

SEPTEMBER 2003

METAL *Finishing*

THE INDUSTRY'S RECOGNIZED INTERNATIONAL TECHNICAL AUTHORITY SINCE 1903

CLEANING AND PRETREATMENT

One-Step Organic Phosphating Revisited

by Scott and Mary Carpenter

Carpenter Chemicals

Several industry journals have written about Plaforization,* the one-step, room-temperature organic phosphating system, including two earlier articles in this magazine^{1,2} that explored the intriguing scientific basis on which it operates. There are good reasons for the industry interest in the process, because it offers a tantalizing set of benefits. In brief, the Plaforization line of metal pretreatment products claims to clean, phosphate, and apply a flash-rust-inhibiting sealant all in one step, at room temperature, in a minute of treatment time, and without a rinsing stage. The process also boasts that it creates no sludge or other solid waste or effluent, requires no oil disposal, and the bath never needs to be changed, only added to as it is consumed. Other benefits claimed for the innovative process include lower capital costs, and installations are small and flexible (an installation can be a dip or spray, and can be anything from manual to semi-automatic to fully automatic). The process uses no water, the solvents contained in the liquid are oxygenated hydrocarbons and therefore biodegrade to CO₂ and water, and they contain no HAPs, ozone-depleting substances, carcinogens, or mutagens.

PROCESS BASICS

Plaforization uses a specialized chemistry, very dif-

ferent from conventional phosphating, to treat metal surfaces and prepare them for painting. The fluid in the tank consists of a mixture of solvents, along with phosphating chemicals and a polymeric resin. Several different actions are taken essentially simultaneously in the one-step bath, whether in a dip or flowcoat process:

1. Oils are **removed** from the metal surface and are **dissolved** in the Plaforization bath.
2. The oils are **absorbed** into the polymeric phosphate resin.
3. The phosphating chemicals **attack the metal surface** and form a crystalline layer of inorganic phosphates.
4. The fluids are flashed off and cause the final reaction and creation of a very thin **organic polymeric phosphate** sealant. This continuous seal provides the resistance against flash rusting that an inorganic phosphate alone cannot, because it blocks access of moisture and air to the metal surface.

Those interested in a fuller explanation of the process and alternative implementations will find them in the two earlier *Metal Finishing* articles.

READY FOR PRIME TIME?

The process has been around, primarily in Europe,

*Plaforization is a registered trademark of PAIKOR Chemical Corporation, Milan, Italy

for two decades and only in the past few years has it been marketed successfully in North America. Judging from the questions on the industry bulletin boards, quite a few shops are intrigued by the technology and the promised benefits, but they've been asking, "Who else is using it?" "What's the catch?" "Is it really ready for prime time?" "How does it compare with conventional approaches at different volumes of work?" This article reports on the current state of commercial installations of the process in North America.

It is clearly a very different kind of pretreatment from the well-discussed conventional systems available on the market, and it has raised a lot of questions. Perhaps the most significant question has been determining at what volume of work (in any specific shop) the benefits of the new technology – in labor savings, heating costs, and reduced waste – are compelling; and at what volumes of work these benefits are outweighed by the incremental cost of the proprietary chemistry required.

Being a "different" process – not just an incremental improvement in an accepted chemistry – has often made it difficult to explain and evaluate the new approach because there is no reference point in pre-existing U.S. technology. Also, many potential users may be reluctant to be the first NAFTA customers, even though the process is well accepted in Europe with some 400 to 500 plants and more than 14 million square feet of metal treated daily.

SOME USERS AND APPLICATIONS

Since its introduction, the PlafORIZATION process has gained acceptance for many different applications in both the U.S. and Canada. Beginning with a single customer in early 2000, a small job shop, there are now operating plants from Quebec City to Toronto to Texas to Puerto Rico. Dip and flowcoat (spray) operations have been built, as dictated by the needs of the customer, and all kinds of products are treated – including wire goods, large steel forms, electrical switchboxes, large industrial light fixtures, and a wide variety of products pretreated by job shops. Moreover, several environmental organizations, such as the Iowa Waste Reduction Center and the Minnesota and Massachusetts Offices of Technology Assistance, have been promoting the use of this new technology.

In the case of CP Bourg of New Bedford, Mass., for example, the Massachusetts Office of Technology Assistance recommended PlafORIZATION as a substitute for the environmentally problematic vapor degreasing operation they had been looking to replace. CP Bourg was pleased to consider PlafORIZATION, and then adopt

it, because they were already familiar with it from their European operations. CP Bourg manufactures steel collating equipment.

The first customer for the process was Johnston Metal Works, from Cheboygan, Mich. They are a small job shop that wanted to go into powder coating but could not afford the expense of a conventional several-stage system. The firm constructed a dip tank that has been operating successfully since early 2000. The firm's management says that the business could not have expanded into powder coating if this process were not available.

Advanced Graphics of Stratford, Conn., is a job shop treating a variety of parts. Their old washer began showing signs of failure, and they needed to increase production capacity to meet new business requirements. They replaced the conventional batch washer with a PlafORIZATION flowcoat installation, and now accomplish their cleaning in 3 to 4 hours, instead of taking all day.

There are three shops in Puerto Rico, one of which is a wire goods manufacturer that was attracted by the simplicity and cost efficiency of the process. In Quebec City, one firm is using the process in the manufacturing of industrial lighting fixtures.

MILITARY SPECIFICATIONS

Another area of application is military specification work, and traditionally mil spec approval is a long and difficult application process. But Intercontinental Manufacturing Company (now General Dynamics Ordnance and Tactical Systems) of Garland, Texas, went to bat for the process by requesting, and obtaining, a modification of Military Specification TT-C-490 in order to use PlafORIZATION in their cleaning operations instead of their 8-stage zinc phosphating process.

Following up on an initial interest in the product, General Dynamics process would be a much more efficient process and would save them very significant costs, including both capital cost and operating costs (energy to heat the bath, downtime for sludge removal, waste-related costs).

General Dynamics needed to obtain approval of an alternate to Mil Spec TT-C-490, Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings, that still would meet the requirements of that specification, in order to use PlafORIZATION instead of its conventional system. They were sufficiently interested to request the modification, which essentially consisted of changing from the existing method and composition standards to performance standards. For example, the existing TT-C-490 required a given coating weight of phosphate crystals on the metal. Since the underlying reason for the

coating weight is salt spray resistance, the modification required meeting a given number of hours of salt spray resistance. In fact, organic phosphating puts on a much thinner inorganic phosphate layer than does the conventional process, but the salt spray requirements are met because of the combination of the inorganic phosphate and the continuous polymer sealant.

The modification process took several months and several drafts, but was put in place in November 2002. At that point, General Dynamics began construction of its new installation and went into production in late January. General Dynamics, the government, and Carpenter Chemicals are working closely to monitor this new Plaforization process. General Dynamics' Manufacturing Engineer on the project, Matt Botter, says: "As with any new process or technology, there are growing pains and product-specific hurdles that have to be addressed, but the Ecophor A447 has performed well, meeting or exceeding our required performance specifications."

On the basis of the experience to date, in the last month a new military specification has been submitted for other applications, and is in process.

LEARNING PROCESS

Introduction of a new process requires new approaches in marketing, customer relations and implementation. The marketing has been highly focused on educating the public on the scientific and technical underpinnings of the new technology, because the novelty and simplicity of the product often engenders the feeling of "It's too good to be true," and dispelling that feeling has been a priority.

Customer relations are likewise geared in large part toward education, and also emphasize technical assistance. This has required a significant investment in visits and personal contact with customers and prospects.

And finally, plant design has been a major focus of the marketing plan. The installations are not complex – a conveyORIZED unit consists of a tunnel with entry and exit areas, a spray or dip zone, and drip-off and blow-off area. Units look a lot like a conventional washer, and therein lies the problem. Builders of a couple of early units misconstrued the engineering guidelines and did not take account of the crucial differences from a water-based system – differences in air flow control and in spray pressure. In a conventional system, exhaust air flow is strong in order to minimize high-pressure spray mist in the plant, and because exhausting water vapor does not cost money. With Plaforization, the exhaust must be minimal, just enough to keep a little air flowing into the tunnel from the plant. The vapors from the tank

must not be exhausted but should be kept in the tunnel, where they will remain if not disturbed because they are much heavier than air. So the exhaust is merely to maintain a slight negative air pressure with minimum gas flow through the tunnel.

As to spray, in a flowcoat unit the pressure is very low compared to a conventional system, because water needs much greater impingement to perform its cleaning operation than does Plaforization. The organic phosphating liquid is applied at pressures in the range of only about 5 psi.

The distributor of the Plaforization chemicals has adopted a new approach to plant design, in order that the advantages of this different process can be fully realized. All installations are now designed by a technical group that has been trained specifically in this process. Construction may be performed by the designers or by another approved builder who adheres to the design.

LESSONS LEARNED

Organic phosphating has come a considerable distance in its introductory phase. There are now plants in operation in various locations, showing good

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results in pretreating a variety of metals. The initial hurdles for a new technology appear to have been overcome and there are now some 20 installations either in operation or under design or construction.

Initial Financial Analysis – the Bottom Line

The most important question, of course, is, "What's the bottom line?" As mentioned earlier, there is a point at which the incremental per-gallon cost of large volumes of the proprietary Plaforization chemistry outweighs the advantages gained in other areas. Determining the comparison is easy in lower volumes, but it is never just a straightforward comparison of two different costs of chemistry. This is a new process in which there are savings in multiple areas – processing time, labor, heating costs, waste treatment, and floor space used that all need to be quantified. Clearly, a shop with existing equipment would not realize the same advantages as a "green-field" shop newly designed and built to exploit the new technology and take advantage of the reduced floor space and heating needs. Of course, heating

costs, labor costs, and waste-treatment costs also vary with locality as well.

So, there is no simple formula, but every shop has to evaluate all the inputs. There is enough experience to date, however, to suggest that shops need to process somewhere well into the range of 30,000 to 60,000 square feet per day before they reach the cross-over point.

REFERENCES

- 1. Carpenter, S., *Metal Finishing*, 97(9):56-60; 1999
- 2. Carpenter, S. and M. Carpenter, *Metal Finishing*, 100(4):73-76; 2002 **MF**

ABOUT THE AUTHORS

Scott Carpenter, a graduate of MIT in chemical engineering, was Vice President of Cabot Corporation before taking early retirement and joining Mary Carpenter in founding Carpenter Chemicals, LC. Mary Carpenter, a graduate of Stanford University and Georgetown University Law School, is a lawyer and speaks six languages.

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