Nitriding Processes

Nitriding and nitrocarburising are low temperature, low distortion "thermochemical" heat treatments carried out to enhance the surface properties of finished or near finished ferrous components. They
are different in terms of suitable materials, processing conditions, the nature of the surface layers imparted and the property improvements conferred.Nitriding, conducted in gas (490 - 560°C) or plasma (400 - 590°C) for treatment times ranging up to 90 hours, involves the diffusion of nitrogen into the surface to produce a controlled depth of hard alloy-nitrides. Unlike the high-temperature case-hardening treatments (carburising/ carbonitriding), hardening is achieved without the need for quenching.Nitrocarburising, generally of shorter duration (30 minutes - 5 hours), involves enrichment of the surface with both nitrogen and carbon to impart a thin iron-carbonitride "compound layer" supported by a nitrogen-bearing "diffusion zone". Conducted at temperatures of 560 - 580°C ("ferritic nitrocarburising") or 590 - 720°C ("austenitic nitrocarburising"), the process may be completed by quenching and can involve additional steps to promote certain properties.Nitrocarburising is a generic term covering salt bath treatments, such as Tufftride , and the equivalent processes conducted in gaseous atmospheres and known by a host of trade names.

What Are The Benefits?

Favoured for components that are subjected to heavy loading, nitriding imparts a high surface hardness which promotes high resistance to wear, scuffing, galling and seizure. Fatigue strength is increased mainly by the development of surface compressive stresses. Hot hardness and resistance to tempering are improved and corrosion resistance is moderately enhanced. The low processing temperature and subsequent slow cooling help minimise distortion.

Typical applications include gears, crankshafts, camshafts, cam followers, valve parts, extruder screws, die-casting tools, forging dies, aluminum-extrusion dies, injectors and plastic-mould tools.
In ferritic nitrocarburising, the resultant compound layer, with good lubricant-retention characteristics, is responsible for the major benefit of high resistance to wear, scuffing, galling and seizure. The diffusion zone contributes improved fatigue resistance if components are quenched after nitrocarburising. An increase in corrosion resistance can be improved upon further by post-oxidation treatment which imparts an aesthetically-pleasing black finish; additional polishing and oxidation steps can yield a surface finish rivaling hard chrome plating, in terms of high corrosion resistance combined with low coefficient of friction.
Typical applications of ferritic nitrocarburising encompass pressings, bearing

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shafts and cages, cams and crankshafts, gears, bushes, liners, pump components,sintered parts, plastic-mould and extrusion dies and tooling. Whilst it can also increase the hardness of alloy steels, the influence of ferritic nitrocarburising on the bulk surface hardness of low-carbon non-alloy steels is moderate .Austenitic nitrocarburising allows the other benefits to be combined with indentation resistance by strengthening the substrate beneath the compound

What Sort of Materials Can Be Treated?

Nitriding: For engineering components, nitriding is most effective when applied to the range of steels containing nitride-forming elements such as chromium, molybdenum, vanadium and aluminum; some, such as 722M24 (En40B), 905M39 (En41B) and 709M40 (4140), a. The process is also applicable to stainless steels and to tool steels such as hot-work, cold-work and mould steels. Some cast irons also respond favorably to treatment.

Nitrocarburising: Ferritic nitrocarburising can be applied to most ferrous materials and is well established for processing tool steels, for example. Latterly, both ferritic and austenitic nitrocarburising have come to particular prominence as methods for up-grading components made from relatively-inexpensive easy-to-form low- and medium-carbon non-alloy steels

What Are the Limitations?

Nitriding

- The process can only be applied effectively to a limited range of appropriate alloy-containing materials.
- Depending upon process parameters and material, nitrided case depths can range from as little as 0.05mm up to 0.75mm.
- Surface hardness depends upon process parameters, the material and its original condition. For optimum results, a steel for nitriding should be in the hardened and tempered condition and free from decarburisation. (The tempering temperature should be higher than the nitriding temperature).
- A fine-turned or ground surface finish is the most suitable for ensuring a satisfactory nitriding response. Pre-nitriding treatments may be required on certain materials subjected to gas nitriding (e.g. acid pickling/vapour blasting of martensitic stainless steels).

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- A stress-relieving treatment ("stabilising") is necessary between the rough and final stages of machining of hardened and tempered high-precision components in order to minimise distortion after nitriding. (The stress-relieving temperature employed should be higher than the nitriding temperature but lower than the tempering temperature).
- On a hardened and tempered/stress-relieved part, nitriding should produce minimal distortion. However, growth can occur, the amount being a function of the treatment parameters and the material. It is fairly predictable and usually less than 0.05mm on a diameter.

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