

## Job Story on Vibratory Stress Relief Prepared by Bruce B. Klauba Product Group Manager

VOITH SULZER is a leading manufacturer of large equipment used in the Power Generation and Paper Mill Industries. The Appleton Plant is their US manufacturing facility for paper mill equipment.

Since 1984, the Appleton plant has relied on a VSR 790 System to perform their stress relief of medium (1/2 Ton) to large (50 Ton), dimensionally critical components. The tenth anniversary of the 790's operation seemed a fitting time to summarize the impact The System has had upon their operation.

The majority of the weldments produced by VOITH are 316 SS, since they are destined to be components of a Paper Mill, and require the physical properties of this alloy to survive that harsh environment. This material is expensive, and not easy to machine (compared to HR steel), and shrinks considerably more than carbon steel during welding. Further, it responds marginally to thermal stress relief (see S.W. HOOPER Job Story; thermal treatment had no effect on production accuracies of paper pulp pump rotors, while Vibratory Stress Relief tightened production dimensional accuracies 3 - 8 times), and, therefore, VOITH Management looked to VSR Technology to solve their problem.

In addition to the marginal effect of the thermal method, the cost of using a furnace for a regular stream of heavy (average, 8,000 lbs.) workpieces was enormous. At a rate of \$ 0.05 / lb. and a production rate of 2-workpieces per. day, thermal treatment could cost about \$ 200,000 a year! (8,000 lbs. X 2 pcs./day X 5 days/wk X 50 wks/yr X \$ 0.05 /lb. = **\$ 200,000.**)

Compare this with VOITH's ten years of experience with the VSR System. The cost of their VSR 790 System, plus two additional vibrators (one, a spare, the other the smaller, lower force output Vibrator for low rigidity parts) plus maintenance, totals about \$ 40,000. The labor used to operate a VSR System for one hour is nominal. It's less than the labor needed to: (1) generate shipping and receiving documents; (2) send workpieces to shipping; (3) track them while out of plant; (4) the returned workpieces; (5) bring them to the proper department for machining.

So if we compare the \$ 40K expenditure for the VSR System to the cost of thermal treatment. The VSR 790 System pays for itself once every 73 calendar days, or 50 times in the course of ten years. And the VSR 790 at VOITH is far from finished, even though, according to this rough ROI Analysis. It's responsible for saving the plant more than **\$ 1,000,000** during its first 10-years of operation.

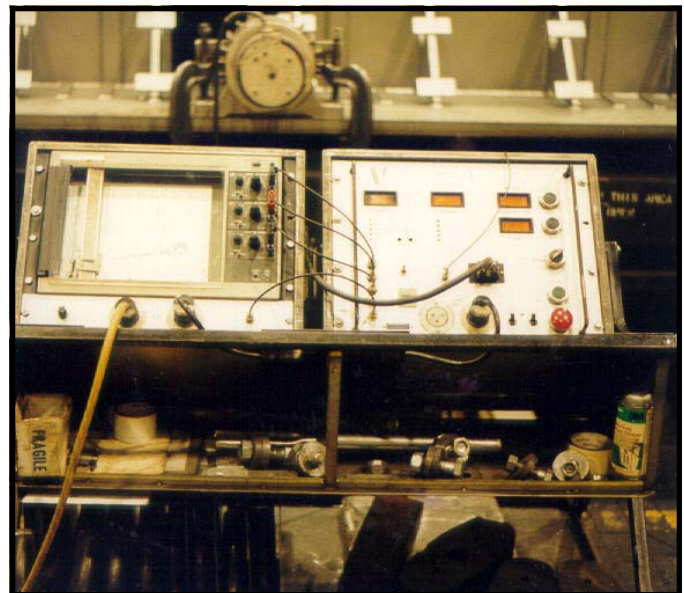
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**A stainless steel workpiece setup for VSR Treatment. The Vibrator (circled) is mounted at the center of the flange behind the Console/Plotter control package.**



**The VSR 790 Control package: Console on the right, the two pen Plotter on the left. The Console contains a super accurate Servo-Motor speed drive:  $\pm 0.04\%$  Vibrator speed regulation, tunable in 1-RPM Increments.**



**These 300" L beams must maintain accuracy to within 0.010", full-length. To do so, on a production basis, requires that they be stress relieved using the VSR 790 System.**



**Here are three (3) other workpieces VOITH SULZER stress relieves with their VSR 790 System.**



Now let's look at performance. VOITH SULZER track record of maintaining excellent dimensional accuracy's using the VSR System is impressive. Little, if any rework is needed, which was not the case when they were relying on thermal heat treatment. This is due, not only to VSR's greater effectiveness on stainless, but also other advantages of the VSR Technology. For example, if a great deal of stock is removed from the workpiece, VSR treatment can be performed both before, and after rough machining. This reduces machining stresses and final machining can be performed on a "well-behaved", predictable workpiece, i.e., one that will not move around during machining, or distort upon being released. Using the VSR System started out being a means of reducing costs, but as with many firms using this technology, it's evolved into a means of improving quality.

The VSR 790 System is the state-of-the-art vibratory stress relief system. It automatically scans thru the Vibrator's speed range, and records both the workpiece acceleration (response to vibration), and the Vibrator's true-RMS power input, vs. Vibrator speed. The vibrator speed data is generated by a four digit PLL servo-motor speed drive, referenced to a 2.000000 MHz broadcast grade quartz crystal. The data displayed on *the* Console's RPM readout is the Vibrator's actual speed, not some form of command signal. Yet, even when being tuned upon a resonance of the workpiece, the vibrator speed regulation is very tight: +/- 1 RPM is typical.

This power data is useful in two purposes: first, *the* operator can use this data to evaluate the vibrator's placement and unbalance setting; second, *the* data is useful in determining if the vibrator needs service, *eg*, a bearing grease recharge, or motor brush replacement. Combined with the Console's automatic motor protection circuitry, the system reliability is unparalleled.

The VSR 790 Console's circuitry consists, primarily of four pull-out modular PC boards. This makes both service and updating a snap; three times VOITH's circuitry has been updated, once with a more effective accelerometer signal filter, and recently with a fine-tuning of the tachometer feedback time constant. The Console, however, has never needed repair, nor has the Plotter.

Years of experience with the System has proven to be a worthwhile investment for VOITH SULZER. The VSR System is effective, generates cost and time savings, and improves quality. At VOITH SULZER, VSR Technology's Vibratory Stress Relief is THE standard in stress relieving.

Bruce Klauba has a degree in Physics and a Level II Vibration Analysis Certification from the American Society of Non-Destructive Testing (ASNT). As a pioneer in the cause and effect of Vibratory Stress Relief, Mr. Klauba was named chief inventor (*Klauba et al.*) in U.S. Patent 4,381,673, which is both an equipment and process patent describing advances in the technology. He has authored numerous articles and original research papers on the subject, which have been published in leading magazines and periodicals. Published papers include:

1. "Use and Understanding of Vibratory Stress Relief ", 1983, *Productive Applications of Mechanical Vibration*, ASME.
2. "Vibratory Stress Relief: Methods used to Monitor and Document Effective Treatment, A Survey of Users, and Directions for Further Research", 2005, *Trends in Welding Research*, ASM International.

A co-author in both papers, Dr. C. Mel Adams, is a leading authority in metallurgy and co-founder of MIT's Welding Research Department. Mr. Klauba, in addition, has extensive experience in designing, building, and troubleshooting Industrial and Commercial Electrical Controls with a focus on extending the performance and reliability of electric motors and the systems they power.



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