Ultimate Surface Performance
HYDRAULIC & PNEUMATIC CYLINDERS & RODS

- HEF Group is the only global supplier of both Liquid Nitriding treatments and PVD/DLC coatings for engineered components.

- HEF Group through its global network of 60 jobbing facilities, in 20 countries, is one of the world’s largest suppliers or wear, friction and corrosion reduction treatments and coatings for components utilized for a diverse range of hydraulic and pneumatic equipment such as: Valves; Pumps; Hydraulic & Pneumatic cylinders and rods; Hydraulic fittings etc.

Liquid Nitriding (LN) / Salt Bath Nitriding (SBN) / Nitrocarburizing

Liquid Nitriding is a thermo-chemical diffusion treatment that enriches the surface of steels and cast iron with Nitrogen.

The surface Compound Layer is composed of iron nitrides + special nitrides. The area below the compound layer, is the Diffusion zone where Nitrogen diffuses into the iron lattice to form a solid solution.

HEF Group’s trademarked family of Liquid Nitriding processes:

ARCOR®: ARCOR V, ARCOR C, ARCOR N, ARCOR DT, SURSULF®,...
MELONITE®: TF1, QP, QPQ, TENIFER®, TUFFTRIDE®,...

LIQUID NITRIDING BENEFITS

- Hard (600-1200 HV) surface layer provides very good wear resistance
- Good frictional properties
- Excellent scuffing / seizure protection (adhesive wear)
- Excellent corrosion protection
- Good surface fatigue resistance
- Decorative black surface
Liquid Nitriding: PROPERTIES

Nitrogen diffusion from a Liquid Bath composed of nitrogen-rich chemicals (salts)

- Sub-micron porosity
- Compound Layer (Iron & Alloying element nitrides)
- Diffusion Zone (Nitrogen in solid solution)
- Bulk Material

**Compound Layer:**
- Very high hardness
  - Abrasion wear resistance
  - Adhesive wear / Scuffing resistance
- Low-friction

**Oxide Layer:**
- Corrosion Resistance
- Impregnate micro-porosity
  - Low-friction, running-in Layer
- Black finish

**Diffusion Zone:**
- Fatigue Strength
- High Compressive Strength
- Hardness higher than bulk

Hardness Profile, including surface hardness level achieved (typically 600 to 1200 HV), is dependent on the grade of steel → alloying elements & carbon content.

Total Case Depth (based on specified hardness threshold)
ARCOR® LIQUID NITRIDING vs. CHROME PLATING

CORROSION RESISTANCE

**ARCOR® LIQUID NITRIDING vs. CHROME PLATING**

**ARCOR® LIQUID NITRIDING vs. PRE-NITRIDED (GAS) CYLINDERS & RODS**

**ARCOR® LIQUID NITRIDING BENEFITS**

- Superior corrosion resistance
- Lower friction coefficient: reduced wear
- Superior bend and impact resistance
- Finished tubes, rods and plungers can be Liquid Nitrided without issues of distortion etc.

**NOTE:** Salt Spray tests are suitable only for comparative and relative evaluation of corrosion resistance. The salt spray hours achieved are a function of several factors, including: steel grade; geometry of the part being tested; and surface treatment/coating.
**ARCOR® LIQUID NITRIDING vs. CHROME PLATING**

**SEAL WEAR in HYDRAULIC CYLINDERS**

**ARCOR® Liquid Nitriding process from HEF – reduced elastomer seal wear**

**TEST CONDITIONS**

- **Surface Treatment**
  - Hard Chrome
  - ARCOR Liquid Nitriding
- **Motion**
  - Alternative rectilinear
- **Travel**
  - 70 mm
- **Linear Speed**
  - 0.1 m/s
- **Contact Pressure**
  - 2 MPa
- **No. of cycles**
  - 4000
- **Hydraulic Fluid**
  - Viscosity @ 40°C: 18 cST
  - Density @ 15°C: 0.83 g/cm³
  - Surface tension @ 20°C: 27.0 mN/m

**Friction Couple**

- PTFE / Hard Chromium
- PTFE / ARCOR Liquid Nitriding
- Fluorinated elastomer / Hard Chromium
- Fluorinated elastomer / ARCOR Liquid Nitriding

**Wear on polymer part**

- 10 mm
- 10 mm
- 80 mm
- 50 mm

**FRICTION COEFFICIENT**

![Friction Coefficient Graph]

**ARCOR® Liquid Nitriding process from HEF – lower friction coefficient**
Why ARCOR Liquid Nitriding is superior to Chrome Plating for Hydraulic and Pneumatic Cylinder applications:

- Vastly superior (6-7 times higher) corrosion resistance than chrome plating. (see attached standardized test). Liquid Nitriding is also superior to pre-nitrided (gas or plasma) tubes and rods, in terms of corrosion resistance.
- Better frictional properties, therefore reduced seal wear – compared to chrome plating.
- Much lower risk of cracking, peeling, or flaking because it is not a coating but an integral part of the surface as opposed to chrome plating that goes on top of the cylinder’s surface.
- Improves the fatigue resistance of the base material – whereas chrome plating has no beneficial impact.
- Impact and bend-resistance is comparable to chrome plating.
- The process is very price competitive to chrome-plating and other nitriding technologies or pre-nitrided tubes and rods.
- Finished tubes, rods and plungers can be Liquid nitrided without issues of distortion etc.
- HEF can Liquid Nitride parts as long as 15 feet in our newest facility in Chattanooga, TN. This is the largest liquid nitriding facility in the Americas and was designed specifically for long-cylinders and heavy components.
## ARCOR® LIQUID NITRIDING APPLICATIONS

### PISTON RODS

<table>
<thead>
<tr>
<th>Surface Treatment (+++ Best)</th>
<th>Wear resistance</th>
<th>Corrosion resistance</th>
<th>Ductility under flexion</th>
<th>Friction properties</th>
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<tr>
<td></td>
<td>Abrasive</td>
<td>Adhesive</td>
<td></td>
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<tr>
<td>ARCOR Liquid Nitriding</td>
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<tr>
<td>Induction Hardening</td>
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<td>Cr plating</td>
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<tr>
<td>Zn plating</td>
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</tbody>
</table>

ARCOR treated cylinder and piston rods have significant advantages and application versatility compared to other surface treatment options

### BENEFITS OF ARCOR® LIQUID NITRIDING

- Minimizes adhesive wear
- Reduced friction
- Significant corrosion reduction
- Treated rods can withstand deflection without surface cracking
ARCOR® HYDRAULIC CYLINDERS & RODS

APPLICATION AREAS

- Waste Disposal trucks
- Dump trucks
- Snow removal trucks
- Automotive & industrial lifting equipment
- Heavy-duty construction equipment
- Compaction equipment
- Fluid handling equipment

ARCOR® GAS SPRINGS & PNEUMATIC CYLINDERS / RODS

APPLICATION AREAS

- Gas Springs
- Piston Rods for pneumatic cylinders
- Clamping devices
- Shock Absorbers
HYDRAULIC & PNEUMATIC CYLINDERS & RODS
ARCOR® LIQUID NITRIDING FACILITY

STATE-OF-THE-ART LIQUID NITRIDING LINE: CHATTANOOGA, TN

✦ Largest Operating equipment in North America. Part size capability:
  • Maximum Length: 8 feet (2.5 m). With flipping: 15 feet (4.5 m)
  • Weight: 4,000 lbs. (1,800 kg.). Heavier - with special arrangements

✦ Fully instrumented, computer controlled and capable of remote monitoring.
  Batch-to-batch traceability and process recording.

✦ Designed to treat hydraulic & pneumatic cylinders and associated components.

✦ An in-line, post-nitriding impregnation process can provide an added level of
  corrosion protection and surface lubricity to the nitrided components.

✦ To achieve customer specified post-nitriding surface finish, the facility
  is equipped with a variety of finishing processes for hydraulic cylinders.