

The curing behaviour of reaction resin compounds

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This test examined the effect of various initiators on the curing behaviour of a glass fibre-filled polyester resin using a laboratory mixer.

Initiators are chemical substances which form so-called radicals under the influence of energy (e.g. heat) and which are thus able to initiate curing reactions.

The processability of thermosetting resins can be influenced by selecting the right initiators and this way to control the reaction time.

Test Purpose

Testing the curing behaviour of two glass fibre-filled reaction resins on the basis of unsaturated polyester using various initiators.

Test Equipment

- Torque rheometer system Thermo Scientific HAAKE PolyLab
- Electrically heated laboratory mixer Thermo Scientific HAAKE Rheomix 540 (Fig. 1)
- Delta rotors (Fig. 2)
- Thermo Scientific HAAKE PolySoft Mixer software

For this test we used the Rheomix 540 with Delta Rotors. This mixer and the rotors are specially designed for thermosetting material. The mixer shows a conical shaped mixer chamber that makes it easy to remove the cured and hardened sample after the mixer test.

Test Conditions

- Mixer temperature: 120 °C
- Rotor speed: 50 rpm
- Sample weight: 63 g

Test Material

- Sample 1: PES with initiator "A"
- Sample 2: PES with initiator "B"

Test Results

Diagram 2 shows the results of the mixer test of the sample using initiator "A".

Torque (M) and melt temperature (TM1) are illustrated against the test time.



Fig. 1: ThermoScientific HAAKE Rheomix 540

Basic Curve Calculation

A first maximum torque point, the Loading Peak (L), is reached due to the filling of the mixer with the test material. This first maximum point serves as a time basis for the calculation of the relevant material characteristics.

Due to the melting of the test substance and the resultant drop in



Fig. 2: Delta rotors

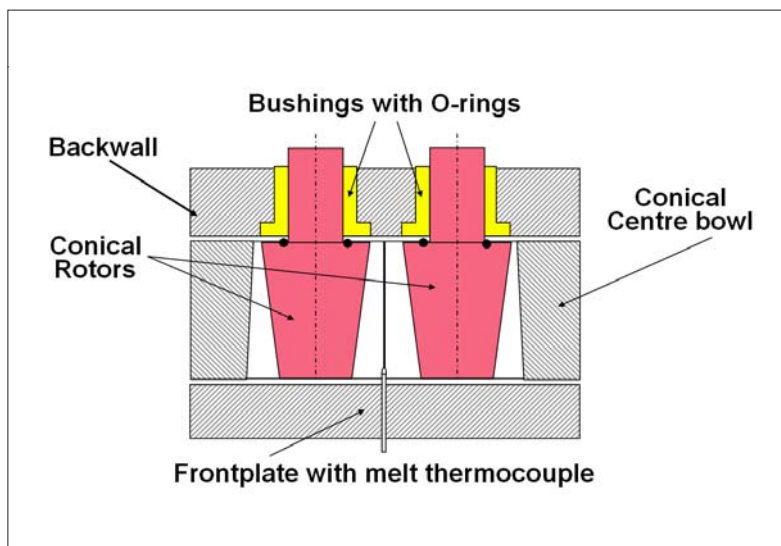


Fig. 3: Thermo Scientific HAAKE Rheomix 540, principle sketch

viscosity the torque decreases until the melting process is concluded at a minimum (MI).

The torque subsequently increases again due to the onset of curing and progresses towards a second maximum point, the Cure Peak (C).

The test is concluded after this point and the substance is mechanically destroyed.

The evaluation of the main curve points is carried out in a table below the graph.

Apart from the transient values for time and torque, the program calculates an onset of curing (On), as 20% of the torque above the minimum and the point (C80) with 80% of the torque of the cure maximum. These points are used to calculate a cure rate (GR) as a measure of the curing speed of the sample.

Fig. 5 shows the torque curves of two samples with the different initiators plotted on one graph. Clearly it can be seen, that the PES with initiator "A" starts to cure much earlier than the PES with initiator "B".

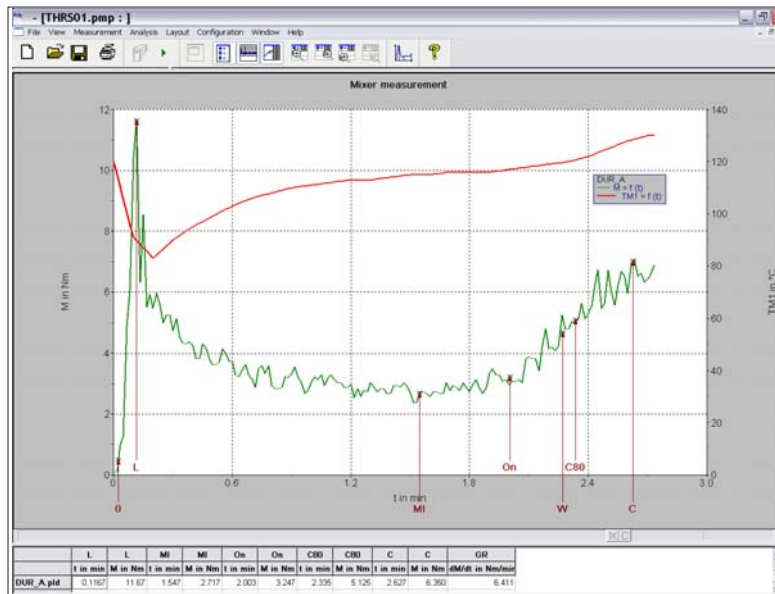


Fig. 4: Result mixer test ("DUR_A_Graph")

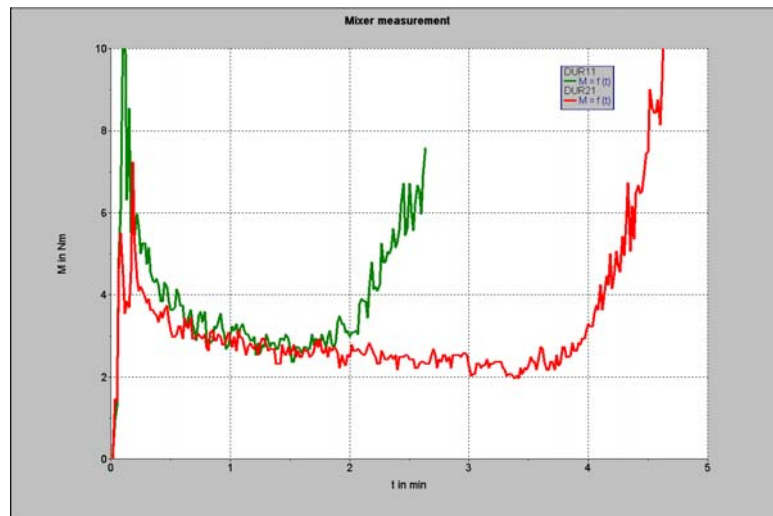


Fig. 5: Comparison of mixer test results ("DUR_1 and 2_Graph")

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