Effective Utilization of Compressed Air Systems and CO₂ Reduction

Objective: Technology transfer of air compressor optimization technology to India

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Research to promote the utilization of low-carbon technologies in India (survey period: Jan. 18, 2012 – Dec. 8, 2013)

Indian SMEs visited: 15 companies

<table>
<thead>
<tr>
<th>First mission</th>
<th>Second mission</th>
<th>Third mission</th>
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<tbody>
<tr>
<td>January 2012</td>
<td>June 2013</td>
<td>December 2013</td>
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<tr>
<td>KANSAL</td>
<td>MASS FLANGE</td>
<td>SANKALP (F/UP)</td>
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<tr>
<td>OSCAR</td>
<td>SANKALP</td>
<td>TRANSAUTO (F/UP)</td>
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<td>GILARD</td>
<td>TRANSAUTO</td>
<td>BOMBAY</td>
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<td>AQUA</td>
<td>DIC</td>
<td>CENTURY RAYON</td>
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<tr>
<td>MALKE</td>
<td>4 companies in total</td>
<td>4 companies in total</td>
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<tr>
<td>ICEBERG</td>
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<td>JAGDISH</td>
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<td>MICROMELT</td>
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<td>DELTA</td>
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<td>9 companies in total</td>
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Objective: We conducted three visits within India during the period from Jan. 1, 2012 to Dec. 2013 as an IGES compressor optimization mission, surveying a total of 15 SMEs (small and medium-sized enterprises).

Overall assessment: We conducted a variety of information exchanges by visiting our customers and interviewing managers in person. These managers were proactive and had a high level of awareness regarding improvements. We also strongly felt that the latest technology was being adopted and that these companies were intent on energy-saving efforts in their factories.

However, at the work sites themselves, with the exception of a few of our customers, awareness was low, and there was a large gap between workers and management. For example, equipment with air leaks would be used as is, and anyone could handle the air tools. It appeared to take a long time for the intentions of management to be reflected at work sites. There were also numerous problems with the introduction of small-group activities (kaizen) as well as the sustaining of such activities and day-to-day improvements.

Our impression of these companies as a whole was that the management situation at all customers is good, and that they are proactively considering facility expansions and new installations. We also feel that these companies are fast at decision-making, are intent on making constant positive efforts. They are poised for rapid growth.

During our last three visits, we made a variety of proposals for energy-saving policies based on the adoption of high-efficiency compressors and the reduction of energy losses (CO$_2$ reduction) through waste elimination and effective utilization of compressed air, and we feel we fulfilled our role as well as could be expected, by improving our customers’ awareness of these issues and reducing CO$_2$ emissions. With regard to our initial efforts, compressor energy consumption accounted for a low proportion and had a small impact overall. From the second visit onward, the impact grew, and the CO$_2$ reductions achieved through our proposals were quite large. There were issues with regard to saving energy through the use of inverters, but compressed air systems have a high potential for reducing CO$_2$, and it is important to take continuous action as well as to perform follow-up.
Factory equipment diagnosis and capacity building through SME visits
Factory equipment diagnosis and capacity building through SME visits
Making a case for CO$_2$ reduction methods at a workshop
The relationship between compressors and CO₂ emissions

Carbon dioxide, the main cause of global warming, is emitted in the course of all human activity. The compressors used in factories also contribute to those emissions. The reason is that carbon dioxide is emitted in the production of the electricity consumed when compressors are used. The more electricity is used, the more carbon dioxide is emitted.

Japanese efforts to prevent global warming

Efforts to reduce CO₂ by establishing energy conservation technologies in India

Comparison with the greenhouse gas reduction volume in Japan

CO₂ (approx. 90%)

Source: Ministry of Economy, Trade and Industry materials
Energy reduction (efficient use) is a priority issue

Transfer of technology for improving compressor operation in order to reduce energy usage is a priority issue for Indian companies.

Energy-conserving activities = CO₂ reduction

Activities by compressor manufacturers
• Development of energy-efficient compressors
• Suitable proposals for operating methods and equipment that will result in energy savings

The role of users
• Raise awareness of energy conservation measures
• Elimination of waste (e.g. preventing air leaks)
• Conducting energy-efficient operation
• Quantity control, reexamining usage pressure, etc.

Contribution to global environmental conservation
Air compression systems are a major topic in energy conservation. In some cases of air compression system improvements, compressor energy consumption has been reduced by half. Most topics do not hold the same potential for improvement.
Policies for reducing energy usage

Observe real-time energy usage in order to quickly identify wasteful consumption and make improvements.

1. Energy observation that involves understanding and monitoring the current status
   - Energy-efficient factories $\rightarrow$ energy-efficient production sites
   - Energy management by adopting ISO50001

2. Discovering waste through consumption rate management
   - Monthly management $\rightarrow$ daily management: Early data-driven discovery of energy losses

3. Improvement through small-group activities
   - Finding waste and fixing the cause
Areas for energy conservation in air compression systems

Four kaizen items

- Energy monitoring
- Check operation status
- Type V introduced
- Check air tank capacity
- Intake filter maintenance
- Inspect dispersion equipment
- Check pipes for pressure leaks
- Inspect quantity control
- Check auxiliary units and filters for pressure leaks
- Discharge pressure reduced
- Check pipes and valves for pressure leaks
- Check for leaks and waste
- Factory A
- Factory B
Energy conservation in air compression systems

What did we survey, and guidance did we provide?

**Compressors**
- Stop and change the compressor.
- Lower the pressure.

**Aux. equipment**
- Dryers
- Filters
- Air tanks

**Pipes**
- Reduce pressure loss.

**Air using devices**
- Cylinders
- Nozzles
- Ejectors
- Etc.

- Reduce consumption.
- Lower pressure.

- Reduce/eliminate consumption (leaks).
- Lower pressure.
Working with the customer to proceed with CO₂ reductions

Driver-side (compressor) energy conservation
- Teach workers why energy-efficient compressors are important.
- Modest cost savings are possible by reducing pressure.
- Why are inverter-based compressors energy-efficient? (compressor makeup)
- Effective use of inverter-based compressors
- Fix pipe pressure losses and clogged filters; increase air tank size.

Compressed air: consumption and transmission-side energy conservation
- How can the same job be done with less consumption?
- How can the same job be done with lower pressure?
- How can leaks be found and fixed?
- What kinds of tools are there for making improvements?

Implementing energy conservation in air compression systems
- Put into practice how to devise energy conservation in air compression systems.
- Verify improvements on both the consumptions die and driver side, and check leak locations.
Reporting the results of our activities

Potential CO₂ reduction (theoretical)

1. Reduce pressure 8%
2. Change compressor control 4%
3. Fix pressure leaks in pipes 10%
4. Reduce leaks 20%
5. Introduce inverters 20%

Verify results afterward. Total reduction of 30–40% is possible.

Impact of adjusting pressure of compressors (zero costs required)

Impact of reducing leakage (minimum cost required: approximately 200,000 Rs)

<table>
<thead>
<tr>
<th></th>
<th>Mass Flange</th>
<th>DIC India</th>
<th>Sankalp</th>
<th>Trans. Auto</th>
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</thead>
<tbody>
<tr>
<td>Primary energy saving (KWh/year)</td>
<td>17,856</td>
<td>41,760</td>
<td>52,080</td>
<td>66,216</td>
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<tr>
<td>CO₂ emission reduction (ton/year)</td>
<td>17</td>
<td>39</td>
<td>48</td>
<td>61</td>
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<tr>
<td>Cost saving (Rs/year)</td>
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<td>271,440</td>
<td>338,000</td>
<td>417,160</td>
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<tr>
<td>Approximate pay back period</td>
<td>Immediate</td>
<td>Immediate</td>
<td>Immediate</td>
<td>Immediate</td>
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</table>
Success — cost-related results

Impact of reducing leakage (minimum cost required: approximately 200,000 Rs)

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<th>Sankalp</th>
<th>Mass Flange</th>
<th>DIC India</th>
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<tbody>
<tr>
<td>Primary energy saving</td>
<td>37,000</td>
<td>40,920</td>
<td>59,520</td>
<td>68,400</td>
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<tr>
<td>(KWh/year)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>CO₂ emission reduction</td>
<td>35</td>
<td>38</td>
<td>55</td>
<td>64</td>
</tr>
<tr>
<td>(ton/year)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cost saving (Rs/year)</td>
<td>233,100</td>
<td>265,980</td>
<td>386,880</td>
<td>444,600</td>
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<tr>
<td>Approximate pay back</td>
<td>10 months</td>
<td>9 months</td>
<td>6 months</td>
<td>5 months</td>
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<tr>
<td>period</td>
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Impact of increasing piping size (medium cost required: approximately)

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<th>Kansal</th>
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<tbody>
<tr>
<td>Primary energy saving</td>
<td>17,280</td>
<td>From 96 to 300</td>
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<tr>
<td>(MWh/year)</td>
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<tr>
<td>CO₂ emission reduction</td>
<td>16</td>
<td>From 90 to 280</td>
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<tr>
<td>(ton/year)</td>
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<tr>
<td>Cost saving (1000 Rs/year)</td>
<td>112,320</td>
<td>From 625 to 1,953</td>
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<tr>
<td>Approximate pay back</td>
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<td>period</td>
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Energy-conserving air compression systems — establishment of inverter-based compressors

Control characteristics of inverters

Screw compressor capacity control

U method: Suction throttle valve method
Regulates air capacity using suction throttle valves when load drops and discharge pressure rises. Effective with continuous air pressure usage and small load variation. Little effect on energy savings.

I method: Integral control method
Shuts off suction throttle valves when load drops and discharge pressure rises to a preset level. Also, shaft power is reduced by releasing compressed air into an oil tank. Saves more energy than the U method.

S-I-I-E method: New control method
A microcontroller automatically selects the U, I, or S control method based on the load. When the load is light, air pressure in the oil tank is reduced, reducing drive force. Saves more energy than the U method only.

M-S-I-I-E microcontroller method
Chooses U, I, or automatic stoppage method based on load. Effective for air blast usage and large load variations. Saves more energy than the S method.

V method: Rotation rate variation control method (inverter)
Controls the rotation rate to maintain steady discharge pressure using a pressure sensor and inverter. Because steady pressure is obtained and power consumption can be kept in line with load, this method offers the most energy savings.

Inverter-based compressors achieve ideal compression and save energy.

- Controlling compressor rotation rate in accordance with load
  Conduct ideal capacity control without wasteful driver consumption by varying the rotation rate.
- Consistent, reliable supply at the minimal required pressure is possible
  Compressors that operate between 0.69 and 0.59 MPa can operate at 0.59 MPa fixed pressure control, built into the V-type.
- Stopping compressors with zero load
  Waste-energy consumption due to continuous operation at zero load is possible.

Energy savings: The benefits of using inverters

Example of reduced consumption using inverter-based compressors

- Introduction process
  Implement energy conservation diagnosis of air compressors (survey previous 37 kW compressors x 1)

- Improvement process
  
  - Average load rate: 52%
  - Power usage: 23,600 kWh/mo.
  
  37 kW inverter-based compressors x 3 unit introduced
  - Power consumption reduced 34%

- Investment and results
  - Introduced unit: 37 kW inverter-based compressor
  - Energy savings: 1,100,000 yen/year

- Wide-scale results
  - Conservation of global environment through CO2 reduction (34%)
  - Longer overhaul cycle (8 years) through improved component durability. Maintenance costs reduced 30% (compared to our company).
Future issues — adopting inverter technology

The process of reducing CO₂ must ultimately involve hardware technology. Introducing inverter-based compressors is an example, and while these exist in India, they are expensive and are not being adopted. However, inverter-based compressors are overwhelmingly effective at saving energy and contributing to CO₂ reduction. Even if it takes time, we would like for this technology to be introduced and firmly established in India.

Impact of installing inverter type air compressor.

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<th>Trans Auto</th>
<th>Iceburg</th>
<th>DIC India</th>
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<tbody>
<tr>
<td>Primary energy saving</td>
<td>Percentage</td>
<td>17%</td>
<td>22%</td>
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<tr>
<td>(KWh/year)</td>
<td>53,196</td>
<td>96,624</td>
<td>99,360</td>
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<tr>
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<td>89</td>
<td>93</td>
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<tr>
<td>Cost saving (Rs/year)</td>
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<td>Approximate pay back period</td>
<td>3 years and 3 months</td>
<td>4 years</td>
<td>3 years and 6 months</td>
<td>2 years and 6 months</td>
<td>3 years</td>
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