From Fleets to Flutes: Cryogenic Treatment Offers Cool Applications; Metallurgists Remain Unimpressed
By Sarah A. O’Brien

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heat treatment to alter certain properties of heat-treated components [such as by way of retained austenite to martensitic transformation]."

During the cryogenic cycle, a piece is gradually brought down to cryogenic temperatures, which is broadly recognized as any temperature below -150°C. The temperature is then held for a set amount of time, determined by the material and size of the part. After what typically ranges from 6 to 40 hours, the temperature is slowly ramped back up to room temperature.

A solid grasp of how various types of metals will react to the treatment is necessary, according to Robin Rhodes, President of the Cryogenic Institute of New England, Inc., which offers NitroFreeze Cryogenic Services. "The oversimplification embraced by many laypeople that cryogenic treatment is a magic wand that cures ills in all metals is an inaccurate portrayal," emphasized Rhodes. "It's a misconception that cryogenic treatment will make any metal a super-performer. The reality is that you need to understand the failure mechanism you're trying to prevent and understand the material you're working with before deciding whether [cryogenic processing] is appropriate. Cryogenic treatment does offer many solutions to many problems, but you also need to understand its limitations."

**Behind-the-Wheel Perspective**

Faster, stronger, and longer lasting — these are just a few of the improvements that competitive racers have noticed about their vehicles after using cryogenic processing on brake rotors, engines, and other parts. In fact, "many, if not all, of the top racing teams have their own cryogenic treatment capabilities," said Rhodes. "It's just not widely talked about, since they don't want to lose their competitive edge."

In automotive shops that Rhodes claims "are cleaner than an operating room," mechanics and technicians ensure that a car is at optimum performance, especially with drivers pushing the vehicle to its absolute limits during each race. "The irony is that the difference between first and second place is usually fractions of seconds. Every edge in terms of how the car performs is critical to them," said Rhodes.

Diedkman of Controlled Thermal Processing added, "We've worked with a top fuel drag racing team who used to change their valve springs in the engine every run. After cryogenic treatment, they can go six runs without changing the springs. This was not a casual decision because if the springs break, they could kill the driver."

The Founder and President of Victor Aviation, Victor Sloan, has worked with six-time World Champion drag racer Brendan Murray to improve the performance of his engine components through cryogenic treatment. In his 2014 article for *Cold Facts*, Sloan wrote, "Certain metals, after being Cryogenically Non-Destructive Tested (NDT) and treated, have shown large increases in their fatigue life. Similarly, improved life of components used in aerospace, vehicle, wind energy, turbine power plants and transmissions has also been documented and can reduce the cost of ownership" (See "LN, Testing and Cleaning at NASA Ames' Transonic Wind Tunnel," February 2014).

Another large application of cryogenic treatment is fleet vehicle components. "There’s a perfect storm of stress and wear in an engine," said Rhodes of such vehicles. "All of the benefits of cryogenic treatments—wear resistance, stabilization, better thermal properties— come to help the performance."

Levine has worked with the US Postal Service to treat the fleet vehicles’ brake rotors, and many police departments take advantage of cryogenic treatments as well. Lenny Burnham of the Department of Public Works in Woburn, Massachusetts, has noticed a difference in cryogenically-treated brake rotors, which the Woburn Police Department uses as replacement rotors after the factory-made rotors wear down. "I know the treated brake rotors do last longer. Unless they're driving metal on metal, and then [the brakes] are junk no matter what."

**Music to a Manufacturer's Ear**

Although cryogenic treating of material is not always advertised, many companies employ this process in order to enhance their products. "The treatment has been adopted as standard by a number of industries. Many of its applications are used routinely," stated Rhodes.

One unique application has been improving the musical capabilities of certain instruments. According to Diekmann, cryogenic processing is used by the Chicago Symphony Orchestra, as well as by Yamaha Flutes. Dean Markley is another company that utilizes this treatment, boasting "Blue Steel" acoustic
While many are still skeptical about cryogenic processing, Levine, whose machines come in three sizes pictured here, said, "It’s catching on. I have been getting more and more business and more competitors." Photo by Michael McCormick

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guitar strings that are cryogenically frozen: “By freezing our strings down to -320°F, we tighten the molecules, minimizing microscopic gaps,” its website states, “This process removes transient frequencies that produce harsh highs and muddy lows, creating a more consistent string, with true tone and longer life.”

Levine has done business with Osmun Music himself, and offered, “I could give [customers] a hand-waving explanation about how [the instrument] changed for the better, but just use it!” In an experiment with Powell Flutes, Levine had a professional musician test three to four head joints “to listen to the nuances of sound,” and the flutist chose the cryogenically-treated head joint in double-blind tests every time except one. However, Levine explains, “They called me later and told me that they had gotten the numbering wrong, and that he had yet again chosen the treated flute.” Although Levine had feared that the stress relief on the material after freezing would change the acoustic properties, it seemed to have done so in a way that pleased those whom Levine refers to as having “the golden ear.”

Dickman said, “It’s a very fine process. I recommend cryogenic processing for any company that wants to make their products the best.”

Overcoming Skepticism
Dickman is optimistic about the future of cryogenic treatments, remarking that research on the subject has advanced over the years: “Research has progressed from ‘Does it work?’ to ‘How does it work?’ to examining what you would specifically do with a certain metal.”

The Cryogenic Society of America has compiled a database of articles written on the subject, hoping to encourage further study into cryogenic treatment (www.cryogenic-treatment-database.org).

Those in the industry predict that cryogenic treatments will become increasingly relevant in coming years. As Papp reminded, “I’m a metallurgical engineer, and I’m not a skeptic of DCT. On the contrary, I believe there is a hidden universe to be discovered in the structural changes of metals and other crystalline materials at very low temperatures. When DCT is scientifically mastered, it will completely revolutionize the heat treatment of metals.”

While countries such as India are researching and publishing studies on cryogenic treatments, American scientists are slowed in their research by rigid safety regulations and industry protocol.

“Scientific researchers must concede time away from creativity to comply with standards and regulations, so it is not easy to discover something new,” said Papp.

Levine, who is “one of the pioneers” in the field according to Rhodes, finds this regrettable, as cryogenic processing originated in America. “A lot of research is being done in India, China, and Eastern Europe, but it started here in the ‘60s with Ed Busch,” said Levine, referring to the first commercial cryogenic processor, developed by Busch in 1966. Levine continued, “In my travels, when I used to do sales calls, I spoke with an old timer — I was a new-timer then — and found out that cryogenic treatments had been used during World War II at the Watertown Arsenal [in Watertown, MA] by Clarence Zener.”

Richard N. Wurzbach and William DeFelice of Maintenance Reliability Group wrote on the subject, “At that time there were no computer controls so the steel tooling would be immersed in liquid nitrogen for a brief period of time, allowed to warm up, then placed into service. This method was crude and uncontrolled. [...] But the tools that would not break would experience a greatly enhanced service life” (See Maintenance Reliability Group’s “Improving component wear performance through cryogenic treatment”).

While cryogenic treatments await more attention by American researchers, companies that offer the process are able to retain not only their austenite (to transform into martensite), but also their sense of humor: “We’re in the growing stage. It’s not a process that we understand 100 percent. I don’t understand gravity 100 percent, but I still use it,” said Dickman.

Levine takes a lighthearted view as well, saying that he knows the treatments are producing real results for his customers because, after all, “They keep coming back for more!”