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THE MOTOR CHALLENGE EUROPEAN PROGRAM
An initiative supported by the European Commission

Technical Guide

The solutions to enhance your motor driven systems

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Why this guide?

Electromotor systems count for 2/3 of the current consumption of the industrial sector both in France and Europe, i.e. 90 TWh per year out of the French 120 TWh consumption per year.

The European program « Motor Challenge » has been implemented to help improve the energy efficiency in the industrial sector on electromotor systems.

The systems involved in this program are:
1. Compressed air systems
2. Cold production systems
3. Pumping systems
4. Ventilation systems
5. Electromotor driving systems
6. Industrial electric power supply network

A label is awarded by the European Commission to those companies undertaking voluntary steps for energy savings after setting up an annual action scheme.

30% of the current consumption e.g. by pumping, air compressed or cold production and ventilation systems could be saved.

Allocation of the current consumption in France

- Electrolysis: 9%
- Lighting: 4%
- Other purposes: 17%
- Electromotors: 70%

Allocation of consumptions of the motor driven systems:

- Compression: 30%
- Pumping: 20%
- Ventilation: 13%
- Other systems: 37%

So far 23 European countries are involved in the Motor Challenge program, with the presence of a domestic contact partner, e.g. ADEME in France. Any business willing to commit itself to an energy savings approach and policy on motor driven systems can join the Motor Challenge partners’ network. A « Motor Challenge » label granted by the European Commission will award this commitment.

ADEME: the French intermediary of the European Commission supports companies to gain the Motor Challenge label and develops its promotion.

Foreword

This technical guide is an introduction to the 6 systems of the Motor Challenge program mostly used in the industrial environment. For each system the energy stakes are detailed along with the major energy improvement tracks to be planned around the representative diagram of an industrial plant. In addition to this, for each track the concrete actions are listed to provide significant short-term or medium-term energy savings. They are organized around the following 5 items: production, network, use, control and maintenance. Such actions are not restrictive and the potential savings will depend on the current plants and the improvements brought.

<table>
<thead>
<tr>
<th>Topics</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why this guide</td>
<td>p. 2 &amp; 3</td>
</tr>
<tr>
<td>Compressed air systems</td>
<td>p. 4 &amp; 5</td>
</tr>
<tr>
<td>Cold production systems</td>
<td>p. 6 &amp; 7</td>
</tr>
<tr>
<td>Pumping systems</td>
<td>p. 8 &amp; 9</td>
</tr>
<tr>
<td>Ventilation systems</td>
<td>p. 10 &amp; 11</td>
</tr>
<tr>
<td>Electromotor driving systems</td>
<td>p. 12 &amp; 13</td>
</tr>
<tr>
<td>Industrial electric power supply network</td>
<td>p. 14 &amp; 15</td>
</tr>
</tbody>
</table>
Compressed air plays a very large part in the French industrial field since it counts for approx. 11% of the current consumption, i.e. about 12 TWh consumed per year (1). A survey conducted for 5 years with the 6,000 hours’ operation of an air compressed system shows that 75% of the operating costs result from the “Energy” item… The output of a compressed air system is only 10% in most cases. Compressed air is an energy carrier difficult to be controlled because it is expensive (0.6 to 3 cents per Nm3) and it has a high improvement potential of around 25% of possible energy saving on an average.

**Compressed air systems**

- **PRODUCTION**
  - Adoption of a more efficient compression system
  - Enhancement of the production conditions
  - Decrease in energy consumption related with the quality of air (filtering – drying)
  - Adjustment of the air pressure to the minimum needs

- **NETWORK**
  - Decreased pressure loss on the network
  - Optimization of the air tanks and of their location on the network
  - Place storage capacities next to machines with high variation of the air required

- **USE**
  - Reduction of waste
  - Regular measurements
  - Reduction of leaks

- **CONTROL**
  - Control of the production with adjustment to the needs
  - Regular maintenance

- **MAINTENANCE**
  - Regular maintenance

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**Ways of reflection**

- Increase the diameter of pipes
- Reduce the length of the network
- Loop the network
- Limit elbows, changes in direction or section
- Repair leaks periodically

- Install a system with several pressure values (multi-pressure systems or networks), separate or connected to each other (with the use of local overpressors)
- Install a heat economizer; upgrading in the process or heating of premises
- Mount for instance an automatic control of the compressed air production via a variable speed compressor or an automatic control of all the compressors according to the needs
- Reduce the inlet air temperature
- Replace compressors with new and better machine(s) with lower specific energy consumption (e.g. more compression stages) more suitable to the requirements of the system
- Use a leak-less free condense traps

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**Potential savings**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>12%</td>
<td>Install a system with several pressure values (multi-pressure systems or networks), separate or connected to each other (with the use of local overpressors)</td>
</tr>
<tr>
<td>20%</td>
<td>Repair leaks periodically</td>
</tr>
<tr>
<td>40%</td>
<td>For cleaning, use preferably vacuum cleaners which need less energy than blow nozzles or air guns</td>
</tr>
<tr>
<td>80%</td>
<td>Enhance and check pressure regulating valves, filters, lubricators, driers and condensate traps</td>
</tr>
<tr>
<td>80%</td>
<td>Install control equipment such as flowmeters and air meters, current meters, pressure gauges...</td>
</tr>
<tr>
<td>25%</td>
<td>Design properly storage capacities to allow operation with higher output of compressors and to avoid unexpected switchings on or off</td>
</tr>
<tr>
<td>7%</td>
<td>Dry off and filter air moderately as needed</td>
</tr>
<tr>
<td>7%</td>
<td>Place storage capacities next to machines with high variation of the air required</td>
</tr>
<tr>
<td>60%</td>
<td>Install a heat economizer; upgrading in the process or heating of premises</td>
</tr>
<tr>
<td>6%</td>
<td>Reduce the inlet air temperature</td>
</tr>
<tr>
<td>5%</td>
<td>Install a heat economizer; upgrading in the process or heating of premises</td>
</tr>
<tr>
<td>7%</td>
<td>Dry off and filter air moderately as needed</td>
</tr>
</tbody>
</table>

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**Allocation of the costs of compressed air**

- Investment 13%
- Maintenance 12%
- Energy 75%

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(1) - Source: European study « Compressed Air Systems in the European Union » Year 2000
Cold production systems

Industrial refrigeration represents 4% of the current consumption in the French industry and almost 7% of the domestic current consumption. This consumption is increasing in the industrial sector since it has risen from 3 TWh in 1990 to 4.7 TWh in 1999. The food-processing sector alone uses 57% of the current dedicated to the industrial refrigeration. The energy savings achieved in the industrial refrigeration sector exceeds 0.9 TWh (200 ktep) i.e. about 20% of possible savings on average.

<table>
<thead>
<tr>
<th>Ways of reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRODUCTION</strong></td>
</tr>
<tr>
<td>Use of a more efficient refrigeration compressor</td>
</tr>
<tr>
<td>Use of more efficient condensers/evaporators</td>
</tr>
<tr>
<td>Recuperation and use of the heat lost by compressors</td>
</tr>
<tr>
<td><strong>RESEAU</strong></td>
</tr>
<tr>
<td>Insulation of the cold supply network</td>
</tr>
<tr>
<td>Reduction of heat inlets in the cold use area</td>
</tr>
<tr>
<td><strong>USE</strong></td>
</tr>
<tr>
<td>Controlling cold production in the compressor area according to the need</td>
</tr>
<tr>
<td>Optimizing the energy output of the plant according to the outdoor conditions and needs</td>
</tr>
<tr>
<td>Optimizing the cold storage</td>
</tr>
<tr>
<td>Controlling the different flow rates</td>
</tr>
<tr>
<td>Optimizing the operation of cold batteries</td>
</tr>
<tr>
<td><strong>CONTROL</strong></td>
</tr>
<tr>
<td><strong>MAINTENANCE</strong></td>
</tr>
</tbody>
</table>

Potential savings (percentages forecast are provided individually for each item and shall not be added up to each other.)

- Use a more efficient compressor (e.g. multi-staged unit)
- Replace an oversized compressor by a more efficient compressor with a power more appropriate to the real associated need, possibly with a storage system (see “control”)
- Use variable-speed refrigeration compressors to adjust the cold production according to the needs
- Use a heat economizer: upgrading the process or heating of premises
- Install automatic closing area curtains
- Install buffer locks/sieves and reduce opening/closing parts of the area
- Install more efficient evaporative condensers than dry condensers
- Install a heat condenser on condenser to upgrade a process or heating of premises
- Implement an optimized subcooling strategy
- Blow out the air from the circuit and condensers
- Clean condensers and install a regular checking device
- Install efficient lighting systems
- Use free cooling (natural cooling)
- Install efficient lighting systems
- Control air outputs in condensers (e.g. via electronic speed variation on fans)
- Up to 30% power consumption savings and 6% of the overall consumption
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- Use free cooling (natural cooling)
- Install efficient lighting systems
Pumping systems represent approximately 20% of the French industrial current consumption and 25% of the worldwide current consumption. Studies have shown that significant energy savings could result from using more efficient equipment and appropriate control systems making it possible to save up to 40% of energy for an average lifetime of 15 to 20 years. The major two pump families are the centrifugal pumps and the displacement pumps. Centrifugal pumps with a 73% market share represent great possibilities of energy savings because it is considered that 75% of the pumping systems are oversized, most of them by 20%.

### WAYS OF REFLECTION

<table>
<thead>
<tr>
<th>PRODUCTION</th>
<th>NETWORK</th>
<th>USE</th>
<th>CONTROL</th>
<th>MAINTENANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using more efficient pumps for the intended purpose</td>
<td>Decreased pressure loss on the network</td>
<td>Decreased pumped material</td>
<td>Optimizing the pumping regulation to avoid waste (accordance with the needs)</td>
<td>To prevent leaks on the network</td>
</tr>
<tr>
<td>Using a more efficient motor and driving system for the intended purpose</td>
<td></td>
<td></td>
<td>Installation of regular data measuring, metering and recording appliances and devices</td>
<td>Periodical maintenance of the pumps and driving system in order to ensure a maximum output</td>
</tr>
</tbody>
</table>

### Potential savings

- **Install positive displacement meters or electric meters, flowrate meters...**
- **Make regular recordings with due follow-up and control (e.g., indicators)**
- **Install a measuring equipment to control the pressure loss**
- **Restore periodically the internal tolerances of the pumps**
- **Apply an internal film to reduce friction in the pump body**
- **Use several parallel-mounted pumps to be operated according to the needs**
- **Replace or modify oversized pumps**
- **Machine or change the diameter of the wheels of centrifugal pumps**
- **Use pumps with higher output**
- **Replace oversized pump motors with better sized and high output ones: label « EFF 1 » (Output higher by 2 to 5 %)**
- **Close any circuit part whenever not used**
- **Blow out air periodically**
- **Use a small-sized overpressure pump for specific needs**
- **Increase the section of pipes and avoid elbows and unnecessary changes of direction**
- **Reduce the length of the network**
- **Use Variable Speed Drives for electromotors of pumps (to regulate the output) rather than valves**
- **Switch off any unnecessary pump**
- **Do not pump for no use!**
**Ventilation systems**

Ventilation is a tool necessary for the proper operation of an industrial plant, ensuring the quality of production and the individual protection against the emission of pollutants or heat in premises.

The energy consumption of a plant represents on average 10% of the current consumptions of the French industrial business. The indirect energy consumption to be considered is still higher when the air has a great energy content due to its conditioning: heating, cooling … On most audited plants, energy savings of up to 30% of the consumption are reported with returning times often under 2 years.

**Ways of reflection**

- Using more efficient fans for the intended purpose
- Reducing pressure loss on the network and balancing problems related to the aerodynamic network
- Using a more efficient motor and driving system for the intended purpose
- Recuperation of energy with the air emission
- Optimizing the ventilation strategy and therefore the ventilation systems used
- Optimizing the ventilating regulation to avoid waste
- Using a more efficient motor and driving system for the intended purpose
- Recuperation of energy with the air emitted
- Using fans with a maximum output
- Replace oversized fans
- Use fans with a maximum output
- Replace oversized fan motors by more appropriate motors and with high output ones: label « EFF 1 »
- Use a more efficient fan driving system: direct coupling with the crankshaft, removal of V-type belts
- Use specific catch systems for the located pollution instead of a general ventilation system
- Look into the implementation of a displacement ventilation system to replace a mixture ventilation system
- Avoid elbows and changes of section
- Increase the free flow area of fluid in the network and use circular sections rather than rectangular sections
- Balance the aerodynamic network: checking of pressure and flow rates in the different lines and balancing of pressure losses
- Clean and remove dust from aerodynamic pipes and filters
- Use an air cleaner in order to recycle a part of the air emitted
- Use a heat economizer (exchanger) on the air emitted
- Use specific catch systems for the located pollution instead of a general ventilation system
- Examples of up to 55% savings
- Examples of up to 30% savings
- Examples of up to 50% savings
- Examples of up to 55% savings
- Examples of up to 50% savings
- Examples of up to 55% savings
- Examples of up to 50% savings
- Examples of up to 55% savings
- Examples of up to 50% savings
- Examples of up to 55% savings
- Examples of up to 50% savings

**Potential savings** (percentages forecast are provided individually for each item and shall not be added up to each other)
Electromotors represent in Europe one of the major sources of current consumption, namely 70% for the industry and 33% for the global consumption of the service sector. 96% of the operating cost of a motor in its life cycle results from its energy consumption (2.5% of its purchase price and 1.5% of its maintenance cost). When purchasing a motor, it is therefore essential to take this energy consumption into account and to try to reduce it to a minimum. Thus to manage a fleet of motors as economically as possible, it is advisable to consider the following parameters namely the output of the motor, its sizes, the downstream transmission losses, maintenance (repair and rewinding) and the use of control systems e.g. Electronic Speed Variation (VSD).

Electromotor driven systems

- Use of heavy-duty transmissions: avoid Y-belts, flat or non-synchronous belts, pinion and endless screw associations
  Examples of up to 45% energy loss
- Adjust the tension of belts
- Adjust and tune alignments of driving systems
- Install either periodical or permanent electrical meters
- Use not oversized motors
- Use high-output motors (Label “EFF 1”)
- Lubricate bearings periodically according to the manufacturer’s specifications
- Avoid rewinding a motor, which often results in a later output reduction or make sure that the rewinder has been approved by the manufacturer of the motor
- Use the Electronic Speed Variation (VSD) in order to adjust accurately the rotation speed according to the need
  10 to 50% savings depending on applications
- Potential savings (percentages forecast are provided individually for each item and shall not be added up to each other)
The industrial electrical power supply fulfils several purposes: good operation of industrial processes, individual safety, keeping the equipment in good condition and maintaining stability, continuity and quality of the electrical power supply of the network. Indeed not controlling the quality of its network will result in being charged with the reactive power, consuming more energy sometimes up to 5 to 10% (loss in cables, transformer...) and last but not least generating costs due to non quality of production or even to non production.

<table>
<thead>
<tr>
<th>PRODUCTION</th>
<th>NETWORK</th>
<th>USE</th>
<th>CONTROL</th>
<th>MAINTENANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of energy losses in transformer(s)</td>
<td>Reduction of energy losses in the network</td>
<td>Reasonable consumption of the electrical energy</td>
<td>Improvement of the quality of electrical power supply</td>
<td>Optimizing the maintenance of the circuit</td>
</tr>
<tr>
<td>Monitoring of pollution loads on the network: creation of harmonics, absorption or emission of reactive current, intensity peak...</td>
<td>Improvement of the power factor (phys cos) of the site to reduce the reactive current on the network</td>
<td>Reduction of the harmonics rate on the network</td>
<td>Installation of regular data measuring, metering and recording appliances and devices</td>
<td></td>
</tr>
</tbody>
</table>

- Use one or more high-output transformers: minimum losses with or without load
- Adjust the sizes of transformer(s) in accordance with the use
- Locate hot points of cables and switch boxes (via infrared thermography)
- Reheat the sets of bars
- Clean cross-parts and connections (to limit risks of corrosion or rust attack)
- Replace old General Low Voltage Switchboards (made in the eighties) by new switchboards, (2000) the length of which has been reduced by 40%
- Select few consumption components of General Low Voltage Switchboards to avoid air conditioning of the premises (7 W efficient/ 20 W standard contactors/circuit breakers
- Lower the level of voltage cuts or off-peaks. Install a non-stop power supply, an automatic compensator in real time, a dynamic electronic voltage regulator...
- Setting of an energy management system (GTC) or electrical energy management system
- Install starters on electromotors
- Install reactive compensations next to sources
- Install harmonics filters next to high pollution sources
- Use blocks of capacitors with electromechanical or electronic control
- Install local energy meters (for each department, workshop, stage) Individual behaviours change depending on the load assignment modes
- Switch off the electrical equipment whenever not required
- Replace old power inverters by new ones

Examples of higher output of up to 25%