Special IMnI Report
Deep Cryogenics

International Manganese Institute

Prepared by: Aloys d'Harambure, IMnI Executive Director

Published on May 14, 2020

Manganese as an abrasive material is very demanding on equipment. The equipment with longer wear life and better performance will help manufacturers to reduce the maintenance and replacement costs, and gain higher net profits. The common solutions to increase the service-life of mining equipment include weld overlays, high-velocity thermal sprays and hard facing. However, the heat-affected zones often cause intergranular corrosion, hydrogen embrittlement and material separation. In the past decades, another solution attracts people's attention - deep cryogenics (DC), which is a cold-temperature process that doubles the wear and corrosion life of industrial equipment. Deep Cryogenics International is a company working on this low-cost, permanent, and effective alternative and on the way to bring it to various industries.

What is Deep Cryogenics International

Deep Cryogenics International (DCI) is a Canadian company founded by Jack Cahn in 2010. Jack has extensive experience in part production and has significant R&D background. He has developed DC test procedures for use on JPL's Mars Exploration Rover, worked with researchers at National Institute of Standards and Technology's cryogenic processing lab and served as the lead investigator in two US Army CRADAs. Jack is also the author of one USPTO-issued patent and five patents-pending.

DCI has developed deep cryogenics treatment (DCT) to improve several performance characteristics in an extensive varieties of metals, including steel, aluminium, copper, superalloys and refractory metals, by slowly cooling the material in ultracold dry nitrogen. The company has worked with partners such as the iUSIT, Rolls-Royce, and the U.S. Army to test its processes. DCI now provides on-site DC treatment, test, and R&D. As of September 2020, its treatment capability is 60,000kg/month, and will increase to 100,000 kg/month as of September 2021. The company aims to sell the DCT to the key players in a wide range of industries including mining, power generation and transportation.

DCT Process & Cost

Process: DCT is performed on new or replacement parts. Items are placed in a specially designed tank where they are slowly cooled from room temperature down to -190ºC, cold-soaked in a dry nitrogen atmosphere for 12 to 40 hours, and then slowly returned to room temperature. (Figure 1)

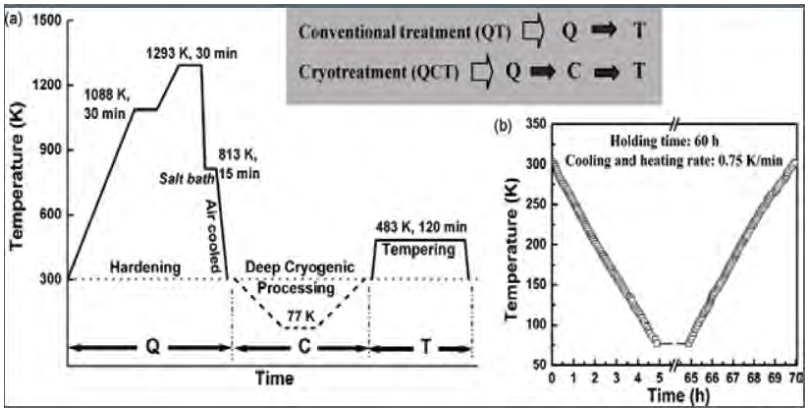

Figure 1: The deep cryogenic treatment process

Science: Items undergo one to three annealing steps to eliminate hydrogen embrittlement and to add ductility. In steel, the process transforms the softer, retained austenite into more durable martensite and fine carbides precipitate throughout the microstructure.

Cost: The treatment costs approximately 15% of the original item. Unlike heat treatment, DCT does not change the part size and allows hundreds of parts to be processed simultaneously.

Benefits

DCT can be applied to numerous mining assemblies, such as manganese cone crusher, grinding mills, hauling rigs, slurry pumps, and gearboxes and it helps increase these items' operational life significantly and reduce the replacement costs by:

1. lowering wear, fatigue, and corrosion by 30-70%,
2. reducing corrosion in high-carbon steel by 20-60%, (Figure 2)
3. increasing tensile and yield strength by 10-30%, and
4. improving surface finish contact area by up to 50%.

Tests conducted by DCI in 2020 on Mn steel used in cone-crusher applications show a significant improvement in abrasive wear-life of cone-crusher mantles and liners used in mining and highway construction environments.

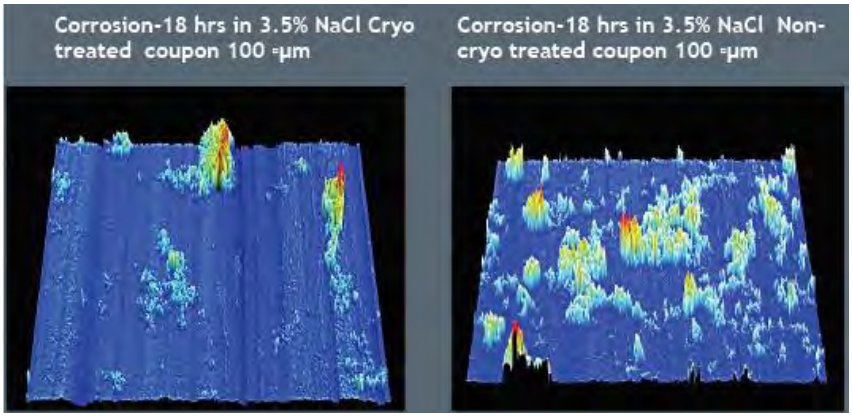

Figure 2: Steel corrosion test (64% reduction in general corrosion)

Besides, DCT is environmentally friendly as it is non-toxic, uses no chemicals, and generates no environmental waste.

For more information, please contact Jack Cahn, jack@deepcryogenics.com or visit https://deepcryogenics.com/

DEEP CRYOGENICS INTERNATIONAL