

# Generator for a Sweet Life

Generating sugar crystals from a sweet liquid is an energy-intensive process. The 9 MW high-voltage steam turbine generator in use at one sugar refinery of Nordic Sugar required a refurbishment. A challenging project for Sulzer's Birmingham Service Center in UK was the special "hairpin" coil design of the generator.

The large sugar refinery Nordic Sugar outputs nearly one million tons of sugar annually (Fig. 1). The company produces sugar from sugar beets at its plants in Scandinavia and Lithuania. The factories operate only during autumn and wintertime, when the sugar beets are harvested and processed. In spring and summer, the factories close. During these six months, all maintenance work has to be completed. Once it has been rewound, the main Brown Boveri generator of one of these factories again delivers the energy required for all sugar production processes. The high-voltage steam turbine generator delivers 10.8 kV and 9 MW.

## Generator with a rare coil design

The site engineers of Nordic Sugar removed the impressive generator to ship it to Sulzer's Service Center in Birmingham. Because of the extreme dimensions of the generator, this was quite a heavy workload. The generator weighed 25 tons, and it has a rare design of coil that is a hybrid of a diamond and a hairpin coil. To produce this special coil design, it requires technical expertise, experience with hairpin coils, and a high production quality standard.

## How to produce hairpin coils

To produce the coils, the Sulzer rewind and coil workshops used the original machine drawings as well as the dimensions obtained during the strip down of the generator. Following these measurements, 72 hairpin coil sides were produced for Nordic Sugar (Fig. 2). Later, workers of the rewind shop joined them together with precision in the stator.

Two engineers at the coil workshop are experienced in the production of similar coil designs from over 20 years ago. During this project, these engineers passed their knowledge to the younger generation. They trained some of the younger engineers how to construct and rebuild this special type of coil. This enables Sulzer also in the future to support other customers with such an unusual hairpin coil design.

The hairpin coil design saves space but is difficult to produce. There are other, more common coil designs. The geometrically regular shape of diamond coils has the advantage that it can be produced with automated shaping machines. Therefore, it is more common: most of the coils produced are diamond coils.

## Manufacturing of hairpin coils

The manufacturing process starts with the raw copper being rolled — using the in-house rolling mill and annealing process. This allows Sulzer to start manufacturing very quickly, because Sulzer operators can do this themselves rather than having to wait for a third-party supplier. Each copper strand is insulated, cut to length, and formed into shape. For a semi-enclosed slot design, a hairpin, or push-through coil, is manufactured, which can be formed and shaped by hand only. Using a CAD-designed, wooden-forming jig, Sulzer employees produce every coil with exactly the right shape and dimensions.

Once formed and taped — using the latest insulation technology — the coils are consolidated in a heated, hydraulic press. Engineers check the accuracy of the

1 The production of sugar crystals is energy intensive.



“Why do companies, such as Nordic Sugar, contact Sulzer for their repair requirements? They know for sure that they will receive the required quality and expertise for all kinds of generators and turbomachinery equipment. Our Birmingham Service Center, with its own coil shop and rewind facilities for large machines, is fully equipped to deliver coils for such large generators.

A 9 MW-generator is a medium-sized rebuild for us. However, the unusual hairpin construction requires specialist's skills to ensure that the coils are manufactured according to our high quality standards. Whether customers order a single set of coils or a complete turnkey project to refurbish a 200 MW hydrogenerator — we offer flexible services for large rotating machines around the world. The exceptional customer loyalty proves that our customers appreciate Sulzer's flexibility and top-quality results on rebuilds, rewinds, and refurbishments.”

**Benny Hinchliffe, Head of International Sales  
at the Birmingham Service Center**

dimensions of each coil against the first coil produced to ensure that it fits securely in the cleaned stator slot. Having confirmed the accurate dimensions of the new design, Sulzer manufactures the full set of coils and transfers them to the rewind shop. There, the operators use their experience and skill to braze all copper strands, insulate, tape, and form the connections to complete the job (Fig. 3).

#### In-house tests assure quality

“Once the construction of the new hairpin coils has been completed, the coil quality is tested with three different testing methods. In our in-house facilities, we are conducting interstrand tests, Tan delta tests and a high-voltage-resistance test. These tests assure the quality of the refurbished generator parts (Fig. 4),” Benny Hinchliffe explains. “Meanwhile, in the rewind shop, the stator is stripped and cleaned. After the core flux tests are completed, the stator is ready for the new coils to be installed and connected.”

Hinchliffe continues: “Our coil shop uses the same high standards in manufacturing, quality, and testing for every coil and for every customer. This attention to details coupled with our precision repair work ensures that Sulzer delivers the service quality expected by our customers.”

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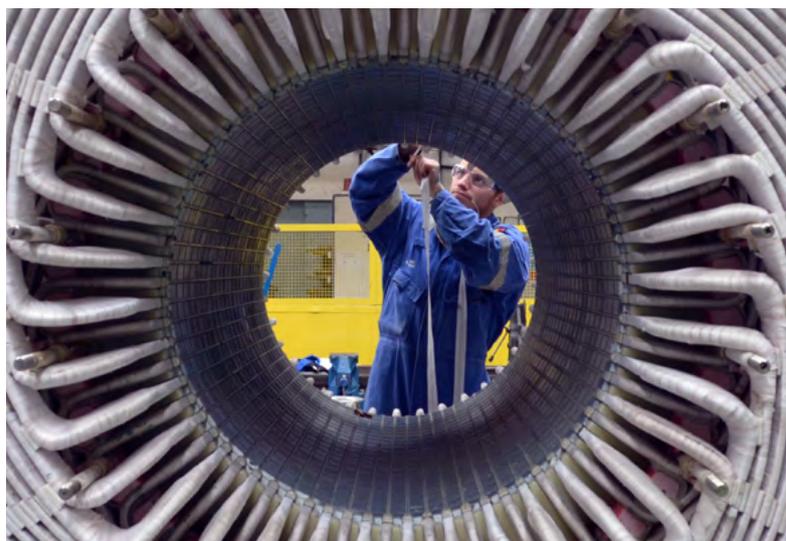
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2 The unusual form of the coil resembles a hairpin.



3 Precise fitting of 72 hairpin coils inside the generator.



4 Final inspection of the generator at the Birmingham Service Center.