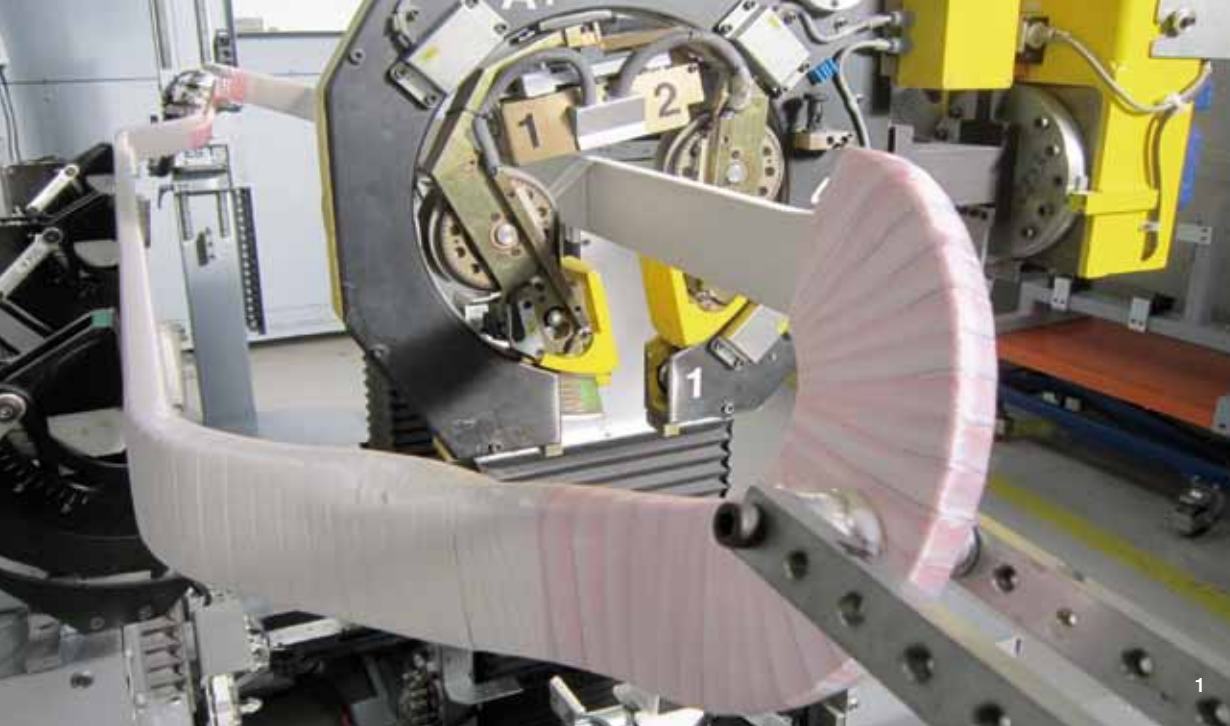


Micalastic insulation For high voltage hydro generators





Micalastic insulation

Voith Hydro is a global leader in hydropower equipment and services for both new and modernization projects. The Canadian Mississauga location has been a market leader in providing generator modernization services within North America having supplied coils for the modernization of over 450 generators located in 340 different generating stations over thirty-five year history of the facility. This represents over one gigawatt of modernization services incorporating coils produced in Mississauga.

Through-out its' history, Voith Hydro in Canada has set new quality and performance standards and by continuously upgrading the engineering and manufacturing resources has consistently delivered best-in-class solutions for the hydro power modernization market. The result is an industry leading reputation for excellence in engineered reliability, world-class solutions and products.

In a globalized world, the generation of sustainable emission-free electricity is more important than ever. Hydro power is well positioned as a major contributor within the renewable energy production. With our long history in hydropower products and services, and excellent processes and tools for engineering and manufacturing, we offer responsive, creative and cost effective solutions in the execution of new or modernization projects.



2



3

- 1 Six-axis auto taping machine
- 2 Coil forming machine
- 3 VPI Plant

Leading-edge in coil manufacturing

Voith Hydro Canada has always pursued a technological leadership approach to the hydro power industry in both its design and manufacturing philosophy.

This is demonstrated by the significant investment in new leading-edge coil manufacturing equipment now installed in Mississauga.

This new equipment consists of an:

- Automated coil forming machine
- Automated electric press of coils
- Six-axis auto-taping machine
- Micalastic vacuum pressure impregnation (VPI) system

One of the key improvements of the winding manufacturing process is the introduction of six-axis controlled taping of coils. The taping machine wraps the fine mica tape with a consistent overlap and tension around the straight section and end-winding portions of the coils, thus ensuring uniform thickness over the full length of the coil. This Insulation process in combination with specialized and sophisticated VPI technology, ensures a void free, high dielectric insulation system.

Benefits of this new coil manufacturing equipment to our customers are:

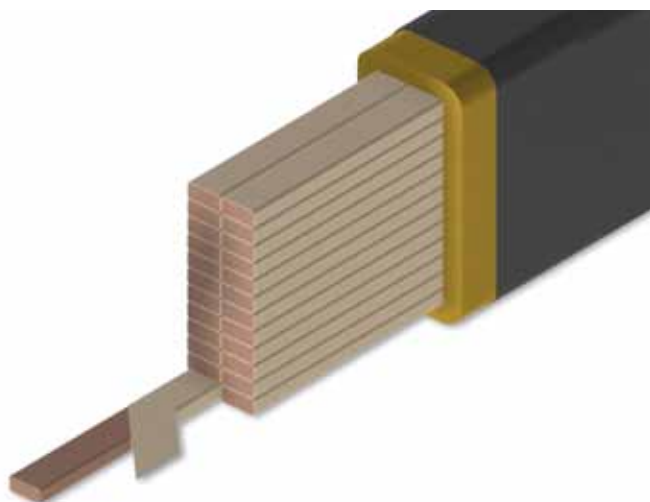
- Best-in-class delivery cycle times driving shorter manufacturing cycles
- 50% less handling of coils in production
- Unprecedented repeatability and reproducibility of coil dimensions

Another key advantage of the new equipment is realized in the design phase for both new and existing generators being modernized. The high precision of the new coil equipment allows the design engineers at Voith Hydro to further optimize the amount of copper in the design which in turn will provide machines that have higher output, efficiencies and lower losses.

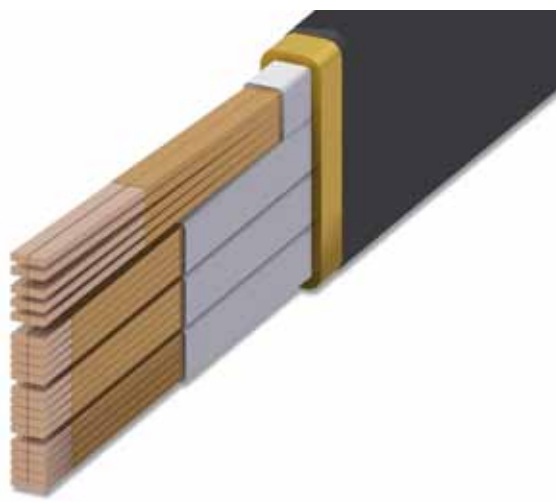
Micalastic in high-voltage hydro generators

The common characteristics shared by all types of Micalastic insulation are the use of inorganic fine mica tape as a base material, and heat-curing synthetic epoxy resins as a bonding material. This, coupled with state-of-the-art manufacturing techniques provides a high dielectric breakdown strength, long-term resistance to electrical stress, and a low power fac-

tor ($\tan \delta$). The mechanical properties of the tape and resin combination also provide excellent resistance to mechanical and thermal stress. The Micalastic insulation system is based on Vacuum Pressure Impregnation technology and meets Thermal Class 155 (IEC)/Class F (IEEE) standards.



Micalastic insulation: copper wire insulated with mica tape



Micalastic insulation with dedicated turn tape

Process control

Six sigma tools are used as a standard to monitor the coil manufacturing process and collect data on an ongoing basis. This allows direct comparison of product performance across all location using the standard process. This commitment to

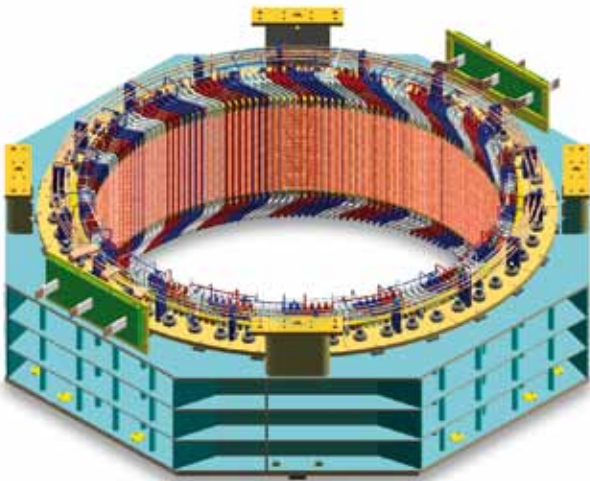
best practice and continuous improvement ensures the products being manufactured in the Voith worldwide network are consistently produced using excellent processes.

Design

Computerized design tools allow modeling of the performance of the whole generator. Based on extensive test results on completed projects, the calibrated calculation allows the winding performance to be optimized and guaranteed. The range of applicability for multi-turn coil winding is up to 200 MVA and voltages up to 18 kV.

Voith Hydro's approach has always been to provide customers with the best engineered solution for their unique applications. Micalastic offers technological advantages that will benefit customers in many ways:

Leading-edge technology in insulation will ensure continuation of the best engineered insulation systems for customer applications.



Generator frame assembly solid modeling and analysis

Micalastic insulation system for field assembly

The Micalastic insulation system has been developed for the field assembly of the winding components.

A combination of fine mica tape, epoxy resin and a room-temperature curing agent provide good dielectric properties and mechanical resistance.

Components insulated in the field:

- Connection between coils and circuit ring
- Circuit ring
- Jumper between coils
- Connection between coils

Power Plants with Micalastic Multi-turn coils

Costa Rica:

Sandillal - 2 units
17.64 MVA, 13.8 kV, 300 RPM, 50 Hz

Europe:

Rånåsfoss III
Akershus Energi
Norway - 6 units
14.67 MVA, 13.2 kV, 250 RPM, 50 Hz

Uluabat
Akenerji Elektrik Uretim A.S.
Turkey - 1 unit
55 MVA, 13.8 kV, 600 RPM, 50 Hz

Akocak
Akenerji Elektrik Uretim A.S.
Turkey - 1 unit
46 MVA, 13.8 kV, 750 RPM, 50 Hz

Toeing
Germany - 6 units
8.5 MVA, 10.5 kV, 214.3 RPM, 50 Hz

Eitting
Germany - 3 units
14 MVA, 16.3 kV, 166.7 RPM, 50 Hz

Vohburg
Germany - 3 units
12 MVA, 6.6 kV, 90.9 RPM, 50 Hz

Goesgen
Switzerland - 4 units
12.5 MVA, 10 kV, 142.9 RPM, 50 Hz

Tiefencastel
Switzerland - 2 units
16.1 MVA, 7 kV, 600 RPM, 50 Hz

Froustul
Norsk Hydro
Norway - 1 unit
50 MVA, 11 kV, 240.3 RPM, 50 Hz

Tevla
Norway - 2 units
30 MVA, 9 kV, 500 RPM, 50 Hz

Planatovryssi - Greese
2 units
68 MVA, 15.75 kV, 200 RPM, 50 Hz

North America:

Gaston
Dominion Generation
Virginia - 1 unit
55.6 MVA, 14.4 kV, 100 RPM, 60 Hz

Moose River
Fortis US Energy Corp.
New York - 1 unit
13.26 MVA, 13.8 kV, 327.3 RPM, 60 Hz

Smith Mountain
American Electric Power AEP
Virginia - 2 units
212.5 MVA, 13.8 kV, 100 RPM, 60 Hz

Ohio Falls
Louisville Gas & Electric
Kentucky - 5 units
14.68 MVA, 14.0 kV, 100 RPM, 60 Hz

Corra Linn
FortisBC
British Columbia - 2 units
20 MVA, 7.2 kV, 85.7 RPM, 60 Hz

Spray
TransAlta Generation Partnership, Alberta - 1 unit
62.2 MVA, 13.8 kV, 450 RPM, 60 Hz

Bay D'Espoir
Nalcor Energy
Newfoundland and Labrador - 4 units
85 MVA, 13.8 kV, 300 RPM, 60 Hz

Wheeler
TVA
Alabama - 1 unit
48.4 MVA, 13.8 kV, 85.7 RPM, 60 Hz

Wyman
FPL Energy Maine
Maine - 1 unit
33 MVA, 13.8 kV, 138.5 RPM, 60 Hz

Safe Harbor
Safe Harbor Water Power Corp.
Pennsylvania - 1 unit
36 MVA, 13.8 kV, 109.1 RPM, 60 Hz

Des Cedres
Hydro Quebec
Quebec - 1 unit
11.0 MVA, 6.6 kV, 52.9 RPM, 60 Hz

Beauharnois
Hydro Quebec
Quebec - 2 units
57.0 MVA, 13.8 kV, 75 RPM, 60 Hz



Power Plants with Micalastic Bars

Shettisham, US Army Corps of Engineers,
Alaska - 2 units
34.5 MVA, 13.8 kV, 600 RPM, 60 Hz

Dardanelle, U S Army Corps of Engineers,
Arkansas - 4 units
32.63 MVA, 13.8 KV, 75 RPM, 60 Hz

Pensacola
Grand River Dam Authority
Oklahoma - 6 units
19.65 / 22.6 MVA, 13.8 KV, 150 RPM, 60 Hz

High Falls
Great Lakes Power
Canada - 2 units
25.0 MVA, 12.0 kV, 276.9 RPM, 60 Hz

South Africa:
Steenbras - 4 units
50 MVA, 12 kV, 600 RPM, 50 Hz

South America:
Santa Clara
Brazil - 3 units
21 MVA, 13.8 kV, 257.1 RPM, 50 Hz

Rio de Peixe
Brazil - 2 units
5.5 MVA, 6.6 kV, 720 RPM, 50 Hz

Antas II
Brazil - 2 units
7 MVA, 6.6 kV, 720 RPM, 50 Hz

Pinhal
Brazil - 1 unit
4 MVA, 6.9 kV, 257.1 RPM, 50 Hz

Elloy Chaves
Brazil - 1 unit
11 MVA, 6.9 kV, 360 RPM, 50 Hz

Africa:
Gigel Gibe II
EPECO Ethiopian Electric Power Corp.
Ethiopia - 4 units
125 MVA, 15 kV, 333.3 RPM, 50 Hz

China:
Ji Lin Tai,
Ji Lin Tai Co Ltd. - 4 units
128 MVA, 15.75 kV, 214.3 RPM, 50 Hz

Three Gorges
China Yangtze Three Gorges
Develop. Corp. - 6 units
840.0 MVA, 20 kV, 75 RPM, 50 Hz

Europe:
Vuzenica
Dravske Elektrarne Maribor
Slovenia - 3 units
26 MVA, 10.5 kV, 125 RPM, 50 Hz

Wehr
Schluchsee Werr
Germany - 4 Units
300 MVA, 21 kV, 600 RPM, 50 Hz

North America:
Holtwood
Pennsylvania Power and Light
USA - 2 units
74.3 MVA, 15.75 kV, 85.7 RPM, 60 Hz

Grand Coulee
U S Bureau of Reclamation
USA - 3 units
825.6 MVA, 15.0 KV, 85.7 RPM, 60 Hz

Bath County
Virginia Electric and Power Company
USA - 6 units
530 MVA, 20.5 KV, 257.1 RPM, 60 Hz

La Tuque
Hydro Quebec
Canada - 3 units
65 MVA, 13.8 KV, 138.5 RPM, 60 Hz

Racoon Mountain
Tennessee Valley Authority
USA - 4 units
425 MVA, 23 KV, 300 RPM, 60 Hz

South America:
El Platanal
Cementos Lima S.A.
Peru - 2 units
120 MVA, 13.8 kV, 450 RPM, 60 Hz

Itaipu 50 Hz
Itaipu Binacional
Brazil/Paraguay - 6 Units
823.5 MVA, 18 kV, 90.9 RPM, 50 Hz

Itaipu 60 Hz
Itaipu Binacional
Brazil/Paraguay - 5 Units
737 MVA, 18 kV, 92.3 RPM, 60 Hz

Irape
CEMIG
Brazil - 3 units
140 MVA, 13.8 kV, 300 RPM, 60 Hz

Peixe Angical
Grupo Rede
Brazil - 3 units
175.0 MVA, 13.8 kV, 85.7 RPM, 60 Hz

Pedra do Cavalo
Votorantim
Brazil - 3 units
90 MVA, 13.8 kV, 257.1 RPM, 60 Hz

Aimores
Cia. Energetica de Minas Gerais
Brazil - 3 units
116 MVA, 14.4 kV, 105.9 RPM, 60 Hz

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