HEF®
NORTH AMERICA | Surface materials engineering

Ultimate Surface Performance

OIL & GAS APPLICATIONS

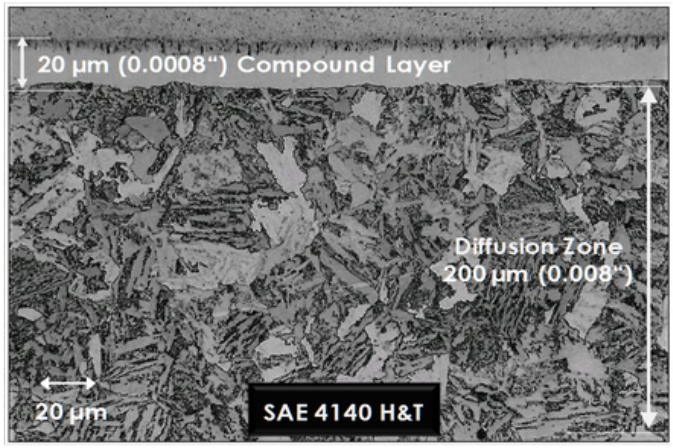
Liquid Nitriding (LN) / Salt Bath Nitriding (SBN) / Nitrocarburizing

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

ARCOR® LIQUID NITRIDING

COMPOUND LAYER:
- ❑ Very high hardness
  - ➢ Abrasion wear resistance
  - ➢ Adhesive wear / Scuffing resistance
- ❑ Low-friction

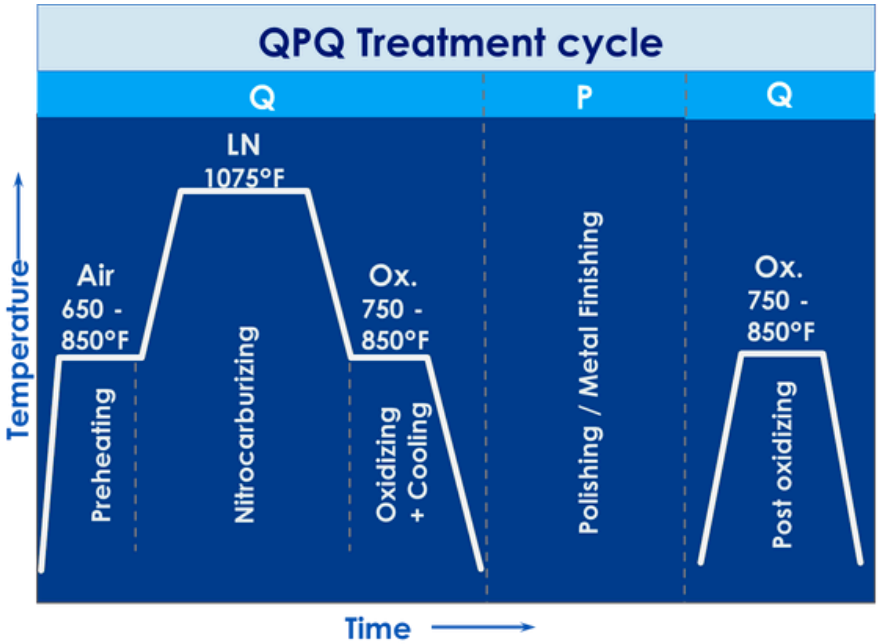
OXIDE LAYER:
- ❑ Corrosion Resistance
- ❑ Impregnate micro-porosity
  - ➢ Low-friction, running-in Layer
- ❑ Black finish

DIFFUSION ZONE:
- ❑ Fatigue Strength
- ❑ High Compressive Strength
- ❑ Hardness higher than bulk

Q • Nitriding (Q):Standard nitriding, followed by oxidation

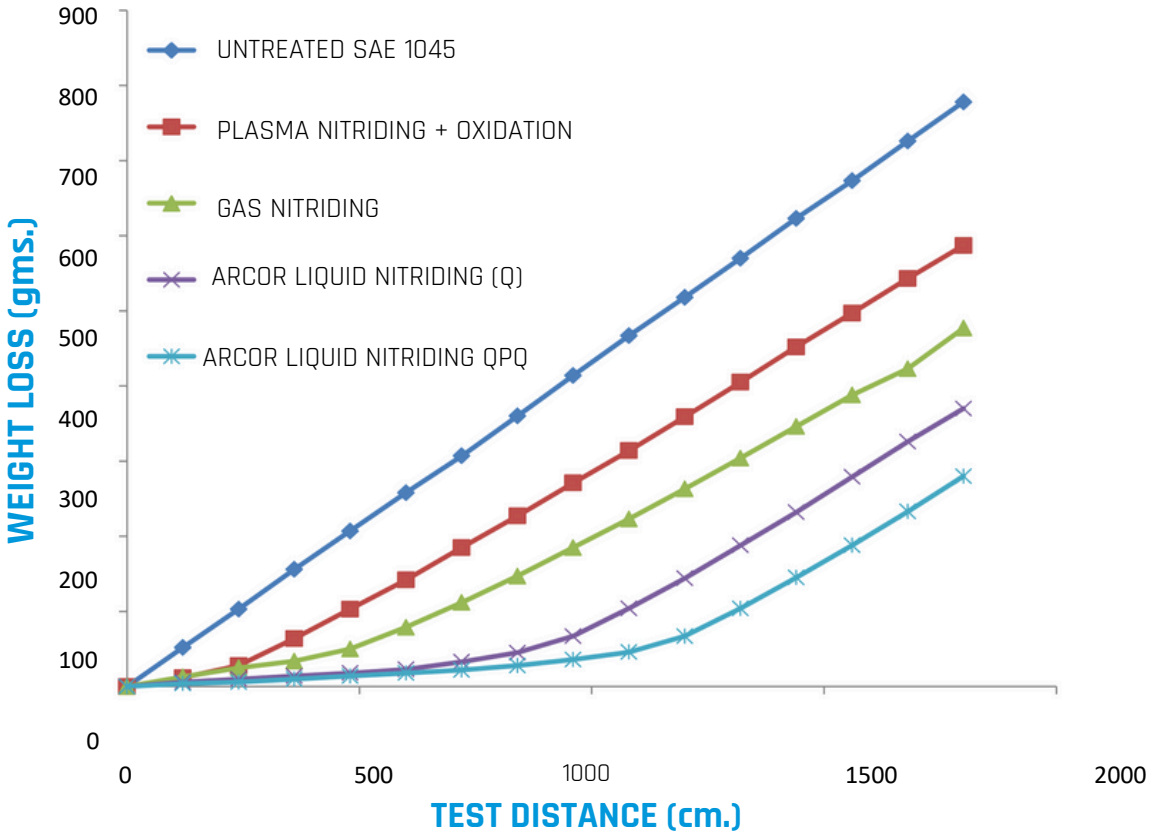
P • Polishing / Metal Finishing (P): To reduce post-nitriding surface roughness

Q • Re-Oxidation (Q): To recover the oxide layer removed during the Polishing / Metal Finishing Step after Nitriding

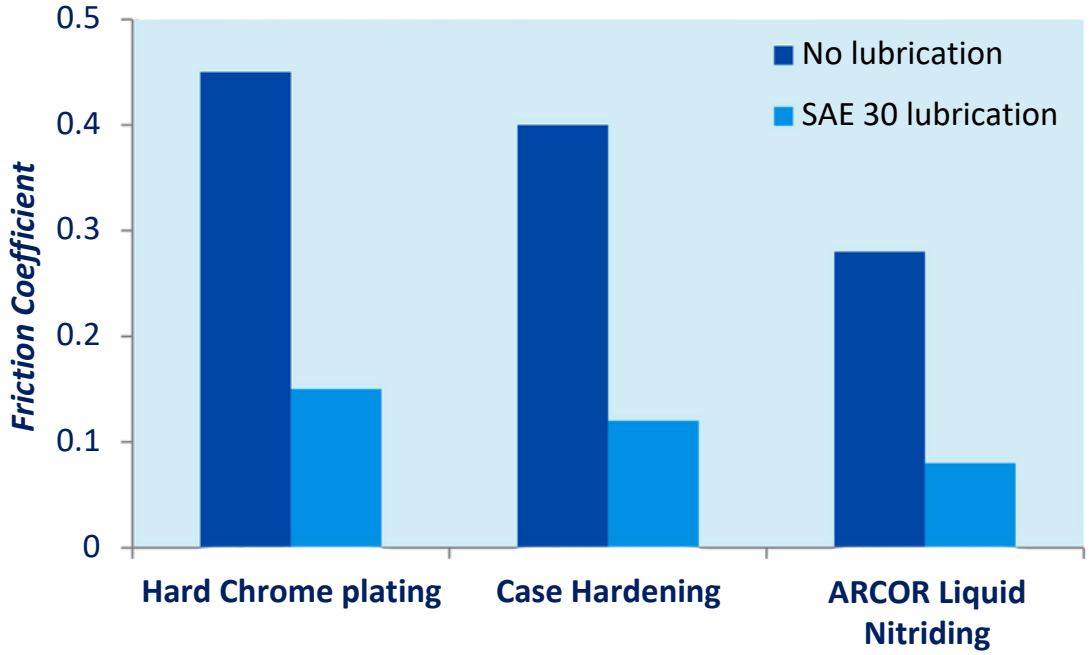


Polishing / Metal Finishing: To reduce post-nitriding surface roughness
Post Oxidation: To recover the oxide layer removed during the Polishing / Metal Finishing Step after Nitriding

WEAR RESISTANCE



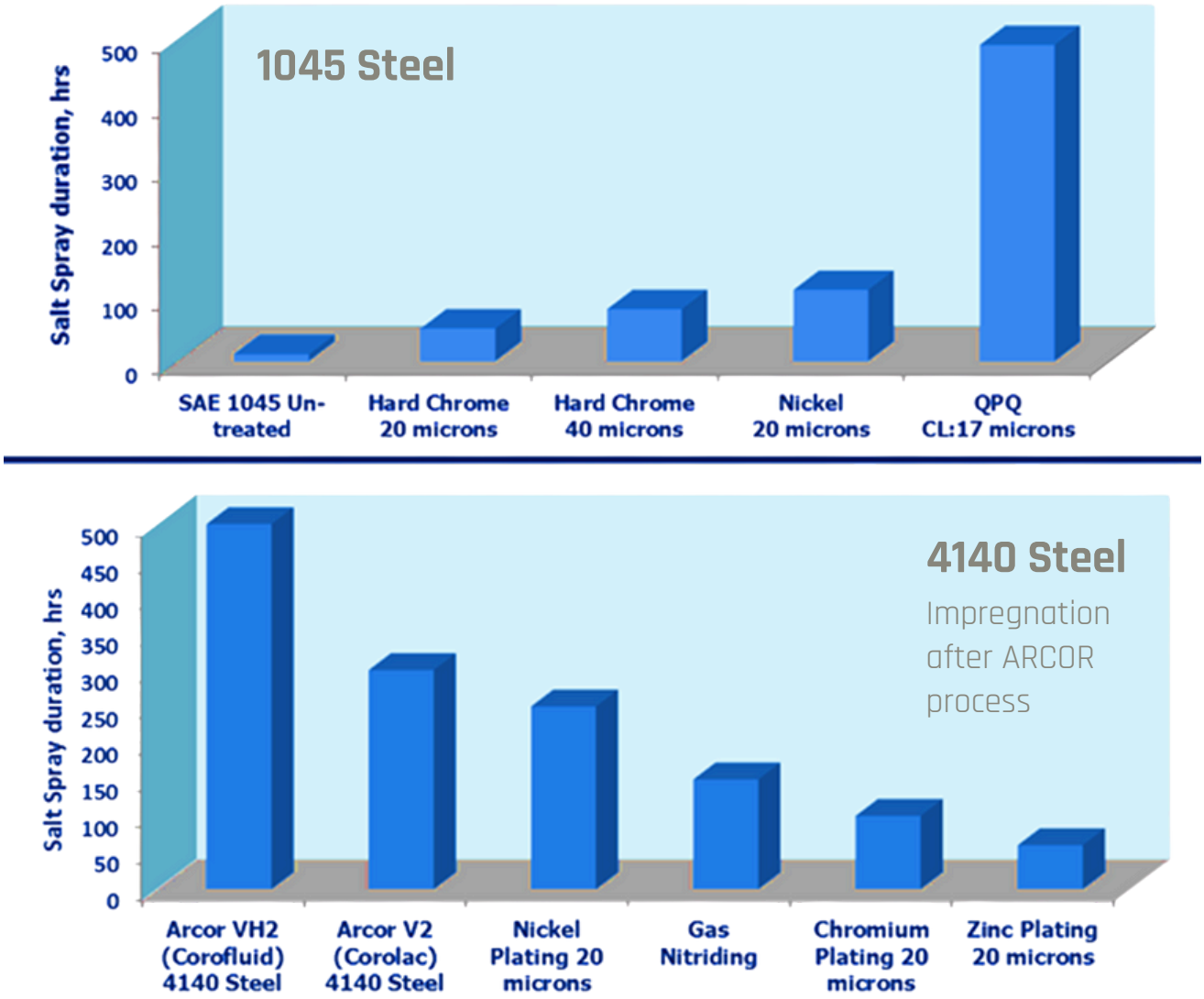
ARCOR® Liquid Nitriding from HEF – superior wear-resistance compared to gas & plasma nitriding options and several fold higher than untreated steels



ARCOR® Liquid Nitriding process from HEF – lower friction coefficient

CORROSION PROTECTION

ARCOR® Liquid Nitriding process from HEF significantly higher corrosion resistance



ARCOR® Liquid Nitriding, coupled with post-nitriding impregnation, can yield 500+ hours of salt-spray resistance. 500% superior than chrome plated & 250% superior than gas nitrided cylinders and rods.

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.

MISCELLANEOUS COMPONENTS

Fracking

Fluid-end Blocks Misc. hydraulic system components

Well-head

Valve chokes
Blowout preventer components
Gate valve components

Drilling

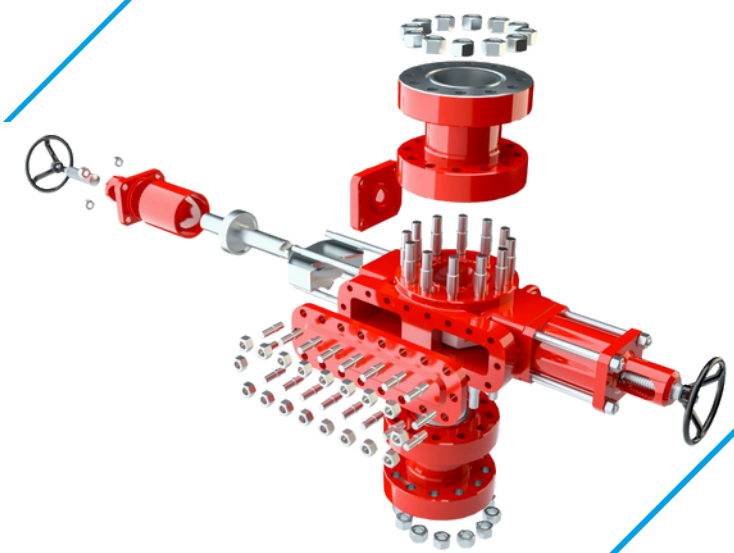
Downhole drilling rotors
Bearing sleeves Flow diverters

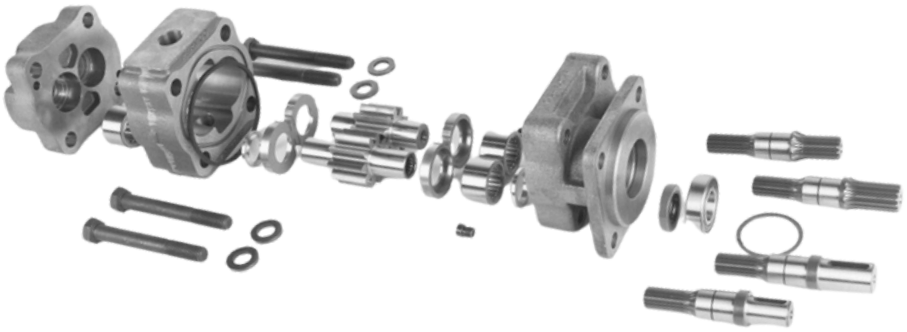
Downhole & Completion Tools

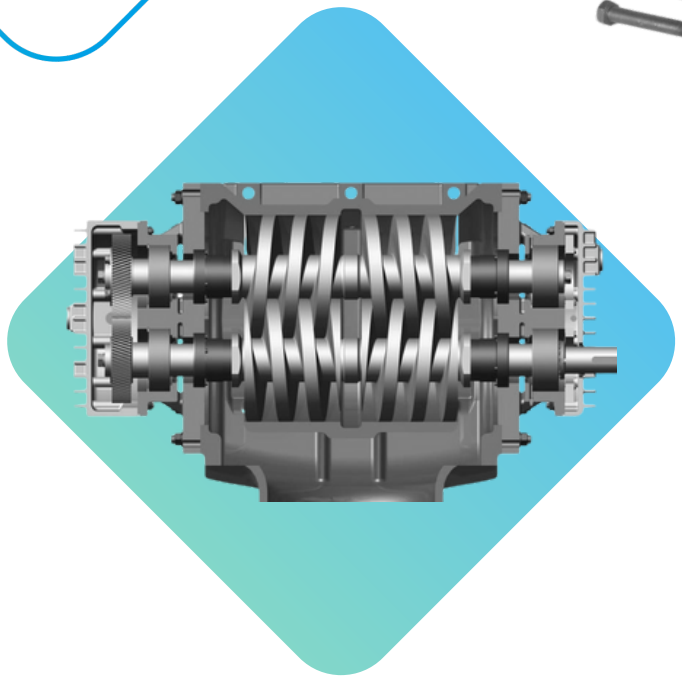
Stems, Piston Rods, Plungers, Mandrels & Connector pins
Collets, Sleeves & Couplings
Wash pipes
Impellers & Diffusers for artificial lift pumps

Hydraulic cylinders:

Excellent chrome & nickel plating replacement option:
5x higher corrosion protection
No surface peeling nor flaking
Lower friction due to post-nitriding impregnation of the surface microporosity
Good impact & bend resistance thanks to the ductile surface
Competitive pricing







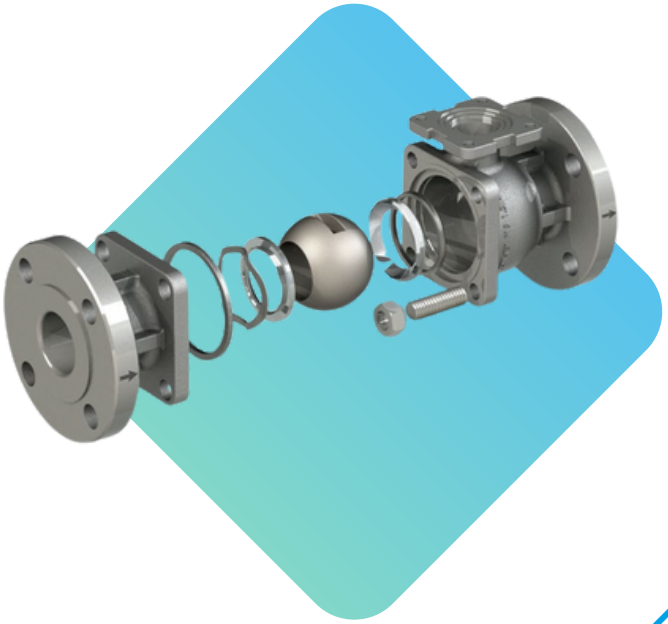
PUMP COMPONENTS

- Screws Misc.
- Components
- Impellers
- Pistons
- Housing
- Swash plates

Reduced wear. Significant corrosion protection. Ability to effectively treat cast-iron and stainless-steel pump components. Treatment ideally suited for high pressure applications handling corrosive and erosive media.

VALVE COMPONENTS

- Metal Seat
- Drive Shaft
- Downstream & Upstream seat
- Glands
- Thrust Washers
- Stem Bushing (upper & lower)
- Ball/Plug
- Stem
- Stem seal



Reduced wear of sliding components. Significant corrosion protection. Lower friction forces.

ARCOR® LIQUID NITRIDING FACILITY 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.

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

The facility is equipped with a variety of post-nitriding surface finishing processes to ensure a customer and application specific surface finish can be achieved after nitriding

ARCOR® LIQUID NITRIDING FACILITY CHATTANOOGA, TN

Facility specifically designed for Liquid Nitriding

of heavy & large size Oil & Gas

valve, wellhead, drilling, fracking, downhole

and logging components.

Fracking Block 4000 lbs.

12 feet long, 2000 lb. accumulator tubes

15 feet long Inconel tubes

Tubes for polymer powder transport

Ability to treat materials widely utilized for Oil & Gas equipment components:

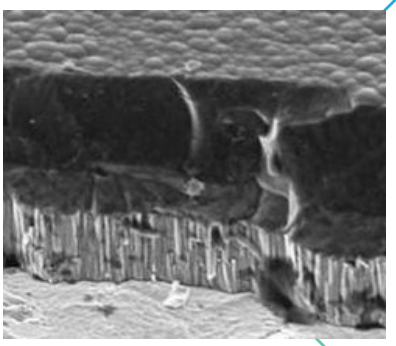
- Carbon & Alloy Steels: 4145H, 4140, 4330, 8630....
- Martensitic Stainless Steels: 13Cr, 410, 420....
- Austenitic Stainless Steels: 316, 304, 321, 317L.....
- PH Stainless Steel grades:17-4, 15-5
- Nickel Alloys: Inconel 718

PVD / Diamond-like-Carbon (DLC) Coatings

While Liquid Nitriding is a surface modification technology, Physical Vapor Deposition (PVD) involves the deposition of very hard, thin (2-4 microns; 0.0001"- 0.0002") films on the surface of components.

The PVD process, conducted under high vacuum conditions, involves the extraction of material, in atomic or ionic form, from a high-purity solid source, such as Titanium, Chromium etc. This extraction is done by bombarding the source material with high-energy inert gas ions. The extracted ions/atoms react with gases such as nitrogen to form thin and very hard coatings such as Titanium and Chromium nitride. If a source material, such as a hydrocarbon gas, is utilized a very hard, ultra low-friction **Diamond-like-Carbon (DLC)** coating can be deposited.

BENEFITS OF DLC COATINGS



- Very hard (1500-3000 HV);
- High resistance to wear, abrasion and erosion.
- Thin (2 to 5 microns) coatings - does not impact component tolerance
- Very low friction coefficients (0.1-0.15). This translates into lower wear rates, lower power losses and higher efficiency.
- Low coating temperatures (150-200°C) - no component distortion or loss of core hardness
- Higher load carrying capacity with fewer lubricant additions, and less erosion.

Electroless Nickel Plating

Electroless Nickel plating's have been used for several decades to enhance the wear and corrosion resistance of Oil & Gas components.

HEF's Benton Harbor, Michigan location can mid-Phosphorus Nickel plate parts that are 9 ft. long and weigh as much as 4,000 lbs. each.

Manganese Phosphate Coatings

Black Manganese Phosphate, also known as Parkerizing, is a process that reduces friction and resists corrosion. Phosphate produces a fine, dense crystalline coating on ferrous metal substrates. This reduces wear, and facilitates break-in of surfaces; it can be applied to virtually any ferrous metal component. It is especially effective in reducing running-in wear of sliding parts, galling and scoring.

HEF's Calico Coatings facility in Denver, NC provides Manganese Phosphate coatings.

HEF GROUP

A GLOBAL SUPPLIER OF SURFACE TREATMENT TECHNOLOGIES FOR THE OIL & GAS INDUSTRY

Liquid. Salt Bath Nitriding. QPQ

PVD & DLC Coatings

Electroless Nickel Plating. Manganese Phosphate coating. PTFE/FEP/PFA Coatings

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