DVS – DEUTSCHER VERBAND FÜR SCHWEISSEN UND VERWANDTE VERFAHREN E.V.	Testing of Fused Joints on liners of Polymer Materials – Tensile creep test on PE –	Direction DVS 2226-4 (November 2000)	D V S

Contents:

1 Range of Application

The tensile creep test is designates to judge fused joints on liners made of PE materials under long-term stress conditions. The seam quality can be judged in combination with other tests. The determined long-term fusion factor[1)] (f_S) makes a statement about the quality of the fused joints. Extensive test experiences about tensile creep test are currently only available for PE.

Liners are made from thermoplastics or elastomer and fused by welding, vulcanization or gluing as sealing systems for ground and water construction. Joint shapes applied are overlap joints with overlap seams as well as coated seams. The liners can be homogenous or multi-layer.

The fusion procedures are treated in DVS 2225-1, the on-site test in DVS 2225-2.

The long-term fusion factors and the fraction structure make a statement about the quality of the workmanship. The requirements are stipulated in part 1 of this guideline.

2 Type and Structure of Test

The tensile creep test is processed in dependence on DIN 53 444. A test unit is required wearing the Samples at constant temperature, continuous quiet tensile strength and constant ambient conditions (temperature bath). Fig. 1 shows the scheme of the test unit, which has to ensure constant strength discharge and test temperature. Depending on the test additive circulation of the test bath is required. To record the endurance of the individual Samples and, if required, the body elongation (stretch) suitable devices have to provided on the test unit.

3 Shape and Number of Samples

Samples in strip shape acc. to Fig. 2a or shoulder shaped Samples acc. to Fig. 2b are used for the tensile creep test. They are taken out of the seam area of the liner vertically in relation to the fusion joint the way the seam is situated in the middle. The relative bodies of basic material have to be taken out of neighboring areas the same direction.

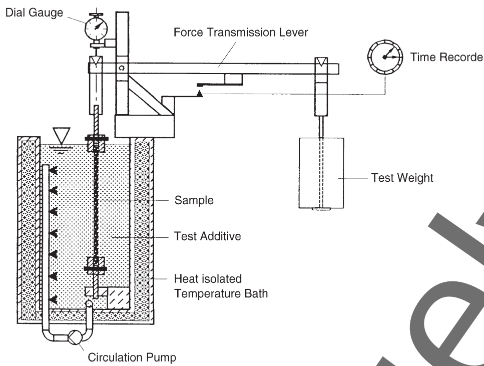

Figure 1. tensile creep test Test Unit.

The Samples can be produced by sawing, milling or cutting (e.g. with water jet). To achieve a cutting edge free of notches they eventually have to be finished in vertical direction by peeling. Punched Samples are only admitted for elastomer respectively PVC-P. For relative samples and fused samples, Samples of the same construction type and preferably same shape have to be used.

Shape 2 is recommended to avoid fractions in the clamping area. For fused samples, the more simple shape 1 may be sufficient. By using both sample shapes in one test series the sample's cross section has to be identical in the area of the measuring length.

The fused joints are tested with reference to the actual execution, either with or without bead. The fusion point is situated in the middle of the sample (Fig. 2).

Prior to the test the outer condition of the seam (bead formation, shape and evenness) has to be checked visually. Furthermore, the essential dimensions (sheet thickness, seam thickness and width) as well as the situation of the seam in relation to the manufacturing direction of the sheets have to be determined (see section [illegible]3 of the DVS 2225-2 guideline).

For comparative tests between basic material and fusion seam with statistic evaluation at least 6 samples each have to be tested under consideration of the take out direction of basic material and the fused samples for manufacturing of the semi-finished product.

1) Due to shape and type of the fused joint, in this case the long-term fusion factor (f_S) is defined in divergence from DVS 2203-4.

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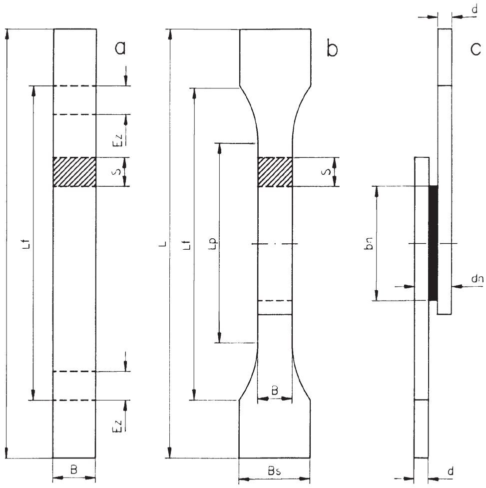

Figure 2. Sample Shapes.

a = shape 1
b = shape 2
c = shape 1 or 2 with overlap joint (e. g. V-seam)
L = length of sample
L_f = free length = clamp distance
L_p = parallel length ≥ 60 mm + b_v (at least 3 x B + b_n)
B = sample length of the measuring length
B_s = shoulder width ≥ B + 10 mm
S = sample thickness
b_n = seam width
E_z = Influence zone of clamping area
d_n = seam thickness
d = sheet thickness

4 Test Conditions

In general, the test conditions have to be adapted to the practice requirements and to be determined according to the specific application. The tensile creep test's are executed, as well as tensile creep inner pressure tests below 100 °C, in a water bath. To shorten the test times (fast time scale) the tests are executed under increased temperatures in a suitable, lifetime increasing medium. Only such medium may be used that neither effect swelling nor chemically modify the material. For tensile creep test a 2 % aqueous wetting agent solution of de-ionized water and Arkopal N100®[2)] has proved its worth as medium. The test tensions have to be chosen material specific to ensure only brittle fracture to occur. The test force is relative to the preset test tension and calculated to the smallest sample cross section. By using the test medium mentioned above brittle fractures generally occur under the testing conditions stated in section 4.1 (tension/temperature).

4.1 Test of PE liners

The following test conditions have proved worth for the tensile creep test of PE-HD liners:

– Test medium: aqueous wetting agent solution based on Nonylphenolpolyglycolether, e. g. Arkopal N 100® as 2 % solution. De-ionized water has to be used.

– Test temperature: preferably 80 °C, eventually 95 °C and 60 °C.

– Test tensions: preferably 4.0/3.0/2.0 N/mm² respectively material specific intermediate values.

4.2 Test of liners of other thermoplastics and elastomer

General applying test conditions for further liner materials have not yet been determined.

Eventually the test conditions have to be determined material specific and according to the respective experiences made in practice.

5 Procedure

The samples are worn at constant temperature (± 1 °C), maintained stationary traction ± 1 % and constant ambient conditions. The sample must be clamped the way to avoid bending and torsion of the worn sample (symmetric clamping, linked bearing). After temperature adaptation in the test bath the test force is to be applied rapidly and collision free. The duration of wear is calculated from the moment the test force has been reached and to be recorded.

A locally and chronologically constant concentration of the wetting agent (2 ± 0.5 %) has to be ensured. Circulation by means of a pump has made proof. The test tensions have to be selected the way that exclusively low deformation fractions occur. In the opposite case, lower test tensions have to be applied. Fractions in the sample's clamping zone resp. in the influenced clamping zone may not be evaluated.

To determine the gradient of the tensile creep test curves (lines in double logarithmic plots), the test have to be executed at least under 2 tensions. At least 6 fused and non-fused samples each have to be tested per tension. The average value is determined as geometric average value out of the individual values.

6 Evaluation

The tensile creep test result represents the achieved plot life in combination with failure behavior, if required in common with the temporary course of the strain. It is designated to judge the long-term behavior of the fused joint. Compared with the plot life of the raw material the long-term fusion factor f_s can be determined (see Fig. 3, 4 and 5).

6.1 Failure behavior

The samples may basically show the following failure characteristics:

– Splitting in the fusion level
– Failure of the welding condition on coated joints
– Failure in the transition area on the seam edge
– Failure of raw material outside the seam area

The kind of failure, especially fraction extension and course as well as the fraction structure (viscid, white or brittle fraction) has to be recorded for each sample. In any case, only results of the same type of failure (deformation or non-deformation fractions) are to be compared.

6.2 Determination of the long-term fusion factor

To determine the long-term fusion factor (f_s) the respective tensile creep test curve of the fused and non-fused samples has to be investigated under consideration of the important gradient of the straight line. Based on the reference tension of the reference curve B the long-term fusion factor (f_s) is determined out of the evaluated curve of the samples (see example Fig. 3).

2) (Hoechst AG). Extensive test experiences are available for this medium, especially for PE, allowing result comparison and determination of requirements. While using other products on the same basis compare the number of the ethylene oxide molecules of the poly glycol ether chain. Hessel, J. and Mauer, E., Tensile creep test of PE in aqueous wetting agent solution.