for Duct Installation Work

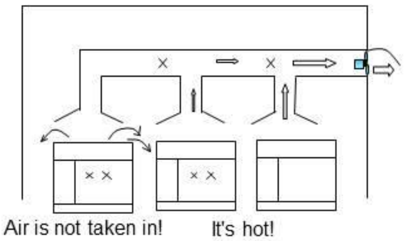
- Provide a suction port low on the wall on the opposite side of the discharge port.
- Be careful that the discharge port and suction port are NOT placed on the same side.
- In such a case, the room will not be ventilated at all.



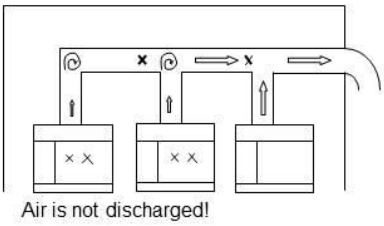
Air will not be discharged properly, leading to a failure.

The same rule applies when air is discharged through a duct using a blower or ventilator.

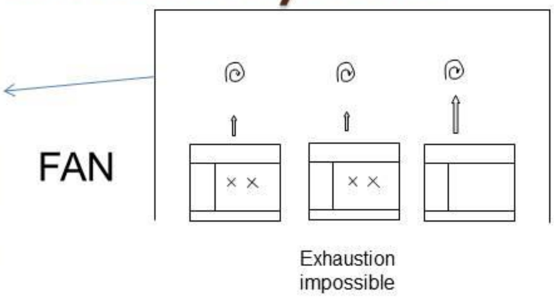
Even with forced exhaust, if ducts are combined into a single duct, balance will not be maintained. Overflowing discharge air may be taken into the neighbor machine.



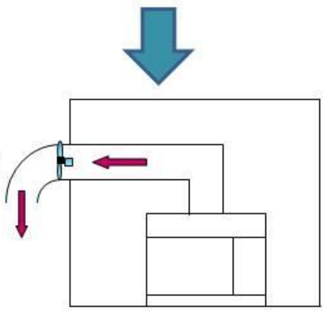
Be sure to provide a separate discharge duct for each compressor. Do not share a discharge duct for 2 or 3 compressors.



Improved exhaust system



- It is an open room; therefore, the existing exhaust fan does not demonstrate any exhaust capacity.
- If a screw type is used, please install an exhaust air duct as shown in the figure below.
- Increase in the compressor room temperature will result in the degraded compressor performance
- For example, a temperature increase of 3 deg. C. will degrade the compressor's performance by 1%.
- If the suction pressure drops; the efficiency of the compressor will also be reduced.



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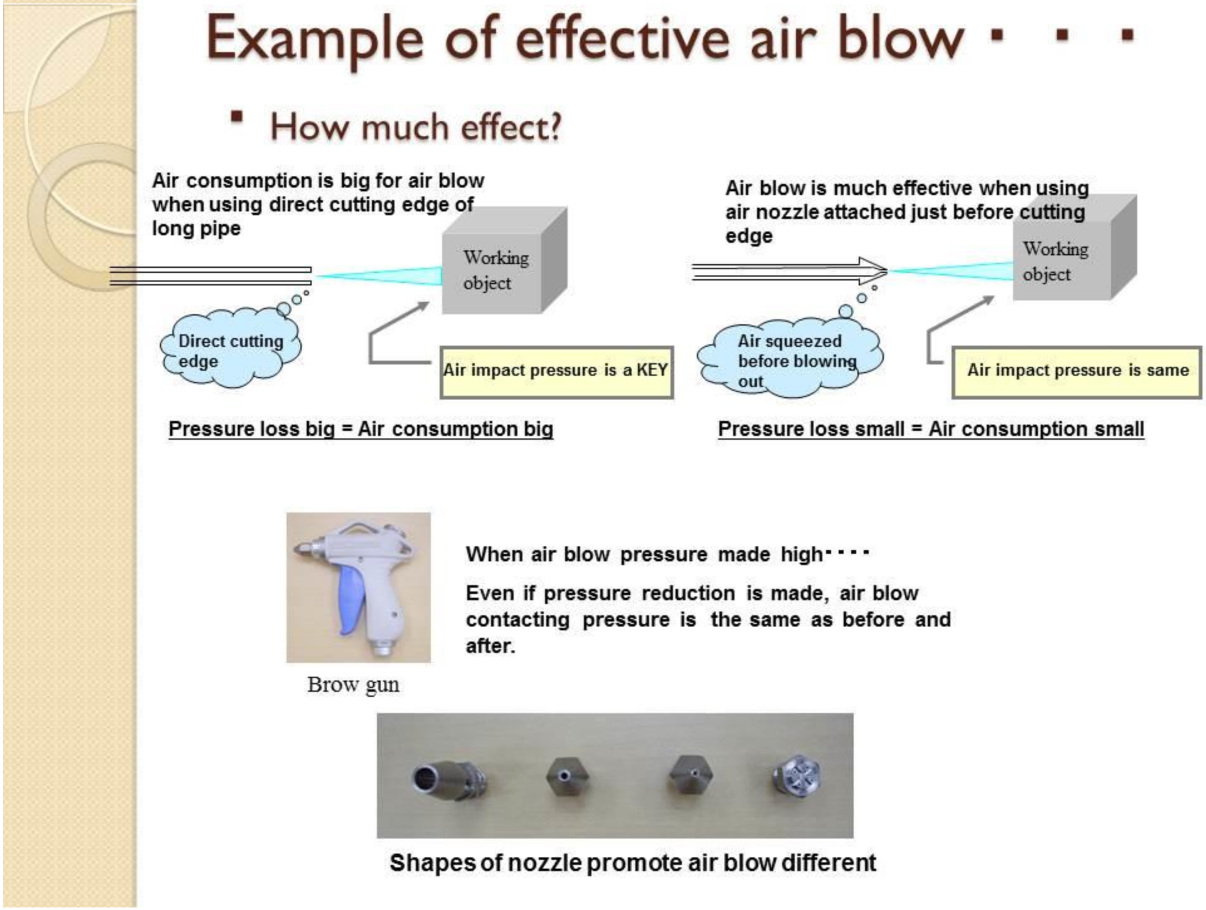
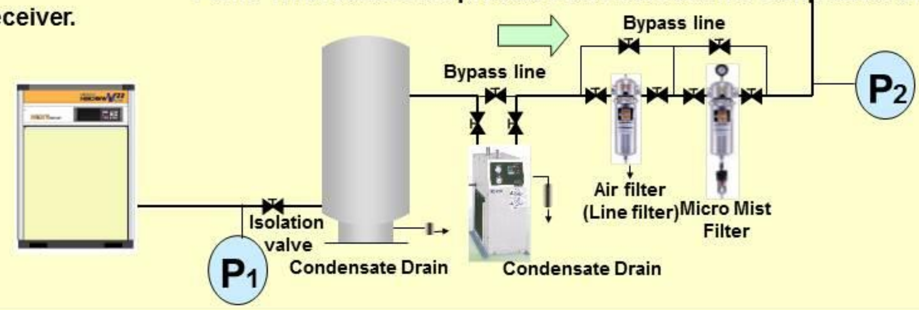
Air leak points (select cases)
Leakage cases
10-20% of leakage exists in a plant on average
point ; valves
１７． ４L/min
point ; air gun
４９． ２L/min
point ; hoses
５９． ４L/min
point ; hose joint
５９． ４L/min
point ; regulator
７１． ７L/min
point ; coupler
２７． ７L/min

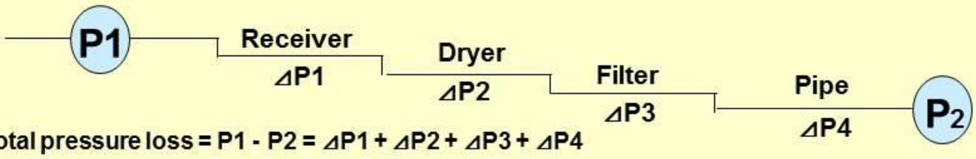

Example of effective air blow ・ ・ ・
How much effect?
Air consumption is big for air blow when using direct cutting edge of long pipe
Working object
Direct cutting edge
Air impact pressure is a KEY
Pressure loss big = Air consumption big
Air blow is much effective when using air nozzle attached just before cutting edge
Working object
Air squeezed before blowing out
Air impact pressure is same
Pressure loss small = Air consumption small
When air blow pressure made high・・・・
Even if pressure reduction is made, air blow contacting pressure is the same as before and after.
Brow gun
Shapes of nozzle promote air blow different

Pressure loss

Any system causes a pressure loss.
Think of how to minimize the loss.

Recommended layout (reference example): Compressor -> Receiver -> Dryer -> Filter
Point: This reduces the pressure loss between the compressor and the receiver.





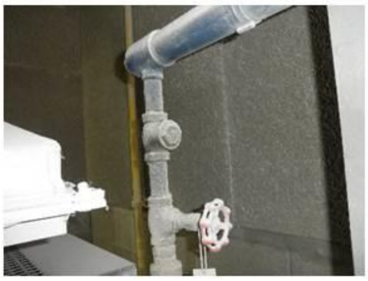
Total pressure loss = P1 - P2 = ⊿P1 + ⊿P2 + ⊿P3 + ⊿P4

To achieve a higher rate of energy saving, select a pipe having a diameter one size larger than the compressor's discharge pipe diameter. Also, select air dryers and filters having a capacity one size larger.

Contents of Improvement Measures - Examination of Piping Work



- Example of pipes having many valves or bends generates resistance, causing pressure loss.
- Change the type of the valves (to the one with low resistance) or reduce bends as much as possible


- A pipe narrowed immediately after the air dryer. Generates resistance, causing pressure loss.
- A riser pipe. Causes a backward flow of condensate, leading to an increasing number of mechanical troubles.

Examples of problematic piping

- Drain trap attached just behind the compressor.
- Clogging of the pipe may be caused.
- Also, it increases the resistance at the immediate back of the compressor, which not only causes energy loss but also makes control difficult.

- Rust of receiver tank and internal corrosion.
- Internal resistance increases.
- It is recommended that a receiver tank with internal treatment with epoxy or similar be selected.

- Rubber hose connected from the compressor to the discharge pipe.
- It causes a large internal resistance and is inappropriate in terms of energy saving.
- Rubber hoses generate resistance higher by 20% or more than steel pipes and are not inappropriate.

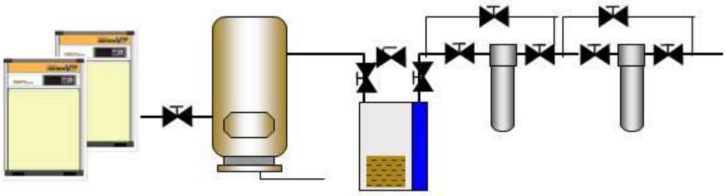
Examples of recommended piping

Provide a drain plug for a riser pipe.

Recommended collecting pipe

Riser pipe installed from above

Large-bore pipe and receiver tank with adequate capacity



Recommended equipment and pipe flow

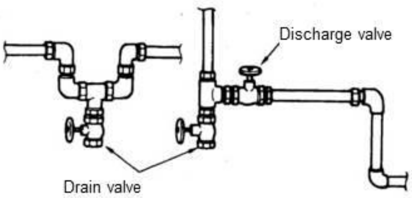
Drain valves

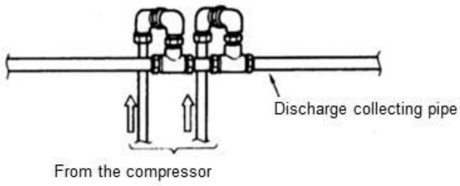
Solenoid control drain valve

Automatic Drain Valve (mechanical type)

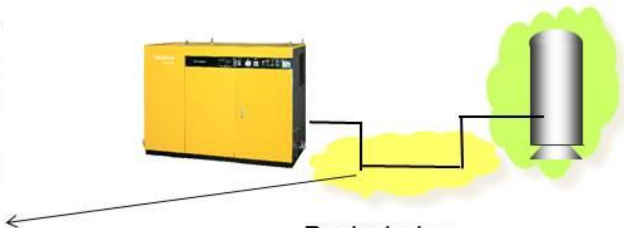
Notes for Piping Work

1. **Be sure to provide a drain connection for a riser pipe. Installation to a collecting pipe must be made from above to prevent backflow. (Similarly, branch pipes must be installed from above.)**
2. **For a collecting pipe, give an inclination (1/100) from the upstream to the downstream. Attach a drain plug at the end of each pipe.**



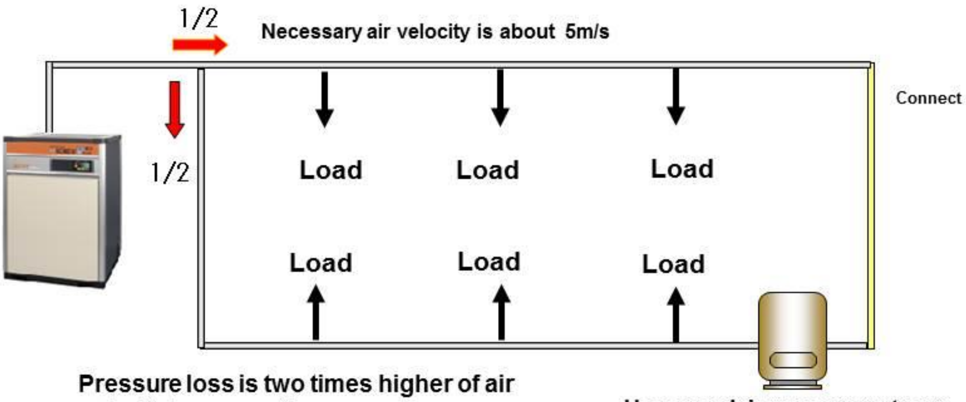


3. **Buried piping makes it difficult not only to detect air leakage but also to repair. Therefore above-ground piping must be adopted. If buried piping is inevitable, install the pipes in a pit.**



Buried pipe

Changing air velocity through internal pipe ・・・ loop piping



Pressure loss is two times higher of air velocity in proportion

Pressure loss is minimized to one quarter, only to make loop piping!

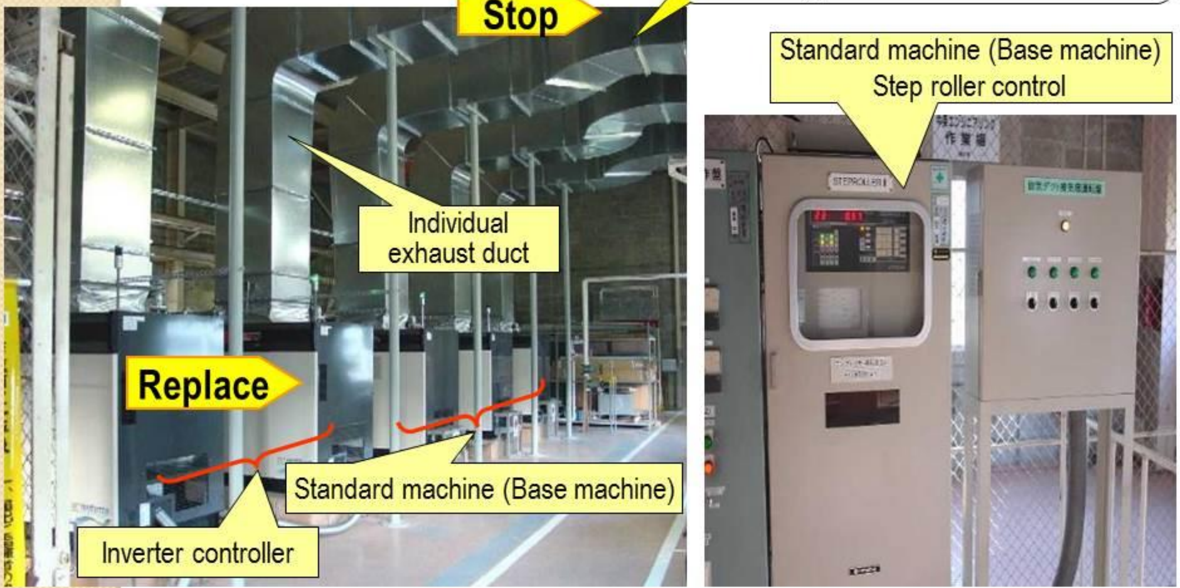
How much improvement can be made with loop piping?

Pressure loss become one quarter, only to make loop piping if there is imbalance among load.

Select dos & don'ts – air compressor area

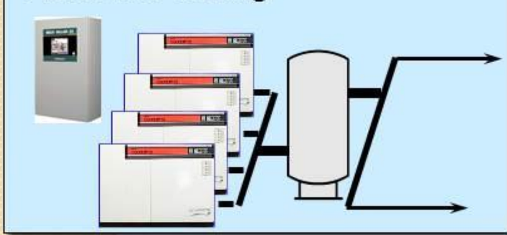
Example of Energy-Savings 【Improvement of Air Compressor】

Screw compressor
Standard machine: 75kW × 3 units
Inverter type machine: 75kW × 2 units

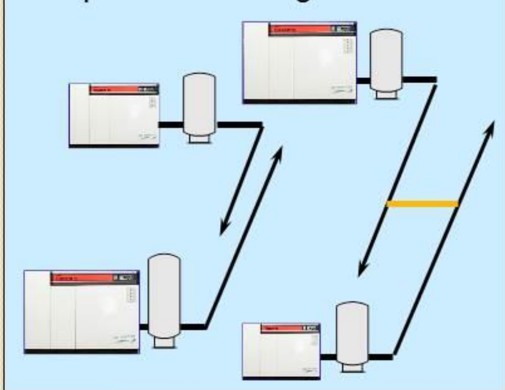


Which Is More Energy Saving - Collective or Independent?

Collective setting



Independent setting



Setting Type	Collective	Independent
Daily Maintenance	Easy	Need to assign staff for each line
Regular maintenance	Easy	Need maintenance in each line
Pressure flexibility	Need to operate with the highest pressure equipment (Some loss)	Able to apply appropriate pressure for each piece of equipment (Min. loss)
Pressure loss	Some Piping tends to be long	Small Piping can be short Adjustment can be made in each line
Air leak	Affects whole air supply system	Affects only line with the leakage
Multi-unit Control	Available	Unavailable

Energy saving can be made using inverter compressor for both collective & independent settings.

1. Collective setting: Inverter compressor absorbs load fluctuation
2. Independent setting: Easy to accomplish energy saving

Air filters cleaning

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Presentation by Chetankumar Sangole, TERI

Exhaust Duct for Screw Air Compressors

Air receiver size

100CFM=1000litres

Air compressor

Base case

Before Air Manager	Total run hr/day	Off time hrs	Total time hr/day	Energy consumption (kWh/day)
Screw compressor (45 kW)	16	0.7	16.7	764
Screw compressor (30 kW)	7	7.7	14.7	154
Screw compressor (22 kW)	14	7	21	302
		Total		1220

Implementation

After Air Manager	Total Run hrs	Off time hrs	Total Time hrs	Per day energy consumption, kWh
Screw compressor (45 kW)	10	13.5	23.5	495
Screw compressor (30 kW)	11	12.6	23.6	301
Screw compressor (22 kW)	17	6	23	331
		Total		1127

Estimated energy saving: 27685 kWh/annum

Implementation- Case Studies

81,776 kWh/year

1.2 Years Simple Payback Period

Rs. 6 lakh/year

Replacement of existing screw air compressor with new EE screw air compressor with VFD and Permanent Magnet Synchronous (PMSN) motor

Implementation- Case Studies

113,002 kWh/year

1.5 Years Simple Payback Period

Rs. 8 lakh/year

Replacement of existing screw air compressor with new EE screw air compressor with VFD and Permanent Magnet Synchronous (PMSN) motor

Implementation- Case Studies

38,965 kWh/year

1.4 Years Simple Payback Period

38.2 tCO_2/ year

Replacement of existing reciprocating air compressor with new energy efficient VFD based screw air compressor

Implementation- Case Studies

9,851 kWh/year

Immediate Payback

9.6 tCO_2/ year

Arresting the air leakages in the compressed air distribution network in the plant (use of crimped hose joints)


Thank you…!!!
The Energy and Resources Institute
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