Fisk Alloy: the genesis of a new product

"Change is inevitable, progress is optional," anonymous.

The way businesses respond to change in the industry may be divided into three modes: those that are resistant to it, those that will react to it as necessary and those that are proactive. This article presents the story of one very proactive business: Fisk Alloy.

The U.S. company, which has a copper alloy redraw wire mill in Hawthorne, New Jersey, began as a materials supplier for electronic connectors, and evolved and expanded far beyond its core focus in anticipation of changing needs. Long before the advent of Europe's RoHS regulations,

Fisk Alloy CEO Eric Fisk holds a hair-thin sample of Percon 28, the company's newest cadmium-free product.

which essentially spelled the end of the use of cadmium by industry, Fisk Alloy introduced Percon, a new cadmium-free copper alloy wire product line. Here, Fisk Alloy CEO Eric Fisk tells the story of how the Percon product line came to be, a journey that included educated guesses, unexpected surprises, fortunate timing, excruciating delays and incredible perseverance, all of which have led to the recent introduction of Percon 28, the first copper-alloy conductor to exceed ASTM B624 strength requirements.

WJI: Let's start with your flagship conductor products, the Percon line. How was it that Fisk was first to develop a family of cadmium-free alloy wires?

EF: For the first two decades of our business, we were solely an electronics materials supplier, and the electronics industry has had a lot of technical issues that require different alloys. In response, we developed a piece of proprietary equipment that rolls heavy gauge strip into wire, so we could offer our customers alloys in a material form (wire) that we couldn't get from the wire casting mills. That capability, which enabled us to compete against the engineering alternate (strip), became the prime mover for many of our subsequent decisions.

That was about 1992. It took us about two years to work the kinks out of the technology, but by'94 we had perfected the know-how. At that point, I started to look around for other opportunities. In other words, "What alloys can we offer as wire that aren't presently being offered?"

WJI: Where did you focus and why?

EF: Well, in the specialty copper alloy wire field, there aren't scads of opportunities. Which is a bad news/good news thing. If there were more opportunities there would be a lot more players in the field. The bad news is that our ambitions are bigger than our marketplace. So we started looking outside electronics and eventually came to know about the realities of the alloy conductor field.

We learned that the big players in conductors were alloy C162 (copper cadmium) and alloy C18135 (copper-chromium-cadmium), also known as PD135, which set the performance benchmarks for the industry—and which Phelps Dodge (now Freeport-McMoRan) had a lock on. PD would sell finished product to anyone who wanted to buy it, but they would carefully control the sale of redraw material to other producers of finished product, affecting a tightly controlled supply of PD135. As a result there was a great market opportunity for an alternative supplier.

So that's what got me started: the fundamental business proposition of a single-sourced material that a lot of people were interested in.

Innovations is a new occasional section where companies can discuss new technology, going beyond "the specs" to cover aspects such as the real-world need for innovative technology. Companies that would like to be considered for future submissions can send an e-mail to editorial@wirenet.org.

WJI: This was ten years before RoHS. Why did you pursue a cadmium-free alternative?

EF: Several reasons. Again, we had been privy to the electronics industry for many years. And on the electronics side, cadmium had lost favor long ago. Even the automotive guys were long out of cadmium copper in radiators—which outperformed brass radiators. Cadmium is an excellent engineering material, but its environmental considerations—especially recycling and waste handling—just kill it.

In fact, the only place that we knew cadmium copper was still used without abate was in the conductor field. But even if we could have come up with our own cadmium copper alloys, any plant still casting cadmium was running on borrowed time. Why waste your time on a dying material? I figured that sooner or later cadmium-free materials were going to win but the question was, "Is it going to be in our time?" So we went straight for green.

Smooth bunching — the newest of alloys running on the most traditional equipment.

WJI: How did the Percon family evolve?

EF: Very slowly. We brought Percon 17 to market in 1994, utilizing our strip-to-rod technology. It is a very good alloy originally developed for integrated circuit lead-frames, which we were producing in square and flat wire for applications in automotive electronics. But as we optimized it for applications in conductors we came to realize, OK, in its soft condition it's better than cadmium-copper soft, but not as good as cadmium-copper hard, for which we later developed Percon 19. Nor was it as good as PD135, which is also sold soft. So although Percon 17 is well-positioned that is not where the larger market is. Alone, it was too limited; we needed to come up with a family.

So in 1996 we went back to work to find a replacement for PD135. It's a lot of work. Each alloy refinement is a casting run, and casting runs are neither cheap nor in small quantity. Three years later we were pretty much dialed in to what we needed to create the alloy that is now known as Percon 24—the chemistry and the processing of it.

WJI: At that point you decided to produce conductors?

EF: No, we were sticking with the commercial decision not to produce conductors. We just wanted to sell the material as redraw, as a cadmium-free replacement. So at that point our family consisted of Percon 17 and Percon 24, which is every bit as good as PD135, but doesn't contain cadmium. So we got a patent on it, and then tried to sell it as redraw material to existing producers of conductors.

WJI: How was it received?

EF: Well, the reaction was not what we had expected. It was more like, "Oh, that's nice." Everyone was interested in it, save for three slight problems: (1) It was no cheaper than the existing alloy, PD 135. (2) Everybody was so busy at the time—this was right around the onset of the Y2K madness and the dot-com bubble—that anybody who had anything to do with electronics was going full-tilt. So nobody had any time for innovation or acceptance of new products—they couldn't make enough of the products they already had. (3) Lastly, and perhaps most tellingly, we had invented a solution for which there was not yet a perceived problem. People in the conductor industry knew that cadmium was nasty, but there was not yet any pressure to do anything about it.

The proper processing of redraw wire for alloy conductors is not speed-driven.

Having invested all this mental, emotional and financial energy into developing these materials—and wanting very much to grow our specialty copper-alloy wire business—we concluded that the thing for us to do was to capitalize and start making stranded conductors ourselves. To be a supplier of Percon alloy conductors in the finished form: silver- and nickel-plated or bare finished alloy conductors per customer specifications. So in 1999 we expanded our plant and started to assemble the necessary machinery and equipment.

WJI: So you came out with your first conductor product…

EF: In August, 2000 (thank you, Quirk Wire). And, ini-

PERCON CONDUCTOR ALLOYS

ALLOY	TEMPER	Min. Tensile Strength (ksi)	Minimum Conductivity (%IACS)	Minimum Elongation Percentage	Flex Life (ASTM B470)	Resistance to Softening
Percon 11	Hard	80	90	1	M	E
Percon 17	Soft	58	85	6	G	M
Percon 19	Hard	110	73	1	VG	G
Percon 24	Soft	60	90	6	E	E
Percon 28	Soft	80	85	6	S	E
HS 95	Soft	95	63	6	S	VG

M = Moderate; G = Good; VG = Very Good; E = Excellent; S = Superior

tially, we encountered a problem that was quite startling to me. We had been making wire for the electronics industry for nearly 30 years, where alloy development and alloy introduction is a well-established experience. People in the electronics industry are very comfortable with the concept of developing alloys for a particular application. In other words, developing alloys to solve technical problems and putting those alloys to work.

The electronics industry faced thorny engineering problems such as increasing circuit density and the heat that goes along with that; the need for higher-speed circuits where resistance of the metal becomes a barrier to speed; increased formability for part-intricacies within increasingly sophisticated interconnect devices; increasing under-the-hood temperature demands from the automotive sector, which stresses materials over the long haul, yet those materials had to hold their properties at those elevated temperatures. Problems of those sorts.

So I was very surprised to find that in the conductor field, they had been using the same materials for so long that they had no tradition of introducing new alloys. As I then came to learn, the innovation in conductors had been in the insulating materials and processes. It was all pretty much copper-cadmium alloys that had been around for 30 or 40 years. So our non-cadmium conductors were a hard sell because nobody had any performance tests or testing regimes by which they could compare alloys.

And, of course, the incumbents sowed doubt to keep us out: "Oh, you've got to be very careful; this is an unproven alloy from an unproven producer." Which was true and was standard blocking and tackling. That was no surprise. We were new to conductors, but not to the wire business nor to what it takes to market new alloys in wire. So we had to work to overcome that.

WJI: And right about then, the dot-com bubble burst.

EF: Right. But it turned out to be a blessing in disguise. One other barrier to selling our conductors was that we had nothing to thunk down on the table and say, "Read this. Here's the proof."

So in the period immediately after the bubble burst, we spent a lot of money developing a testing regime to do a full technical review of Percon 24 for NAVAIR. At the time NAVAIR was the keeper of all military specifications and gave production approvals for wiring that went into military systems. So we approached them with this new cadmium-free material with the request that with all the testing completed that they would then review it and pass judgment. It took two years.

We hired Raytheon to do comparative third-party testing for both silver- and nickel-plate conductors. Raytheon has the laboratory and regularly does that kind of testing for NAVAIR. There were a lot of long-term tests and when they were complete, NAVAIR read the reports and said, "Yes, it's eligible material for military application." Thunk.

Another reason that the downturn was a blessing is that it's possible to bring a product in too early to the marketplace. And in the case of Percon 24, the alloy was ready, but our ability to be a good manufacturer of it was not. Had we had any real commercial pressure placed on us, we would have failed. We had a lot to learn about the processing of the material to achieve its consistent high performance. So we spent 2001 to 2003 honing our skills and when the market returned, we were ready.

WJI: Was it ever touch and go?

EF: Sometimes the ice under our feet was so thin we could feel the cold water. It was rough trying to get a toehold in conductors. Nevertheless we kept running around making samples and there was enough business, I think, to keep three people going as we kept working to develop the processing of the alloy into the finished conductor form. And fortunately, we were still one of the major suppliers of the electronic connector industry, though that side took a big hit, too. But our company was still above break-even so we could continue to support our hoped-for breakthrough into conductors.

WJI: Which was right around the corner. Talk about RoHS.

EF: Early in 2003 the European Union adopted the Restriction of Hazardous Substances directive (RoHS), which was a subset of the WEEE (Waste Elimination in Electrical Equipment) regulations. The basic premise of RoHS was that the waste stream of electronic equipment contains all kinds of hazardous stuff that shouldn't be there. So the way to control the problem is to not use that stuff in the first place. The regulations listed several organic chemicals and heavy metals that needed to be phased out, specifically, lead, mercury, hexavalent chromium, and cadmium.

The European military and aerospace industries were given a pass until 2017, but most industries had to comply by 2006.

When RoHS happened, nobody paid much attention to it at first—ourselves included. It was a European thing, not an American thing, and so on. So it caught everybody napping. What really put the news on the front page was a consensus by global corporations selling in Europe that they weren't going to make "green products" just for Europe—that the next generation of products was going to be their global standard. In other words, if this is a good idea, we're going to do it globally. The business reality was that managing two levels of products was untenable. It made no sense to have RoHS-compliant products in Europe and a different set of products doing the same job in North America. So while the North American market never officially imposed these requirements, it became the commercial standard. If you wanted to be in the game, your products had to be RoHS-compliant.

By the middle of 2004, industry people were wide awake, because they had 18 months to solve their problem. And for some markets it was a problem of epic proportions: RoHS limits for lead are 1,000 ppm, whereas cadmium's RoHS limits are 100 ppm. The conductor industry was especially walloped because PD135 has 4,000 ppm of cadmium and cadmium-copper has 10,000 ppm.

So when that word trickled down into the tiers of products that we work at, suddenly things changed dramatically. We had been knocking on their doors for four years telling them about the importance of cadmium-free products. All of a sudden it became, "Geez, how did you guys know?" And there we were with the technical and environmental solution, with the thunk on the table to go with it.

WJI: They finally got the message?

EF: It's a classic tortoise story: steady, steady, steady. Working through the obstacles. What makes the story unique is that if we hadn't been in electronic materials—which took us backward into the raw material capability—we couldn't have done what we did. And, as I said awhile back, our innovative strip-to-rod technology was the prime mover that impelled us forward, eventually, into finished conductor products.

WJI: What's special about Percon 28, your latest offering?

EF: We're very excited about Percon 28 and for it we have again significantly expanded our plant. It's got excellent specs and to date, it's the only copper alloy to ever exceed ASTM B624 strength requirements without compromising performance. And it doesn't just exceed those requirements, it leaves them in the rear view mirror. Its 80 ksi (550 MPa) minimum tensile strength is a 33% increase over ASTM B624 requirements—with no loss in electrical conductivity. It shows twice the flex life of either PD135 or Percon 24. I could go on but we've got spec sheets and a website to do that.

The value in use of alloy conductors requires nothing less than perfection.

But like all of our products, Percon 28 is a tortoise story, too. From our previous efforts we approached the development of Percon 28 with a good understanding of the technical challenge but it still took a major R&D effort. It also took many years to develop and our entire team deserves a tremendous amount of credit, for it takes knowledge, great patience, and great respect for the empirical process. Starting with the proven Percon 24 alloy, we focused on modifying it with different alloy compositions. We ran numerous trials of these different alloy compositions, some with significant alterations some with small. And then, having a broad range of manufacturing equipment for producing conductors, we processed the redraw trials into finished products. This helped tremendously for you can never fully predict the synergy by which added elements will combine and perform—how the elements will interact to achieve your desired end.

This synergy is taking place at the molecular level, right down among the atoms of an alloy's crystal structure. The stuff of which the universe is built. Sure, we get excited by our success, that's only human. That's our entrepreneurial DNA talking. But there are other times, when you consider the dance of these elements that you can't feel anything but awe. It's just fascinating, this continuous stream of innovation in copper alloys that goes back to the beginnings of civilization. We're just part of that, and we were fortunate enough to find opportunities within wire to follow these paths. We've been blessed to be able to innovate and develop copper alloy wire products that are on the leading edge or are an important part of the best that can be done in our time. It's very satisfying.

To request a free white paper, please contact Fisk Alloy via email at percon28info@fiskalloy.com. ■