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Artamonova E.N.,
Dr. of Technical Sciences, Professor,
Saratov State Technical University,
Russia
Conference participant

ITEMS DURABILITY FOR VISCOELASIC POLYMERS

In this paper we propose a mathematical model of destruction, based on the relationship of boththese approaches to allow for the dependence of the limiting critical conditions at which the destruction, the time of stress, temperature environmental exposure, exposure, etc.

Keywords: deformation, vickoelasticity, mehanicheskie properties, degradation

Polymers are now well-accepted for a wide variety of applications, and for mass-manufactured as well as one-off speciality products. The growth in their use has continued in the last two decades or more, despite the effects of several recessions in industrial activity . In the same period the demand for traditional materials like metals, ceramics and glasses has remained static or even fallen. Polymers the basic materials of the rubber and plastic industries and important to the textile, petroleum, automobile, paper, and pharmaceutical industries as well exhibit viscoelasticity to a pronounced degree. Their viscoelastic properties determine the mechanical performance of the final products of these industries, and also the success of processing methods at intermediate stages of production. Whilst the behaviour of many real materials does approximate to these idealised models, that of polymers deviates markedly from them. In particular, their solid state deformation is time-dependent and nonlinear and so resembles some combination of elastic and viscous responses, whilst their melt rheology is also significantly nonlinear.

In this paper we propose a mathematical model of destruction (the relations connecting parameters of efficiency at the time of fracture characteristics material), based on the relationship of both these approaches to allow for the dependence of the limiting critical conditions at which the destruction, the time of stress, temperature environmental exposure, exposure, etc. This is especially typical for polymers [1]. An examination of these experimental data one can draw conclusions that should be taken into account when constructing the mathematical correlations for the conditions of fracture:

1. Mechanical properties and the process of destruction of polymer materials substantially depend on time and operating conditions.

2. Destruction is a two-stage process. At the first stage the degradation of the properties of the material, the accumulation of damage, microcracks occur. The stage ends at a time when the merger of microdamage formed macroscopic crack [2].

3. At the failure of the material from effect of aggressive media, corrosion or caused by visco-elasticity the value of the first stage is so large that when evaluating time of destruction the destruction process can be generally described as the accumulation of damages and degradation properties of plastic.

4. Because of the irreversibility of the process of destruction is determined not only the current values of parameters characterizing it, but the entire prior history change of these parameters.

5. Because of the private nature of the experimental data on the effect of medium on behavior of plastic the composition of the general mathematical for all materials the phenomenological description of fracture based on mechanical ideas due to the difficulties and serious shortcomings. Therefore it is necessary and the molecular interpretation of macroscopic changes in the material. Thus, the phenomenological theory of time dependence as would provide a common framework, which must fit the theory of material behavior, and that put a detailed mechanical theory of change of macroscopic and microscopic properties of the polymer. This need arises in the interpretation of the parameters of the phenomenological equation, allowing you to identify not only the common features, as well as the difference between the materials.

6. Because of significant time effects for polymers the process of their destruction more difficult than traditional materials, the phenomenon of viscous and brittle fracture occur simultaneously. Fracture criterion in this case must take into account the achievement σ, ε of the instantaneous and destructive values σ p, ε p, at the time $t_{разр.}$, and their dependence on the development of degradation of material properties ω (t).

7. When the stresses are removed from a polymeric material before fracture, the strain recovery path is not necessarily identical to that of the loading part of the deformation cycle. So energy must have been dissipated during the deformation of such materials – another indication of deviation from perfect elasticity [2, 4]:

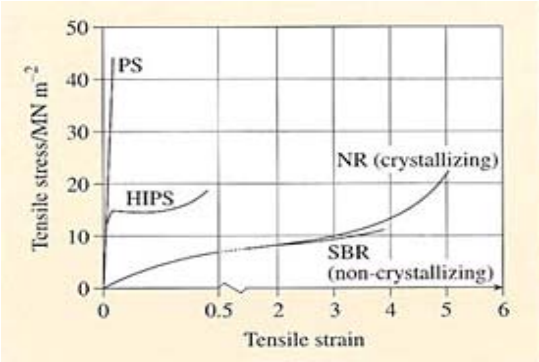

Fig. 1. Tensile stress-strain curves for some rubbers and plastics

Analysis of experimental data suggests characteristics of the temperature dependence of relaxation processes and fracture for viscoelastic polymers with the same value of energy activation for each material.Both aspects of the strength of polymers (short-term and long-term loading) depend on the local structural changes that primarily can be linked with the process of accumulation of damage, education grid hairline cracks. Combining different approaches to describing these processes, i.e. formulation of a general mathematical theory of deformation and fracture of polymers depends on the study of the relationship of deformation, destruction and action of strain, temperature, aggressive factors in the whole time interval of operation of the element.

Viscoelastic behavior reflects the combined viscous and elastic responses, under mechanical stress, of materials which are intermediate between liquids and solids in character. Viscoelastic Properties of Polymers examines, in detail, the effects of the many variables on which the basic viscoelastic properties depend. These include temperature, pressure, and time; polymer chemical composition, molecular weight and weight distribution, branching and crystallinity; dilution with solvents or plasticizers; and mixture with other materials to form composite systems. With guidance by molecular theory, the dependence of viscoelastic properties on these variables can be simplified by introducing certain ancillary concepts such as the fractional free volume, the monomeric friction coefficient, and the spacing between entanglement loci, to provide a qualitative understanding and in many cases a quantitative prediction of how to achieve desired results. The phenomenological theory of viscoelasticity which permits interrelation of the results of different types of experiments is presented first, with many useful approximation procedures for calculations given. A wide variety of experimental methods is then described, with critical evaluation of their applicability to polymeric materials of different consistencies and in different regions of the time scale (or, for oscillating deformations, the frequency scale). A review of the present state of molecular theory follows, so that viscoelasticity can be related to the motions of flexible polymer molecules and their entanglements and network junctions. The dependence of viscoestic properties on temperature and pressure, and its descriptions using reduced variables, are discussed .

Relaxation properties influence the process of destruction, enhancing the growth of

microdamages. This is explained by the fact that in the process of development forced highly elastic deformation near the damage is occurred the transition mechanical energy into heat [3].

According the survey of the literary sources for the analyzing of long-term durability of materials and elements made of them two alternative approaches are basically exist: mechanical (benchmarking) and kinetic.

According the first approach we model the generalized condition for material destroying:

$$\phi\ (\theta 1, \theta 2, \theta 3\ ) = \phi\ p.$$

Here ϕ – the functional is some combination of the components of the stress or strain. The functional ϕ depends on the accepted theory strength or given empirically and then the functional contains parameters determined experimentally.

1. The strain tensor can be represented as a sum of tensors of elastic deformation of inelastic deformation:

$$\varepsilon\ ij = \varepsilon\ ij^{1} + \varepsilon\ ij^{2}.$$

2. For description the strain state and fracture in the framework of a generalized model of inelasticity is necessary to consider the history of deformation of the sample depends on the loading path and on time. For different loading paths for the processes of varying duration results will be different. We give a physical explanation of the above stated hypothesis. Usually characteristics of any model of a continuous medium mathematically depend of state parameters. The number of state parameters can be infinite, but the state of a thermodynamic system is defined by a finite number of parameters:

$$\varepsilon(t) = \sigma/E + \int_0^t K(t,\tau,\omega)\sigma(\tau)\,d\tau.$$

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