Relationship between Environmental Stress Cracking resistance and Creep properties in Polyethylene

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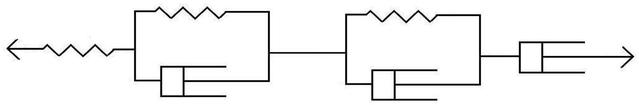
Creep Behaviour of Polyethylene

High density polyethylene (HDPE) is viscoelastic: When they are subjected to stress they show an immediate elastic deformation/strain, symbolized with a spring and over time they deform further like a fluid would. For this reason they are said to have a built-in viscosity symbolized with a dashpot. This study focuses on measuring both responses for five different kinds of HDPE to model the mechanical properties of them and also to compare the time dependant stress/strain behaviour with the environmental stress cracking resistance to see if there is a correlation.

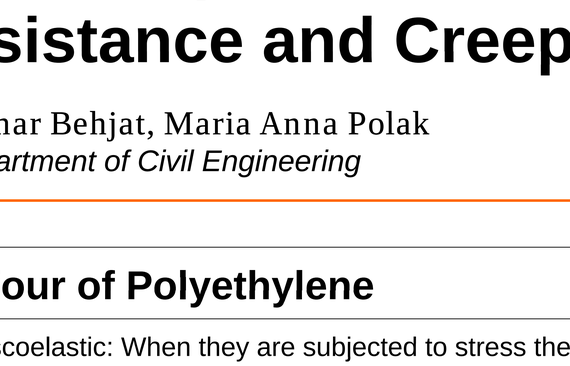


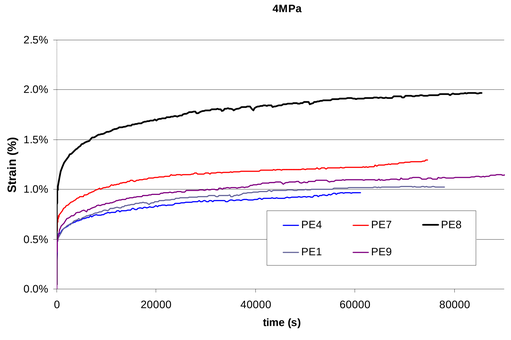
Kelvin Chain

- **Typical strain vs. time curves for a given stress**

  Five different samples of HDPE have been studied in creep experiments at four different stress levels

The figure on the right hand side shows a typical set of curves for PE8 at different loads. It can be seen that an increase in tensile tress increases the initial strain and also with time samples stretch more. From other experiments it is known that PE8 starts to yield at a tensile stress of 20 MPa



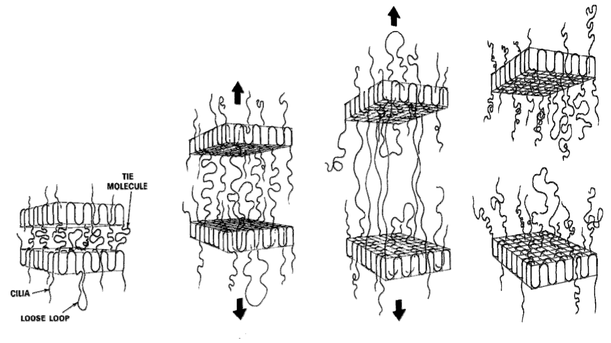


The figure on the left hand side shows a typical set of curves for five samples of polyethylene at 4MPa. When looking at the curves from top to bottom, the same order was observed at three, out of four, stresses that were used for the experiment.

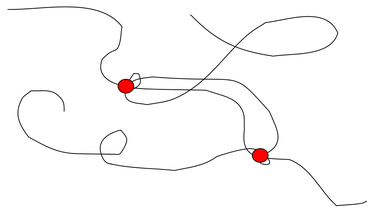
Softer materials have better ESCR?

Environmental Stress Cracking

ESC is a type of brittle fracture occurs through a mechanism of disentanglement.

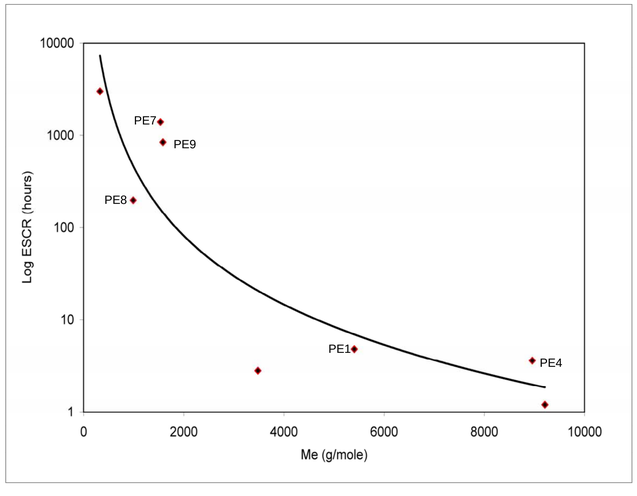


- ESCR is controlled by the number of inter-lamellar links
- In addition to bridging tie-molecules, chain entanglements should also form part of inter-lamellar linkages



Molecular weight between entanglements

$$M_e = \frac{\rho RT}{G_N^0}$$



- ESCR of resins increases with decreasing M_e values.
- Smaller M_e means there are more chain entanglements for the same length of polymer chain