SEVES

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Comparison of C 130 Alumina Porcelain High Voltage Insulators manufactured by Plastic and Isostatic Process.

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CONTENT

1. Plastic and Isostatic Porcelain Manufacturing Process

The Alumina Porcelain Insulators are traditionally manufactured so called "Plastic" Process", as well called "Conventional" or "Wet-Process. This process is has same steps then the process developed in China during the Shang Dynasty (1600–1046 BCE).

The conventional process consist simply to mill the basic raw materials: Kaolin (Clay), Alumina, Silica and Feldspar a homogenous powder, mix it to water, press the water out, and extrude the mass to get a cylindrical body for the shaping. The process contains time-consuming homogenisation and drying cycles to have the optimal moisture content giving the right plasticity for turning. After the turning, the porcelain body is fully dried; the moisture level must be below 0.5 %, sprayed by glaze and immediately fired.

The Isostatic manufacturing Process was developed in the 70'ties for the needs of Powder Metallurgy. The isostatic process allowed metal alloys and products, which were not possible to manufacturer otherwise. On the Isostatic Process, a rubber-mould is filled by dry powder, pressed with a very high-pressure (up to 200) bar to give the wanted form to the product. On Hot Isostatic Pressing (HIP), the pressing is done by Argon and the temperature is raised to several hundreds of degrees of Celsius to do the sintering on same operation. On Cold Isostatic Pressing (CIP), the pressing is done by oil or water in room temperature. So, the Alumina Porcelain can as well be manufactured by CIP.

On the Isostatic Process, the raw materials are the same and the exact receipt is identical with the Plastic Process. After mixing the milled powder to water, it will pass to a spray dryer where the mass is instantly dried into fine mixed powder. A rubber-bag is filled and pressed in a cylindrical form, which can be turned immediately. On the fig.1 both processes are presented schematically.

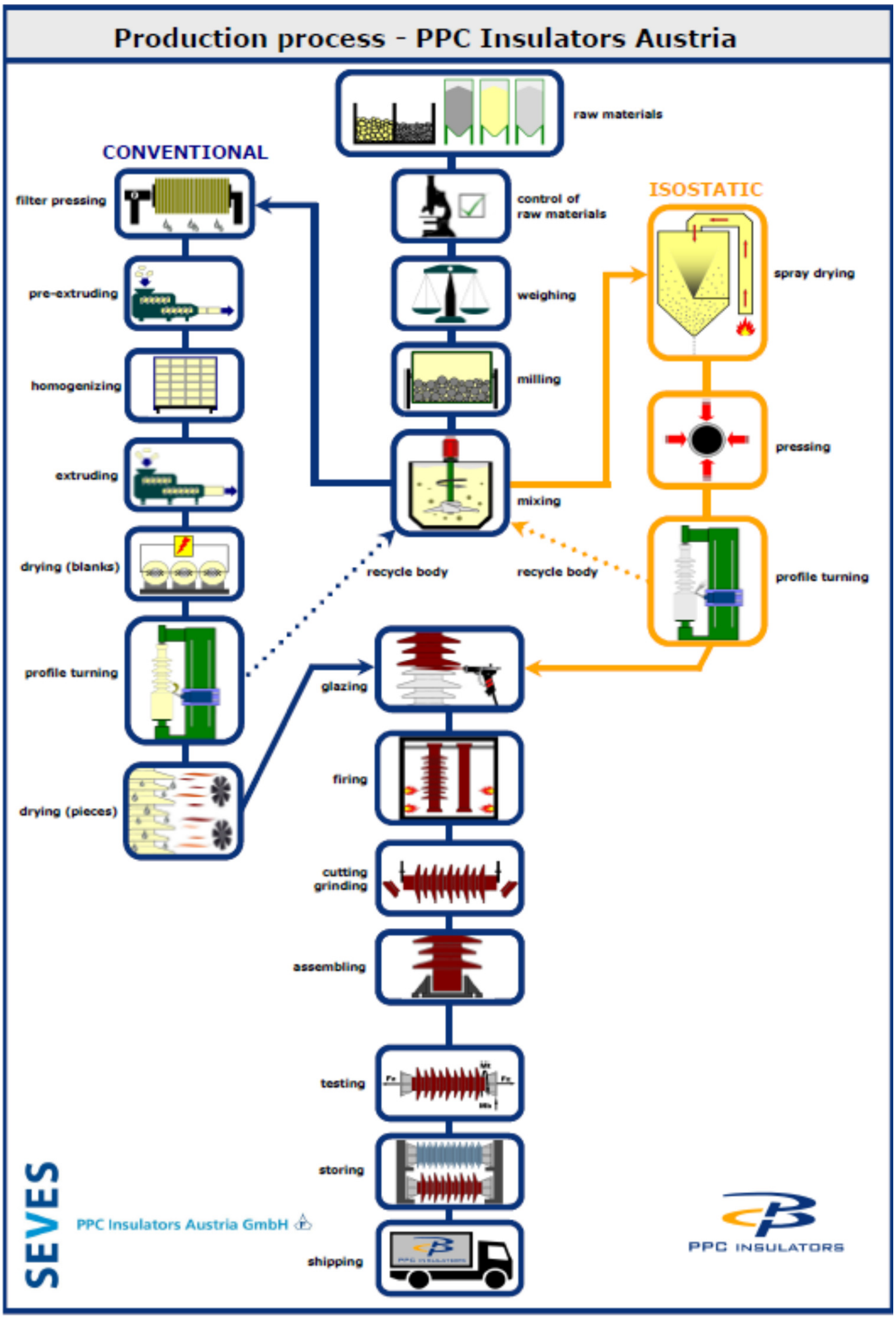


Fig. 1: The Plastic and Isostatic porcelain manufacturing process.

The main advantage of the Isostatic process is that most of time-consuming homogenisation and drying cycles are not needed and the lead-time is reduced from 7 weeks down to 2 weeks, compared to the Plastic Process.

2. Micro Structure

As the chemical analyse is identical, no microstructural differences between porcelain manufactured by Plastic and Isostatic can be observed. In fact, it is not possible recognize from a micrograph which process is in questions.

The di-electrical strength is a function of the microstructure of the porcelain, so both Isostatic and Plastic Porcelain have the same characteristics.

In Figures 2: Plastic Porcelain and 3: Isostatic Porcelain we can compare the two microstructures.

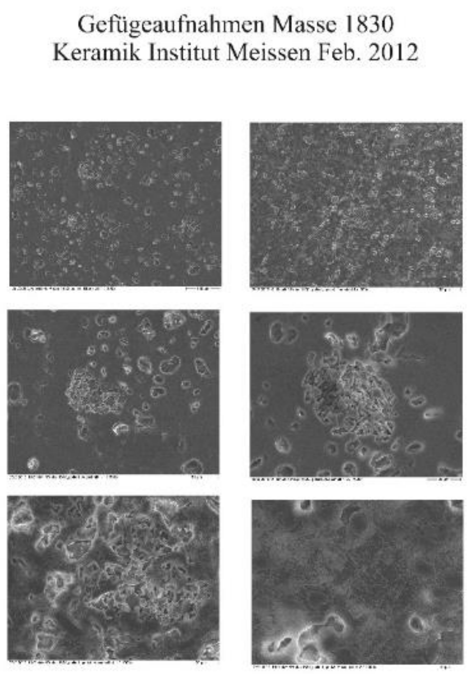


Fig. 2: Micrographs of Plastic Porcelain.

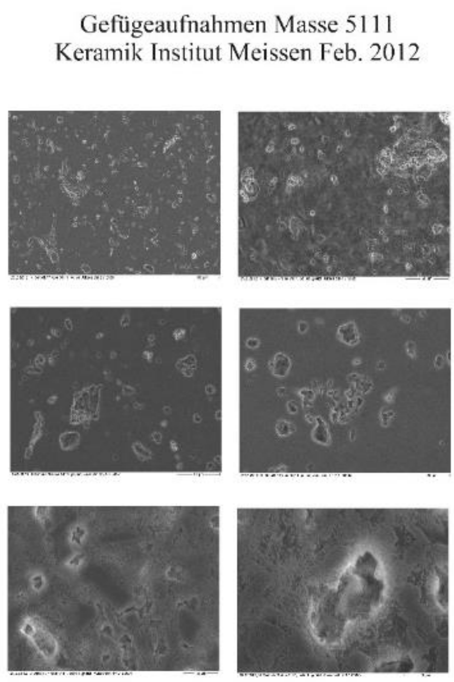
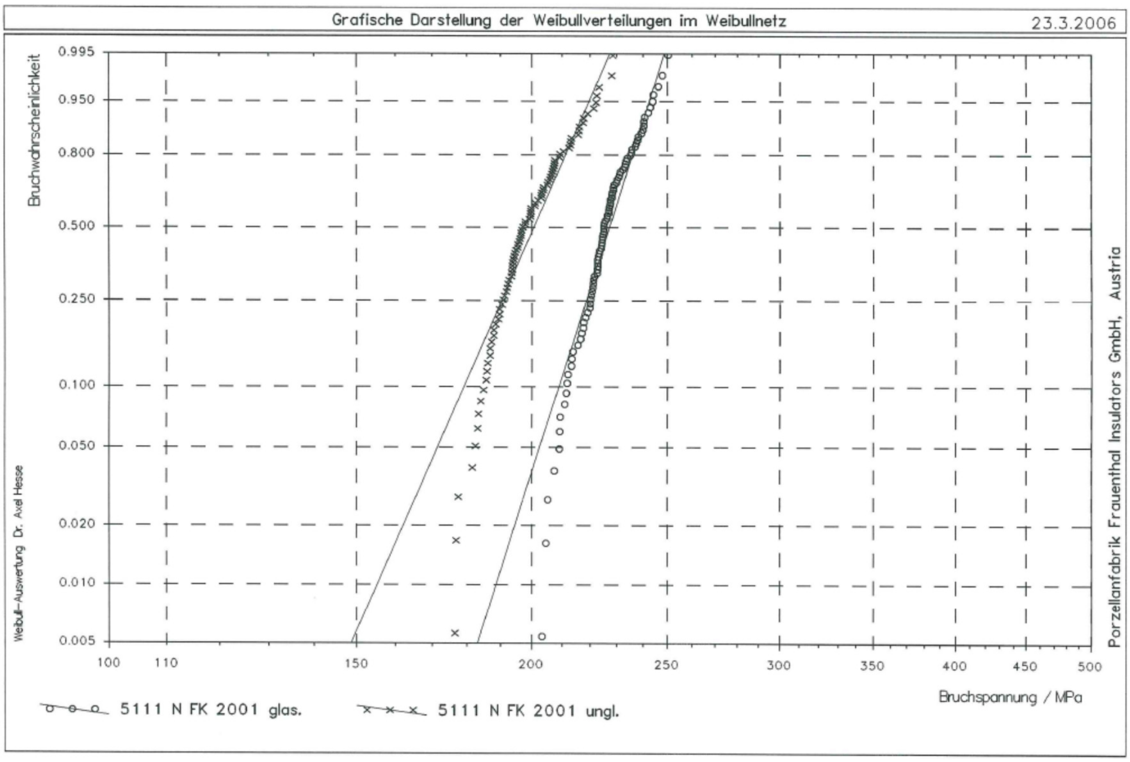


Fig. 3: Micrographs of Isostatic Porcelain.

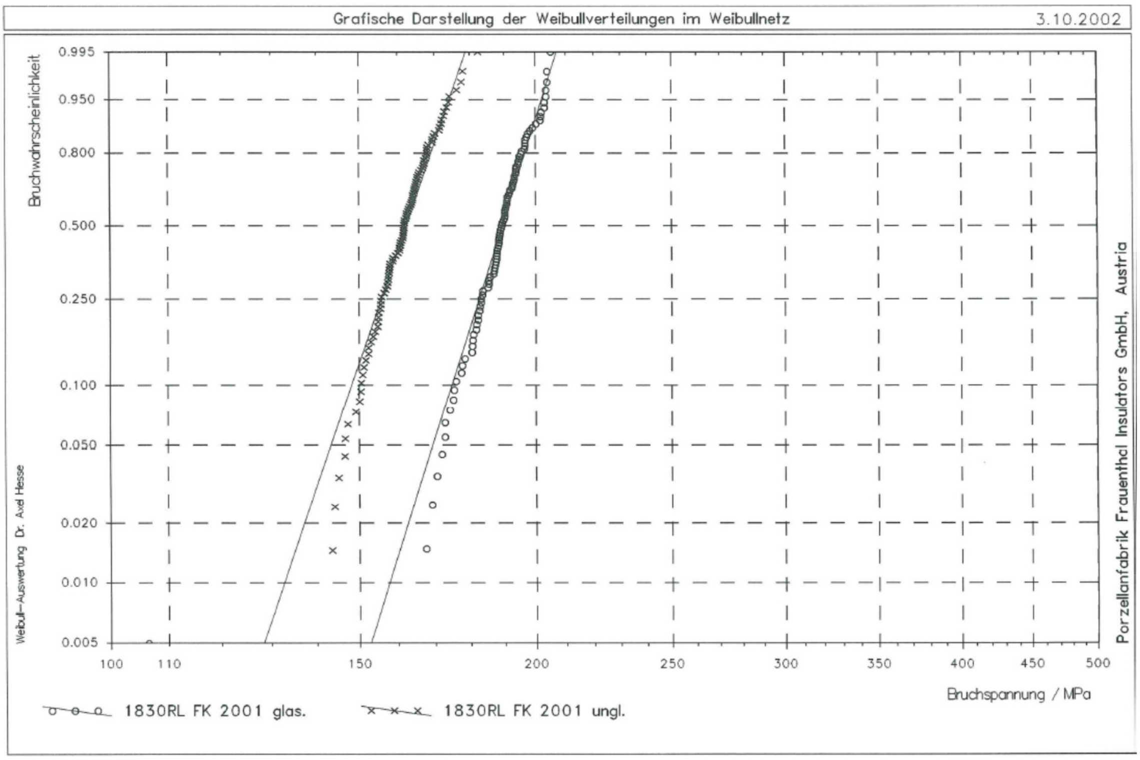
3. Mechanical Characteristics

The 3-points-bending test is the standard test to control the mechanical characteristics of any ceramic body. The strength is only depending of the alumina content; the manufacturing process is not having an impact on the mechanical strength of the Alumina Porcelain. Another critical factor is the glazing, which is improving the mechanical strength as it is covering all surface roughness, which could potentially be a nucleation point for a fracture.

Below we have on the graph. 1 and 2 the 3-Point-Bending test Weibull-analyses, according DIN 51110, of Isostatic porcelain body bar, without and with glaze, graph 1; and the same for plastic porcelain bar in graph 2. The impact of the glaze can be observed by a clear and repetitive shift of the curb.



Graph. 1: 3-Point-Bending Test Weibull-Analyse of Isostatic C 130 Porcelain



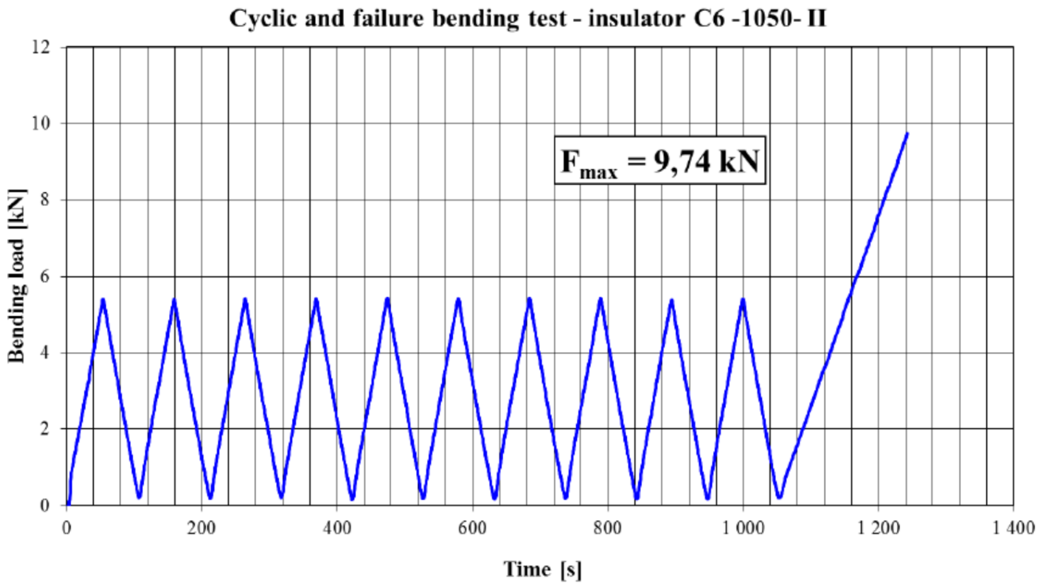
Graph. 2: 3-Point-Bending Test Weibull-Analyse of Plastic C 130 Porcelain

We see as well that for the both Plastic and Isostatic curbs are identical. On long-term analyses, it can be observed, that Isostatic samples have lower standard deviation at the bending test then the Plastic samples. This can be explained by the fact that Isostatic body is free of any extrusion related material defects.

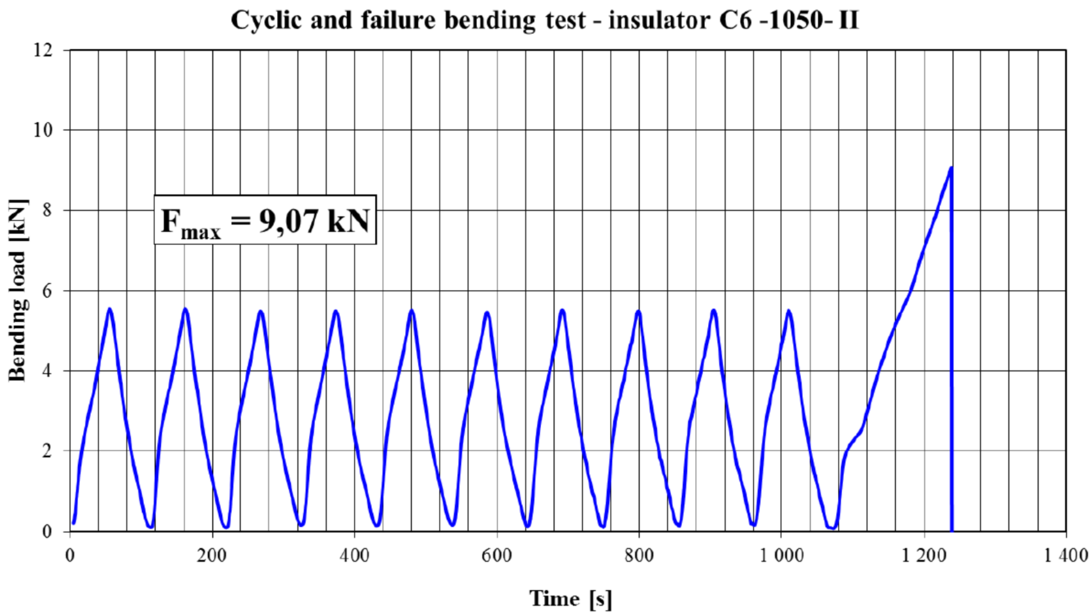
4. Type Tests

The Type Test comparisons confirms that laboratory test and clearly shows that the test results between Isostatic and Plastic Alumina Porcelain are identical. Below the mechanical tests results from type test of a Standard IEC Post-Insulator BIL C6-1150-II according IEC 60672, at Klokner Institute in Prague from 2015.

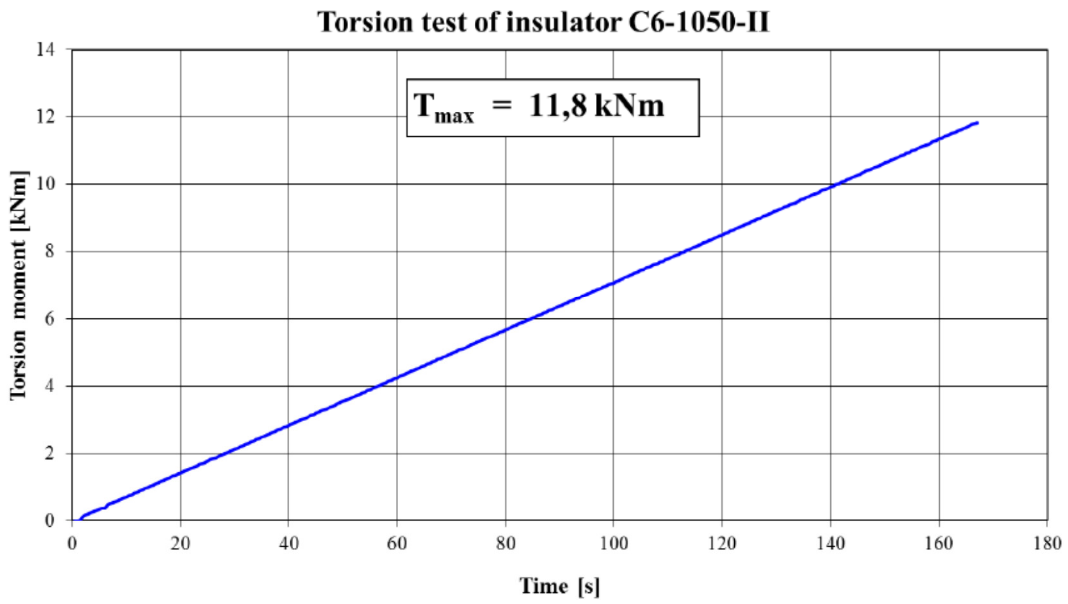
The graphs 3-6 shoes that both in bending and torsion test the Isostatic Insulators and Plastic Insulators are identical. A copy of both original test reports is enclosed as annex.



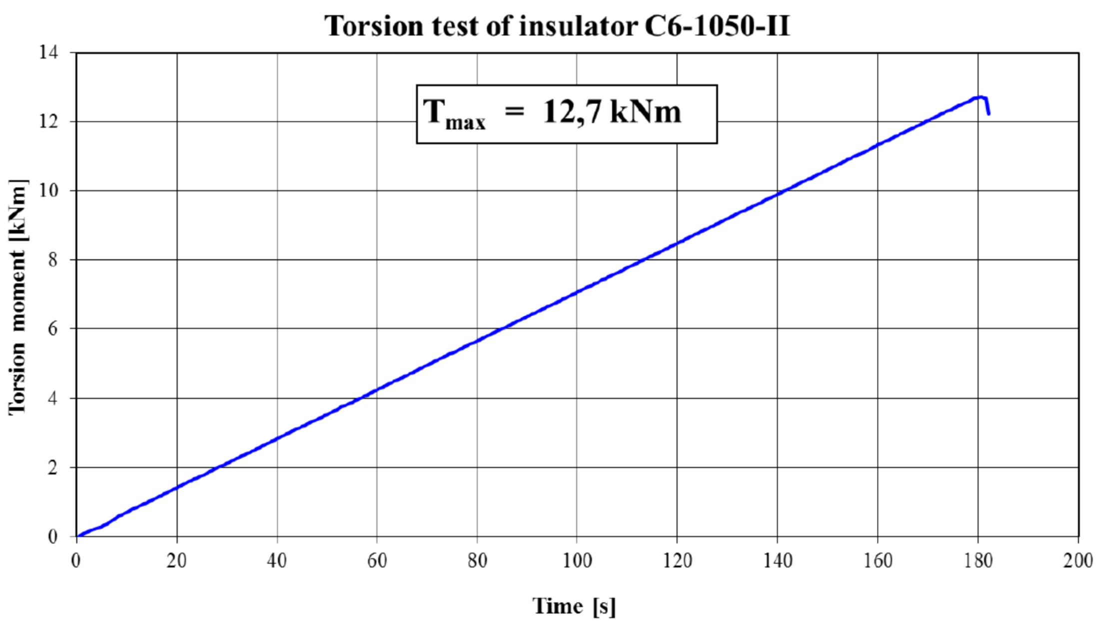
Graph. 3. Cyclic and Bending Failure Test with Isostatic insulators.



Graph. 4. Cyclic and Bending Failure Test with Plastic Insulators.



Graph. 5. Torsion Test with Isostatic Insulators.



Graph. 6. Torsion Test with Plastic Insulator

5. Conclusions

All analyses are clearly demonstrating that there is no structural, mechanical or di-electrical difference between Alumina Porcelain Insulators manufactured by Isostatic or Plastic Process.

Independently of this physical similitude between the isostatic and plastic Insulators, the Isostatic is having the advantage of much shorter lead-time in production and smaller standard deviation on mechanical characteristics.

Further the Isostatic process allow more advances designs of the insulators as the turning of completely dry body allows finer shed thickness and more precise geometry then the plastic process.

This difference is coming from the fact that on the plastic process the porcelain body must have 17% - 20% moisture in the turning, then in drying the there is a shrinkage and some level deformation which is affecting the geometry of the insulator. On the isostatic process, the body is already dry and the turned geometry will go directly to glazing and firing.

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