Standardization of sample preparation for mechanical tests on cable Insulation and sheathing materials

P.V.Satheesh kumar, G.K.Raja, K P Meena; Central Power Research Institute, (India),
pvskumar@cpri.in, gkraja@cpri.in, meena@cpri.in,

ABSTRACT

Majority of underground power cables are insulated with polymeric insulation materials such as PVC, XLPE And EPR. The thermo mechanical characteristics of these materials under service conditions are evaluated by conducting tensile strength & percentage elongation at break tests on unaged and aged samples. Basically , the tests are conducted by preparing dumb bell samples from the extruded insulating and sheathing materials of power cables as per IEC 60811 /IS 10810 guidelines. As the test results varies with the accuracy of the dumbbell cutting die, it is mandatory to standardize the sample preparation procedure .The dies shall be sharp and free from nicks in order to prevent ragged edges on the specimen.Here in this paper , a study is conducted with samples prepared from different dies. The test results are also compared and a procedure is mentioned for standardisation of the die with respect to ragged edges, so that accurate results can be obtained for various insulating and sheathing materials.

KEYWORDS

XLPE, PVC, PE, Mechanical tests, Dumbell speciments

INTRODUCTION

The selection of various polymeric materials for any application is selected based up on its various thermal, electrical and mechanical characteristics. Tensile strength & percentage elongation at break is one of the main mechanical tests on materials which decide its suitability to specific applications. Presently, Polymeric materials such as XLPE, PVC PE etc are used as insulating and sheathing materials of extruded power cables. The cable insulation and sheathing materials undergo mechanical stress and strain during installation, laying, bending etc. The ability of these materials to withstand these mechanical stress and strain is evaluated by measuring the force required to break and elongation of the specimen at break. Tensile properties are generally included in material specifications to ensure quality. The effect of ageing of these polymers is also evaluated by conducting tensile tests after simulated thermal ageing. However, the accuracy of these results depends up on the quality of dumbbell specimens prepared for testing.

TENSILE TEST

One of the most important characteristics of polymers is their inherent toughness and resistance to fracture. The tensile strength or the tensile stress is the ratio of applied force and cross sectional area. Ductility of the material is assessed by carrying out elongation at break or strain. At low strain, the deformation of most solids is elastic, that is, the deformation is homogenous and after removal of the deforming load the plastic returns to its original size and shape. In this regime, the stress (σ) is proportional to the strain (ε):

Stress / Strain = Constant

Or $$\sigma = E\,\varepsilon$$

where E is the tensile (or Young's) modulus of the plastic which is a measure of the stiffness of the material. It means, when a plastic specimen is pulled at a (constant) strain rate the applied stress (or load) is directly proportional to the observed strain (or elongation). The maximum stress up to which the stress and strain remain proportional is called the *proportional limit*. If a plastic material is loaded beyond its elastic limit, it does not return to its original shape and size, i.e. a permanent deformation occurs. With increasing load, a point is eventually reached at which the material starts yielding. This point is known as the *yield point*. A further increase in strain occurs without an increase in stress. The general stress strain behavior of various polymers is given below.

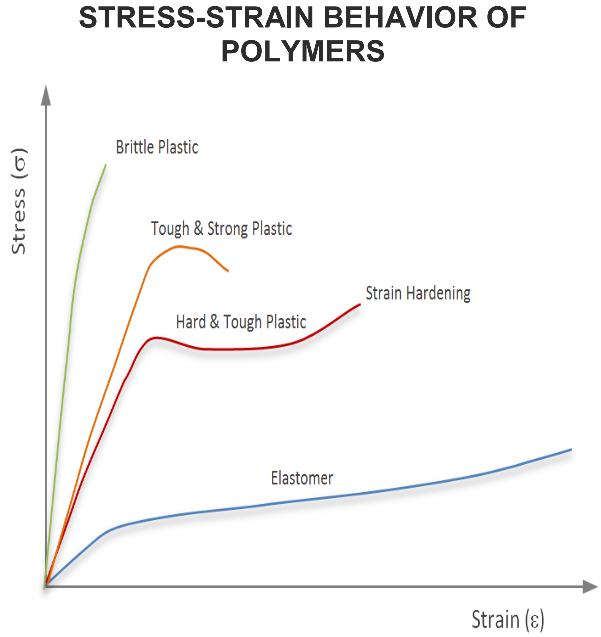

Figure 1.Stress-strain behavior of various polymer materials.

(Source: Chemical Retrieval on the Web (CROW)