Remote Plant Plays Key Role in ABB Insulator Business
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The reindeer country in the far northern reaches of Sweden is not exactly the type of place where one might expect to find a supplier of strategic components for HV networks.

However, tucked away in Piteå, a town located in a region near the Arctic Circle and where trees, rivers and lakes far outnumber people, is ABB Plast - a factory supplying the hollow core composite insulators that are now finding increasing application on electrical networks worldwide. One of many production centers within the huge Swiss-Swedish multinational, this particular plant has actually been in existence since the mid 1960s - well before Asea and Brown Boveri merged to form ABB.

In this article, INMR Contributing Editor Dr. Claude de Tourreil, travels to visit what may well be the world’s most northerly factory in the field of HV engineering and reports on this facility’s products as well as manufacturing technology.

Over the years, it became increasingly apparent that adding the silicone housing onto these tubes was a step which might more efficiently be performed at the same location where the tubes were themselves being manufactured.

Says R&D Manager Anders Strömbeck, “Plast already had the expertise necessary to manufacture the FRP tubes. All that we needed therefore was to incorporate into our facility the special extrusion molding technology used to apply the housing to the tube. The strategic decision was therefore made to focus all of ABB’s production of insulators in Piteå.”

Generally-speaking, a production facility for hollow core composite insulators is much more compact than would be required to manufacture equivalent insulators made of porcelain. This is because the manufacturing process involves far fewer steps - a fact which becomes very evident when moving through the Piteå plant.

Strömbeck explains that all incoming raw materials needed for manufacturing these insulators are checked for conformity to Plast specifications. In the past, this was already routine work for the high-temperature vulcanized (HTV) silicone rubber used in the external housing.

ABB Corporate Research in Sweden devoted several years of development work during the mid 1990s aimed at evaluating the relative electrical performance of various silicone formulations as well as reviewing alternative insulator production technologies. This work helped to clarify the requirements for what would be regarded as the ideal silicone material for the special production process ultimately selected.

Then, in mid 1998, the first small-scale pilot plant for insulators was established in Ludvika, Sweden amid much internal fanfare (see INMR Vol. 6 No. 3). At the plant’s inaugural ceremony in the Spring of that year, key personnel from all of ABB’s nearby manufacturing centers for HV apparatus were invited to tour the new facility. Management at the new pilot plant used this opportunity to put forward their arguments about all the potential benefits of replacing externally-purchased porcelain with the new, internally-produced composite insulators.

Plast had, by this time, in fact already started to play an important role in ABB’s insulator business, being the sole supplier of the fiber-reinforced plastic (FRP) tubes used by the new Ludvika facility.

The process of ABB’s entry into the business of producing hollow core composite insulators began long before the first such insulator ever rolled off the production line in Piteå.
ABB has been supplying composite insulators to the electrical utility industry for many years. Today, we deliver thousands of pieces annually to an expanded portfolio that includes applications for high voltage breakers, instrument transformers, lightning arresters and bushings. Our patented helical extrusion method makes applying varying silicone rubber shed profiles on differing housing geometries less of an investment than other methods. Composites insulators of today are a proven technology with well-established manufacturing practices ensuring reliable service over the life of ones electrical apparatus. Composites insulators with silicone rubber sheds offer several advantages over traditional ceramics being self-cleaning, reduced incidence of flashover, low weight and non-brittle construction. The self-cleaning property of silicone remains over its lifetime reducing incidence of flashover due to airborne contaminants. Their lightweight and non-brittle construction makes handling and transportation easier and reduces incidence of an outage due to an earthquake. In addition, their non-brittle construction can reduce personnel injury and property damage due to electrical apparatus failure. The inherent advantages of composites improve insulator performance over varying mechanical and environmental conditions. The hollow composite tube provides for a strong but light construction that remains flexible and able to survive under varying mechanical loads. The silicone rubber sheds ensure reliable performance in harsh environmental conditions. Together, the hollow composite with silicone rubber sheds is the best solution for today’s applications.

For every given epoxy formulation and type of glass fiber, a change in the sizing of these fibers can result in FRP tubes having very different mechanical and electrical performance.

According to Strömbeck, a decision was made to work with two different silicone suppliers so as to best ensure an uninterrupted supply of this key strategic and what he says is a relatively costly material.

The Piteå plant is set up such that there are two separate winding stations to produce the FRP tubes which form the core of each insulator. One station can simultaneously accommodate two 4 meter-long steel mandrels while a second winding machine can produce tubes of up to 7 meters in length. The parameters of the manufacturing process for each tube can be adjusted so as to obtain exactly the mechanical performance required from each insulator in its final application.

This is accomplished mainly by selecting the correct angle for winding onto the mandrel the glass fibers which have been pre-impregnated with resin.

The thickness of the tube wall also influences its final mechanical strength.

After the impregnated glass fibers have been wound onto the mandrel, the entire unit is placed into a curing oven where polymerization of the epoxy resin takes place.

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Using only one dye placed on the head, the special extrusion machine can produce a wide range of insulators with different diameters and lengths.

In contrast, one of the main alternative production technologies for hollow core composite insulators is a very efficient and cost-effective way to apply the housing onto the FRP tube. This is because the special extrusion machine can employ only one dye placed on the machine head to produce a wide range of insulators with different diameters and lengths. This contrasts with one of the main alternative production technologies for hollow core composite insulators which optimizes bonding between them and the resin. Says Strömbeck, “the specific type of glass fibers and epoxy resin used to manufacture tubes are certainly important in ensuring high performance. However, for every given epoxy formulation and for every type of glass fiber, a change in the sizing of these fibers can result in FRP tubes having very different electrical and mechanical performance.”

Strömbeck goes on to explain that the quality of the fiber-resin interface is a determining factor affecting the mechanical stress level at which micro-cracks will appear when the insulator is placed under mechanical loads. On a microscopic level, this is basically equivalent to the damage level concept used in the IEC 61462 standard.

Indeed, mechanical testing of FRP samples having different resin to glass fiber bond strength clearly demonstrates the influence of sizing on the appearance of such micro-cracks. FRP tubes can be manufactured to have cylindrical, conical or even barrel-like shapes so as to best adapt to the type of apparatus component which will be placed inside them. When the silicone material is extruded onto and bonded to the tube in a later step, the resulting finished insulator maintains exactly the same shape since the housing follows all the contours of the tube.

The quality of every tube is then verified using various IEC-specified tests as well as other testing procedures developed in-house. Finally, the tube extremities are machined to receive the flanges which are glued onto both ends.

The next operation in the production process is performed in an atmosphere-controlled chamber where a special primer is applied to the surface of the tube in preparation for the next major production step. The tube is now ready for the external silicone housing.

Strömbeck states that the production technology selected by ABB for application of the silicone onto the FRP tube - an extrusion process in which the housing is helically wound onto the tube - is especially interesting inasmuch as it offers several important production advantages. The shape of the sheds, a key factor influencing the insulator’s electrical performance, is then determined by the design of the extrusion head.

According to Strömbeck, this production process, which he indicates has now been patented in many countries, is a very efficient and cost-effective way to apply the housing onto the FRP tube. This is because the special extrusion machine can employ only one dye placed on the machine head to produce a wide range of insulators with different diameters and lengths. This contrasts with one of the main alternative production technologies for hollow core composite insulators which
requirements and regular quality control checks are performed to test for leaks using a mixture of air and hydrogen.

The finished insulators are then shipped to various OEM customers where they will become an integral part of a range of HV equipment and components such as circuit breakers, bushings, instrument transformers and cable terminations.

Although the technology behind hollow core composite insulators has existed for more than 20 years now, the process of its broad acceptance by electric utilities has taken a very long time and much longer than was the case for insulators used on overhead lines. This, in turn, has made most electrical apparatus OEMs reluctant to commit too intensively to this technology, preferring instead to let the final customer decide on choice of insulator type in each case.

Indeed, the fact that the end user of apparatus is typically not in direct contact with the manufacturer of the composite insulator is seen by some in the industry as having played an adverse role in the extent of market penetration of this technology.

Another factor which was not helpful in the process of rapid market acceptance was the relatively long time it took to issue international documents and standards for these types of insulators.

IEC Technical Report 61462 was published in 1998 and used by some in the industry as a Standard. However, this was already more than ten years after these insulators had first been developed and marketed.

With a fairly large production capacity now in place, Plast will put a significant effort to promoting sales to other OEM customers, even if they might be competitors to ABB.