A second life for reciprocating compressors

Compressor upgrade and revamp

HOERBIGER

because performance counts
HOERBIGER upgrade and revamp dated compressors in ways that are tailored to the existing and future requirements in your industry. This increases the efficiency, reliability and environmental soundness of your compression system.

Simply select the application most appropriate for your industry and we will provide more information to allow you to see the benefit of our services for yourself.

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<thead>
<tr>
<th>Nr</th>
<th>Industry</th>
<th>Gas</th>
<th>Compressor</th>
<th>Country</th>
<th>Short Description</th>
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</thead>
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<td>Refinery</td>
<td>N₂</td>
<td>Nuovo Pignone</td>
<td>Germany</td>
<td>Manufacture cylinder and install reconditioned compressor</td>
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<tr>
<td>2</td>
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<td>Engineer and manufacture crankcase</td>
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<td>Engineer and manufacture crankcase and cylinder</td>
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<td>6</td>
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<td>Chemical Plant</td>
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<td>Nuovo Pignone</td>
<td>France</td>
<td>Upgrade control to HydroCOM</td>
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<td>9</td>
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<td>Natural gas</td>
<td>Borsig</td>
<td>Germany</td>
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<td>Refinery</td>
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<td>Worthington</td>
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<td>12</td>
<td>Refinery</td>
<td>H₂</td>
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<td>Germany</td>
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<tr>
<td>13</td>
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<td>C₂H₆</td>
<td>KOHO</td>
<td>Russia</td>
<td>Convert to new operating / process conditions</td>
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<tr>
<td>14</td>
<td>Technical Gases Plant</td>
<td>O₂</td>
<td>Linde</td>
<td>Norway</td>
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<tr>
<td>15</td>
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<td>C₂H₄</td>
<td>Ingersoll Rand</td>
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<td>16</td>
<td>Refinery</td>
<td>H₂</td>
<td>MB Halberstadt</td>
<td>Germany</td>
<td>Extend lifetime of compressor by full overhaul and service, including foundation</td>
</tr>
<tr>
<td>17</td>
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<td>Natural gas</td>
<td>RUMO</td>
<td>Romania</td>
<td>Reduce emissions</td>
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<tr>
<td>18</td>
<td>Chemical Plant</td>
<td>Propylene</td>
<td>Linde</td>
<td>Norway</td>
<td>Upgrade compressor control to HydroCOM</td>
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<tr>
<td>19</td>
<td>Refinery</td>
<td>H₂</td>
<td>Dresser-Rand</td>
<td>UK</td>
<td>Convert compressor for new process conditions with increased capacity</td>
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<tr>
<td>20</td>
<td>Chemical Plant</td>
<td>CO₂, NH₃</td>
<td>Atlas Copco Crepelle</td>
<td>France</td>
<td>Upgrade crosshead guide and overhaul compressor</td>
</tr>
<tr>
<td>21</td>
<td>Natural Gas Plant</td>
<td>Natural gas</td>
<td>Ingersoll Rand</td>
<td>Hungary</td>
<td>Convert compressor from engine to electric drive</td>
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<tr>
<td>22</td>
<td>Natural Gas Plant</td>
<td>Natural gas</td>
<td>MB Halberstadt</td>
<td>Hungary</td>
<td>Convert compressor for new process conditions and upgrade to HydroCOM control</td>
</tr>
<tr>
<td>23</td>
<td>Technical Gases Plant</td>
<td>H₂</td>
<td>LMF</td>
<td>Germany</td>
<td>Upgrade capacity control system</td>
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<tr>
<td>24</td>
<td>Technical Gases Plant</td>
<td>H₂</td>
<td>Dresser-Rand</td>
<td>USA</td>
<td>Convert compressor for new process conditions</td>
</tr>
<tr>
<td>25</td>
<td>Chemical Plant</td>
<td>H₂</td>
<td>MB Halberstadt</td>
<td>Russia</td>
<td>Repair heavy crankcase damage</td>
</tr>
</tbody>
</table>
Manufacture cylinder and install reconditioned compressor

A refinery wanted to rebuild a poorly-running compressor using parts from another manufacturer.

<table>
<thead>
<tr>
<th>Compressor manufacturer: BORSIG / NUOVO PIGNONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Lubrication</td>
</tr>
</tbody>
</table>

Customer requirements
- Replace NP frame with 205 mm stroke by a Borsig frame with 200 mm stroke
- Adapt existing NP cylinders to the Borsig frame
- Check and adapt throughput from compressor
- Increase efficiency through optimisation of the gas flow

Solution applied
- Upgrade to HOERBIGER CP valves and new liner with full-size valve ports
- Design modified pistons for the new stroke length, with improved flow geometry and clearance
- Redesign piston rods with new diameter, combined with new Superbolt crosshead connection adapted to original Borsig crosshead
- Deliver re-engineered cylinder liners
- Install HOERBIGER cylinder rings, pressure packing and oil wiper packing
- Assemble and install all new parts on site
- New electric motor, coupling, flywheel and guard to suit Borsig frame
- Project management and documentation

Results
- Compressor has run safely since 2008 with the Borsig frame
- Energy consumption reduced by 10% for the same flow
- Pressure peaks have been reduced

Project Execution by:
HOERBIGER Service GmbH
Walsrode, Germany
A refinery in Germany required more hydrogen for the desulphurisation process.

### Compressor manufacturer: DRESSER-RAND

<table>
<thead>
<tr>
<th>Type</th>
<th>Gas</th>
<th>H₂ mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1,080 kW (1468 hp)</td>
<td>Suction pressure: 22 bar (319 psi)</td>
</tr>
<tr>
<td>Speed</td>
<td>371 rpm</td>
<td>Discharge pressure: 47 bar (681 psi)</td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
<td></td>
</tr>
</tbody>
</table>

### Customer requirements
- Increase the throughput of the three single-stage compressors by 9.1–9.8 t/h to meet an increased need for hydrogen for desulfurization

### Solution applied
- Compressor audit and simulation
- Evaluation of possible capacity increase
- Capacity increase achieved by combining slightly bigger cylinder diameter with reduced clearance volume
- Pulsation calculation
- New HOERBIGER valves and piston rings
- Installation of HydroCOM system for continuous control
- Change pistons from a single-piece to a two-piece design
- Documentation and CE marking

### Results
- Economical investment compared to six new cylinders
- Capacity increased by 8%
- Fast and accurate control has improved operability of the hydrogenation process and extended the catalyst lifetime

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**One of the three hydrogen compressors**

**Pulsation calculation**

**New dummy valves for reduced clearance**

**New FEA-optimised pistons**

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**Project Execution by:**

HOERBIGER Service GmbH
Walsrode, Germany
A Hungarian refinery needed to increase both the quantity and pressure of the hydrogen supplied to its oil and wax hydro-finishing unit.

### Facts in Brief

New process requirements in the lube oil and wax hydro-finishing unit required substantial compressor modifications:

- Capacity increase from 4,500 Nm³/h to 6,000 Nm³/h
- Discharge pressure increase from 40 bar to 45 bar

### Customer requirements

- Cost-effective solution to meet a budget cap
- Compressor modification conforming to API 618
- Reduction of vibration level

### Solution applied

- Capacity increased by enlarging cylinder and piston diameter
- New coating on cylinder running surface
- New electric motor, coupling, gearbox, other compressor parts and auxiliary equipment
- New pulsation dampers
- Assembly and commissioning
- Calculation of the capacity and the required power
- Preparation of a risk analysis including recommendations for safe and reliable operation
- Verification of rod load and strength for higher pressures
- Check of pulsation level at new higher capacity and design new pulsation damper
- Preparation of documentation

### Results

- Hydrogen capacity and pressure meet new requirements
- Vibration level reduced
- Compressor operating successfully since 2008
A chemical plant in Germany used a 30-year-old three-stage compressor to provide air for the oxidation of cyclohexane. Repeated cracking of the frame affected production availability.

### Facts in Brief
- Repairs over the years included welding of cracks and, in 2008, realignment by a third party using epoxy grout.
- A similar crack in 2010 was repaired by the end user.
- High vibration levels were reduced by adding massive external supports between the cylinders of stages 3 and 4.

### Customer requirements
- A new reliable crankcase with reduced vibration.

### Solution applied
- Vibration measurement.
- Compressor, fracture and foundation force analysis.
- Used FEM to engineer new crankcase with high safety margin, better fixing to foundation and reduced vibration.
- Fabricated new crankcase.
- Installed rebuilt compressor on new foundation with A-type cylinder supports.
- HOERBIGER rings, packing cases and oil wiper.
- Commissioned compressor and checked vibration.

### Results
- Compressor is running well with new HOERBIGER frame.
- Reduced gas emission thanks to HOERBIGER BCD packing.
- Stronger design means improved durability.
- Improved frame and better attachment to foundation reduced vibration.

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**Compressor manufacturer: HALBERG**

<table>
<thead>
<tr>
<th>Type</th>
<th>4C 2.8/8 11/200</th>
<th>Gas air</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1.000 kW (1360 hp)</td>
<td>Suction pressure 11/34 bar (160/493 psi)</td>
</tr>
<tr>
<td>Speed</td>
<td>485 rpm</td>
<td>Discharge pressure 34/82 bar (493/1190 psi)</td>
</tr>
<tr>
<td>Lubrication</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

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**Project Execution by:**

HOERBIGER BENELUX BV
Heerlen, Netherlands
A 700kW compressor used for natural gas suffered a catastrophic failure. The crankshaft, connecting rod and housing of the compressor were among the parts that were severely damaged.

### Facts in Brief
Failure of lubrication caused major damage to this natural gas compressor. The crankcase assembly, second-stage distance piece, liner and piston rod were all wrecked. The operating company commissioned HOERBIGER to assess the damage and develop a proposal for how to get the compressor running again with a higher level of safety.

### Customer requirements
- Complete review of all compressor parts
- Determine the causes of failure

### Solution applied
- Upgrade the pressure packing to HOERBIGER BCD rings
- Upgrade the oil wiper packing to OT oil wiper rings
- Install new cylinder rings
- Repair the cylinder and cylinder cover
- Replace the second-stage cylinder liner with one of improved surface quality
- Supervise installation and commissioning

### Results
- Cost-effective solution to repair a seriously damaged compressor
- Two non-working compressors were used to create an up-to-date, fully functioning unit
- Compressor was up and running within 4 months

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**Compressor manufacturer:** BORSIG  
**Type** BX28-20/2S2  
**Gas** NG  
**Power** 700 kW (952 hp)  
**Suction pressure** 1.8 bar (26 psi)  
**Speed** 375 rpm  
**Discharge pressure** 8.8 bar (128 psi)  

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**Project Execution by:**  
HOERBIGER Service Middle East FZE  
Dubai, United Arab Emirates
A European refinery discovered a crack in one of its major compressors, which had more than 40 years of service.

### Facts in Brief
- After 40 years of operation the second-stage cylinder cracked
- No spares available from compressor manufacturer

### Customer requirements
- Improve the original design
- Replace damaged parts quickly

### Solution applied
- Audit compressor and analyse damage
- Design a new and improved cylinder and use finite element analysis to verify strength
- Create drawings for production
- Cast a new cylinder from nodular iron and machine it to specification (turning, milling, honing)
- Final checks (ultrasonic and magnetic particle inspection, pressure and leak tests, material test)
- Painting and packaging
- Project management and documentation

### Results
- Replacement cylinder designed, cast and machined in less than 4 months
- New cylinder fitted exactly and provided the required flow and pressure
- Rebuilt compressor operating reliably since 2007

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**Old cylinder cracked: new cylinder designed / manufactured / installed**

**Compressor manufacturer:** NUOVO PIGNONE

<table>
<thead>
<tr>
<th>Type</th>
<th>2HE/2AP</th>
<th>Gas</th>
<th>CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>565 kW (768 hp)</td>
<td>Suction pressure</td>
<td>1.2 bar (17 psi)</td>
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<td>Speed</td>
<td>296 rpm</td>
<td>Discharge pressure</td>
<td>21 bar (305 psi)</td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Project Execution by:**

HOERBIGER UK LTD
Bradford, United Kingdom
In a French ammonia plant a broken compressor piston rod needed urgent replacement.

### Facts in Brief
The piston rod of the Dujardin & Clark compressor suffered a fatigue failure.

### Customer requirements
- New piston rod redesigned to suit the current working conditions
- Time limit of 4 weeks

### Solution applied
- Strip, inspect and measure the old piston rod
- Ultrasonic inspection of the material
- Select material for new piston rod and nut
- Design and manufacture piston rod, nut and cylinder ring
- Apply coating and check integrity
- Final inspection and documentation

### Results
- New piston rod quickly designed and manufactured
- Compressor started up within 4 weeks

### Compressor manufacturer: Dujardin & Clark

<table>
<thead>
<tr>
<th>Type</th>
<th>CLRA4</th>
<th>Gas</th>
<th>H₂, N₂, CO, CH₄</th>
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</thead>
<tbody>
<tr>
<td>Power</td>
<td>Suction pressure</td>
<td>53 bar (769 psi)</td>
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<tr>
<td>Speed</td>
<td>333 rpm</td>
<td>Discharge pressure</td>
<td>153 bar (2219 psi)</td>
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<td>Lubrication</td>
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</table>

Ammonia plant compressor

New piston rod assembly

Project Execution by:
HOERBIGER France S.A.S.
Avignon, France
A French low density polyethylene (LDPE) plant could not achieve effective control of a booster/primary compressor.

### Compressor manufacturer: NUOVO PIGNONE/ PARSONS

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<thead>
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<th>Ethylene</th>
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<tr>
<td>Power</td>
<td>Suction pressure</td>
<td>2.7 bar (39 psi)</td>
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<td>Speed</td>
<td>Discharge pressure</td>
<td>287 bar (4163 psi)</td>
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<tr>
<td>Lubrication</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

### Facts in Brief

New compressors were installed by Nuovo Pignone in an LDPE plant in France. The booster/primary compressor was supplied with a high-end HydroCOM system, but the operator could not start up the reverse flow control.

### Solution applied

- Compressor audit traced the failure to condensation problems in the fifth stage
- Design new control scheme to reduce interstage pressure and increase the discharge temperature from the previous stage
- Repair and recondition valves, packing cases, and actuators
- Install hydraulic piping, valves, actuators, and top dead center according to specification
- Program new control layout into the DCS
- Check installation and test software
- Start-up and monitoring

### Results

- With HydroCOM operating correctly, the compressor now delivers the required flow to the hyper-compressor
- Stable interstage pressure avoids condensation
- The process is now smooth and reliable, with lower energy costs when running at partial load

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Project Execution by:

HOERBIGER France S.A.S.

Geispolsheim, France
A chemical plant in Switzerland was facing abnormal bearing failures in all the 4-stage nitrogen compressors on its air separation unit.

Facts in Brief
- After several years of wear on the crankshaft and bearings, combined with lack of oil pressure because of a lubrication design problem, the crosshead pin bushing had to be changed every 2000 h
- OEM recommendation of special bearing clearances did not improve the situation

Customer requirements
- Adapt compressor design to increase bearing life

Solution applied
- Rod load calculation showed insufficient load reversal and poor lubrication of crosshead pin
- Evaluated different crosshead designs and weights, and selected an optimal weight to produce the right load reversal for each operating condition according to API 618
- Constructed, fabricated and installed the new heavier crosshead (260 kg compared to the original 80 kg)
- Crankshaft coated and re-ground, and new bearings fitted
- Project management and documentation
- Start up

Results
- With the new heavy crosshead, load reversal ensures proper lubrication of the crosshead pin
- MTBF has been extended to more than 12,000 hours

Compressor manufacturer: BURCKHARDT Compression

<table>
<thead>
<tr>
<th>Type</th>
<th>Gas</th>
<th>Suction pressure</th>
<th>Discharge pressure</th>
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</thead>
<tbody>
<tr>
<td>4DE250-4A</td>
<td>N₂</td>
<td>90 bar (1305 psi)</td>
<td>200 bar (2900 psi)</td>
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<tr>
<td>Power</td>
<td>750 kW (1020 hp)</td>
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</tr>
<tr>
<td>Speed</td>
<td>480 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lubrication for two crossheads and conrods from a single main bearing in the centre

Original 80 kg crosshead in cast steel

Load reversal diagram after assembly of new crosshead

New crosshead in forged steel weighs 260 kg

Project Execution by:
HOERBIGER Service GmbH
Walsrode, Germany
To meet an urgent need for an increase in supply pressure, a German natural gas distributor was forced to re-use old compressors under new operating conditions.

<table>
<thead>
<tr>
<th>Compressor manufacturer: BORSIG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Suction pressure</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Discharge pressure</td>
</tr>
<tr>
<td>Lubrication</td>
</tr>
</tbody>
</table>

Facts in Brief
- A change in customer required a sudden increase in gas pressure
- Two old compressors that had been in storage for more than 10 years were required to run at higher capacity and lower pressure than they were designed for

Solution applied
- Evaluate control options: speed control or HydroCOM?
- HydroCOM was chosen because speed control required a bigger flywheel with a higher bearing load
- Simulation of HydroCOM for different operating conditions
- Optimized size of flywheel and electric motor
- Calculation of compressor load, static and dynamic foundation forces, and torsional vibration analysis
- Layout and 3D drawing of packaged compressor with new foundation design, bigger cylinder bores, without original tailrod, and electric motor instead of original gas engine
- Comprehensive overhaul including frame, running gear and cylinder
- Complete installation at site with leakage gas recompression, water cooling and lubrication
- Project management and documentation with ATEX certification

Results
- The old compressors have been revamped to as-new condition and adapted for their new operating conditions
- They now run safely and with zero leakage

Project Execution by:
HOERBIGER Service GmbH
Walsrode, Germany
**Install reconditioned compressor**

An Italian refinery operated suffered major damage to a feed compressor of a steam reformer following poor maintenance.

<table>
<thead>
<tr>
<th>Compressor manufacturer: WORTHINGTON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Lubrication</td>
</tr>
</tbody>
</table>

**Facts in Brief**

Work by an external contractor resulted in a loose suction valve, which in turn caused a broken cylinder.

**Customer requirements**

- Replace the broken compressor as quickly as possible
- Use a reconditioned compressor to reduce costs and downtime

**Solution applied**

- Audit the replacement compressor, including pulsation check and calculation of pressures, temperature and loads
- Calculate and optimize pipe lengths
- Adapt compressor to new operating conditions
- Upgrade compressor with HydroCOM stepless control, RecipCOM rod position monitoring, and control panel
- Design and install new foundation
- Install coolers, auxiliary equipment and electric motor
- Assemble all parts
- Provide CE certification

**Results**

- The refinery obtained a reliable compressor within a very short lead time
- HydroCOM significantly reduced energy costs
- The compressor has run trouble-free since installation

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Project Execution by:
HOERBIGER Italiana S.P.A
Verona, Italy
Cylinder corrosion problems: new cylinder designed / manufactured / installed

A German refinery was facing corrosion problems on the recycle compressors of its hydrodesulphurisation unit.

<table>
<thead>
<tr>
<th>Compressor manufacturer: MB HALBERSTADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Power</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Lubrication</td>
</tr>
</tbody>
</table>

Customer requirements
- Replacement of old corroded cylinders with two new cylinders for each of the two identical compressors
- Design engineering from existing cylinders and liners
- Strength calculation
- Pressure and leakage tests

Solution applied
- Measurement of the original cylinder on site
- Material selection (CK35) to avoid corrosion problems
- Finite element stress calculation for new cylinders
- Construction and production of the cylinders, and design of the cylinder liners
- Pressure and leakage tests
- Assembly and installation of all new parts on site
- Project management and documentation

Results
- The rebuilt compressors have been running since 2008 with no corrosion problems
- The liners effectively protect the cylinders from wear by the piston rings

Project Execution by:
HOERBIGER Service GmbH
Walsrode, Germany
A leading petrochemical company in Russia and Eastern Europe required a revamp of two propane compressors. The company awarded HOERBIGER to do the job.

### Facts in Brief
The plant was flaring propane vapour from its outdated refrigeration unit. The customer decided to revamp the unit and requested two boil-off compressors so that the propane could be re-compressed, liquefied and returned to storage.

### Customer requirements
- Short lead time: 10 months
- Reliable solution: 24,000 hours mean time between maintenance (MTBM)
- Energy-efficient configuration

### Solution applied
- Efficient compressor valves
- Pressure packing rings made from HY54 PTFE compound
- Manufacturer commissioned the two compressor packages
- Added compressor step control system
- Compressors started up
- Operational tests

### Results
- Project delivered in exactly 10 months
- Compressors have run safely and reliably since installation
- No more propane flaring

### Compressor manufacturer: KOHO Kompressorsysteme

<table>
<thead>
<tr>
<th>Type</th>
<th>TWZ 14.33 / 885.661 / 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>C$_3$H$_8$</td>
</tr>
<tr>
<td>Power</td>
<td>160 kW (218 hp)</td>
</tr>
<tr>
<td>Speed</td>
<td>590 rpm</td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
</tr>
<tr>
<td>Suction pressure</td>
<td>1.0 bar (14 psi)</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>15 bar (218 psi)</td>
</tr>
</tbody>
</table>

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*Project Execution by:*

HOERBIGER LTD.
Moscow, Russia
An air separation plant in Norway needed a replacement compressor after a fire in an oxygen compressor.

### Facts in Brief
An oxygen compressor was seriously damaged by a fire in a cylinder.

### Customer requirements
- Replace the compressor as quickly as possible with a machine suitable for the same operating conditions with the same capacity

### Solution applied
- Locate an equivalent compressor in the HOERBIGER database
- Verify suitability and plan necessary upgrades
- Carry out comprehensive mechanical check
- Provide drawings and documentation for all main parts and wear parts
- Recondition valves, packing cases, and bearings
- Redesign piston rings and rider rings
- Special cleaning of damper and cooling system
- Repair and certify electric motor
- Adjust foundation level
- Install on site and start up

### Results
- The overhauled compressor was shipped within 4 months
- Since installation it has run safely and reliably

### Compressor manufacturer: LINDE

<table>
<thead>
<tr>
<th>Type</th>
<th>3SH-250-3P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>400 kW (544 hp)</td>
</tr>
<tr>
<td>Speed</td>
<td>485 rpm</td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
</tr>
<tr>
<td>Gas</td>
<td>O₂</td>
</tr>
<tr>
<td>Suction pressure</td>
<td>1.0 bar (14 psi)</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>31 bar (450 psi)</td>
</tr>
</tbody>
</table>

Burned piston

Finite element analysis of new piston

Collecting replacement compressor

Installing the overhauled compressor

Project Execution by:
HOERBIGER Service Nordic AS
Ski, Norway
Reliability and troubleshooting project, pulsation / vibration reduction

Operators of an LDPE plant in Serbia, were facing high levels of compressor vibration, with many unexpected shutdowns.

<table>
<thead>
<tr>
<th>Compressor manufacturer: INGERSOLL RAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Gas</td>
</tr>
<tr>
<td>C₂H₆</td>
</tr>
<tr>
<td>Power 933/6000 kW (1269/8158 hp)</td>
</tr>
<tr>
<td>Suction pressure 0.1/250 bar (1.5/3626 psi)</td>
</tr>
<tr>
<td>Speed 375/250 rpm</td>
</tr>
<tr>
<td>Discharge pressure 250/2400 bar (3626/34810 psi)</td>
</tr>
<tr>
<td>Lubrication yes</td>
</tr>
</tbody>
</table>

Customer requirements
- Improve valve reliability on booster and primary compressors
- Reduce vibration to avoid pipe cracks
- Install monitoring and protection system for booster, primary and hyper-compressors

Solution applied
- Install RecipCOM diagnostic and monitoring system to measure pressures, temperatures, and vibration.
- Carry out full pulsation/vibration analysis
- Install orifices at various points in the pipes to reduce vibration
- Replace IR valves with reliable high-efficiency HOERBIGER CE valves, with ability to monitor indicating pressure
- Overhaul compressors fully, including replacement rods, pistons and liners as required
- Project management and documentation

Results
- Piping orifices reduced vibration as predicted
- RecipCOM monitoring assures safe operation
- CE valves have cut energy consumption, extended maintenance intervals, and facilitated monitoring

Project Execution by:
HOERBIGER Kompressortechnik Europa Services GmbH
Novi Beograd, Serbia
A refinery in Germany needed help from HOERBIGER to overhaul an existing H₂ compressor and its foundation.

**Facts in Brief**
- The original steel supports were placed in wet concrete. The resulting corrosion caused misalignment, resulting in shutdowns to repair heavy bearing and crosshead wear.
- The special design has a single motor mounted at the centre of two 4-throw compressors

**Customer requirements**
- To extend the lifetime of the compressor and reduce downtime, the customer wanted an overhaul including a new foundation

**Solution applied**
- Disassembly of the complete units including piping, vessels and internals for a complete rebuild, including laser alignment
- New epoxy grouting
- Bore shafts installed to allow on-site machining of the bearing tunnel in both frames
- Installation of repaired crankshaft, crossheads and new bearings
- Project management and documentation

**Results**
- The compressor is now more durable
- The bearings run at lower temperatures due to the reduced web deflection of both crankshafts

**Compressor manufacturer: MB HALBERSTADT**

<table>
<thead>
<tr>
<th>Type</th>
<th>Power</th>
<th>Suction pressure</th>
<th>Discharge pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1HB8KT-400/270 Gas H₂</td>
<td>2600 kW (3535 hp)</td>
<td>11 bar (160 psi)</td>
<td>36 bar (522 psi)</td>
</tr>
</tbody>
</table>

**Project Execution by:**
HOERBIGER Service GmbH
Walsrode, Germany
A modernization project increased the availability of compressors at a gas distribution station in Romania.

**Facts in Brief**
- Modernization project to improve MTBF and compressor availability, and reduce lube oil consumption
- Change of operating parameters for one compressor out of three

**Solution applied**
- Detailed compressor examination
- Conversion from two-stage to single-stage operation for one compressor out of the three
- New compressor valves with non-metallic sealing elements
- Conversion to non-metallic piston rings and packings
- New packing boxes
- Improved oil wiper packing
- Modification and reconditioning of existing piston rods, pistons and cylinder liners
- New lubrication system and piping
- Pulsation evaluation to API 618
- On-site supervision and installation

**Results**
- Non-metallic sealing elements minimize wear on cylinder bores and piston rods
- Lube oil consumption cut from around 180 l/day to 62 l/day
- Increased compressor availability
- Runtime between maintenance intervals increased to 8,000 hours, from 1,100–2,000 hours previously

<table>
<thead>
<tr>
<th>Compressor manufacturer: RUMO</th>
<th>Integral compressor in new condition, with 5 compression and 10 power cylinders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 10GKNA</td>
<td>Old lubrication system</td>
</tr>
<tr>
<td>Power 1100 kW (1496 hp)</td>
<td>Modified pistons with shrink-fit rider rings</td>
</tr>
<tr>
<td>Suction pressure 4.0 bar (58 psi)</td>
<td></td>
</tr>
</tbody>
</table>
| Discharge pressure 40 bar (580 psi) | Reduce emissions
| Lubrication yes              | Project Execution by: HOERBIGER Service Romania SRL. Odorheiu-Secuiesc, Romania |
A propylene plant in Norway needed better control of a boil-off compressor.

### Facts in Brief
- Propylene vapor boiling off from storage tanks is recompressed and re-liquefied by two 6-cylinder compressors.
- Vapor flow is intermittent and enters the compressors at a temperature of –45°C.
- The existing pneumatic capacity control system resulted in excessive energy consumption.
- Poor balancing at partial load reduced compressor reliability.

### Customer requirements
- Improve control to reduce energy consumption and increase reliability.

### Solution applied
- Calculated possible saving with HydroCOM continuous reverse-flow control compared to existing step control.
- Retrofitted actuators with polyamide discs to protect against low suction temperatures.
- Redesigned the valves.
- Integrated the HydroCOM system into the main plant DCS.
- Supplied and installed all new wear parts.
- Commissioned HydroCOM.
- Installed RecipCOM compressor monitoring system.
- Project management and documentation.

### Results
- Lower energy costs.
- Longer run times between maintenance shutdowns.

---

**Compressor manufacturer: LINDE**

<table>
<thead>
<tr>
<th>Type</th>
<th>6 LX220-2P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>propylene</td>
</tr>
<tr>
<td>Power</td>
<td>1700 kW (2311 hp)</td>
</tr>
<tr>
<td>Suction pressure</td>
<td>0.05 bar (0.73 psi)</td>
</tr>
<tr>
<td>Speed</td>
<td>585 rpm</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>10 bar (145 psi)</td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
</tr>
</tbody>
</table>

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**Project Execution by:**

HOERBIGER Service Nordic AS

Ski, Norway
## Convert compressor for new process conditions with increased capacity

A leading refining company in UK wants to revamp their 40+ years old compressors to include them in a new process plant.

### Customer requirements
- Remove the compressor cylinders and moving parts from the crankcase and transport to the service shop for upgrade or refurbishment.
- Revamp the compressor, with new HOERBIGER core products (valves, rings and packing’s)
- Convert and overhaul to meet new process requirements
- Capacity increase, change of gas mix
- Pulsation and mechanical response analysis (Approach 3 conforming API618)

### Solution applied
- Data gathering and measurement of critical cylinder dimensions for compressor simulation.
- Calculation and verifying of data according new requirements.
- Calculation of volume flow and driver power at different regulation cases.
- Replacing of all wear parts with HOERBIGER solutions.
- Modification of piston and cylinder head and liner for new performance requirement and to improve gas flow.
- New valve cover and valve chair design to eliminate valve centre bolts
- Project management and documentation

### Results
- The two revamped compressors meet all the new process requirements.
- Recommendations made for revisions to process piping design to make certain that pulsation and vibration levels are within customer limits

<table>
<thead>
<tr>
<th>Compressor manufacturer: DRESSER - RAND</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>10'' 2HHE-1</td>
</tr>
<tr>
<td>287 kW (390 hp)</td>
</tr>
<tr>
<td>495 rpm</td>
</tr>
</tbody>
</table>

Project Execution by:
HOERBIGER UK LTD
Bradford, United Kingdom
A French chemical plant had to replace a crosshead guide due to an age-related crack (the compressor is 40 years old).

### Facts in Brief
- Crosshead guide cracked after 40 years of operation
- No spares available from compressor manufacturer

### Customer requirements
- Deliver one crosshead guide
- Supervise installation
- Re-machine crosshead

### Solution applied
- Inspected the cracked crosshead guide, with on-site meeting to clarify any doubtful points
- Used original AC Crepelle drawings from customer to cast and machine new crosshead guide
- Final checks (magnetic particle and ultrasonic inspection)
- Supervised installation
- Re-machined crosshead
- Old crosshead guide was repaired by Atlas Copco, with increased diameter
- Project management and documentation

### Results
- New crosshead guide was manufactured to dimensions and quality approved by the customer
- Crosshead guide was delivered and installed as requested

---

**Compressor manufacturer: ATLAS COPCO CREPELLE**

<table>
<thead>
<tr>
<th>Type</th>
<th>3-3HC6GT</th>
<th>Gas</th>
<th>CO₂/NH₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1470 kW (1998 hp)</td>
<td>Suction pressure</td>
<td>1.0 bar (14 psi)</td>
</tr>
<tr>
<td>Speed</td>
<td>428 rpm</td>
<td>Discharge pressure</td>
<td>9.0 bar (131 psi)</td>
</tr>
<tr>
<td>Lubrication</td>
<td>no</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Old, cracked crosshead guide**

**Original drawing for crosshead guide**

**Finished crosshead guide**

**Crosshead guide installed on the compressor**
A leading oil supplier company in Hungary suffered a vibration problem, with frequent damage to the coupling, following a change of compressor driver.

### Facts in Brief
- **HOERBIGER** provided recommendations for drive train engineering
- Drive train modernization project resulted in the original gas engine being replaced by an electric motor
- Startup was aborted after loud noises were heard from the coupling at higher compressor speeds.
- Coupling lamellas were found to be damaged
- The new drive arrangement had not been checked for torsional vibration

### Solution applied
- Detailed check of flywheel and coupling
- Gathered data on torsional vibration
- Carried out full torsional vibration analysis
- Recommended new coupling type able to withstand the calculated vibration moments and forces
- Recommended further modifications to flywheel

### Results
Calculations showed that the new driveline arrangement produces higher than expected levels of torsional vibration at normal operating speeds. The recommended modifications will ensure many years of safe and reliable operation.

### Project Execution by:
HOERBIGER Service Hungaria Kft.
Dunakeszi, Hungary
To suit new process conditions and cut energy costs, a German natural gas distributor upgraded the compressors at its gas storage plant in Hungary.

**Compressor manufacturer: MB HALBERSTADT**

<table>
<thead>
<tr>
<th>Type</th>
<th>2HB6K-400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>CH₄ mix</td>
</tr>
<tr>
<td>Power</td>
<td>1840 kW (2502 hp)</td>
</tr>
<tr>
<td>Speed</td>
<td>370 rpm</td>
</tr>
<tr>
<td>Lubrication</td>
<td>yes</td>
</tr>
</tbody>
</table>

**Facts in Brief**
- Upgrade existing 2HB6K-400 compressors in response to an energy rationalization project
- Gas storage was required to operate at higher suction and discharge pressures than previously
- Thorough investigation of all possible conversion alternatives: new motor, new first-stage cylinders, HydroCOM control system

**Solution applied**
- HydroCOM flow control system indentified as the most economic solution for this revamp project
- Capacity of the first stage can be adjusted to match available motor power. HydroCOM ensures that intermediate pressure ratings are not exceeded
- No modifications to cylinder diameters required
- Only the suction valves needed to be changed
- No danger of cylinder oil accumulating in idle cylinders
- Products fitted: valves, RecipCOM with HydroCOM, explosion relief valves

**Results**
- Effective and safe gas storage operation thanks to HOERBIGER’s HydroCOM flow control and RecipCOM
- The storage reservoir can now be filled to the required higher pressure in a much shorter time
- As storage requirements change over time, HydroCOM adjusts the gas flowrate accordingly
- For each operating condition the compressor can be operated at the maximum installed drive power level

Project Execution by:
HOERBIGER Service Hungaria Kft.
Dunakeszi, Hungary
A producer of technical gases in Germany required a cost-effective capacity control system to eliminate the energy losses associated with the existing bypass control.

### Facts in Brief
- T162-236 N 2.4 compressor handles a H2/CO mixture
- Capacity was controlled at 80% by a bypass system

### Customer requirements
- Reduce energy costs by avoiding bypass control
- Implement cost-efficient and reliable capacity control
- Payback within 2 years

### Solution applied
- Calculate the clearance pocket volume required for the first-stage cylinder to achieve 80% capacity
- Design a new cylinder head incorporating the clearance pocket and a cooling water jacket
- Specify layout of the clearance valve and actuator
- Stress analysis (FEA) of the complete cylinder head
- Manufacture and inspect all components
- Hydraulic pressure and leak test
- Project management and documentation, including functional description and certification

### Results
- The modified compressor met the customer’s requirements and can be controlled at 80% of full capacity
- Energy costs were reduced by eliminating bypass control

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**Compressor manufacturer:** LMF  
**Type:** T162-236 N 2.4  
**Gas:** H2/CO mix  
**Power:** 120 kW (163 hp)  
**Suction pressure:** 4.5 bar (65 psi)  
**Speed:** 590 rpm  
**Discharge pressure:** 24 bar (348 psi)  
**Lubrication:** no

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**Project Execution by:**  
HOERBIGER Service GmbH  
Walsrode, Germany
A leading supplier of industrial gases revamped a pressure swing adsorption (PSA) unit used to purify hydrogen.

### Facts in Brief
The highly variable hydrogen demand from the PSA unit required this compressor to be relocated from the hydrogen delivery pipeline to the feed pipeline, with substantial modifications.

### Customer requirements
- An efficient way to control the compressor and the hydrogen feed pressure to the PSA
- Short project timescale: 9 months

### Solution applied
- Torsional analysis, pulsation study and rod load calculations to determine the feasibility of a capacity increase
- Redesign (with FEA) and manufacture new piston and crosshead
- Manufacture new cylinder to updated specifications
- Check and repair crankshaft
- New HydroCOM control system with highly efficient CE valves
- BCD packing with HY material
- Emissions control panel
- New lubrication system with divider block
- RecipCOM monitoring and protection system
- Add pulsation bottles, partial re-grouting
- Reassemble, paint, and provide start-up assistance

### Results
- The revamped compressor feeds 99.99% pure hydrogen to the PSA unit
- HydroCOM control system prevents lifting of the PSA bed during process upsets - no flaring anymore.
- HOERBIGER BCD packing reduces hydrogen emissions
- Project delivered on time

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**Compressor manufacturer: DRESSER-RAND**

<table>
<thead>
<tr>
<th>Type</th>
<th>HHE-VL</th>
<th>Gas</th>
<th>H₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>16,778 kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(22,811hp)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suction</td>
<td>24/32 bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(348/464 psi)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>327 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discharge</td>
<td>33/53 bar</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(479/769 psi)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lubrication</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Project Execution by:**
Hoerbiger Service Inc.
Houston, Texas
A chemical plant asked HOERBIGER as MBH know-how holder to manufacture new crankcase and crosshead guide.

### Facts in Brief
- Severe failure occurred following a design modification by an industrial service provider (piston design changed from welded to a 2-piece-design)
- Crankcase and other components were damaged by high collision forces

### Customer requirements
- Inspection of broken crankcase and approval for limited operation pending delivery of new crankcase
- Delivery of one crankcase and one crosshead guide including auxiliary equipment (supports, anchor bolts, etc.)

### Solution applied
- Inspected damaged crankcase
- Took 6th row out of service and clamped crankcase to stop crack growth
- Approved for limited operation (balanced operation mode)
- Cast and machined new crankcase following original MBH drawings, to which HOERBIGER has the rights
- Sourced all necessary auxiliary equipment
- Specified installation procedure
- Project management and documentation

### Results
- Trouble free operation after repair
- Crankcase, crosshead guide and all auxiliary equipment delivered in time
- All goods inspected and approved for dimensions and quality
- All delivered parts installed and compressor is in operation again
How is your compressor running? How should it run? How could it run?

Ask yourself these three questions and don’t settle for your compressor’s current performance. Because every compressor can be made more reliable, efficient and environmentally friendly. Process changes or the need to improve process stability, safety, or standardization of performance-determining components are no reasons to put your aging compressor on the scrapheap.

If you believe your compressor is showing its age and approaching the end of its life, we at HOERBIGER would like to prove you wrong. We can conduct a comprehensive analysis and carry out a customized optimization and/or upgrade of your compressor to suit the individual production environment and industry benchmark.

The optimal solution may comprise the simple replacement of one or more performance-determining components, or go as far as a major compressor overhaul and conversion by HOERBIGER’s technical experts.

You receive a binding offer from HOERBIGER, which, in most cases, is more economical than a new compressor. Even the complete conversion of an existing compressor is usually much faster than a new acquisition, without even taking into account the cost and time associated with the removal of the old compressor.

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Email: info-hkth@hoerbiger.com
www.hoerbiger.com

HOERBIGER is active throughout the world as a leading player in the fields of compression technology, drive technology and automation technology. In 2013, its 6,400 employees achieved sales of 1.05 billion euros. The HOERBIGER brand is synonymous with performance-defining components in compressors, industrial engines and turbines, automobile transmissions, and multifaceted mechanical engineering applications. Innovations in attractive technological market niches are the basis for components, systems and services that offer unique selling propositions and long-term benefits for the customer. We set standards.

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