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STRESSTECH BULLETIN 4

Dynamically loaded, critical components

Grinding Damages

Grinding thermal damages, also known as grinding burns, will shorten the fatigue life and can cause severe failures in dynamically loaded, critical components.

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Grinding burns will mostly arise in hardened components when the material's microstructure is changed because of too large amount of the grinding energy being converted to heat then transferred to the component.

Reaching temperatures between the tempering range and below the austenization temperature, the surface of the component will be re-tempered. This means that the hardness decreases and tensile residual stresses will occur in the surface. This thermally softened material is called over-tempered martensite (OTM) and known as re-tempering burn. With microscopic analysis, OTM is indicated by a dark layer under the surface.

Reaching temperatures above the austenization temperature, the surface will re-harden, resulting in very high hardness and high compressive residual stresses in the surface. This thermally hardened material is called untempered martensite (UTM) and known as re-hardening burn. These re-hardened areas are normally surrounded by tempered areas, which will result in

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surface cracks and pitting when the component will be taken into service. With microscopic analysis, UTM is indicated by a white layer on the surface.

The main purpose of grinding is of course to remove material to specified dimensions. However, a large amount of the energy can rise the temperature up to 1500°C in the surface layer. This heat energy must be transported away by cooling effectively.

Some of the important factors are the coolant type, coolant concentration, coolant age, and coolant flow. Also, the grinding wheel's condition and properties such as type, speed, feed rate and wearing rate are very important. The prior processing of material, i.e. heat treatment has also effect of the result.

Grinding wheel wear

One of the major causes of overheating of the component causing grinding burns is related to grinding wheel wear.

During the grinding process, abrasive grains on the grinding wheel can be blunted due to mechanical and thermal loads and physicochemical wear. Blunting of the abrasives can reduce the working performance of the grinding wheel.

After blunting phase, some of the abrasive grains can chip off and even split which will cause grinding wheel to have a smoother surface, thus the wheel will have an increased contact area with the component.

A smoother surface will transfer more heat to the component due to higher friction rate which will also cause to fall out of remaining abrasive grains.

After this phase, the pores where we previously had abrasive grains, will be filled with metal chips of the component which will cause an increase in the depth of the heat affected zone on the component.

The wearing of the grinding wheel should be controlled with regular dressing procedures. The dressing procedure is a sharpening process, exposing fresh abrasives grains on the grinding wheel. However, this will reduce the abrasive layer of the wheel and is costly if performed too often.

Productivity vs. quality

We can of course avoid grinding burns by being very careful in our grinding process. Using always freshly dressed grinding wheels, a proper cooling mechanism and using low feed rates will increase the quality of the grinding process and optimize the quality of the component. However, this may cause low productivity and increase the both fixed and running costs of the grinding process.

The hard and difficult work is to optimize both quality and productivity to manufacture a high-quality component with no grinding burns at lowest cost.

Feel free to contact us for your grinding damage problems.

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