Problem Solving Forum

This Month's Question

What are the differences among metallic abrasives (e.g., cast iron, malleable iron, and cast steel)? What are the advantages and disadvantages?

From David Hale, Ervin Industries, Inc., Ann Arbor, MI:

From a global perspective, 2 distinct types of metallic abrasives are used for blast cleaning: chilled cast iron and high carbon cast steel. While chilled cast iron is used in some markets, the total usage is in decline. High carbon cast steel abrasives, meeting all of the requirements of SAE J827 and J1993 (pending—formerly part of SAE J827), are used in 90 to 95 percent of all of the North American blast cleaning applications that use recyclable abrasives. (See also Steel Structures Painting Manual, Volume 1, Chapter 2.2.)

Because grit is the predominant blast material used in field blast cleaning applications, only grit is discussed here. Cast steel grit is the only metallic blast cleaning material engineered and manufactured, from its beginning as molten electric furnace steel, to produce the optimum characteristics for recyclable blast cleaning media. Some cast steel shot is used for blast cleaning new or coated structural or sheet steel in various applications, but shot is usually confined to manufacturing/blast cleaning in factory operations. ISO has also developed standards for metallic abrasives. These standards, which will be published very soon, are ISO 11124 Part 2, Chilled-iron grit; Part 3, High-cold cast-steel shot and grit; Part 4, Low-carbon cast-steel shot; and Part 5, Cut steel wire.

In the early days of blast cleaning, the only metallic material available was chilled iron, often referred to as “iron sand,” pioneered in the 1920s. Chilled iron was melted in a cupola and chill cast in water to make chilled iron shot. It was either sold as shot or crushed and sold as grit. Because of its high carbon content, in excess of 3 percent, and the resulting high percentage of iron carbides in the microstructure, chilled iron was very brittle (frangible), very hard, and very aggressive as blast cleaning media.

My company makes a laboratory test machine that simulates the impact stresses and failure of abrasive due to friability. The test is accepted as a standard by blast operators and abrasive manufacturers alike. In the machine, under laboratory conditions, chilled iron survived about 100 to 150 impacts. Chilled iron also caused very high wear in the blasting equipment. Over the years, heat treatments were developed for chilled iron to offset the high friability and high equipment wear characteristics, but these treatments also reduced cleaning aggressiveness. This “family” of cast iron media included annealed and tempered irons.

Later, in the mid to late 1960s, the carbon content of most chilled iron was reduced to 2.5 to 3 percent by melting all steel charges in the cupola, typical of the base material for malleable irons in the foundry industry. These chilled irons of lower carbon content were as hard as the old chilled iron, but somewhat less brittle, producing somewhat less wear in the blast cleaning equipment, and were less aggressive in cleaning. These lower carbon chilled irons were also heat treated to produce annealed and tempered chilled iron, malleable iron, and de-carburized iron. Again, all of these heat treatments reduced the brittleness and wear on the blast cleaning equipment, but, as the friability decreased, the cleaning aggressiveness also decreased. When evaluated in the test machine, these products would survive in the range of 150 to 1,500 impacts.

Cast steel abrasives were introduced in the 1930s and immediately began to erode the chilled iron and chilled iron derivatives markets. Cast steel grit is heat treated to produce all of the hardness ranges and blast cleaning performance characteristics of these irons, with much less friability and equipment wear. The manufacture of cast steel abrasives resulted in the demise of domestically produced chilled iron and its derivatives, although as noted above, chilled iron is still used in some markets outside the U.S. The most popular hardness range for cast steel grit in field blast cleaning of new or previously coated surfaces is 55-60 Rockwell C. With this hardness and a superior microstructure, cast steel grit is aggressive and fast cutting, striking a good balance between high productivity and low friability. As tested in my company’s machine, cast steel grit of this hardness will survive approximately 1,700 to 2,000 impacts.

Many other types of “steel” particles have been tried as blast cleaning abrasives.
When You Need Containment Screen, Ask for ENVIRO-Green

- FLAME RESISTANT
- FABRICS FOR ALL DEGREES OF CONTAINMENT
- MANY STANDARD SIZES IN STOCK FOR IMMEDIATE SHIPMENT
- CUSTOM SIZING AVAILABLE
- WOVEN POLYPROPYLENE, REINFORCED HEMS, RUGGED SPUR GROMMETS

Other Indian Valley Products:
- ENVIROTARP FUNNEL SYSTEMS
- ENVIROSCREEN FOR OVERSPRAY
- ENVIROBAG FOR STREAM POLLUTION
- COATED FABRICS FOR ACHIEVING TOTAL CONTAINMENT
- EMERGENCY SPILL KITS
- WIPING CLOTHS

INDIAN VALLEY INDUSTRIES, INC.
P.O. Box 810
Johnson City, NY 13790
Nationwide Toll Free 800-659-5111
FAX: 607/729-5158

Problem Solving Forum continued

sives. Products such as reclaimed grit from foundry blast cleaning operations, crushed steel turnings, steel mill spittings, nail “whiskers,” and other similar products have been marketed and, for the most part, have not gained broad market acceptance. Since the market is the ultimate gage, it could be concluded that the advantages of cast steel microstructure, hardness options, low friability, and speed of cleaning are significant.

From Bill Hitzrot, Chesapeake Specialty Products, Inc., Baltimore, MD:

Before describing these 3 types of metallic abrasives, I would like to define some terms. Cast iron is any iron carbon alloy that contains more than 1.7 percent carbon and usually between 2 percent and 4 percent carbon. Steel or cast steel is an alloy of iron with carbon. Steel has a carbon content of less than 1.5 percent with most steels ranging from 0.1 to 0.8 carbon.

Cast iron abrasives are made from molten cast iron and therefore contain 2.5 percent to 3.5 percent carbon. Cast iron abrasives are hard, generally in the Rockwell C 55 to 65 range. Cast iron abrasive, because of its hardness and carbon content, breaks down rapidly. Generally, it has less than one-third the life of conventional steel abrasives. Cast iron's major advantage is lower initial cost as compared to steel abrasives. To its disadvantage, cast iron abrasives generate more waste by-product than steel and create a deep profile, which increases paint requirements.

Malleable iron abrasives are made by annealing cast iron abrasives to bring down the hardness to the Rockwell C 40 range. Malleable iron has somewhat longer life than chilled iron, but because of the high carbon content, malleable iron is considerably less durable than steel abrasives. Malleable iron is generally less costly than steel abrasive but more costly than cast iron.

Steel abrasive, because of its lower carbon content and fine-grained structure, has excellent durability, generally more than 3 times that of any iron
abrasive. For most paint removal operations, the optimum hardness for steel abrasive is about Rockwell C 43 to 46 ± 5. At this hardness, steel abrasive combines excellent durability with optimum cleaning. However, hard steel abrasive, in the 50 to 60 Rockwell C range, tends to break down too fast and can create excessive profile on the blast-cleaned surface. Excessive profile requires more paint and can result in premature coating failures. Steel abrasive, because of its high productivity and durability with minimum waste, is the most cost-effective metallic abrasive product for most blast cleaning operations.

From Chris Norton, Peerless Metal Powders and Abrasives, Butler, PA:

First of all, the only cast iron (chilled iron) abrasive sold now in the U.S. is imported. My company discontinued manufacturing chilled iron abrasive earlier this year due to the low demand. At one time, chilled iron abrasive offered a cost advantage. Today, however, cast steel abrasive is just as competitive. Also, chilled iron, being more friable, cuts faster but is not as durable as other metallic abrasives.

Malleable abrasives, or "heat-treated cast iron," have not been produced for several years. This abrasive was generally replaced with tempered cast steel abrasive. At one time, this item was also a lower cost abrasive.

Cast steel abrasive is the most widely used metallic abrasive in the surface preparation industry. Properly produced, cast steel abrasive can be tailored to meet specific requirements such as speed of cut, profile depth, and durability. For example, harder grit retains its angularity and sharpness and cuts faster, but it also breaks down fairly rapidly. Softer grit tends to round off quickly but does have long life. Cast steel abrasive generally is clean and free from dust. It can be recycled numerous times depending on the reclamation system.

In addition to cast steel abrasive, my company is producing a mid-range carbon grit used for surface preparation. This is not a cast steel abrasive but is manufactured through a proprietary process. It is a sharp, aggressive grit similar to cast steel in appearance. The advantage of this product over cast steel and cast iron abrasive is that the density is somewhat less, allowing greater carrying capacity without losing velocity over longer distances from the blast machine to the blast nozzle. This material is clean and free from dust. It has the same life expectancy of cast steel abrasives.

Reprocessed steel abrasive originates from cast steel abrasive. This material...
Problem Solving Forum continued

is obtained through carry out and other disposition of spent or contaminated abrasive. Properly processed, this abrasive can be a viable, low cost alternative to cast steel abrasive. The same profile, life, and cleaning rates can be achieved.

There are other metallic abrasives processed from the by-products of the metals industry. Generally, these products are not as consistent as manufactured steel abrasives in chemistry, hardness, shape, and cleanliness.

We invite your participation in "Problem Solving Forum."

Send comments and questions to Forum Editor, 2100 Wharton Street, Suite 310, Pittsburgh, PA 15203.

COST Mate®

Spec-Mate® — 1 For Land-Based Industrial Plants

- Quickly Identifies Most Cost-Effective Systems for New Construction or Maintenance
- Database Contains:
  - 100 Most Commonly Used Generic Coating Systems and Projected Life in Specific Environments
  - 1993-94 Material and Application Costs
- Ideal for Budget, Projects, or System Cost Estimates
- Produces Short- and Long-Term Costs and a Present Value Analysis
- Analyses in Square Feet, Square Meters, or Per Ton

SM1 Customizer® For Use with Spec-Mate-1

- Change Application and/or Material Costs
- Change Product Names from Generic to Brand Names

To Adapt for Worldwide Use

- Change USA Costs to Any Currency
- Change USA Locations to Local City and Country

BREVOORT CONSULTING ASSOCIATES, INC.

1007B Long Beach Boulevard ● North Beach, NJ 08008
(609) 494-8645 - Fax (609) 494-0188


You’ve seen the ads for abrasives time and time again, you give them a call and ... 

"STICKER SHOCK"

INTERNATIONAL GARNET, INC.

MINERS AND MANUFACTURERS OF GARNET MINERAL ABRASIVES

ECONOMICAL

Comparative in Cost to Staurolite • Better Recycling • Cuts Like Aluminum Oxide and Steel Grit • Faster Production than Silica Sand or Slag • More Sizes Available • Meets MIL Spec, MIL-A-22262 • No Free Silica • Low, Low Dust • Price: $140/ton for size 2040

INTERNATIONAL GARNET, INC.

New Bern, North Carolina

(919) 633-6305 (919) 633-3905 Fax