Advantages to the Automotive Industry of the Thermal Cycling Process

A White Paper

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Introduction

The automotive industry relies heavily on ferrous alloys, from driveline and suspensions, to vehicle frames, engine blocks and braking systems. Durability and wear resistance is critical to maintaining long operating life cycles for these components. Thermal Cycling offers a unique process to both increase component performance and increase component cycle life.

Treating materials with the Thermal Cycling Process provides a unique and valuable technology to improve the wear resistance and longevity of metal components. This patent protected technology has been demonstrated through extensive independent third party testing to improve the performance of ferrous components without increasing brittleness and while maintaining the component appearance and dimensional stability. Treatment of ferrous alloys with the Thermal Cycling Process has been proven to improve the wear resistance of automotive components, improving the life of these parts.

Research and Testing Overview

Fort-Bruce Testing Inc. has performed extensive testing of automotive components treated with the patented Thermal Cycling Process. The process was developed by Thermal Technology Services, Inc., of Clearwater Florida (13130 6th Court North Bldg 602, Clearwater, Florida 33760, Office: 727-532-9755, Cell: 727-656-2844.) The testing performed includes microstructural analysis, scanning electron microscopy analysis, energy dispersive X-ray analysis, hardness testing and wear resistance testing. The process has been demonstrated through this testing to improve wear resistance of automotive components through the unique treatment that results in realignment of the material at the molecular level. Microstructural analysis conclusively confirms that the grain coherence of ferrous alloys are radically altered, resulting in an improvement to the mechanical properties of the material. These transformations are highly time-temperature dependent, and optimized performance enhancement only results when parameters are precisely controlled.

In the case of brake components, including both drums and rotors, these parts are typically fabricated from gray cast iron because of its good wear resistance. Additives, including manganese and silicon, encourage graphitic flake formation to facilitate machinability, but at the cost of lowering the matrix carbon content, thereby reducing wear properties, fracture resistance and strength. From the test data we have compiled, the following can be concluded:

Thermal Cycling dissipates carbon from the graphitic flakes back into the iron matrix, re-introducing cementite into the material. This improves wear performance, and by reducing graphitic flake size, enhances strength and toughness (removes stress crack coalescence).

Essentially, the parts manufacturer takes a potentially very wear resistant material and by slow cooling turn it into a much more machinable material. However, by this process they must sacrifice some of the wear resistance to accomplish this - same as a knife maker tempers a knife, sacrificing some of the edge hardness (ie., sharphness) to increase the overall knife toughness (i.e, reduce likelihood of edge cracking and blade fracturing) - these trade-off's are very common with iron alloys.

Essentially, after machining of a part is complete, the machinability aspects of the material are irrelevant. It would be desirable to restore the maximum wear resistance of the baseline gray cast iron material, but before Thermal Cycling, no commercialized process had been developed as an effective method to restore the material to its full potential without distorting the machined component dimensions. Thermal Cycling restores the wear resistance of the material while maintaining dimensional stability. Essentially, the process restores the material properties to those if it were quenched rather than slow cooled.

By parallel, slow cooling will convert a steel heated to normalization temperatures to pearlite, but quenching converts it to martensite. Slow cooling a cast iron allows graphitic flakes to form, while quenching results in the creation of cementite (the extremely hard ceramic, Fe_3C). The Thermal Cycling Process acts to convert easily machinable materials into the preferred high strength, high toughness, high wear resistant form, without involving reheating of the material, which invariably results in dimensional distortions and surface oxidation formation.

Summary

Thermal Cycling offers a unique process to improve both the wear resistance and longevity of ferrous automotive components. Treating automotive parts with this patent protected technology can significantly improve component performance and life cycle. Improved material characteristics and mechanical properties resulting through treatment of ferrous alloys with the Thermal Cycling Process will increase component performance without altering component dimensions.

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