DEEP CRYOGENIC TREATMENT:
What’s In Store for the Future?

Knowing the size of the cryogenic treatment industry and understanding the commercial applications are important yardsticks for assessing the status of the technology. This perspective provides an objective basis to evaluate both the science and the business, as well as their potential.

Robin A. Rhodes*
Cryogenic Institute of New England Inc.

The process of treating materials (primarily metals) at cryogenic temperatures (-300°F, or -185°C) to enhance metallurgical properties has been practiced to varying degrees of success for more than 20 years. Its purported benefits have been embraced and promoted by some and dismissed by others. While technical data and analysis that validates metallurgical change has been generated by a variety of independent sources, it can more generally be characterized in its incompleteness; that is, there is not enough published research to fully understand all of the mechanisms that occur from deep cryogenic treatment across a wide range of materials.

To determine the current status of the cryogenic treatment industry, and by extension, the technology, Cryogenic Institute of New England (CINE) conducted a survey of commercial cryogenic processing companies. Quantifying the size of the industry and better understanding the applications that have formed its commercial viability are important yardsticks that can be used to assess the status of the technology. This perspective provides an objective basis for evaluating not only the science, but also the business, and their potential.

A comprehensive search to identify companies that offered cryogenic treatment services was conducted via several search engines on the Internet. This yielded 40 companies within the profile, 30 of which completed the survey via telephone interview. (See Sidebar: “Who was in, Who was out”)

Macro view

Based on information supplied by the 30 survey participants (U.S. companies only), revenues for deep cryogenic treatment services in the U.S. amounts to US$8 million, with 75% coming from cryogenic treatment services and 25% coming from equipment sales.

Most of these revenues are generated by a handful of companies. In fact, 66% of the sales are generated by the eight largest companies. Of these, four are located in the midwestern United States, a region that also has the largest number of iden-
To identify companies offering deep cryogenic treatment services on a commercial basis, CINE conducted an extensive search using multiple Internet search engines including Google, MSN Search, Yahoo! and Thomas Register.com. Thousands of results were reviewed, culminating in the identification of 40 U.S. companies that offer deep cryogenic treatment services as a focused business activity. Phone interviews of the 40 were attempted, and after accounting for a handful of firms that had either suspended operations, closed, or were unable to be contacted, 30 companies participated in a phone interview with the study author. A breakdown of company locations geographically is: Northeast (4), Mid Atlantic (5), Midwest (17), Southeast (8), Southwest (3), and West (3). Participants and company locations are listed at left.

A number of companies classified as heat treaters purported to offer cryogenic treatment services, but were not included in the survey due to the sheer huge number, (over 200,000 listings on Thomasnet.com alone), and the fact that they often did not offer deep cryogenic treatment (-300°F/-185°C for extended dwell), but instead offered a “cold-box” capability. Cold box treatment refers to shallow cryogenic treatment (typically at -100°F or -75°C for only several hours), which is often characterized by heat treaters as cryogenic treatment capability. Consequently, it is likely that some heat treaters that offer deep cryogenic treatment were excluded from the survey results due to this confusion over terminology and the vastness of the heat treater audience, which made such identification a daunting, if not impossible, task for this study.

Other companies excluded from the survey include OEMs who use deep cryogenic treatment in their respective captive manufacturing operations (e.g., sporting goods manufacturers, tool makers and metal-working companies), companies that treat parts within their operations to extend machine-tool life or enhance performance of critical components, racing teams (e.g., NASCAR, Formula One, etc.) who have dedicated units for use within their own custom motor building operations, and manufacturers of cryogenic treatment equipment who do not offer the treatment service to outside customers.

The 22 companies accounting for the balance of revenues (34%) can be generally categorized by the following attributes:

- Sales revenues range between $25,000-150,000/year
- Revenue from deep cryogenic treatment services typically is 25-60% of total revenue
- About 30% of the companies have sales in excess of $1 million, but cryogenic treatment is only a small portion of the business (1-5% of total revenue)
- Nine companies were established in 2000 or after

The age (or maturity) of the companies surveyed was a significant factor in determining its size (based on revenue). For example, 14 companies surveyed were established in 1996 or before, collectively accounting for 80% of the total cryogenic processing revenue and 100% of equipment sales.

### VAR Strategy and Pricing

A number of companies have adopted a value-added reseller (VAR) component to augment their deep cryogenic treatment service business, which generates between 20 and 80% of their total revenue. Some companies adopting this strategy market the products under their own private label or brand. Others use existing commercial brands that are then expressly sold as modified, enhanced and/or improved via cryogenic treatment. Automotive and cutting applications accounted for a significant portion of these products, but there were numerous examples, including fleet vehicle, high performance motor sports, machine tools, drilling, pumps, wood cutting, pulp, paper, personal care, audio, electronics, food processing and construction.

Surveyed companies used a variety of pricing models, including:

- Cost per piece
- Value modeling using a cost-benefit model (for example, if the service life of a $1,000 item is doubled, the “value” of the treatment is calculated to provide a desired ROI)
- Component size
- Component weight
• Combination of above factors (most common)

A common denominator applied across all types of items treated is revenue/pound, which while imperfect, at least establishes a benchmark measure. A majority (24) of companies provided data using this measure, with values ranging from $2 to $30/lb (the average is $5.35/lb), which is attributed to the wide variety of items being treated. For example, heavy construction or mining pieces weighing hundred or thousands of pounds generated a low dollar/lb but high gross dollars, while carbide microdrills and other high value tooling generated a high dollar/lb with more modest gross dollars.

**Employees and Ratios**

Companies were asked to quantify the number of employees directly involved in all aspects of its cryogenic treatment service business. Further, a measure of full time equivalents (FTE) was established; that is, one FTE equals one person working 40 h/wk. Excluded from the calculations were any activities not directly related to cryogenic treatment services and employees involved in production of cryogenic processing equipment (when applicable).

Nearly 37 FTE’s were identified, 62% (22.7) with the largest eight firms and 38% (14.2) with the rest. This shows that deep cryogenic treatment is almost a “part time” activity for many of the smallest 22 service providers. On average, these companies employ fewer than one FTE (0.65) each compared with 2.85 FTEs for the largest eight companies.

A ratio of sales revenues to FTE was calculated for the industry. Across all companies, it is $162,602 per FTE. Among the largest eight, it is $176,211 per FTE compared to $140,845 per FTE for the remaining 22.

**Materials and Applications**

A majority of companies surveyed were unable to provide historic data showing a breakdown of the type of materials they were treating either as a percentage of their entire production, or in absolute terms (e.g., weight). However, respondents were able to identify their top tier materials and characterize them based on revenues by application. This, coupled with the author’s analysis of all available data, resulted in the following (somewhat subjective) ranking of materials treated as it related to overall volume (by weight):

- Cast irons (all types)
- Tool steels
- Carbon steels
- Alloy steels
- Stainless steels
- Carbides
- Mold steels
- Aluminum
- Copper
- Other

It is necessary to understand what applications are sustaining the deep cryogenic treatment industry to determine its greatest areas of penetration and opportunity. This information was derived from revenues generated by application type as shown in the following table.

A further breakdown of these categories is given below.

**Motor sports** is mainly distinguished between two types of applications.

**Revenue by market and/or application**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Market/application</th>
<th>% of revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Motor sports/automotive/rotors</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>Industrial/tooling/cutting</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Heavy components</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>All others</td>
<td>18</td>
</tr>
</tbody>
</table>

Cross section of cryogenically treated (left) and untreated (right) cast-iron rotors. The treated rotor was run on a racetrack for 91 laps versus 50 for the untreated rotor. The treated rotor demonstrates less distortion, reduced cracking, and less oxidation and grooving, which is why automotive applications and cast irons are both number one in terms of deep cryogenic treatment applications. Photo courtesy of Diversified Cryogenics, Burnsville, Minn.

Revenues for deep cryogenic treatment services in the U.S. amount to US$8 million, with 75% coming from cryogenic treatment services and 25% coming from equipment sales.
Equipment particulars

Of the 25 survey respondents who provided information on the cryogenic processing equipment that they were using, 28% were using a custom built processor and 72% were using a commercially manufactured processor including:

- ACI
- Applied Cryogenics
- ColdFire (no longer making/selling equipment)
- DMP

Five commercial equipment manufacturers (less than one half of all suppliers of such equipment) provided information on equipment installations. When combined, these five manufacturers reported approximately 500 cryogenic processing systems were delivered within the past decade. Adding other manufacturers could possibly increase this number by another 500 units. Yet, the commercial operators interviewed accounted for less than 20% of these units. This would seem to indicate that the majority of processors in use are in captive, in-house, or OEM applications. By extension, the scope of total cryogenic treatment activity could be to 5 to 10 times greater than the activity captured in this survey of commercial providers.

Breakdown of “All others” category

<table>
<thead>
<tr>
<th>Rank</th>
<th>Market/application</th>
<th>Revenue, $ (1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Undisclosed(a)</td>
<td>600</td>
</tr>
<tr>
<td>2</td>
<td>Recreational(b)</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Firearms</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Audio/electronics</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>Paper/pulp</td>
<td>60</td>
</tr>
<tr>
<td>6</td>
<td>Pumps/piping</td>
<td>60</td>
</tr>
<tr>
<td>7</td>
<td>Gears</td>
<td>50</td>
</tr>
<tr>
<td>8</td>
<td>Copper electrodes</td>
<td>40</td>
</tr>
<tr>
<td>9</td>
<td>Food</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>Grinding wheels</td>
<td>10</td>
</tr>
</tbody>
</table>

(a) Proprietary applications. (b) Consumer (retail) products including golf clubs, softball bats, tennis string, fishing line, etc.

A number of commercial cryogenic treatment companies have adopted a VAR (value added reseller) strategy, either creating their own brands, like Diversified Cryogenics’ Frozen Rotors® brake discs, or using existing brands that are expressly sold as modified or enhanced by cryogenic treatment. These sales account for up to 80% of total revenues for some cryogenic treatment companies. Photo courtesy of Diversified Cryogenics, Burnsville, Minn.

Conclusion

In general, the technology is still in an early adoption phase, somewhere between the “bleeding edge” and leading edge. There are several true success stories, however, generally found among older companies that were able to sustain the revenue drought of initial years and who were nimble enough to develop a cadre of customers or adopt other revenue streams such as value added reselling of products that benefit from deep cryogenic processing.

Despite its incompleteness, the survey results establish a benchmark for commercial cryogenic processing activity within the U.S. To the author’s knowledge, it is the only comprehensive industry market survey ever published, but it appears to only scratch the surface of the world of cryogenic processing activity. Future efforts should aim at gathering information about in-house (captive) and OEM data, commercial heat treater activity, racing industry data, and overseas and/or NAFTA activity. However, this presents a challenge because many deep cryogenic treatment users do not want to divulge application details in order to maintain any competitive advantage that they enjoy.

Robin A. Rhodes is president of Cryogenic Institute of New England, Inc., 90 Ellsworth St., Worcester, MA 01610, a company offering Nitrofreeze™ cryogenic services. For additional information, call (508) 459-7447; fax: (508) 459-7426; or e-mail rrhodes@nitrofreeze.com.