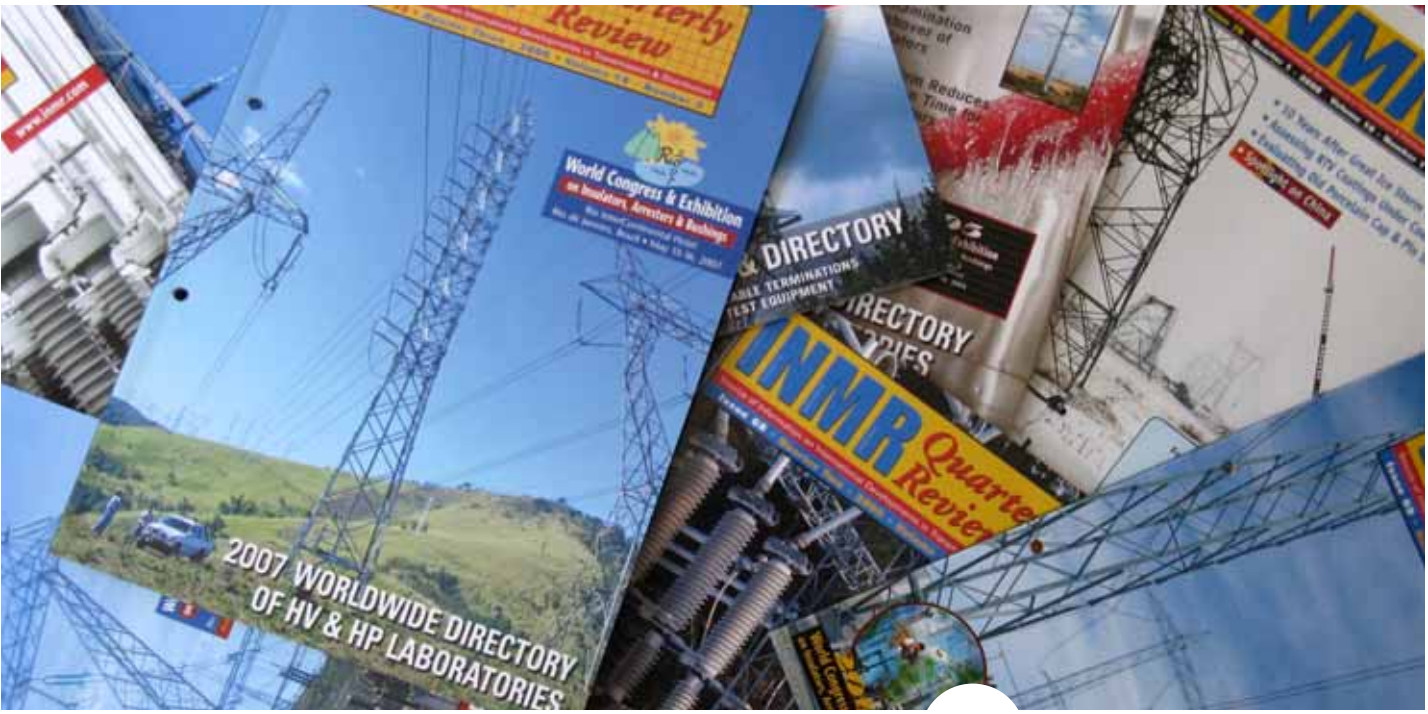

vogel making the difference

Reprint of:

Equipment Manufacturer Aims to Boost Productivity Of Insulator Molding Cycle

INMR Magazine, Quarter 2/2008

Save 30 %. With AVT!

Our customers' time is precious. Being aware of this, Vogel engineers have developed a technology to shorten the silicone processing cycle.
The benefit: improved productivity.

The **"Advanced Vulcanization Technology"** (AVT) uses a patented method: Increase of inlet temperature of the processed LSR silicone, resulting in a cycle time reduced by up to 30%.

This invention is a great result of our strategy:
creating innovative and beneficial solutions for our customers.

SILICONE PROCESSING

Equipment Manufacturer Aims to Boost Productivity of Insulator Molding Cycle

During the past 15 years, the number of manufacturers of composite long rod insulators for overhead line applications has literally exploded. By some estimates, there are already some two hundred such firms scattered throughout the world – mainly in China. Yet, surprisingly, during this same time interval, the number of suppliers of hollow core composite insulators has remained more or less the same – little more than a handful.

It is hard to know for certain whether this unusual situation developed because the demand for hollow core composite insulators was relatively small. Or, alternatively, whether this comparatively low demand was due to the fact that only a small number of suppliers were actively promoting this technology.

Whatever the case, there are efforts now to make the manufacturing process for hollow core (as well as other types of polymeric components) far more productive – something which is expected to expand the number of suppliers and potentially also significantly increase their market penetration.

INMR visits a Swiss-based supplier of production equipment for insulators and looks at a new technology intended to increase productivity by shortening the molding cycle.

Pistons provide necessary clamping force to mold during injection and vulcanization of silicone.

Photo: INMR©

"Today," says Gerhard Mais, "customers in the electrical equipment industry are looking for more standardization. Therefore, it seems only natural that suppliers of manufacturing equipment, such as ourselves, should increase their focus on the issue of productivity." Mais is General Manager of Swiss-based Vogel, a subsidiary of the Hedrich Group with some 250 employees and other manufacturing operations in Germany and China. Vogel specializes in clamping machines as well as dosing equipment and molds for producing silicone insulators, particularly the hollow core type.

Hedrich, a supplier of customized production lines for casting epoxy as well as vacuum impregnation and drying of transformers, acquired Vogel in 1995 and has watched this business expand rapidly since that time. Managing Director Ralf Hedrich explains, "the high voltage sector is now growing very fast for us and at a much higher rate than we ever expected. And we still see even more opportunities for further expansion, especially in places such as China and India."

Photo: INMR©

Mais reviews the alternative production methods available for manufacturing hollow core composite insulators. These range from the most common, i.e. molding the entire unit in a single injection shot, to various other methods of casting, extruding or gluing the unit shed-by-shed over the hollow FRP tube. He concludes that the single injection process is by far the most economical and also the most productive from an equipment utilization point of view.

"Because customers in the electrical equipment industry today are looking for more standardization, it seems only natural that suppliers of manufacturing equipment should increase their focus on the issue of productivity."

Rainer Röder, a former executive with one of the world's leading suppliers of hollow core composite insulators and now a consultant to Vogel, agrees. Says Röder, "today, some ninety percent of all hollow core insulators are required by customers in only a narrow range of different diameters, creepage distances and shed geometries – typically a single shed versus an alternating shed design. All this contributes to growing emphasis on standardization and more efforts to enhance productivity in manufacturing."

Another variable of the different manufacturing processes for hollow core composite insulators is attachment of the end flanges. Mais and Röder note that flange specifications are today the most variable element of the product requirement specified by an individual customer. In one production technology, the silicone housing is molded over the tube prior to attachment of flanges. In the second technology, the flanges are glued to the tube before the molding step.

Left: Mold section ready for use (right) in insulator production.
Bottom: Modern machining center for mold production.

Injection molding machine for hollow core insulator in process of being assembled.

According to Röder, the second production method is preferable from an electrical performance point of view. "I am sure that this is how most hollow core insulators will be manufactured in the future," he predicts.

Mais explains that one of the factors behind Vogel's success has been that they were among the first to offer production equipment in this category, going back to 1985. Over those years, he notes that the size requirements of hollow core composite insulators have continued to grow. He also remarks that this fact has driven efforts to develop ever larger molds allowing an insulator to be produced in as few molding injection shots as possible. "The less shots, the better," he emphasizes, "because there are less potential problems of adherence and also fewer interfaces to deal with. Basically, the most economical and effective way to produce such insulators, except for units having extremely long lengths, is in only one shot."

Mais notes that clamping force is typically one of the determinants of the capabilities and cost of molding equipment. "We designed our equipment with 160 tonnes of force," he says, "which is a sufficiently high value when looking at the requirements for molding hollow core insulators. Lower clamping force equipment is a less expensive solution, but not one that we feel is optimal over the long run."

Mais points out that the typical size of one of Vogel's molding machines is 2.65 meters which allows a 230 kV insulator to be molded in a single injection shot and a 500 kV unit in only two shots. But, he says, to enhance productivity, a 3.5 meters machine is now going to be offered which can hold two molds side-by-side. Mais also states that Vogel molds offer the potential for different block lengths so as to better adjust to the dimensional requirements of the insulator within a single molding machine.

But the innovation that Vogel is now actively promoting to the insulator industry worldwide relates not to molds or to the molding machine but rather to the silicone material and how it is treated as part of the injection cycle. Referred to as advanced vulcanization technology (AVT), this patented process is based on technology originally developed by Hedrich and used for casting epoxy.

Mais explains that this technology is based on pre-heating the silicone material using hot water to increase its reactivity and thereby lower molding cycle times. The end result is that, with exactly the same equipment resources, the manufacturer can produce more insulators each day.

"The silicone used in manufacturing composite insulators is normally processed at room temperature," says Mais. "The heat required for vulcanization is then added in the mold, usually by electrical heating to about 80°C. But," he adds, "if a way can be found to pre-heat the silicone before filling the mold, cycle time will be reduced and cooling down after molding can take place during the normal waiting period."

Photo: INMR©

Dosing and metering system for two component LSR

Mais and Röder emphasize that the pre-heating of the rubber is done preferably using hot water versus electrical heating which is far less efficient when it comes to rapid cooling. This is especially important when looking at insulators having larger tube diameters. "With our new technology," says Mais, "each section of the mold is water-heated and then water-cooled. The maximum temperature normally encountered during molding is then about 110°C since beyond this there is a risk of exceeding the usual tg or glass transition temperature of a standard tube."

One of the keys to AVT technology is the physical properties of the housing material used which, in this case, is a very low viscosity liquid silicone rubber (LSR) formulation. Hans-Jörg Winter, a technical specialist with Wacker Chemie in Germany, explains that silicone is a material which has low thermal conductivity. This means that heat transfer through the silicone material is slower and becomes a limiting factor in determining the time normally required for molding. By starting off with an LSR pre-heated to 80°C (versus the more normal room temperature i.e. 20°C), he says that vulcanization can proceed more rapidly. Also because the expansion from the incremental heating in the mold is less, lower clamping force is necessary to resist the pressures typically built up during this process.

Winter goes on to explain that LSR is ideal for this application because of its low viscosity and because of its reactivity, meaning that it does not cure excessively fast – something that would not be desirable. He also notes that the specific LSR formulation being used in AVT technology is an especially low viscosity material, close in some respects to RTV2 and specially-adapted for this process. This low viscosity also ensures consistent void free filling of the mold.

Says Winter, "it is not easy to produce such a low viscosity LSR while still keeping good mechanical properties as required from the insulator performance point of view. But there are techniques and expertise originally used for RTV2 which we have found can then also be applied to LSR."

According to Röder, the majority of hollow core composite insulators being manufactured today are made with LSR versus high consistency rubber (HCR). He claims that LSR is ideal for this type of an insulator since high-pressure during molding, as would be required with an HCR silicone, risks causing distortion to the critical flange-tube interface, assuming the flange has been attached before the molding cycle. Another advantage of LSR, claims Röder, is a lower risk of trapped air as might be found in a thick, pressed HCR material. He and Winter state that, beginning from the original formulation of RTV2, LSR has now accumulated the most service experience for hollow core insulators and for this reason is preferred by European-based users. Röder observes that each insulator manufacturer basically has to decide what is the ideal material for the application. And, he adds, this is often a question of superior processability during manufacturing. He also goes on to note that when comparing LSR to HCR, what matters most from an economic point of view is price to

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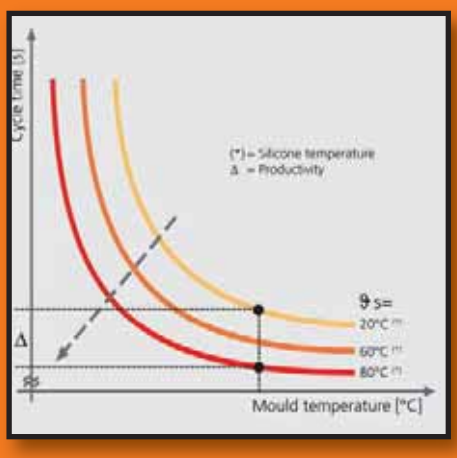
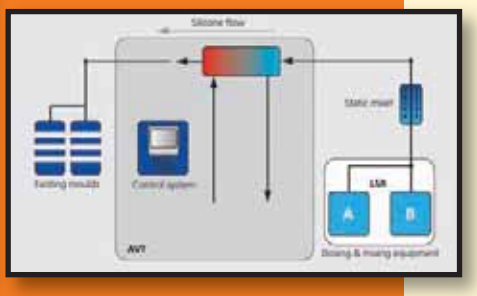


Higher temperature of silicone results in reduced curing time and increased productivity of injection molding equipment.



volume and not the price to weight ratio. Mais agrees. "For us as a machine builder," he remarks, "low viscosity is preferred since it makes for an easier and superior overall molding process."

AVT technology is now being offered either as a stand alone technology incorporated into any new dosing and molding equipment from Vogel or as a retrofit to existing such equipment, even if from a different supplier. Mais estimates that the incremental investment cost of this technology is about 20-25 percent of usual production line costs. Yet he points out that for those manufacturers faced with the need to increase output by 30 percent due to growing market demand, AVT gives them a solution where this can be accomplished without the need to buy another molding machine.

From the quality perspective, Mais and Röder indicate that there is absolutely no difference in final product performance. Says Mais, "AVT is only an issue of productivity."

So far, Vogel has identified that the types of components which can benefit most from this productivity-enhancing technology include hollow core composite insulators and silicone-based cable accessories such as joints and stress cones. The reason for this is that the volumes of silicone material being molded for these tend to be far greater than for other types of insulators. Says Mais, "the larger and thicker the component to be molded, the greater the relative benefit of AVT."

For example, a 145 kV hollow core composite insulator can require about 8 liters of silicone material to be molded compared to only about 0.5 l needed for manufacturing a typical composite long rod. Applying AVT therefore translates into much greater productivity gains, i.e. 30-40 percent for the hollow core versus about 20 percent for the long rod.

Looking to the future, Mais expects that the market for silicone insulators will continue to grow in many substation applications. He mentions live tank breakers as one piece of equipment where thicker tubes are required and where there has already been considerable positive experience with composite insulators in place of traditional porcelain. With this anticipated growth will come more needs for molding equipment to produce such insulators. Indeed, this expectation has already driven the decision to build an entirely new Swiss plant to replace the existing Vogel facility, which is now operating at capacity.

Says Mais, "we are quite confident that AVT will prove successful in the marketplace since it provides something every insulator manufacturer wants to realize these days – enhanced factory productivity. In this respect it's a highly desirable add-on from the customer's point of view." Röder underlines this sentiment by stating that he is now in discussion with a growing number of new manufacturers, even in such distant places as India, who intend to offer hollow core composite insulators incorporating AVT production technology. ☒

New AVT equipment

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