DETERMINATION OF GEOMETRY-INDEPENDENT FRACTURE MECHANICAL PARAMETERS OF POLYMERS

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REQUIREMENTS ON SPECIMEN THICKNESS USING J-INTEGRAL CONCEPT

For the determination of toughness properties of polymer materials during impact loading the instrumented Charpy impact test has been used (1-3).

Experimental results and FEM-simulation showed that for assessing the toughness of polymer materials it is advantageous to use J-integral approximations of Merkle and Corton (4) and Sumpter and Turner (5). The evaluation method according to Sumpter and Turner can be defined from the equation (1) for $0 < a/W < 1$.

$$J_{Id} = \eta_e \frac{A_e}{B\,(W-a)} + \eta_p \frac{A_p}{B\,(W-a)} \qquad (1)$$

The J-integral values determined experimentally, are geometry-independent if they satisfy the criterion (2), where ε is a specific constant of the material.

$$B,\ (W-a),\ a > \varepsilon \frac{J_{Id}}{R_e} \qquad (2)$$

Experimental values of ε (they lie between 10 and 90) were investigated for influence of specimen thickness (2), see fig. 1. The knowledge of the general -J- connection permits the evaluation of the respective specimen thickness.

The advantage of determination of dynamical fracture mechanical values is that geometry-independent values can be obtained with small specimen thickness. In consideration of experimental conditions (2), B = 4 mm was chosen.

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MODEL FOR DETERMINING THE COD

Besides the J-integral concept, the COD-concept has been used especially to describe the brittleness of anorganic filled polymers. The formation of a quasi-static tension state is a prerequisite for investigating critical crack opening displacements. On the basis of the plastic-hinge model the critical crack opening displacement can be investigated with the help of equ. (3). Prior to the investigation it is necessary to separate the maximum deflection f_M into a notch-portion f_k and a bend-portion f_b.

$$\delta_{dk} = \frac{1}{n}\,(W-a)\,\frac{4\,f_k}{s} \qquad (3)$$

In (2) it has been shown for several materials that δ_{dk} is independent of a/W ratio, when B = 4 mm and $a/W \geq 0.2$. The critical crack opening displacements are geometry-independent, when the criterion (4) is satisfied.

$$B,\ a \geq \xi\,\delta_{dk} \qquad (4)$$

Fig. 2 shows, that ξ depends on material and that a considerable overestimation of the necessary minimum specimen dimension is possible, if the evaluation of the necessary notch depth respectively specimen thickness is unknown.

SYMBOLS USED

$A_{e,p}$ = deformation energy (elastic, plastic part)(mm)
a = notch depth (mm)
B = specimen thickness (mm)
J_{Id} = J-integral value (N/mm)
n = rotation factor
s = distance between supports (mm)
W = specimen width (mm)
δ_{Id} = critical crack opening displacement (mm)
$\eta_{e,p}$ = corrective functions

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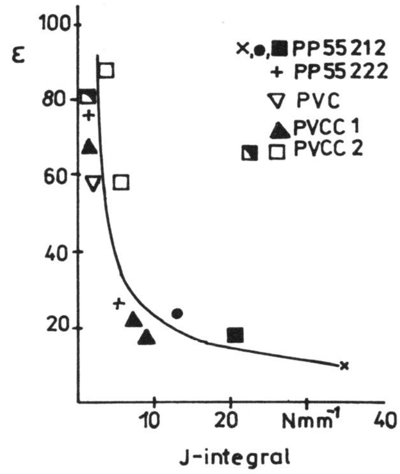

Figure 1 Dependence of ε on J-integral value.

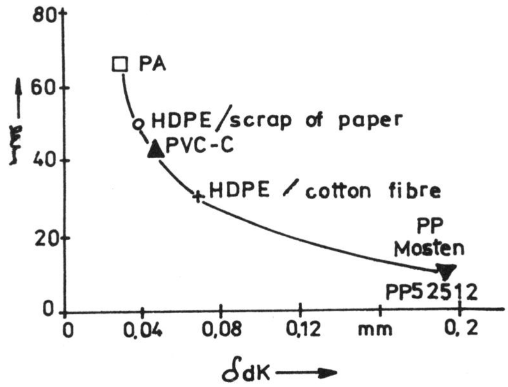

Figure 2 Dependence of ξ on δ_{dK}