What makes a premium high voltage coil?

Houghton International
Electro mechanical innovation

At Houghton International we have been manufacturing coils for over 30 years. As a market leading rewind company ourselves, we understand the challenges faced by the repair industry and have refined our services, insulation systems and processes to address these.

Our reputation for quality precedes us and by implementing time proven processes, premium materials and our vast experience we support our customers to select the most appropriate coil for the application.

What makes a premium high voltage coil?

Insulation system

The insulation system of an HV motor or alternator is critical in terms of its performance, longevity and value as an investment to the asset owner. Selecting the appropriate insulation requires consideration of application, circumstance, atmospheric condition and geographic location.

Houghton International has developed a range of systems that cover the broad scope of requirements faced by our expanding customer base.

There are two fundamentally different insulation systems ranging across almost all types of high voltage (HV) rotating electrical machines.

Vacuum Pressure Impregnation (VPI)

VPI requires the main insulation of epoxy, polyester or silicone resin to be introduced to a winding after coil insertion inside a pressure chamber. The impregnated stator is then baked in an oven to cure the resin, thus completing the insulation system.

The machine is then fully tested at high voltage to ensure dielectric integrity and compliance to international repair standards, i.e. BS EN ISO 60034.

Resin rich

Resin rich coils are insulated with premium quality mica tape which is impregnated with a B-stage epoxy resin. Hot pressing the coils activates and fully cures the resin which then bonds the conductor strands to ensure a homogenous and well-sealed coil. Electrical testing can be performed on each individual coil and the connected winding, guaranteeing the individual dielectric integrity of each HV coil. This system also allows for tan delta testing and PD testing to be carried out which proves resin penetration in the coil slot section and confirms low levels of PD activity within the coil.

There are many differing schools of thought on which system is the most appropriate. This view depends on experience, personal preference, manufacturing cost, verified technical data, whether the machine is being built new or is undergoing repair, and the application, such as pump or alternator.

VPI systems can offer an improved degree of sealant against moisture ingress and, arguably, heat dissipation compared to resin rich coils. However, there are questions against consistency of impregnation throughout the slot portion of a VPI coil giving rise to concerns about Corona Discharge undermining the insulations system's integrity.

Corona discharge protection

Corona discharge is an electrical phenomenon created by the ionization of air around a conductor as a side effect of an electric field with a high potential gradient or strength.

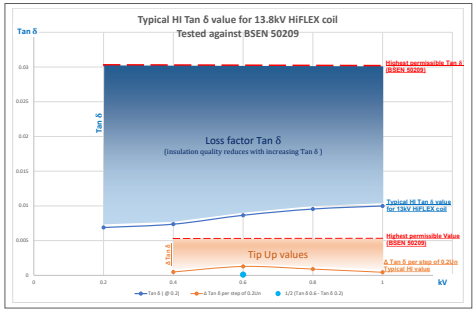
In high voltage rotating machines, Corona activity is present at 6600V and above, increasing in intensity and severity as the machine's potential gradient rises. The protection against Corona discharge and its adverse debilitating effects on a winding's insulation is what governs the design concept and features of a premium HV coil.

Every HV coil should posses a conductive outer layer which grounds the coil in the slot. It should also feature a stress grading system which protects the coil as it leaves the slot, where the potential gradient is at its greatest and Corona activity is therefore most intense.

Tan δ / Tip Up

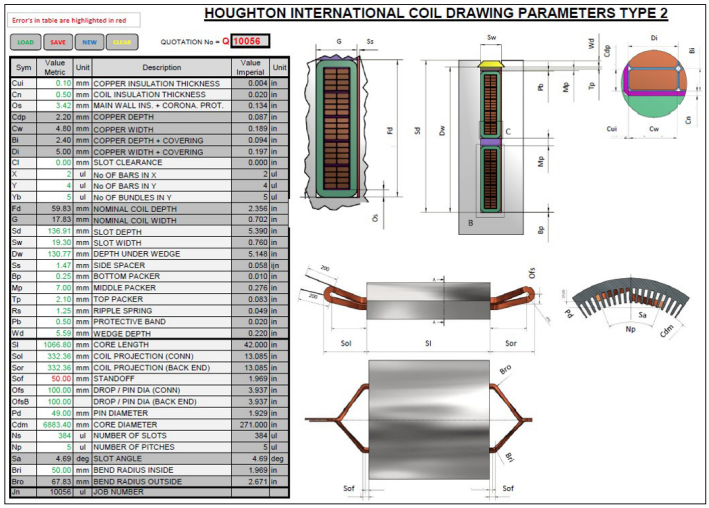
Tan δ and Tip Up is the accepted measure of a premium HV coil. What is measured is the AC power factor involved in the passage of AC leakage current through the insulation wall.

This measures the air gaps or void content in a cured HV coil. This measure is taken using a Schering bridge rectifier, which quantifies the capacitive content of insulation through the slot portion of the coil. Most standards require only a sample percentage of coils out of an entire coil set to be tested. However, we advise testing the entire coil set in order to ensure dielectric integrity and machine longevity.



Fit

When describing fit we refer to how closely together the coil fits into the stator slot. Any area of the slot section that is not ground leaves an air gap, meaning Corona discharge activity will occur above 6600V. Variances in fit promote Corona activity, hence coils should be manufactured to at least 0.25mm across the length of the coil and similarly 0.5mm for skew slot coils from any given slot width.
Hot pressed resin rich slot sections guarantee such a fit, where VPI systems rely on sufficient resin penetration to ensure the main wall is adequately ground.



HOUGHTON INTERNATIONAL COIL DRAWING PARAMETERS TYPE 2

Error's in table are highlighted in red

LOAD SAVE NEW DRAW QUOTATION No = Q 10056

Sym	Value Metric	Unit	Description	Value Imperial	Unit
Cui	0.10	mm	COPPER INSULATION THICKNESS	0.004	in
Cn	0.50	mm	COIL INSULATION THICKNESS	0.020	in
Os	3.42	mm	MAIN WALL INS. + CORONA. PROT.	0.134	in
Cdp	2.20	mm	COPPER DEPTH	0.087	in
Cw	4.80	mm	COPPER WIDTH	0.189	in
Bi	2.40	mm	COPPER DEPTH + COVERING	0.094	in
Di	5.00	mm	COPPER WIDTH + COVERING	0.197	in
Cl	0.00	mm	SLOT CLEARANCE	0.000	in
X	2	ul	No OF BARS IN X	2	ul
Y	4	ul	No OF BARS IN Y	4	ul
Yb	5	ul	No OF BUNDLES IN Y	5	ul
Fd	59.83	mm	NOMINAL COIL DEPTH	2.356	in
G	17.83	mm	NOMINAL COIL WIDTH	0.702	in
Sd	136.91	mm	SLOT DEPTH	5.390	in
Sw	19.30	mm	SLOT WIDTH	0.760	in
Dw	130.77	mm	DEPTH UNDER WEDGE	5.148	in
Ss	1.47	mm	SIDE SPACER	0.058	in
Bp	0.25	mm	BOTTOM PACKER	0.010	in
Mp	7.00	mm	MIDDLE PACKER	0.276	in
Tp	2.10	mm	TOP PACKER	0.083	in
Rs	1.25	mm	RIPPLE SPRING	0.049	in
Pb	0.50	mm	PROTECTIVE BAND	0.020	in
Wd	5.59	mm	WEDGE DEPTH	0.220	in
Sl	1066.80	mm	CORE LENGTH	42.000	in
Sol	332.36	mm	COIL PROJECTION (CONN)	13.085	in
Sor	332.36	mm	COIL PROJECTION (BACK END)	13.085	in
Sof	50.00	mm	STANDOFF	1.969	in
Ofs	100.00	mm	DROP / PIN DIA (CONN)	3.937	in
OfsB	100.00		DROP / PIN DIA (BACK END)	3.937	in
Pd	49.00	mm	PIN DIAMETER	1.929	in
Cdm	6883.40	mm	CORE DIAMETER	271.000	in
Nb	384	ul	NUMBER OF SLOTS	384	ul
Np	5	ul	NUMBER OF PITCHES	5	ul
Sa	4.69	deg	SLOT ANGLE	4.69	deg
Bri	50.00	mm	BEND RADIUS INSIDE	1.969	in
Bro	67.83	mm	BEND RADIUS OUTSIDE	2.671	in
Jn	10056	ul	JOB NUMBER		

Shape consistency

Shape consistency is a critical feature because the more fitting the shape of the coil, the less mechanical stresses are placed on it during the insertion process.

Shape consistency is critical because across a significant number of coils, if the shape is out, the engineer can lose the space available, which creates many problems, not least placing further adverse stresses that can increase the likelihood of failure.

Houghton International's tried and tested methods of controlling shape consistency have underlined our value to the people who work with our products.

Dielectric integrity

All coils produced by us are designed to meet the relevant electrical standards, such as BS EN 60034, BS EN 50209 and IEEE 1553 & 1043 and our in-house testing facility has the capability to test up to:

- Surge comparison or turn to turn test up to 50kV
- Tan δ / Tip Up measured at intervals of 0.2 U_N, loss tangent maximum increment = 5 x 10^{-3}
- Hi-pot (AC and DC flash) test up to 50 kV
- Lamination test – when there are multiple conductors per / turns @ 240V AC
- Partial discharge test
- Voltage Endurance test up to 50kV

In addition, we can also test to customers specification as required.

For more information on our range of high voltage coils and specialist insulation systems, visit www.houghton-international.com.

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