

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 of 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.

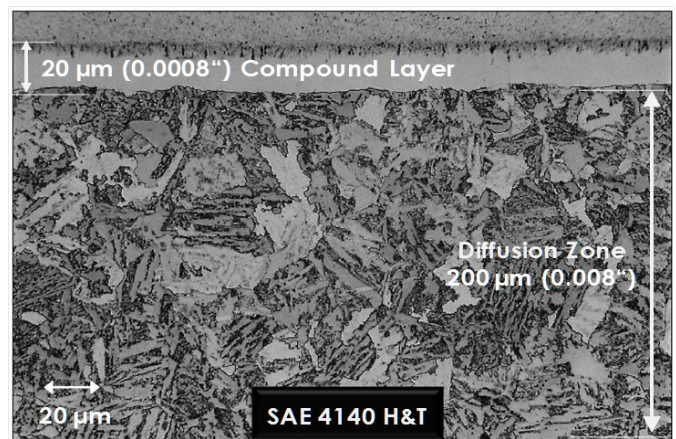
Liquid Nitriding (LN) / Salt Bath Nitriding (SBN) / Nitrocarburizing

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:

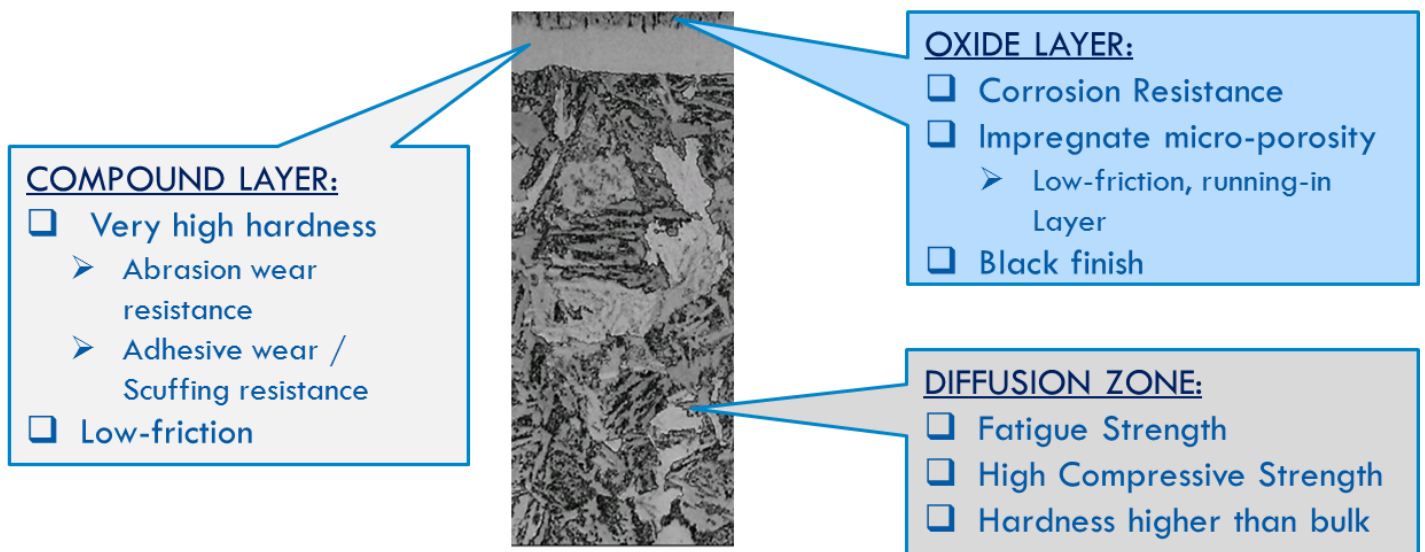
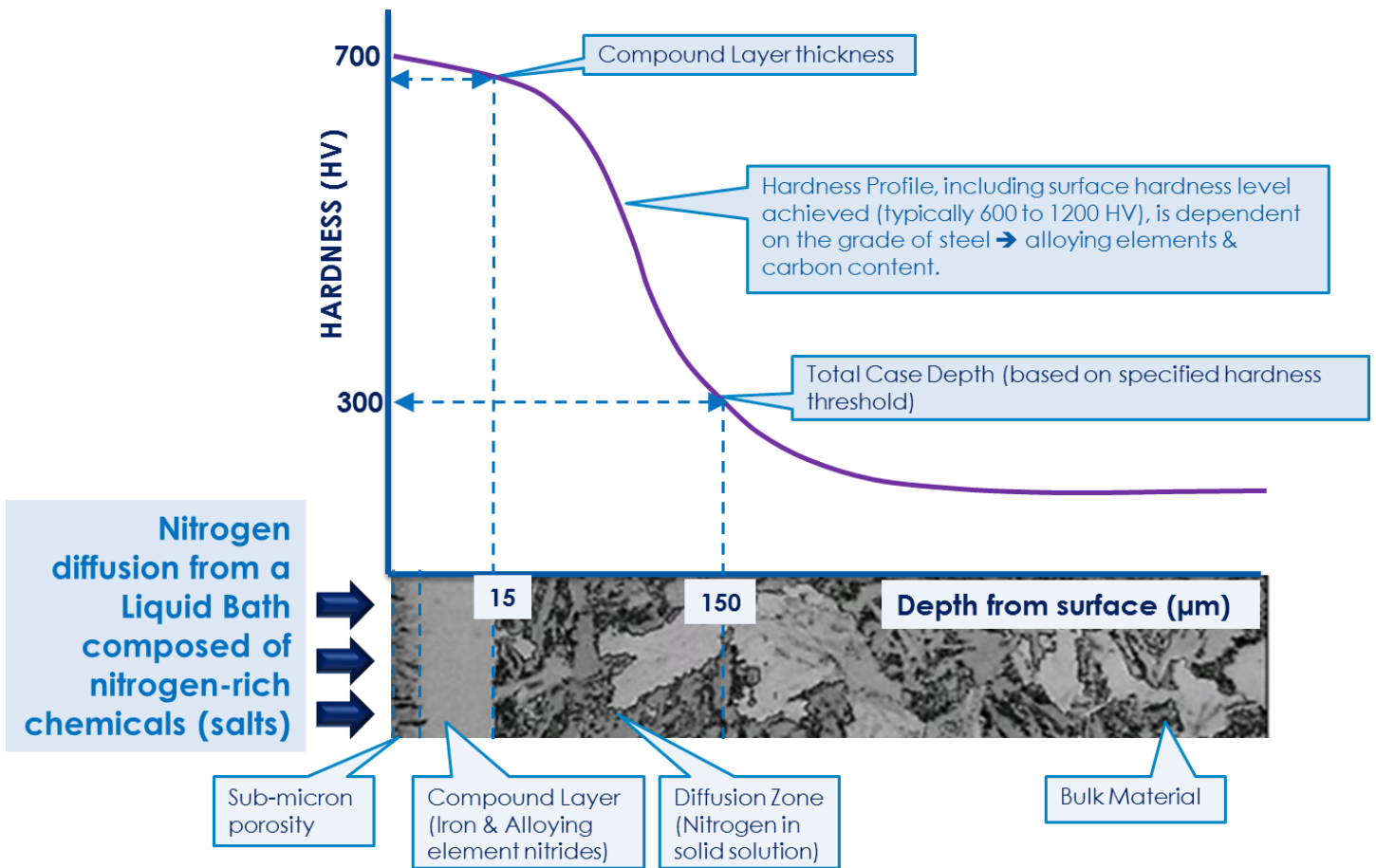
ARCOR® : ARCOR V, ARCOR C, ARCOR N, ARCOR DT, SURSULF®,...
MELONITE® : TF1, QP, QPQ, TENIFER®,...
TUFFTRIDE®,...



LIQUID NITRIDING BENEFITS

- Hard (600-1 200 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

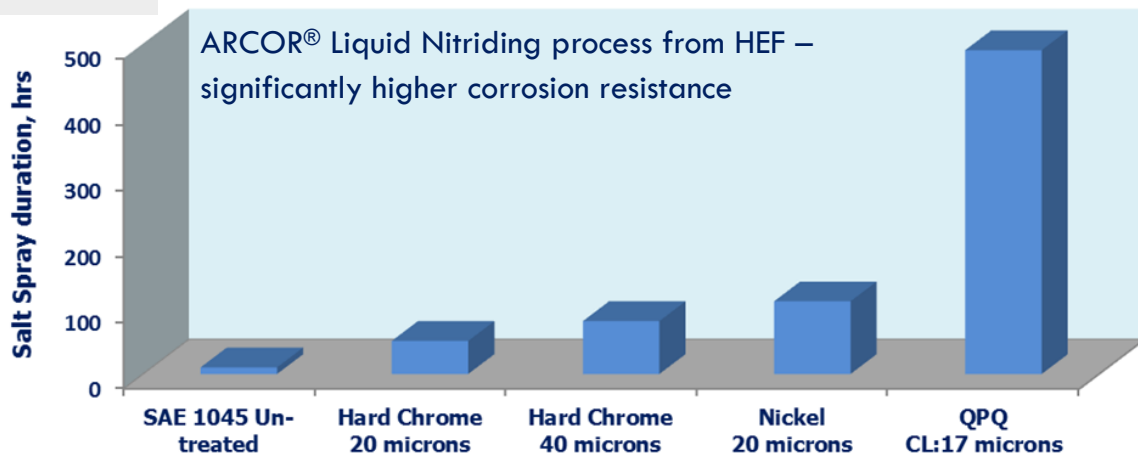
Liquid Nitriding: PROPERTIES



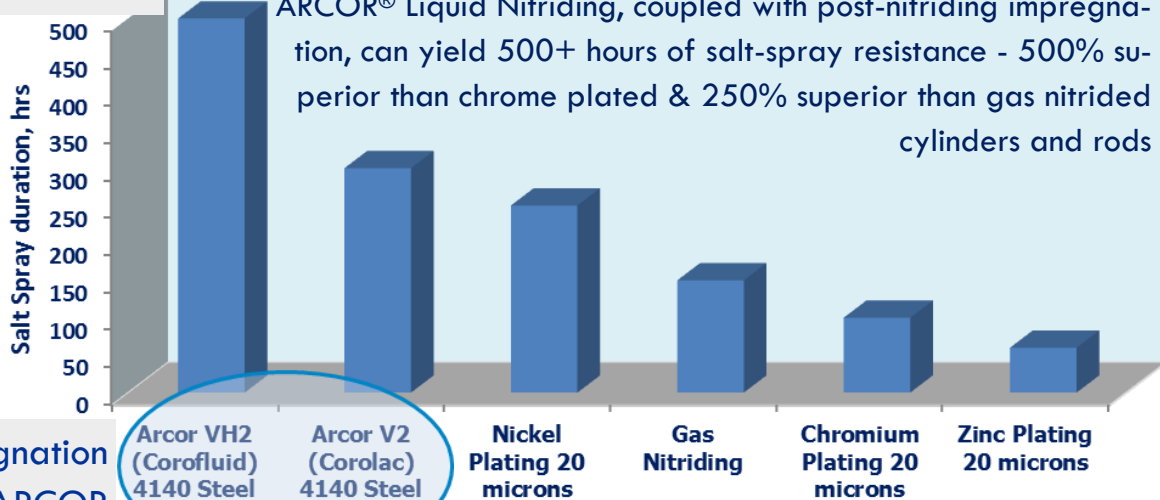
ARCOR® LIQUID NITRIDING vs. CHROME PLATING

CORROSION RESISTANCE

1045 Steel



4140 Steel



Impregnation after ARCOR process

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. 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.

ARCOR® LIQUID NITRIDING vs. CHROME PLATING

SEAL WEAR in HYDRAULIC CYLINDERS

TEST CONDITIONS



Surface Treatment	<ul style="list-style-type: none"> • 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/cm ³ Surface tension @ 20° C: 27.0 mN/m

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

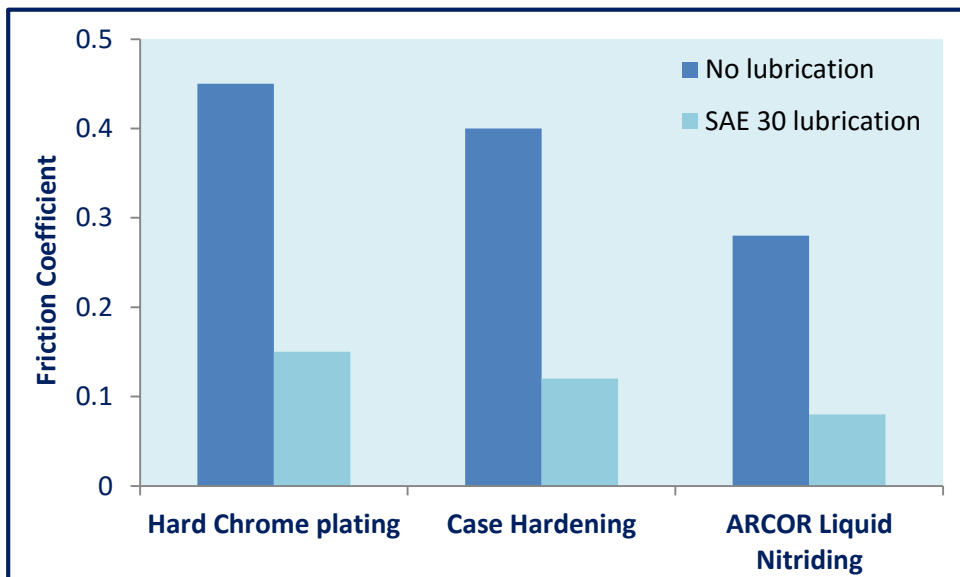
Friction Couple

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 ★

FRICITION COEFFICIENT



ARCOR® Liquid Nitriding process from HEF – lower friction coefficient

ARCOR® LIQUID NITRIDING APPLICATIONS

HYDRAULIC CYLINDERS

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.

Hard
Chrome



ARCOR
Liquid Nitride



500 hours Salt Spray



ARCOR® LIQUID NITRIDING APPLICATIONS

PISTON RODS

Surface Treatment (+++ Best)	Wear resistance		Corrosion resistance	Ductility under flexion	Friction properties
	Abrasive	Adhesive			
ARCOR Liquid Nitriding	++	+++	+++	+++	+++
Induction Hardening	++	0	0	-	0
Case hardening	++	0	0	-	0
Electroless Ni plating	+	++	++	+	+++
Cr plating	+	++	+	+	++
Gas nitriding	++	++	++	+	++
Zn plating	0	0	+++	+++	+

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

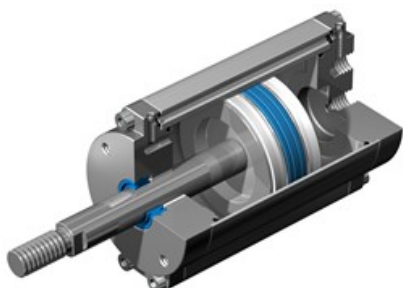
- Waste Disposal trucks
- Dump trucks
- Snow removal trucks
- Automotive & industrial lifting equipment
- Heavy-duty construction equipment
- Compaction equipment
- Fluid handling equipment



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.