Speciality Papers - Insulating Papers and Boards

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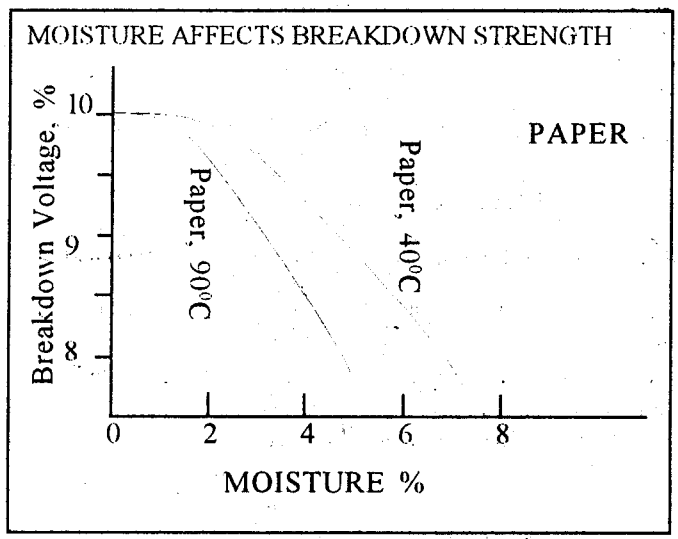
Paper making has undergone many changes in course of time. While, the basic paper making fundamentals remain the same, improved methods of manufacture have been constantly evolved.

There are many varieties of speciality papers, one of them being, Electrical Insulating Paper and Boards. These are essentially used in Electrical Engineering equipment, as di-electrics. Materials can be classified as Insulation, depending on the di-electric property. All kinds of electrical devices and circuits use di-electrics to insulate parts which are current carrying from those that do not, or where different potentials are involved. In capacitors too, di-electric is used to provide the required values of capacitance.

Solid di-electrics are extremely diverse in origin and properties and many of them are of natural origin, example, paper and cloth from vegetable fibres. Cellulose serves as raw material for various insulations as, for instance, in insulating paper and board.

Fibrous materials are made up of a great many elementary filaments, usually flexible. Individual cotton fibres are woven into and used as fabrics and tapes. Non-woven sheets are used as yarns, paper and pressboard. In the former case, these materials have a more or less regular structure because they consist of yarn woven in a definite fashion. Papers and pressboard, on the other hand, comprise quite complicated systems of tangled fibres sometimes having a direction of preferred orientation. A distinct form of fibrous materials includes braided or knitted sleevings which serve as the base for varnished insulating sleeves.

Some specific properties of fibrous materials are primarily determined by their structure. Those of particular interest are the large surface area and relatively small thickness, non-uniformity and hygroscopicity due to macroporosity. Vegetable fibres possess a certain inherent porosity of microscopic and sub-microscopic nature. The latter may arise from the presence in the fibres of minute capillaries. Certain fibrous materials contain hydrophilic substances, which, due to their great affinity for moisture, can absorb it from the surrounding air and swell through formation of colloidal systems. Cellulose is a typical example of this. Even when a material consists of fibres which do not exhibit volume hygroscopicity it will, as a rule, absorb moisture from the surrounding air because of the presence of pores and the wettability of the surfaces by water. Owing to the large aggregate surface area of the fibres, such materials can display considerable hygroscopicity. It is, of course, clear that volume-hygroscopic fibres will exhibit particularly high hygroscopicity.



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The electric strength of fabrics is determined by the breakdown voltage of the air contained in the macropores. In papers and press boards there is less probability for large through pores. In any case, however, all porous fibrous materials have a relatively low electric strength; the electric strength is the lower the less the structural density of the material. In view of the properties of fibrous materials described above, these materials require impregnation in the majority of cases in order to use them as insulation. The impregnation serves to raise the electric strength and to retard moisture absorption. Cellulose is a natural organic polymer with dipole groups due to which cellulose has a high dielectric constant (5 to 8), neglecting the pores.

The insulation materials can be classified as follows depending on the temperature class:

class	max temp deg. C	examples
0	90	Cotton, silk, paper
A	105	same as above impregnated with suitable medium.
B	130	Mica, asbestos
H	180	fibreglass with high temp. bonding agents; silicone rubbers
	220	Nomex and other high temp. Polymers.

Insulation paper belongs to the Thermal class A insulation.

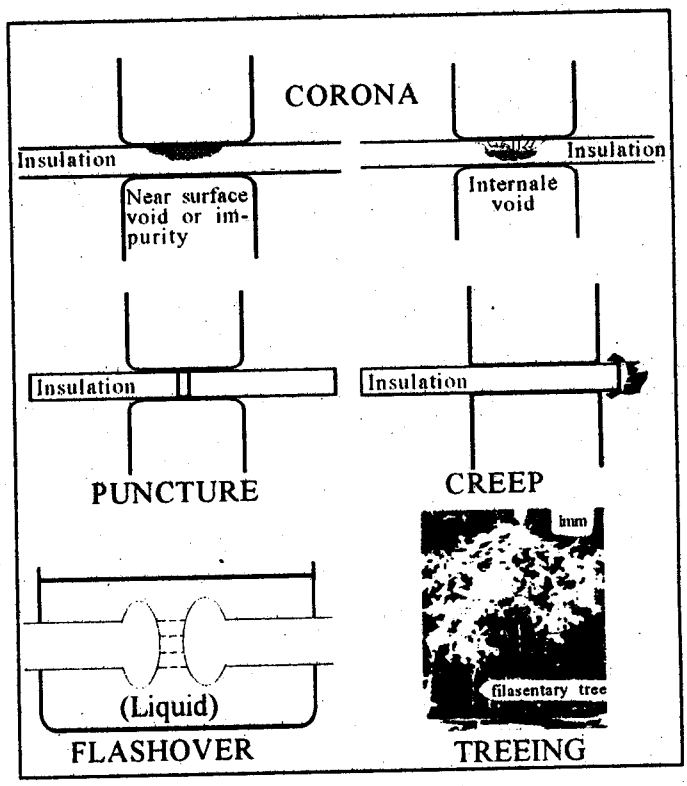
Properties of Electrical paper

Physical	Mechanical	Chemical	Electrical
Density	Fibre length	Ash content	Dielectric
Shrinkage	Tensile strength	pH	constant
Moisture content	Elongation	Conductivity	Breakdown
Oil Absorption	Flex. strength	Chlorides	
	Comp. strength	Degree of Polymerisation	

Material and Structural effects

Material influences such as impurities, metal particles, grease, oils and mineral salts can irreversibly damage the cellulose insulating materials to varying degrees. While conductive particles that have not been eliminated cause partial discharges below or at normal field strength and consequently bring about uncontrolled ageing (especially in places with a high field strength concentration), contamination from perspiration of the hands, for instance, leads to an introduction of electrolytic impurities. Larger foreign particles, larger occlusions of fibrous masses and undissolved cellulose knots can be detected within the manufacturing process, on-or off-line, with the aid of a reference-detector testing method that is integrated in the process. Any imperfections can be eliminated by removing the appropriate material areas.

Negative effects in cellulose insulation are imperfections of the structural homogeneity, which originate from dielectrically differing structure boundaries and dielectrically incompatible insulating components and barriers within the insulating arrangement, especially when the fiber structure is uneven. Boundary layer phenomena between the dielectric material and the conductor arrangement can also be disturbing factors. In the processing of cellulose insulation for use as a dielectric material, a through oil impregnation is achieved. In addition to the enhanced dielectric strength of the oil-cellulose system, the oil plays a significant role impeding the initiation as well as the process of ageing.



Finally, the chemical and physical ageing mechanisms of cellulose cause hydrolytic and oxidative imperfections, due to decomposition. These are, in particular, due to the effects of oxygen, increased temperature, high air humidity, air pollution, and microbiological contamination.

In conclusion, insulation papers and boards are products which are very sensitive to changes in the raw material, environment and actual use conditions. While, attempts are being made to replace this with synthetic fibres, cellulosic insulation paper and boards continues to be the economically viable insulating material produced, as of today, in the Transformer Industry, across the world.

Types of Electrical DIELECTRIC BREAKDOWN

* Corona occurs below breakdown voltage. Starts in voids containing air.
* Results in ionization, gas bubbles, insulation deterioration: may lead to total breakdown.
* INTERNAL BREAKDOWN (TREEING) Due to moisture etc.

FACTORS AFFECTING BREAKDOWN STRENGTH

Moisture Level
Polar Impurities
Voids
Temperature