

EndurAlloy™  
Abrasion and Corrosion Resistant Solutions

Diffusion  
Alloying



## Diffusion Alloying

Diffusion alloyed surfaces form an integral part of the base material. The physical properties are controlled by a careful selection of the diffusion alloying pack composition and by control of the thermodynamics and kinetics of deposition reactions. As a result of past experimentation, Endurance Technologies Inc. has selected the more promising boride systems for commercial application.

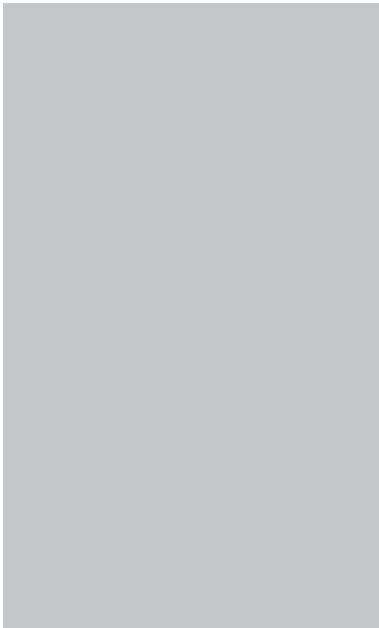
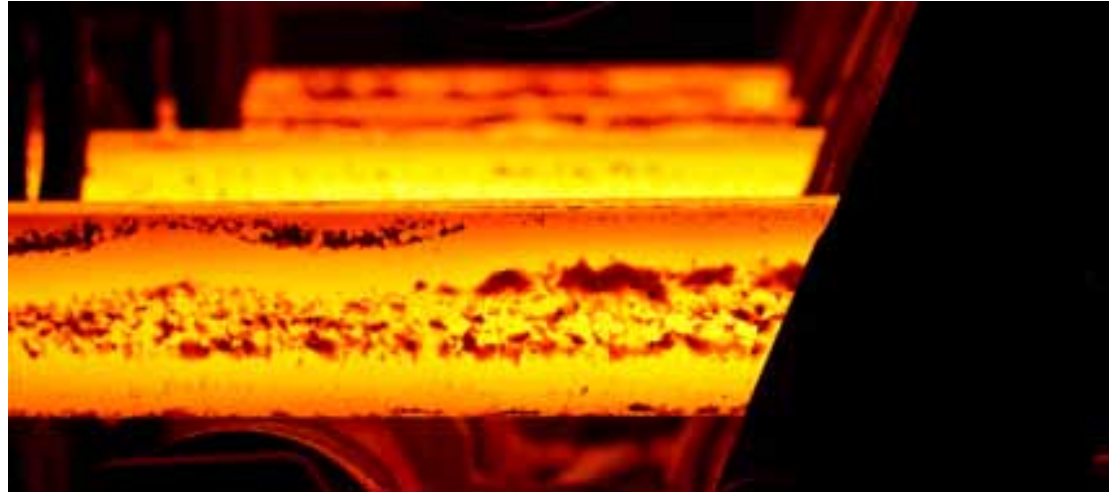
### Types of Diffusion Alloying

EN10	Thickness of over .030" can be realized depending on the base material. This engineered surface is extremely hard. 75HRC to 85HRC.
EN20	This process is used to improve corrosion resistance and material hardness on alloys and various stainless steel materials.
EN32	Thickness up to .020" economically realized with this process. Excellent for wear contact with other systems. Very hard and corrosion resistant.

### Coating Properties on Carbon Steel Substrates

Hardness	1600 - 2000 KHN (HRC 75 - 82). Depends upon base alloy.
Wear Resistance	Excellent against all hard surfaces.
Corrosion Resistance	Excellent in Hydrochloric Acid, H <sub>2</sub> S, CO <sub>2</sub> , Produced Water.
Coeff.. of Friction	Low: approximately 1/3 of substrate.
Adherence	Excellent metallurgical bond, not mechanically bonded.
Galling Resistance	Excellent against most wearing surfaces.
Gas Barrier	Excellent against oxygen, hydrogen, and hydrogen sulfide gas.
Thickness	Can control thickness from .003" to .035" (nominal .018 - .022)
Abrasion/Resistance	Excellent against abrasives in liquids and dry flowing abrasives.
Microhardness comparisons on steel using Knoop Indenter, 200 gm. Load, Tukon Microhardness Tester.	

Carburized	750 - 900 KHN
Nitrided	800 - 1100 KHN
Chromium Plate	920 - 1000 KHN
Boride	1600 - 2000 KHN



### Characteristics of Diffusion Alloying Processes

- Diffusion alloying reproduces the original surface finish.
- This process is not limited to the configuration of the component to be “coated”.
- The diffusion alloyed surface continuity and thickness uniformity is excellent.
- Masking of areas not to be diffusion alloyed can be accomplished.
- The diffusion alloying processes can be versatile and economical.
- Diffusion alloyed case thickness to .035” is attainable on carbon and low alloy steels.
- Coatings to .005” are attainable on various grades of stainless steel.
- This process is readily applicable to large or long components.
- The Endurance process can be automated for mass production.
- It is possible to arc, torch weld and braze to boride surfaces.
- Buttweld ends can be masked to allow for welding.

### Representative Applications

Production Tubing  
Adjusting Rings  
Mule Shoes  
Poppets  
Seating Nipples  
Pump Cases  
Pump Impellers  
Wear Plates  
Casing  
Wedgemeters

Fan Blades  
Blast Joints  
Valve Seats  
Packer Mandrels  
Choke Bodies and Trim  
Valve Bodies  
Ball Valve Trim  
Weld Fittings  
Tees - Elbows  
Transfer Pump Rotors

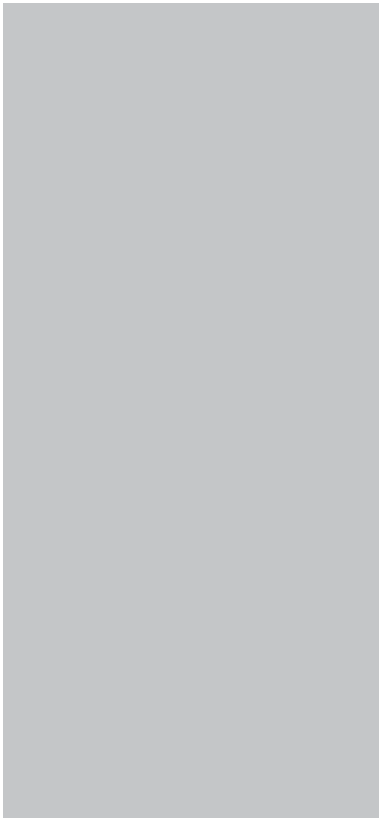
Fly Ash Handling Equipment  
Sucker Rod Couplings  
Dump Valve Bodies & Trim  
Misc. Pump Components  
Pipe Spooling  
Thermowells  
Extrusion & Draw Dies  
Steam Nozzles  
Polished Rods

### Special Note

Carbon Steel materials coated with our process are extremely corrosion resistant as well as wear resistant. Documentation of corrosion testing and wear testing is available upon request. Also available are tensile and yield test results for many materials, after the diffusion alloying process.

### Temperature Limitations

Most boride cases begin to oxidize at temperatures exceeding 950 degrees F. Endurance has other diffusion alloying process used in extreme temperatures. These high temperature “coatings” can be applied to most materials in the same fashion as borides.



## Diffusion Alloyed Tubing

Your answer to tubing wear and corrosion....

Tubing wear or corrosion is a commonly encountered cause of failure of oil and gas wells which can be easily avoided by installing Diffusion Alloyed tubing joints within the existing string or retrofitting the entire well with Diffusion Alloyed tubing.

### Installation locations

- Severe dogleg profiles
- Deviated wells
- Horizontal Locations
- Above PCP pumps
- Above Rod Pumps
- Crooked holes
- Entire Wells

## Oil and Gas Industry

### Production and Drilling Applications of Endurance Technologies Inc. Diffusion Alloyed Equipments

Due to its superior properties, Endurance Technologies Inc. Diffusion Alloyed equipment is utilized in applications where either one or any combination of the following are encountered:

- Abrasion
- Erosion
- CO<sub>2</sub> Corrosion
- H<sub>2</sub>S Stress Corrosion
- Acidic Condition

In all of the above applications, the need for costly work overs and the loss of production is significantly reduced, resulting in rapid pay-out in the investment of the Diffusion Alloyed product provided by Endurance Technologies Inc.



## Diffusion Alloyed Tubing Accessories

Your answer to unnecessary tubing work overs.....

Erosion and corrosion of tubing accessories are commonly encountered causes for necessary well work overs in oil and gas wells. The installation of diffusion alloyed tubing accessories reduces or can essentially eliminate this problem. Diffusion alloyed tubing accessories are resistant to erosion during fracturing, sand production and corrosive fluids and are re-useable once the tubing is pulled or the well is abandoned.

Endurance Technologies Inc. supplies the following Diffusion Alloyed tubing accessories and can custom diffusion alloy other completion equipment on demand:

- Seating nipples
- Flow Couplings
- Blast joints
- Landing nipples
- Wellhead equipment
- Production tubing, ID, OD or both

**Diffusion Alloyed tubing is readily available from Endurance Technologies Inc. inventory locations throughout western Canada.**

The benefit of installing Diffusion Alloyed tubing joints in the tubing string have been successfully demonstrated in oil fields throughout Western Canada, where the technology was pioneered. The incremental cost of Diffusion Alloyed tubing joints, installed at critical sections of producing wells, is easily offset by the increased oil and gas production and lower costs due to fewer work overs required. Costs for a typical workovers due to tubing failure, can be very expensive. The costs due to the associated loss of oil and gas production are generally much higher, depending on work over rig availability. By comparison, the costs of installing Diffusion Alloyed tubing in these areas within the production string are minimal.

In many cases, Diffusion Alloyed tubing joints also eliminate the need for expensive tubing rotators and other equipment designed to prevent tubing string failure.

Please contact our sales office with your specific requirements. We will be happy to review your well design and provide you with our suggestions as to the placement of Diffusion Alloyed tubing.

### Sales and Contact Information

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[www.endurancetechnologies.com](http://www.endurancetechnologies.com)