Cleaners, Coatings & Lubricants Affect Raw Wire Material Quality

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Good process chemistries can increase efficiency & eliminate a drawing step in generating wire materials for applications demanding complex geometries & high dimensional tolerances.

U.S. production of carbon and stainless steel wire grew substantially from 6,150,537 metric tons in 1990 to more than 7,585,132 metric tons in 1997 (most recent statistics).

As the size of the industry has expanded, so has the diversity of applications for carbon and stainless steel wire. Today, uses for these materials include bone plates for surgical products, telecommunications devices as well as components used in advanced industrial turbines, aircraft and agricultural equipment. Such applications are among the most demanding in terms of geometric complexity and dimensional tolerance.

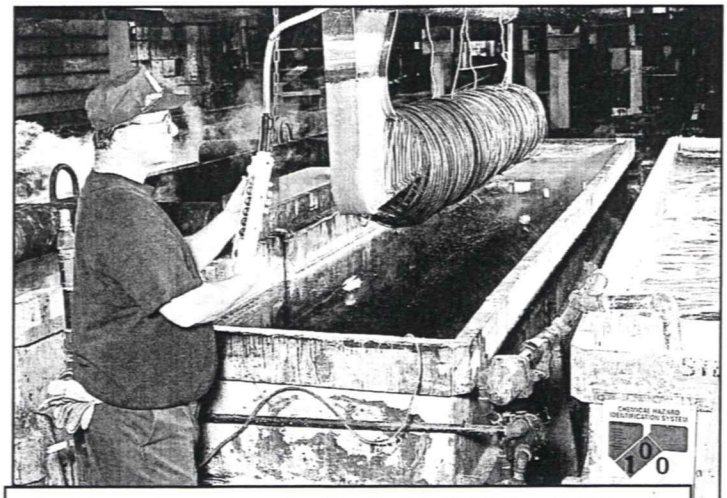
One of the leading USA producers of drawn wire is **Rathbone Precision Metals, Inc.**, Palmer, MA, USA, a business unit of **Carpenter Engineered Products** and **Carpenter Technology Corporation**. The 94-year old firm began as a processor of brass wire. Today, Rathbone's specialty is product with intricate or challenging profiles—and with good reason.

"If the work is straightforward standard shapes," says **James Fleischer**, Director of Manufacturing Operations, "our parent, Carpenter, will likely have the lower price. It's the highly precise projects, for example demanding tolerances of ±0.0005" (±0.013 mm), that distinguishes Rathbone in the marketplace."

Rathbone's incoming "raw" material is typically bar or wire. Occasionally, the company starts with extrusions. "We consider multiple sources and material possibilities for everything, everywhere," says Fleischer. "If Carpenter makes the appropriate raw materials (for example, Carpenter is prominent in stainless steel), we would try to direct the business there.

"Our real mission is getting the best value for our customer. The priority is to help lower customers' costs while maintaining the highest quality."

In addition to multiple rolling and drawing steps (three or four of each is not unusual), Rathbone performs numerous other operations. Included are specialized coiling, straightening and cutting-to-length.



Rathbone cleans wire using Heatbath's Uni Kleen 1705® and then dips the coils in Heatbath's Permic to condition oxide scale.

Surface Finish: A Critical Specification

The appearance of the surface is surprisingly important. "Delivering a product that is cosmetically pleasing is often as critical as any other specification," says Fleischer. "Sometimes the reason is simple eye appeal. In other instances, customers who perform surface operations such as tumbling and polishing need to begin with product that is highly uniform. So, they specify a particular surface finish, and may demand there be no variations in color. There are also important examples such as anti-lock braking systems where good finish quality can eliminate the need for centerless grinding of the final product's OD to result in significant cost savings.

"Our customers are not very different from consumers buying appliances or cars. To buyers, the quality of finish equates directly to the quality of the product."

Process Sequence

Cleaning Steps—Rathbone's cleaning house is designed to process bar or coiled material. Before cleaning and coating, materials are chemically or mechanically "pointed" to facilitate passage through the die. The goal is to transition the rod or wire to avoid a "shoulder" which could damage the die.

The first step in the cleaning process uses Uni Kleen 1705®, a heavy-duty alkaline cleaner from Heatbath. Uni Kleen 1705 quickly and thoroughly removes chlorinated rolling oils, phosphate coatings and reactive stearate lubricants. Immersion time is typically five to 15 minutes at 180°F (82°C).

After alkaline cleaning, the work is immersed in Heatbath's Permic to condition any oxides that formed during annealing. Permic works by transforming acid insoluble oxides into their soluble form, thus permitting easy removal in acid without compromising the base metal. Permic contains a buffering agent that retards the breakdown of the bath's active ingredients, thus extending bath life and reducing chemical consumption.

Once the scale is conditioned in Permic, it is easily removed by inhibited hydrochloric acid used at room temperature. Certain grades of stainless may require nitric acid pickling.

Coating Steps—*Stainless steel grades* are treated with Heatbath's Oxicoat®, in a process that converts the metallic surface into a nonmetallic, porous, oxalate coating. Oxicoat is a three-part formula, which facilitates cold forming by reducing metal-to-metal contact. Die life is lengthened and work can be drawn at faster speeds with greater reductions. Surface finishes are highly uniform and free of cosmetic irregularities.

Using Oxicoat can eliminate an extra drawing step. According to Fleischer, "Margins in our industry are extremely tight. One draw can equal the job's entire profit. Oxicoat allows the number of draws to be reduced in many instances. It is also most compatible with all the lubes we use, from soap to moly. Oxicoat is essentially the best answer for all stainless applications and is the *only* thing that works for some of them."

In 1998, with growth in stainless bar processing, Rathbone expanded its oxalate tank from 1000 to 2800 gal. The larger tank simplifies material handling and accommodates bars up to 20' (6.1 m) long. The chemistry's stability and ease of temperature control in the larger tank contribute to coating uniformity.

Plain carbon steel grades are treated with a zinc phosphate conversion coating designed specifically for Rathbone. Based on our Phos Dip® 38 chemistry, this zinc phosphate is very effective in retaining lubricants and facilitating cold drawing and forming. It has a unique phosphate-to-nitrate ratio and an increased metal accelerator that creates a highly uniform, tight-grained crystalline surface. Coating weights are typically 10 to 15% heavier than conventional zinc phosphates.

Selecting the Best Lubricant

The drawing lubricant used depends on the material and particularly on the material's final configuration. It is needed at all points of contact in the die. If its performance degrades, work will seize in the die and a drawing scratch will result.

For drawing applications needing a reactive lubricant, Heatbath Drylube 1000 is used. This high titre stearate, which used over oxalate or zinc phosphate coatings exhibits excellent film strength and resistance to seizing and galling.

For stainless steel shapes that are exposed to high temperatures and pressures, Rathbone applies a moly disulfide/graphite suspension over the Oxicoat. The formula has a low coefficient of friction and is highly resistant to these extremes.

Rathbone has established optimum temperatures for each chemical bath. Continuous monitoring assures they stay within a few degrees of the set point. The chemistry of each bath is tested daily, on-site by a technician. The results for each tank are plotted on SPC charts. Additions are calculated based on daily analyses, rather than on operator judgement.

"This is science, not guesswork," says Fleischer. "Maintaining bath consistency is essential to producing a quality finished product. And it is an important part of our overall Quality System, which is registered to ISO 9002."

Heatbath supports Rathbone's efforts with monthly analyses that independently audit and confirm results generated in-house. Heatbath's laboratory also performs coating weight testing on oxalate, phosphate and lube coatings in order to assure highest process integrity.

Rathbone's proprietary cold working and cold forming techniques, combined with Heatbath's chemistry, work together to allow Rathbone to achieve the greatest reductions with minimal wear and to produce the highest quality finished product.

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***Company Profiles...Heatbath**'s chemical products including Zn phosphate for mild steel, oxalate for stainless, reactive/nonreactive lubricants and specialized and proprietary formulas. The firm's "System Solution" includes scale removers, cleaners, acid inhibitors/extenders, conditioners, neutralizers and specialty products.*
***Rathbone Precision Metals** makes carbon, low alloy and stainless steel wire as well as brass, tool steel and high-temp alloy wire.*

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