

# Arrester Manufacturer Expands Range to Include Polymeric Cage Designs

Over the past several years, there has been a rapid growth in the market acceptance of polymeric-housed surge arresters for HV applications. This trend has been influenced to some extent by the successful experience with polymers applied on MV lines and also by the growing emphasis within IEC on how arresters are expected to behave under short-circuit overload conditions.

Alternative designs of polymeric station-class arresters have evolved over time and typically fall into one of three broad categories – tube designs, wrap designs and cage designs – all of which have different economic and performance attributes (extensively described in INMR Issue 76, Quarter 2, 2007)

Recently, a German supplier, Tridelta Überspannungsableiter, has developed its own cage type polymeric arresters as an addition to the tube and wrap types it already offers. INMR visits Tridelta to report on the design and production of this new product.



Cage design demonstrates safe failure mode after 63 kA short circuit for 0.2 seconds.

New cage design arresters after production.

According to Sales Director, Karsten Laue, the basic rationale behind Tridelta's program to develop its own cage-type arrester was to complete the full range. He explains that the tube design incorporates an FRP tube with silicone sheds molded onto it and is the strongest from the cantilever point of view, finding use in applications as high as 400 to 800 kV.

"So there has been a gap in what we offered," he says "especially as concerns the important 230 kV voltage level where tube types are seen as being too costly and where the wrap design may not be sufficiently strong. Now, by having all three polymeric arrester designs, we know that we can compete no matter what the voltage range or client specification."

Tridelta has long been a supplier of porcelain-housed HV arresters but about a decade ago first began development of its own wrap design using slip on polymeric housings. Over this time frame, Laue has observed the evolution of this business and reports that there has been a growing market acceptance and even preference for polymeric-housed HV arresters. In fact, he estimates that, unlike the situation only a few years ago when porcelain was dominant, the market is now divided about equally between porcelain and polymer types.

"Unlike the situation only a few years ago, the market for HV arresters is now divided equally between porcelain and polymer types."

Walter Kleinsteuber, who was recently appointed Head of Purchasing & Production, says that the quantities of polymeric type arresters produced at the Tridelta plant in the east German town of Hermsdorf are 30 percent

higher than only two years ago. "The number of porcelain units is also growing," he reports, "but more slowly than for polymers." Kleinsteuber goes on to say that apart from handling this growth, one of the main challenges for him in his new position has been to effectively integrate all three polymeric designs into the overall production scheme. "There are different raw materials, different machines and different testing requirements."

R&D Head, Hartmut Klaube was closely involved in the development of Tridelta's new cage design over a two and a half year period and explains that it is different from the other two cage technologies currently being offered by competitors. While also involving fiberglass rods tensioned over the inner metal oxide module, Tridelta's patented system employs forged aluminum wedges inserted into notches in these rods. Once tensioned

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Laue (right) discusses new cage type arrester with Kleinsteuber.

at both ends, he says this design can offer sufficient cantilever strength up to 363 kV for pedestal mounting and up to 400-500 kV for suspension mounting.

Walking into the new area for the cage design arresters, located directly below the existing production area, Klaube reviews the key steps involved in their manufacture.



Porcelain housings are declining in terms of relative share of all HV arresters produced at Tridelta.

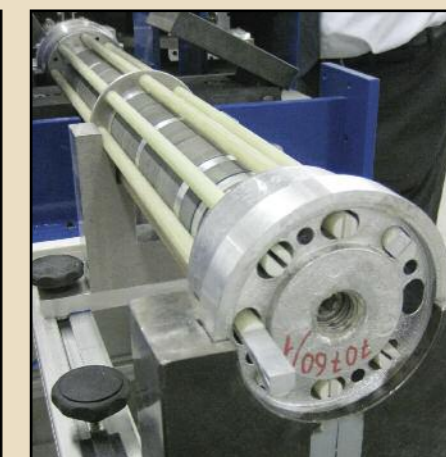


Photo: INMR ©



Wedges are driven into notches in fiberglass rods to complete cage around varistor blocks.



Machine attaches end fittings and transfers tensile load to rods to yield mechanical strength of caged module.



Drying of cleaned caged module prior to priming

Production begins with assembly of the active inner part comprising metal oxide blocks of varying diameters and thickness stacked into modules. Special ECR type fiberglass rods are cut to the right lengths and have special notches added at both ends. The rods are then placed around the stack and forged aluminum wedges are pneumatically driven in pairs into the notches. The machine that performs this task was apparently custom-designed for this purpose and Klaube says that the entire process has been patented.

Once the wedges are in place at both ends, the module comprising the stacked blocks and fiberglass rods is placed vertically into a machine that attaches the end fittings and applies a strong tensile load. A screw is inserted and, by turning, imparts this tensile

strength to the module, thereby ensuring its future mechanical performance.

After tensioning of the rods, the next step in production sees the completed arrester module washed ultrasonically in warm water. The electrically conductive water contains a cleaning liquid to remove any loose particles or dirt. This process is followed by further cleaning, this time with distilled water and the module is then air-dried and inserted into an oven for several hours to dry completely.

After removal from the oven, a special primer is automatically sprayed thinly and uniformly over the module's surface. The chemicals in this primer, says Klaube, are intended to ensure perfect bonding between the silicone rubber and the blocks as well as fiberglass

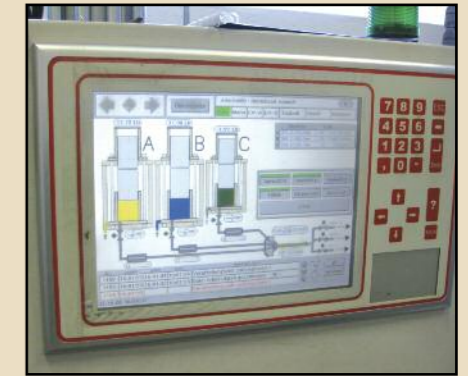
rods. After priming, the module goes on to what Klaube calls the "heart of production", namely molding on of the external silicone housing.

Kleinsteuber and Klaube explain that they have selected a standard grade of liquid silicone rubber that has been formulated by their outside supplier to ensure superior tracking and erosion resistance. In fact, Laue claims that the erosion resistance of this LSR formulation is the highest available in the marketplace and that Tridelta arresters have already passed more than 10,000 hours of accelerated ageing – double that required in the standards.

The LSR is a two-component system and pressed out of barrels by hydraulic cylinders to be delivered to a static mixer. After that, the material is pumped to yet another mixer before



Photo: INMR ©



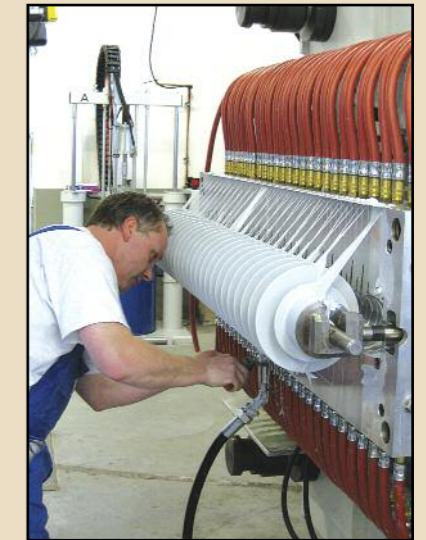
Liquid silicone rubber in two-component system is dosed to static mixer before being pumped into mold cavity.



Primed module inserted into mold.



Molding cycle is the critical parameter determining productivity of equipment.



being ready for delivery to the molding machine. The critical time component in production is the molding cycle since it determines the productivity of a machine that represents the biggest investment and also the typical bottleneck of any such process. This is why virtually every manufacturer who uses molding in production does whatever they can to optimize this one single step.

According to Kleinsteuber, the molding machine has been specially built to allow the greatest amount of hot water possible to pass around the mold to heat it quickly and evenly with a view to accelerating vulcanization of the silicone. "The more hot water you can bring to the mold" he explains, "the shorter will be the cure time."

Another key element of this critical molding step is ensuring that pressure

is applied evenly across the plates so as to avoid any risk of distorting and damaging the very costly mold. This is achieved by computer-controlled pistons which apply a uniform force of up to 100 kN.

Afterwards, cool water is used to bring the cured unit to a temperature where it can be removed safely for further processing, which involves removing any excess silicone flashing and then final curing in the same oven used earlier to dry the modules. The mold cavities are then cleaned by high-pressure air and ready for the start of another curing cycle.

Arrester units typically vary from 0.5 up to a maximum of 1.5 meters in length – a size that would typically mean a single arrester unit can be used for 170 kV applications.

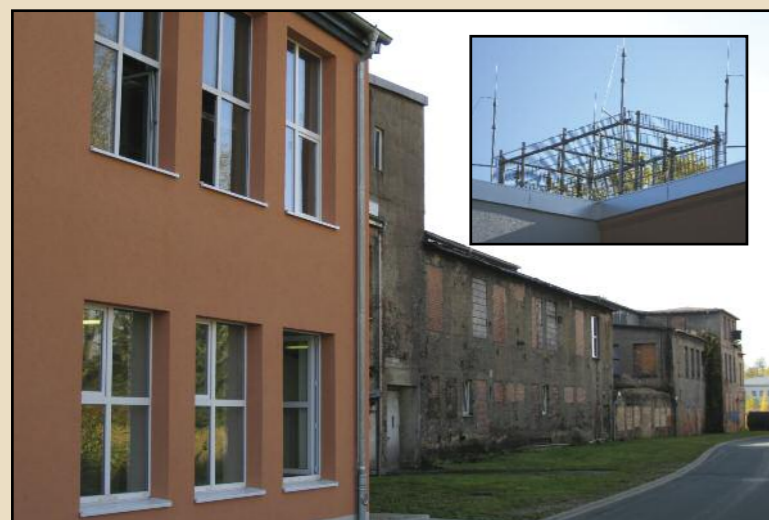
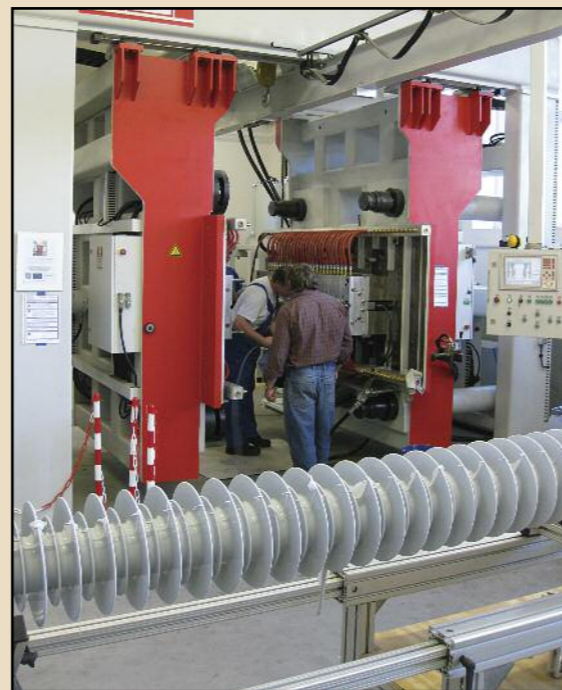
Kleinsteuber points out the irony that all production of the new cage technology is being done in an area where manufacture of old silicon carbide arresters used to take place. Yet he notes that while the area of the plant may be the same, today it bears little resemblance to what existed here in the past. In fact, modernizing the old buildings has been a high priority in recent years.

Another area where there has been investment is testing. Kleinsteuber points out that the upgraded in-process test area now relies on all new instrumentation. "All this integrates with our database," he says, "so that testing is performed automatically and the results stored and linked with each arrester code and order."

Another benefit, he adds, is that all partial discharge and reference voltage



Cleaning mold cavities prior to start of next curing cycle.



Arrester test field (inset) is located atop totally renovated production plant in Hermsdorf.



In process test field equipped with all new instrumentation automatically links test results with all production data.

tests can now be performed in one place without the need to move units to another part of the factory. This reduces time and cost. Kleinstauber also notes that even power loss measurements can now be done in a single step which is more accurate than in the past since it is based on digital instead of analog inputs.

Another part of the testing regimen at Tridelta is conducted in a separate R&D area where a mechanical testing machine simulates alternating loads by performing bending tests in one direction and then the next. Klaube remarks that according to new

recommendations by the IEC, seismic tests with constant acceleration and vibration tests with natural frequency for a million cycles will soon be conducted at a special facility located in Dresden – something that will provide a better understanding of the mechanical withstand of each arrester design.

Apart from this, an additional testing program is now underway designed to measure the distribution of the tensile force among the eight fiberglass rods in the new cage design arrester. Strain gauges have been placed on each rod and a student from the nearby

University in Jena is doing the work necessary to develop this data. Says Klaube, “we want to verify the quality of the design and production method for connecting the rods by means of the wedges. This will give us even more experience with this new type of construction.”

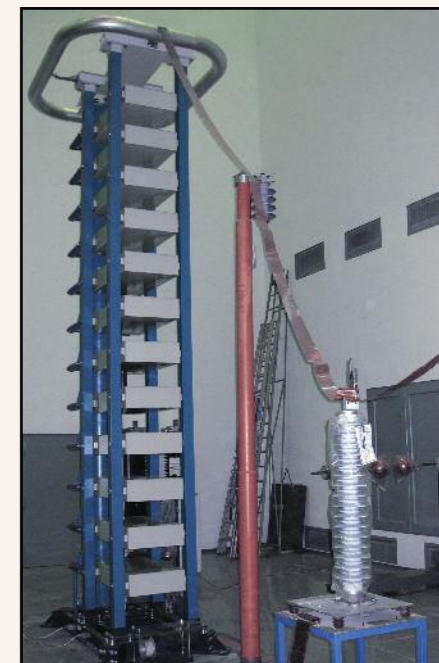
The high voltage test hall at Tridelta has also benefited from recent investments that include a new 1.2 MV impulse current generator to replace the former one that was decades old. “With this new equipment,” says Klaube, “we will be able to test single or multi-unit

arresters with different current wave shapes, including 8/20 $\mu$ s or 30/60  $\mu$ s, as required by the standards.”

Also, a special new test field has been established for quality control purposes and which examines metal oxide blocks according to the duty cycling test as well as other required tests on varistors. All this new equipment is computer-controlled and allows for better graphical representation of results. Klaube also states that samples from incoming shipments of blocks are tested up to temperatures as high as 220° C, even higher than their normal thermal capacity, in order to provide data on behavior during thermal runaway. Says Laue, “all this means that we want to improve the efficiency of our testing

and to be able to inspect more blocks with even more accurate results.” He also points out that there are plans to install new equipment to test all LSR raw materials as well.

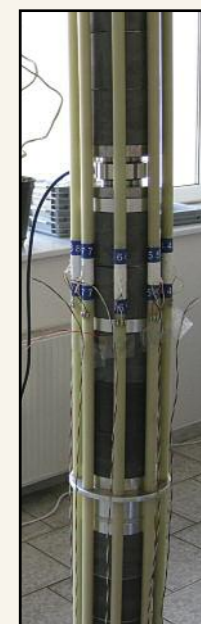
Tridelta Managing Director, Heinrich Matthias, estimates that spending so far on new machinery, test equipment and plant renovations has totaled close to Euros 4 million. Still, he finds that this is justifiable given the growth in demand for arresters coming from all over the world. Says Matthias, “we have invested because it’s sensible to do so. We have a lot of experience in arresters and we want to continue to grow, both by natural expansion and also by developing additional products such as this new cage design.” ☒



New impulse generator at HV test hall.



Wrap design polymeric arrester being tested for bending load.



Strain gauges designed to evaluate distribution of tensile strength among rods of new cage design.



New test field for verifying quality of incoming varistor blocks allows graphical representation of results (right).

