WEL-COME

EnCon in Compressed Air Systems

By
TATA Motors Ltd. CVBU, Pimpri, Pune

Facilitator
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Energy Manager

Presentation by
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Assistant General Manager (CPED & Environment)
**Company Profile**

- **Spread of Plant**: 568 acres.
- **Production Level**: 178,696 Eq.Veh (PUNE Commercial Vehicle)
- **Total Sales turn over**: Rs. 38,364 Crores (Incl. Pune, Jamshedpur, Lucknow & Pantanagar)
- **Total shop Sub-stations**: 63 Nos.
- **Total connected load**: 172 Mw.
- **Contract demand**: 55,372 KVA. (Incl. CVBU & PCBU)

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**TATA Motors's Manufacturing Process**

- **Vehicle Assembly Line**
  - **Chassis Assembly**: Finished product for Vehicle Assy.
  - **Axle Assembly**: Finished product for Vehicle Assy.
  - **Gear Box Assembly**: Finished product for Vehicle Assy.
  - **Painting**: Vehicle Assembly
  - **Engine Assembly**:
  - **Cowl Assembly**:
  - **Chassis Assembly**:

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TATA Motors, CVBU Pune: ENCON STRATEGY

➢ Eliminate wastages of resources by maximising "NO INVESTMENT" projects & emphasize on improved productivity of all operations & processes.

➢ Adopt the faster pace for deployment of all ideas in all areas of business thro’ maximizing involvement of people

➢ Focus on accomplishing investment projects with payback less than 2 years at faster pace & deploy across all TATA Motors plants Jamshedpur, Lucknow & Pantanagar.

➢ Share the best practices & performances with vendors, suppliers, partners & other industries & assist them to reduce their ENERGY INTENSITY ..... => ENERGY KAIZEN
Trend of Reduction in Specific Energy Consumption
- Electricity -

Sp. Energy Cons. (Kwh/Eq.Veh)

559 536 561 531

5.01% Reduction over the year 2006-07

Trend of Reduction in Specific Energy Consumption
- Fuel -
(LDO + FO + Propane)

SpFuel Consum. (Mkcal/Eq.Veh.)

0.3897 0.3712 0.3500 0.3091

20.68% Reduction over the year 2006-07
**Roadmap to achieve Benchmark / Global best :-**

Based on above results of National & International companies, TATA Motors CVBU plant is “Highly Energy Efficient Automobile company”. As part of continual improvement we would further reinvestigate all our processes to achieve further cost reduction by reducing Energy consumptions at all levels.

**To sustain the best achieved level.**

We are following robust process of assessment of performance vis a vis comparative information / benchmark from different organisation & standards.

**Our emphasis would be:-**

1. To optimise the use of Resources while using appropriate and innovative method to reduce the energy consumption in all the areas of operation on the continuous basis through evaluation and improvement.
2. Use of Latest technologies wherever possible.
3. Maximize the use of non-conventional Energy resources wherever possible.
4. Under climate change initiatives, assessment & abatement measures are being taken to reduce carbon foot print through resource conservation.
Compressed Air Management

Planning for Selection of Compressor & Associated equipments

Planning of compressed air pipeline in Compressor house & Shop

Installation of Compressor & Associated equipments & pipeline

Operation & Maintenance of the Compressor installation

Management Tools

TPM (Total Productive Maintenance)

ISO 14001

SQDCM

5 - S

Management tools Adopted & Implemented

Six Sigma

Poka Yoke

TS 16949

TBEM (Tata Business Excellence Model)
Spread of the TML - Compressed Air System

**Spread of the TML CVBU - Compressed Air System**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>27,500CFM</td>
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</tr>
<tr>
<td>Centrifugal Compressor</td>
<td>2*5500CFM</td>
</tr>
<tr>
<td>4*3000CFM</td>
<td></td>
</tr>
<tr>
<td>Screw Compressor</td>
<td>3*1500CFM</td>
</tr>
<tr>
<td>Compressed Air Peak Draw</td>
<td>15000CFM</td>
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<tr>
<td>Compressed Air Consumption in Kwh Avg.</td>
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<tr>
<td>40000Kwh/Day</td>
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<tr>
<td>Length of Header Pipe line</td>
<td>3.0 KM</td>
</tr>
<tr>
<td>Total Pipe length</td>
<td>19 KM</td>
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</table>
A) Supply side Management
- Compressor Performance Monitoring System
- Optimization of Pressure & Operation of Compressors.
- Intake Air Performance measures.
- Water Recirculation system - Pump, Cooling Tower etc.
- Compressor Efficiency Measurement
- New Technology Item - EnergAir SX System.

B) Demand side Management
- Plant level Leakage Test
- Block wise leakage as & when required.
- Machine Compressed Air Leakage Audit.
- Special Type of Nozzles
- New Technology Item - Intermediate controller

C) Procurement Guideline/Check-List for New Compressor.
Energy Saving by introduction of Intermediate Control System (IC Unit) for Compressed Air Network:

**Intermediate Control System:**
- It has electronic controller
  - Continuously monitors the downstream demand.
  - Directs the I/C to increase or decrease flow accordingly to correct the deviation from set point.
  - Peaks demands are met with stored energy instead of additional horse power.
  - Air Pressure Boosters are also provided to meet high pressure demand on critical machines.

**Benefits:**
- Operating pressure is 72PSI (5.06Kg/cm²) instead of 84PSI (5.91Kg/cm²)
- Constant Air pressure within 1PSI (0.07Kg/cm²)
- Annual Energy Saving in 14 Lakh KWh.
- Maintenance cost saving due to less pressure operation.
- Leakage reduction due to optimum pressure.

**Annual Energy saving** in **Rs. 56 Lakh**
**Annual Energy Saving** in **KWh 14Lakh**
**Annual CO₂ Reduction** in **1176 tCO₂**
**Investment** in **Rs. 72 Lakh**
A) SUPPLY SIDE MANAGEMENT

Optimization of Pressure & Operation of Compressors

TATA MOTORS CVBU Pune

ENCON CASE STUDIES - 01

Energy Saving by Operating Centrifugal Compressor at Base Load

TATA MOTORS CVBU Pune
Energy Saving by Operating Centrifugal Air Compressors at base load :-

Before: Earlier Reciprocating and Centrifugal air compressors were connected to the upstream of the Intermediate Controller Unit. In this set-up, each compressor was generating compressed air at 84 psi (5.91Kg/cm²) pressure to cater the final pressure requirement of 72 psi (5.06Kg/cm²) at the end-use point inside the Shops.

After: The base load of CVBU plant is more than 5500 cfm, for which round the clock running one 3000 cfm centrifugal compressor was essential. The 3000 cfm centrifugal compressor has been now connected directly to the down stream of the Intermediate Controller Unit as shown in the following fig.. Pressure setting of the compressor was reduced from 84 psi to 72 psi, since the same is feeding to the compressed air network directly.

Energy Saving :- Rs. 12.00 Lac per annum

Annual Energy saving in Rs. 12 Lakh ;
Annual Energy Saving in KWh 2.67Lakh ;
Annual CO₂ Reduction in 224 tCO₂-
Investment about Nil
Water Recirculation System,

Pump,

Cooling Tower etc.

Energy Saving by

Modification in Cooling Water recirculation System
Energy Saving by Modification in Cooling Water recirculation System.:-

**Before:** Earlier, there was common water recirculation system for D-block compressors and E block.

**After:** Separated water recirculation systems for D-block compressors and E block, with this system become flexible & optimized the water pumping operations. Studied the system and backward calculation done for water requirement, pipe line sizes and frictional losses. **Benefits:** 1) By separating systems & optimizing pumping saved power Rs.24.48 Lac per year. 2) Eliminated chances of cooling water contamination with oil carried with E-block water.

**Annual Energy saving in Rs. 24.48 Lakh ;**
**Annual Energy Saving in KWh 5.03Lakh ;**
**Annual CO₂ Reduction in 423 tCO₂.**
**Investment in Rs. 3.69 Lakh**
Energy Saving by installation of Natural Draft – Fanless Cooling Tower at D-blk Compressor House:-

**Before:** Earlier, induced draft type conventional cooling tower, suction of air takes place with the help of electrical operated Fan.

**After:** Now, Cooling Tower water cooled by air using Natural Draft, Suction of air takes place with venturi effect created in the tower by using specially designed nozzles.

Annual Energy saving in **Rs. 2.64 Lakh**; Annual Energy Saving in **KWh 0.587 Lakh**;  
Annual CO₂ Reduction in **70 tCO₂**;  
Investment in **Rs. 2.7 Lakh**

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Energy Saving by Introduction of CORO COAT for Pump Casing & Impeller at D-blk Comp. House:-

**Before:** Earlier, over the period of pump operation, pump efficiency get reduced due to normal wear and tear of impeller and casing of pump. Due to this friction loss of pump increases & in turn energy is wasted.

**After:** By introduction of Coro Coating for Impeller & Casing of pump, the frictional losses of pump are reduced. Coro Coating is fluid glide coating & hydrophobic (i.e. it repels water) in nature. After Coro Coating the pump efficiency is increased by 8 to 10% with corresponding energy saving of 5%.

Annual Energy saving in **Rs. 0.58 Lakh**; Annual Energy Saving in **KWh 0.105 Lakh**;  
Annual CO₂ Reduction in **9 tCO₂**;  
Investment in **Rs. 0.46 Lakh**
Compressor Performance Monitoring System

Comp. Performance Monitoring System covers...
- Air Intake Filter
- Air Inlet
- Intercooler,
- After cooler,
- Water inlet & outlet temp.
- Compressed Air outlet temperature
- Compressor Efficiency
- Specific Energy Consumption of Compressor

Results into...
1. Increased involvement of People.
2. Increased Level of knowledge
3. Predictive maintenance & enhanced pro-actions.
4. Reliability & cost effectiveness.
Performance of Intercooler & Aftercooler Monitoring

Effect of Intake Air temperature on Power Consumption

<table>
<thead>
<tr>
<th>Inlet Temperature (°C)</th>
<th>Relative Air Delivery (%)</th>
<th>Power Saved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.0</td>
<td>102.0</td>
<td>+ 1.4</td>
</tr>
<tr>
<td>15.5</td>
<td>100.0</td>
<td>Nil</td>
</tr>
<tr>
<td>21.1</td>
<td>98.1</td>
<td>- 1.3</td>
</tr>
<tr>
<td>26.6</td>
<td>96.3</td>
<td>- 2.5</td>
</tr>
<tr>
<td>32.2</td>
<td>94.1</td>
<td>- 4.0</td>
</tr>
<tr>
<td>37.7</td>
<td>92.8</td>
<td>- 5.0</td>
</tr>
<tr>
<td>43.3</td>
<td>91.2</td>
<td>- 5.8</td>
</tr>
</tbody>
</table>

- For Every 4°C rise in inlet air temperature results in a higher energy consumption by 1 % to achieve equivalent output.
- Hence, cool air intake leads to a more efficient compression.
Centrifugal Compressor Air & Cooling Water Temperature Audit

1st Stage Inter cooler
2nd Stage Inter cooler
3rd Stage After cooler

Air In
30.6°C
140°C
47.6°C
118.2°C
43.2°C
35.8°C

Air Out
32.8°C
40.2°C
38.2°C
32.8°C
32.8°C
35°C

Inlet Water

Outlet Water

Performance of Intercooler & After cooler Monitoring By...
Stage wise Temperature Monitoring
## Introduction of EnergAir SX System for Reciprocating Compressor

**Before ENCON :-**
- Compressor ON-OFF operation was manual.
- Compressor LOAD / UNLOAD operation pressure band = 4PSI

**After Introduction EnergyAir SX:-**
- Automatic ON, OFF, LOAD & Unload operation of Recip. compressor
- Auto sequencing of reciprocating compressor.
- Load/Unload operation pressure band changed from +/-4PSI to +/- 2PSI
- Eliminated compressor manual starting delay.

### Annual Energy saving
- Rs. 8.42 Lakh
- KWh 1.53Lakh
- 128 tCO$_2$

### Investment
- Rs. 9.09 Lakh
35 Years Old Reciprocating Compressors replaced with new Energy efficient Centrifugal & Screw Compressors

Improvement in Moisture Separation in Compressed Air System
**Introduction of High Efficient Centrifugal Moisture Separator**

**Before Baffle type Moisture separator :-**
- Pressure drop across separator is more than 3PSI
- Measured Moisture drain is approx. 10 Liters /Hour.
- Compressed air temperature after moisture separator is more.
- No feasibility for Internal cleaning.

**After Introduction High Efficient Centrifugal Moisture Separator:**
- Delta P across Moisture separator is low 1 to 1.5PSI
- Measured Moisture drain -26 liters/hours.
- Compressor discharge air temperature is reduced by 1Deg.C due to whirling action.
- Load on Dryer is reduced results in Energy saving & Easy for maintenance.

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**Energy Saving by Transvector Nozzle for Cleaning application by using Compressed Air:-**

**Before:** Earlier, Compressed air was used for cleaning the jobs after machining by using open pipes or conventional nozzles.

**After:** Now Transvector Nozzles are installed in place of open pipe or conventional nozzles used for cleaning the jobs after machining. It reduces the compressed Air Consumption by 30-60% & reduces the noise level by 8-10db.

<table>
<thead>
<tr>
<th>Before Conventional Nozzle</th>
<th>After Transvector Nozzle</th>
<th>Before Conventional Nozzle</th>
<th>After Transvector Nozzle</th>
</tr>
</thead>
</table>

**Annual Energy saving in Rs. 2.32 Lakh ;**
**Annual Energy Saving in KWh 0.58Lakh ;**
**Annual CO₂ Reduction in 49 tCO₂.**
**Investment in Rs. 0.19 Lakh**
Energy Saving by Installing of Master Cut-off Circuit in Compressed Air Line:

**Before:** Earlier, during non-working period like lunch time, tea break, shift change & C shift period minimum comp. air leakages were wasted.

**After:** Now Master cut-off circuit with timer is installed in compressed air line which cuts off air supply to fixture, assembly line etc. Eliminating air leakage loss effect during non-working period lunch break, tea break, shift change & it saves air leakage loss. At Winger BIW & TCF line, E-block (50 Nos. Installed)

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**Annual Energy saving in Rs. 3.0 Lakh;**
**Annual Energy Saving in KWh 0.55 Lakh;**
**Annual CO₂ Reduction in 46 tCO₂.**
**Investment in Rs. 5.0 Lakh**

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Best Practises at Distribution Level --

Compressed Air Leakages

Actions taken to reduce the compressed air leakages --

- Blockwise compressed air leakage test to check the unproductive draw of compressed air (Leakages) once in a three months.
- Physical shop leakage audit & display a Tag on leakage points & feedback to concern owner.
- Identification & Isolation of Non working areas.
- Periodic audit of Main Header line & checking any leakages.
- Displayed banners indicating cost of compressed air leakage.
- Training programme for the Employee.
Compressed air Leakage test - Compressed air network

Compressed Air Leakage - Performance Monitoring Format

Compressed air Leakage in Cubic Feet per minute

Compressed air leakage test report - Auto Division (in CFM)
ACTION TAKEN TO REDUCE AIR LEAKAGES

- Auditing of leakage points all Blocks,
- Mark leakage point by - Air leakage tag or paint marked
- Mail the soft copy of Leakage points to all Factory Managers, Cx Owners
- Get feedback from the respective maintenance after correction
- Re-audit the points & detect new Leakage points generated
- Conduct Air leakage test to see the improvement.

Air Leak detector used to detect leak points in pipe lines & joints

LOCATOR
Compressed air leak detector

LOCATOR® function principle
What produces ultrasound in a leak? When a gas passes through a restricted orifice under pressure, it is going from a pressurised laminar flow to low pressure turbulent flow.

The turbulence generates a broad spectrum of sound. There are ultrasonic components in the sound and since the ultrasound will be the loudest by the leak site, the detection of these signals using the LOCATOR® is usually quite simple.
### Compressed Air Leakage Audit of J5 bay on 8th Aug 2010

<table>
<thead>
<tr>
<th>S No</th>
<th>Date</th>
<th>Equipment / Machine</th>
<th>Leakage point</th>
<th>Block</th>
<th>Location</th>
<th>Identified by</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>08-Aug-10</td>
<td>Nut runner</td>
<td>Pipe Joint Leakage</td>
<td>J5</td>
<td>PDI J post chassis</td>
<td>VMS/AINN</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>08-Aug-10</td>
<td>Nut runner</td>
<td>Tool end leakage</td>
<td>J5</td>
<td>PDI J post chassis</td>
<td>VMS/AINN</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>08-Aug-10</td>
<td>GRC</td>
<td>GRC leakage</td>
<td>J5</td>
<td>PDI J post chassis</td>
<td>VMS/AINN</td>
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<td>4</td>
<td>08-Aug-10</td>
<td>GRC</td>
<td>GRC leakage</td>
<td>J5</td>
<td>PDI J post chassis</td>
<td>VMS/AINN</td>
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</tr>
<tr>
<td>5</td>
<td>08-Aug-10</td>
<td>GRC</td>
<td>GRC leakage</td>
<td>J5</td>
<td>PDI J post chassis</td>
<td>VMS/AINN</td>
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<td>6</td>
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<td>GRC</td>
<td>GRC leakage</td>
<td>J5</td>
<td>PDI inspection</td>
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<td>7</td>
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<td>cock</td>
<td>cock leak</td>
<td>J5</td>
<td>SUMO 207 DI</td>
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<td>10</td>
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<td>J5</td>
<td>Safari PDI gate</td>
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<td>TELCO line Exp on column</td>
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<td>13</td>
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<td>Safari PDI under pt</td>
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<td>14</td>
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<td>J5</td>
<td>SAFARI PDI</td>
<td>VMS/AINN</td>
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<td>SAFARI PDI</td>
<td>VMS/AINN</td>
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### No of Air Leak points identified 2010-11

<table>
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<th>S.no</th>
<th>Block</th>
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<th>May-10</th>
<th>Jun-10</th>
<th>Jul-10</th>
<th>Aug-10</th>
<th>Sep-10</th>
<th>Oct-10</th>
<th>Nov-10</th>
<th>Dec-10</th>
<th>Jan-11</th>
<th>Feb-11</th>
<th>Mar-11</th>
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<td>TOTAL</td>
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<td>624</td>
<td>697</td>
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Compressed Air leakage points identified during Audit 2010-11

Cumulative Leakage points

Month
Apr-10 May-10 Jun-10 Jul-10 Aug-10 Sep-10 Oct-10 Nov-10 Dec-10 Jan-11 Feb-11 Mar-11

Cumulative Leakage points
0 500 1000 1500 2000 2500 3000

2" METER bypass line

From compressor house

Valve closed

Valve open

To Shop floor

2" by pass line

Valve open

6" Main line

REGULAR 6" METER line

From compressor house

Valve Open

Valve closed

To Shop floor

2" by pass line
ZERO LEAK AIR Connectors
Swivel connectors for CL 10 Hoses  Swivel connectors for coiled Hoses
Swivel type quick release coupling for CL 10 & coiled Hoses

THE AIR YOU BREATHE IS FREE.
THE AIR YOU USE IS NOT!

Use AIR wisely
Arise, Awake & Realise
If you realise it here & now, Yours is the infinite Gain
If you do not make an attempt to do so
Equally great is your Loss.
...a journey towards excellence

THANK YOU!

ENCON CASE STUDIES - 01

Air Intake Filter

Performance

Monitoring By... Manometer
The location of air compressors and the quality of air drawn by the compressors will have a significant influence on the amount of energy consumed.

Compressor performance as a breathing machine improves with cool, clean, dry air at intake.

**Importance of Location of Air Compressor & the Quality of Air**

- Pressure Drop Across the Air Intake Filter are measured & Monitored regularly.
- Servicing of Air Intake filter is done after reaching the Pressure drop @ 150mm WC.

**Importance of Air Intake Filter In Compressor**

<table>
<thead>
<tr>
<th>Pressure Drop Across air filter (mmWC)</th>
<th>Increase in Power Consumption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>200</td>
<td>1.6</td>
</tr>
<tr>
<td>400</td>
<td>3.2</td>
</tr>
<tr>
<td>600</td>
<td>4.7</td>
</tr>
<tr>
<td>800</td>
<td>7.0</td>
</tr>
</tbody>
</table>

**Air Intake Filter Performance Monitoring By... Manometer**

Pressure drop across Air intake filter mm WC
Air Intake Filter Performance Monitoring By... Manometer

- Do not Wait for Preventive Maint. Schedule
- Regular Monitoring helps to predict Health of Air Filter in turn we can save Energy.

Reciprocating Compressor Air & Cooling Water Temperature Audit

TATA MOTORS CVBU Pune
Introduction of Backflushing System For Reciprocating Compressor

Before ENCON :-
- Cleaning of Inter-cooler / after-cooler was done whenever 2nd stage inlet & outlet temperature was increased, results in more power is required to generate compressed air.
- Time required for Maintenance of Intercooler & after-cooler is 18 man-days.
- Sometimes compressor was not available for schedule maintenance in turn run the compressor with high temperature results in increase in power consumption.

Schematic of Recip. Compressor water recirculation system
**After Introduction Back Flushing System:**

- Inter-cooler & after-cooler of compressor are cleaned without waiting for schedule maintenance.
- It results into...
  - 3°C drop in 2nd stage air temp.
  - Approx. 0.6% reduction in energy consumption.
  - Comp. efficiency improved by 1%
  - Improved quality of air.
  - Cost reduction in spares & man days.
  - Fatigue less operation
  - Saving in Energy consumption by 8424 Kwh/annum/Compressor

**Backflushing provision for ZR 250 Screw compressors**

### Sr. N | Item Description | Before Back Flushing Modification | After Back Flushing Modification
--- | --- | --- | ---
1 | Compressed Air Temp. after Inter-cooler | Avg. 41 °C | Avg. 37.8 °C
2 | Compressed Air Temp. after After-cooler | Avg. 36 °C | Avg. 34.5 °C
3 | Inter & After Cooler Maint. time reduction | 18 Mandays | 2 Hrs.
4 | Compressor Reliability on account of I/C & A/C | 100 % | 100 %
5 | Compressed Air Quality | Improved | Improved
6 | Energy Consumption reduction | | 8426 Kwh/Comp/annum

**Total Saving in Energy Consumption / Compressor** = 8424 Kwh/annum/comp.
1. COST REDUCTION IN SPARES & MANDAYS (162 MANDAYS / YEAR)
2. FATIGUELESS OPERATION
3. DECREASE IN FREQUENCY OF OVERHAULING

Approx. 0.6% Reduction in Energy Consumption

Compressor Efficiency Improved By 1%

3°C. Drop in 2nd Stage Air Inlet Temp.

Total Saving in Energy Consumption / Compressor = 8424 Kwh/annum/comp.

IMPROVED QUALITY OF AIR

ADVANTAGES OF BACKFLUSHING

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