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Another Case for Coating

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Check out the impressive results reported from this efficiency improvement study of a horizontal split-case pump repaired and coated with Polyamide-11 based powder coatings.

Editor's note: *This case study is a follow-up project to the coating study reported in "A Case for Coating," Pumps & Systems, October 2005.*

TPumps are one of the single largest users of electricity in water supply systems. The overall drop in efficiency for an un-maintained pump can be around 10 to 15 percent. Most of the loss occurs in the first few years of life, and an un-maintained pump can fail catastrophically after about 20 years service.[1]

Monroe County Water Authority (MCWA) in New York State draws raw water from Lake Ontario and distributes potable water throughout the city of Rochester and the surrounding area – employing more than 90 horizontal split-case pumps. Daily demand averages 55-mgd to 60-mgd. The energy cost to operate these pumps is about $4 million dollars per year, a major operational cost of their water supply system. Horizontal split-case pumps begin to corrode over time, thereby reducing pumping efficiencies and increasing their energy costs.

This study was designed to determine the efficiency improvement of an in-field, cast iron horizontal split-case pump, referred to as the Denise No. 2 pump, by coating the pump housing and impeller with a polyamide 11-based powder coating. Figure 1 shows the Denise No. 2 being taken out of service.

Efficiency measurements were made before and after the process of the pump being repaired and coated with RILSAN® Fine Powder, the polyamide-11 based powder coating. In addition to the efficiency data, the coating process steps were documented.

This Denise No. 2 pump, a 100-hp horizontal split-case pump, was installed in 1987. The condition of the pump housing at the initiation of this study was poor – highly corroded with ¼-in pits. The condition of the impeller was not as severe but did show wear on the internal fins.

Independent laboratory measurements of cavitation erosion were performed using raw water from MCWA's inlet from Lake Ontario. Uncoated cast iron, metal samples coated with the polyamide-11 based

Figure 1. Denise No. 2 horizontal split-case pump being taken out of service for repair and coating.

powder coating, and metal samples coated with fusion-bonded epoxy were evaluated.

The repairs made to the Denise No. 2 pump, including coating the interior and impeller with the polyamide-11 based powder coating, restored pumping efficiency by 10 percent. The independent cavitation erosion study comparing uncoated cast iron, metal coated with the polyamide-11 based powder coating, and metal coated with fusion-bonded epoxy indicated that the polyamide-11 based powder coating was 10X better than cast iron for wear resistance, and 175X better than the epoxy coating.

These findings suggest that the polyamide-11 based powder coating may provide superior performance for newly manufactured split-case pumps to prevent corrosion – maintaining the original pumping efficiency over a long period of time and reducing energy costs over the life of the pump.

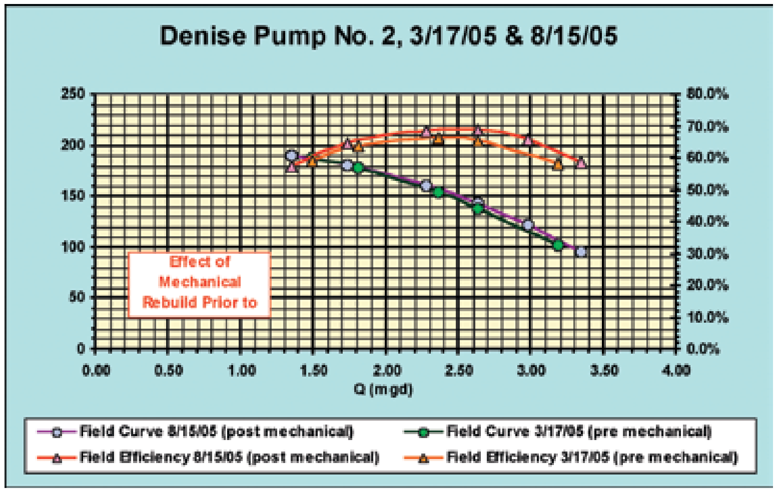

Figure 2. Efficiency measurement data of Denise No. 2 pump comparing pre and post mechanical repairs.

Initial In-Field Efficiency Data Prior to the Coating Process

The efficiency of the Denise No. 2 pump was measured at two stages prior to the coating process to evaluate the effect of mechanical repairs. Mechanical repairs included resurfacing the shaft and sleeves and replacing worn items, such as wear-rings and bearings.

The pre-mechanical efficiency measurement was made on March 17, 2005. Peak efficiency was measured at 66.3 percent. After the mechanical repairs, the pump was placed back into service and efficiency data was collected on August 15, 2005. Peak efficiency was measured at 69.9 percent. The mechanical repairs increased efficiency by 3.6 percent.

Repair and Powder Coating Process of the Pump Housing

After mechanical repair efficiency data was collected, the Denise No .2 pump was again removed from service to undergo the coating process. The initial state of the top and bottom sections of the split case pump housing was severely corroded, as shown in Figures 3 and 4.

Abrasive Blast Cleaning

Both sections of the pump housing were cleaned at Miller Sandblasting and Painting (Rochester, NY). The exterior and interior of the castings were manually abrasive grit blast cleaned to an SSPC-SP5 white metal finish with a 2 to 4-mil surface profile. Grit employed was Beauty 3535. Figures 5 and 6 show the results of the grit blast cleaning.

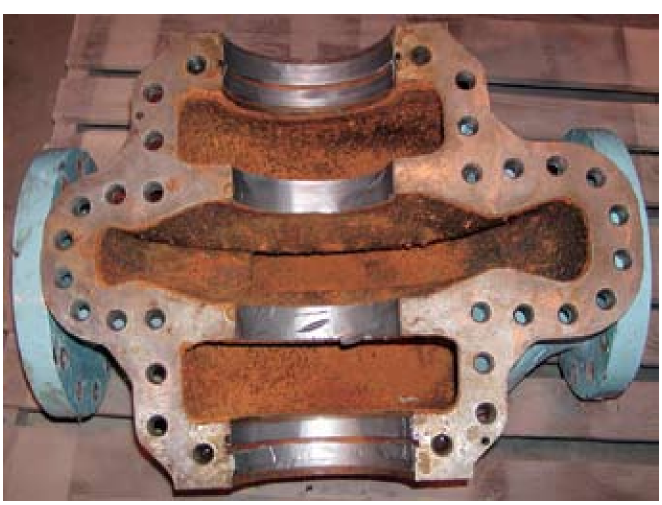

Figure 3. Denise No. 2 horizontal split-case pump – lower half of pump housing prior to refinishing.

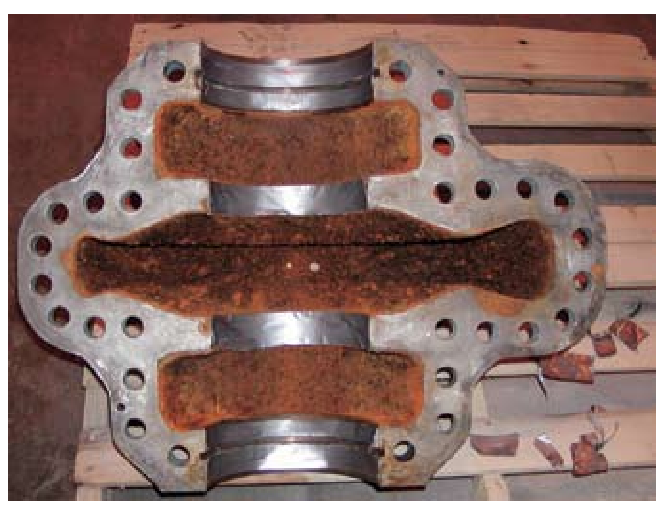

Figure 4. Denise No. 2 horizontal split-case pump – upper half of pump housing prior to refinishing.

Figure 5. Denise No. 2 horizontal split-case pump – lower half of pump housing after masking the seal areas and grit blast cleaning.

Figure 6. Denise No. 2 horizontal split-case pump – upper half of pump housing after masking the seal areas and grit blast cleaning.

Interior Surface Plasma Coating

Immediately after grit blast cleaning, preparation of the interior surface commenced at Swain Tech Coatings (Scottsville, NY).

The first stage was to mask the bearing and seal surfaces to protect them from being coated. After the masking process, Swain applied a stainless steel plasma coating onto the interior surfaces. The purpose of this coating was to fill in the large voids caused by the severe corrosion and to provide a good surface profile for the polyamide-11 powder coating to adhere to. Photos of the housing parts after the stainless steel coating are shown in Figures 7 and 8.

Priming and Powder Coating of the Pump Housing

After plasma application of stainless steel, the housing was coated by JRLON, Inc. (Palmyra, NY), with a RILSAN® Fine Powder primer and powder that complies with the American Water Works Association Standard C224-01: *Two-Layer Nylon-11 Based Polyamide Coating System for Interior and Exterior of Steel Water Pipe, Connections, Fittings, and Special Sections*, www.awwa.org and NSF/ANSI Standard 61: *Drinking Water System Components – Health Effects*, www.nsf.org.

JRLON first applied a thin layer of RILPRIM™ P23V40 primer at ambient conditions using manual spray equipment.

Figure 7. Denise No. 2 horizontal split-case pump – lower half of pump housing after stainless steel plasma coating.

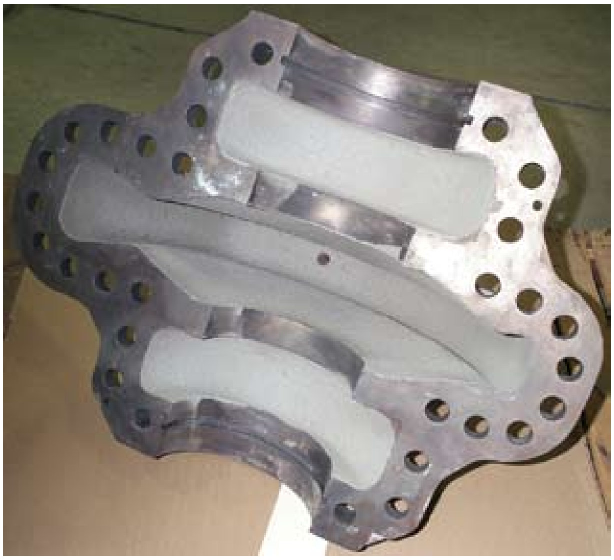

Figure 8. Denise No. 2 horizontal split-case pump – upper half of pump housing after stainless steel plasma coating.

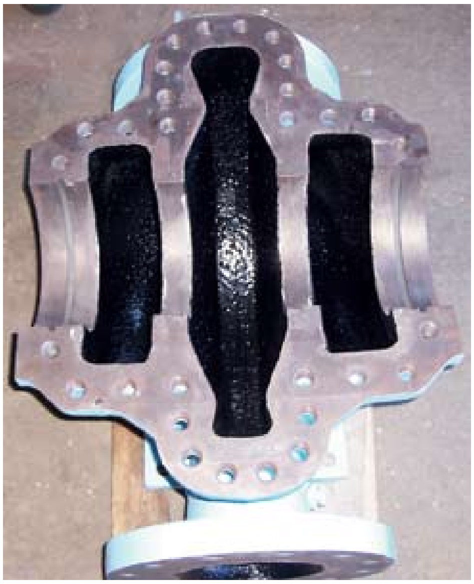

Figure 9. Denise No. 2 horizontal split-case pump – lower half of pump housing after the application of RILSAN® Fine Powder.

Figure 10 – Denise No. 2 horizontal split-case pump – upper half of pump housing after the application of RILSAN® Fine Powder.

A thin dry-film thickness of 0.2 to 0.5-mils (thousandths of an inch) was targeted. After the primer dried about ten minutes, the housing was placed into a convection oven maintained at 525-deg F for one hour. The time and temperature allowed the casting to reach a metal temperature well above the melting point of the RILSAN® Fine Powder grade 625 BLACK MAC ES (melting point of polyamide-11 is 367-deg F).

After the preheat stage, the housings were removed from the oven, one half at a time, and the RILSAN® Fine Powder was immediately manually sprayed onto the interior of the housing using electrostatic powder spray equipment. The application of spraying powder onto a hot metal part is called a *hot-spray*, or *hot-flock,* application.

Upon contact with the hot metal, the thermoplastic powder melted and flowed, forming a continuous coating film on the entire interior surface. A film thickness of 12-15 mils was targeted. After air-cooling, the molten polyamide coating solidified into a durable finish. Photos of the coated housings are shown in Figures 9 and 10.

Pump Impeller Coating

The ideal method for powder coating the pump impeller is the *fluidized bed method* so an even, uniform coating can be applied on all surfaces of the impeller. The preparation and coating of the impeller was completed by Arkema, Inc. (King of Prussia, PA). The condition of the impeller is illustrated in Figure 11.

The following steps were taken to clean, prime, and powder coat the impeller with RILPRIM™ P23V40 primer and RILSAN® Fine Powder grade 7174 Blue MAC FB, which, like the other grade mentioned above, also meets the requirements of AWWA Standard C224-01 and NSF/ANSI Standard 61:

- The surface was cleaned by abrasive blast cleaning using clean, 500-micron aluminum oxide to yield a surface profile of 2 to 4 mils.
- The areas not to be coated were masked with aluminum duct/ventilation tape. The photo in Figure 12 shows the condition of the impeller after abrasive blast cleaning and masking.
- A 50:50 mixture of RILPRIM™ P23V40 primer and methylethyl ketone was applied by squeeze bottle (note there were a large number of hidden areas and crevices – a diluted solution was used to prevent the primer layer from being too thick). A dry-film thickness of 0.2 to 0.5 mils was targeted. The primed part was air-dried for 15 minutes.
- The impeller was placed in a pre-heated oven maintained at 550-deg F for a time of 40 minutes. This brought the metal temperature to about 450-deg F.
- The hot impeller was transferred from the oven, and a 2.5-in threaded steel pipe with couplings was placed in the center hole and screwed tight against the part to enable lifting, immersion and rotation of the article in a fluid bed containing the RILSAN® Fine Powder grade 7174 Blue MAC FB. The part was rotated in the fluidized powder to allow the powder to uniformly coat the internal fins. The immersion time was approximately 8 seconds.
- The coated impeller was allowed to cool at room temperature.

Efficiency Data After Repairs and Coating Process

MCWA reassembled the Denise No 2 pump after the housing and impeller were repaired and coated with RILSAN® Fine Powder, and efficiency data was measured. The results of

Figure 11. Denise No. 2 impeller prior to the coating process.

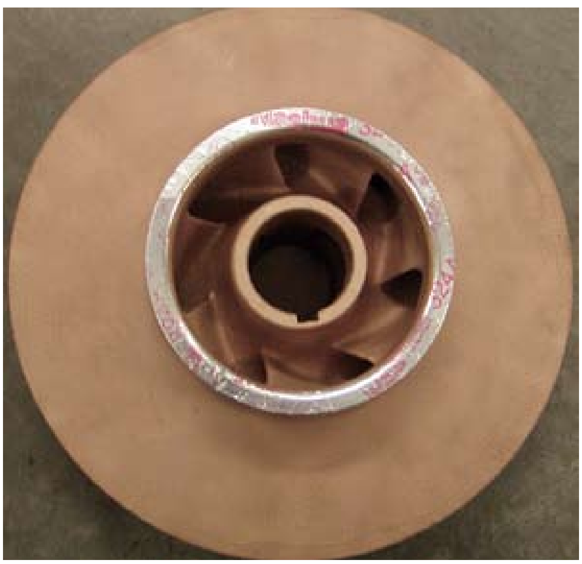

Figure 12 -Denise No. 2 impeller prior to the coating process.

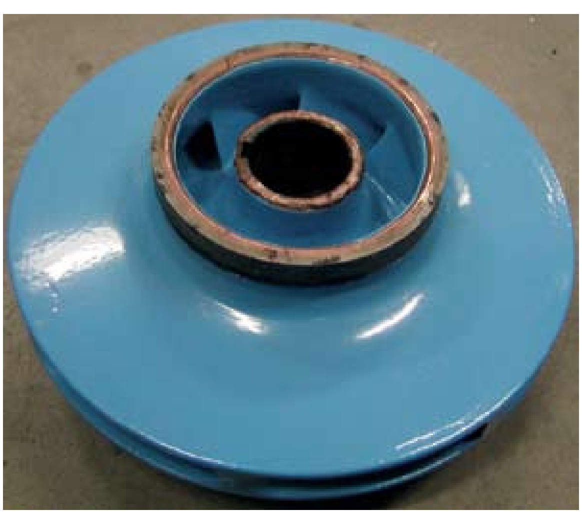

Figure 13. Denise No. 2 impeller coated with RILSAN® Fine Powder grade 7174 MAC FB.

the mechanical repairs and coating with RILSAN® Fine Powder yielded a total increase in efficiency of 10 percent as shown in Figure 14.

Cavitation Erosion Testing

A raw water sample was taken from MCWA's inlet from Lake Ontario. The turbidity and pH of the raw water was measured to be 8.0 and 8.8, respectively. This water was collected to measure cavitation erosion properties of uncoated cast iron, RILSAN® Fine Powder coated metal substrate, and fusion-bonded epoxy coated metal substrate according to ASTM G32, Cavitation Erosion Using Vibratory Apparatus.

The results of cavitation erosion are reported in Figure 15, which shows that the RILSAN® Fine Powder coating outperformed the fusion-bonded epoxy by 175X and the cast iron by 10X.

Cavitation erosion resistance of RILSAN® Fine Powder coatings in deionized/distilled water has been evaluated extensively.

Acknowledgements

Monroe County Water Authority is acknowledged for providing the Denise No. 2 pump for this project. Doug McEwen of Miller Sandblasting and Painting is acknowledged for providing information about the abrasive blast cleaning process. Dan Swain of Swain Tech Coatings is acknowledged for providing information pertaining to the stainless steel plasma coating. John Knorr of JRLON Inc. is acknowledged for assisting with the application of RILSAN® Fine Powder.

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[1] European Commission, February 2001, Study of Improving the Energy Efficiency of Pumps, page 44; Contractor: ETSU, AEAT, PLC, (United Kingdom); Participants: CETIM (France), David T. Reeves (United Kingdom), NESA (Denmark), Technical University Darmstadt (Germany).

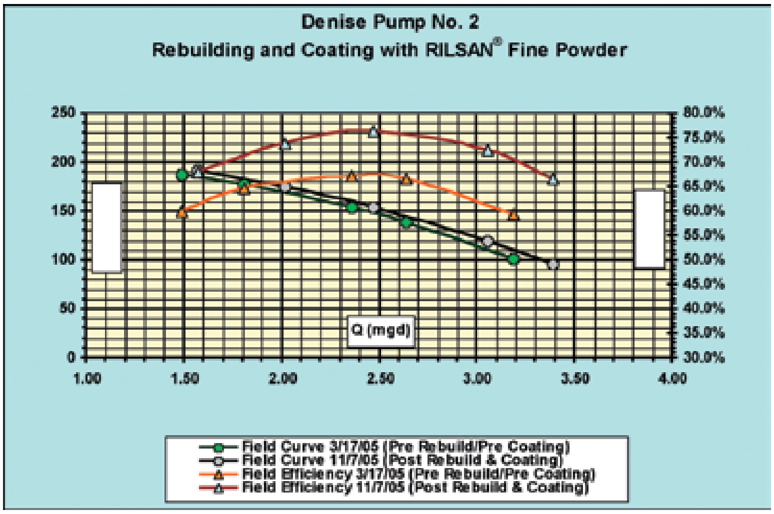

Figure 14. Efficiency measurement data of Denise No. 2 pump prior to mechanical repairs and after repairs.

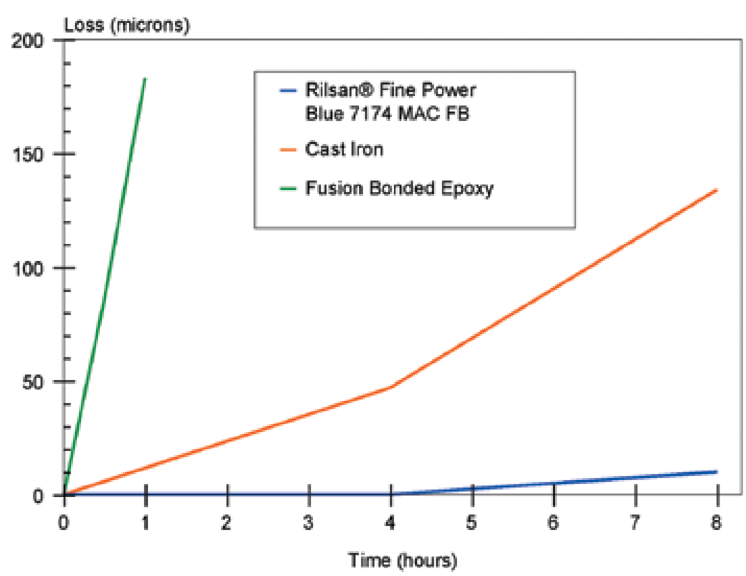

Figure 15. Cavitation Erosion Test Results of Rilsan® Fine Power, cast iron, and Fusion Bonded Epoxy.

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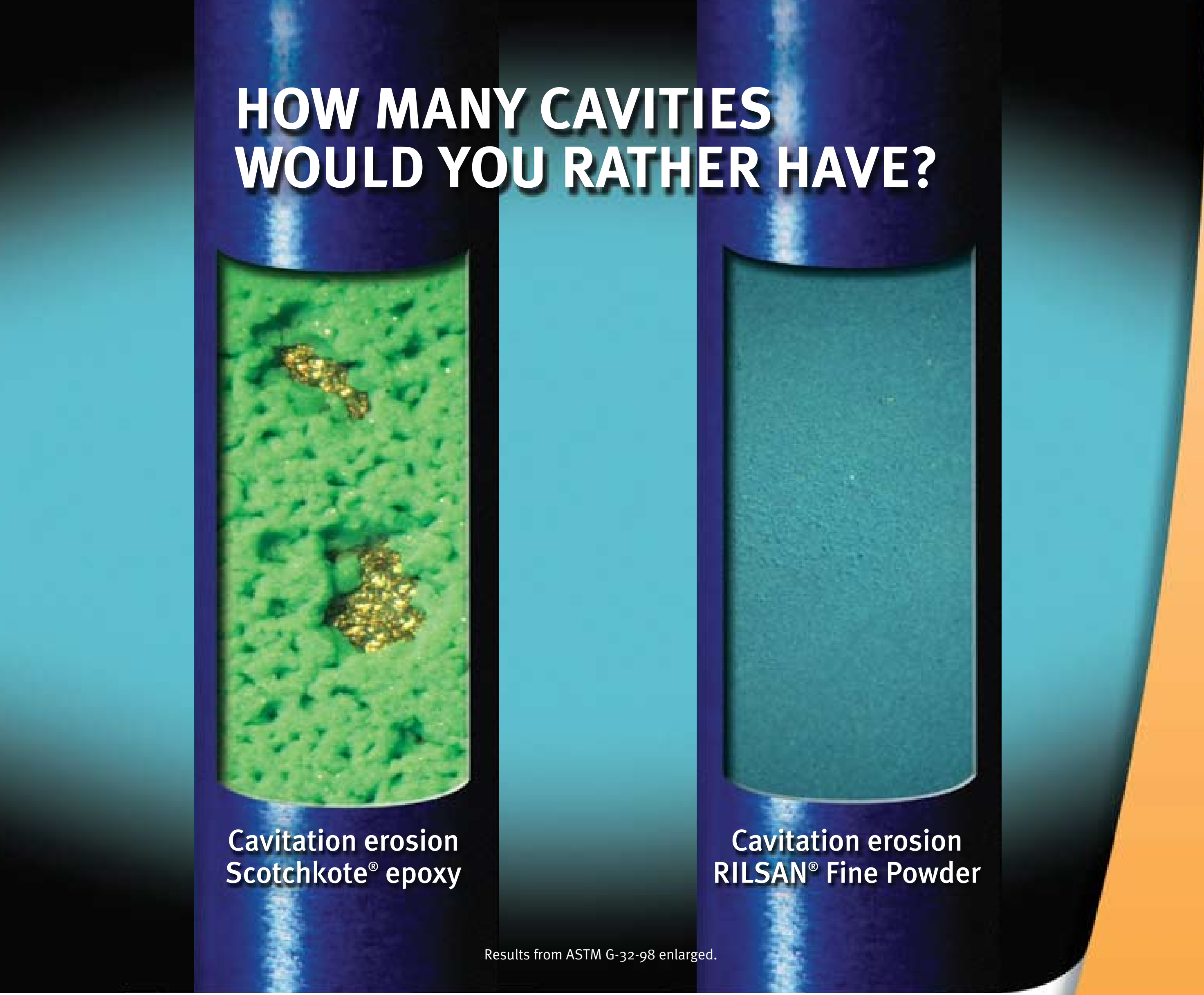
HOW MANY CAVITIES
WOULD YOU RATHER HAVE?
Cavitation erosion
Scotchkote® epoxy
Cavitation erosion
RILSAN® Fine Powder
Results from ASTM G-32-98 enlarged.