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HEAT TREATMENT FOR HIGH PERFORMANCE TURBINE PARTS

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In steam turbine environments, especially in power generation applications, heat treatments are used to increase strength, wear resistance and fatigue strength in critical steam path components. Most, if not all, materials used for parts in this stressful service are used in conditions where strength or hardness is optimized. This optimization is usually the result of specific heat treatments performed on the materials.

Typically, the higher strength materials of construction are alloy steels, either low alloy or high alloy, such as stainless steels. For these materials, quench and temper heat treatments are normally used to optimize properties. During the quench, the steel is generally heated to over 1500°F. It is then force cooled by immersing the material into liquids (water, oil, etc.) or forced air. After this quench, the material is in a hardened, but somewhat brittle or at least less ductile condition.

Tempering is then performed to lower the hardness and restore most of the toughness or lack of ductility that resulted from the quenching operation. Depending upon the materials involved, tempering treatments are performed in the range of 400°F to upwards of 1400°F. The resultant materials have a higher yield strength (the stress below which the material will not exhibit permanent deformation) than the original non-heat treated material and a toughness generally exceeding the original material.

If these parts must resist extreme wear, such as metal-to-metal or resist hard particle erosive wear, additional heat treatments may be required. For example, gears may require carburizing. Steam turbine valve components – including stems, bushings, washers, valve seat pins, and discs to name a few – generally require nitriding for longevity in high temperature, high pressure steam service. While carburizing is performed in a carbon rich atmosphere at high temperature (>1650°F), nitriding is performed at lower temperatures (usually <1100°F) in a nitrogen rich atmosphere. Interestingly, a carburized surface starts to soften at relatively low temperature (>350°F), whereas a nitrided surface only starts to soften when it sees temperatures over approximately 950°F.

(Left) A CRV Valve Disk with its bore and face nitrided. Note the off-green masking on the remainder of the disk. (Right) The valve disk after polishing and before magnetic particle inspection.

Another specific heat treatment given components is called stress relieving, which in most cases is performed below the tempering temperature that the original material was given. This is used to reduce tensile stresses created during welding, to reduce stresses on parts later to be surface hardened (i.e., nitrided), or to allow for parts to be stable at high operating temperatures. Treatments such as this generally increase the fatigue strength of such components.

Other heat treatments such as precipitation hardening, which is more often seen with aluminum heat treatable alloys, certain stainless steels, some copper and nickel alloys, are used in some cases for properties improvement.

For more information about specific heat treatment processes, and how they can benefit your equipment, please contact Toshiba's Milwaukee Service Center.