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Temperature Measurement in PU Samples during the Chemical Reaction

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Standard laboratory methods for measuring the temperature profile of polyurethane samples during the chemical reaction are mainly based on thermocouples (TC) or PT sensors which are positioned manually inside the test samples. In polyurethane foam samples the highest temperatures are normally reached in the lower third part of the sample. Non foaming polyurethane samples of **C**oatings, **A**dhesives, **S**ealants and **E**lastomers (C.A.S.E.) have their hot spot in the center of the reaction volume. Strong temperature gradients are typical inside of the samples. The exact positioning of the temperature probe is therefore critical in order to achieve reproducible and reliable temperature data. Based on this, Format Messtechnik GmbH has introduced three new test containers for measuring the reaction parameters of PU samples including improved temperature profiles.

The **B**ox **F**oam **C**ontainer **BFC 200** (fig. 1) is a new test container especially designed for low density foam formulations. The BFC 200 is made of SRBP boards forming a cube with an edge length of 200mm. For easy access to the finished foam sample two of the boards are hinged and can be flapped aside. Temperature is measured by a metal sheathed thermocouple rod. Precise positioning of the thermocouple is enabled by a specially designed holder mounted at the edge of the BFC 200. It has a boring at an angle of app. 30 degrees and a stopper for positioning the thermocouple right into the hot spot of the sample. For easy removal after the test a release agent is recommended.

The **A**dvanced **T**est **C**ontainer **ATC** (fig. 4) is a heated conically shaped container for testing PIR and PU foam formulations under elevated temperature conditions. The core temperature is measured by a glass fibre insulated thermocouple. There are three fixed thermocouple ports available in the Al body of the ATC. The flexible thermocouple is inserted from the side into the lower third part of the foam sample. In case of the thermocouple being stuck in the cured foam, it can be cut and then a new tip can be prepared. The **BFC 200** and the **ATC** are part of the Foam Qualification System FOAMAT®. A measurement result of a rigid foam formulation, measured with the ATC can be seen in fig. 2. The red curve shows the temperature profile.

SubCASE® is a test device for monitoring the pot life and the curing reaction of non-foaming PU formulations. The basic principle is measuring the dielectric polarization and the temperature during the polymerization reaction. A PT temperature probe is integrated into the bottom surface of the test container. This is used for a closed loop temperature control of the polarization sensor. A new cover plate featuring a bushing has been introduced for precise and repeatable core temperature measurement. A thin metal sheathed thermocouple is inserted into a glass tube, the tip of which is pre-positioned into the center of the sample going to be tested (fig. 5). There is no direct contact between the thermocouple and the reactive mixture. The thermocouple can be easily removed from the glass tube after the test. No cleaning is needed and it can be reused for the next test. A measurement result of a PU composite formulation is shown in fig. 3. The green curve is the core temperature. The red curve shows the contact temperature at the bottom of the sample.

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Fig. 1: The Box Foam Container BFC 200 is placed onto the base plate of the extended mechanical set. The metal sheathed thermocouple is inserted into the lower third part of the foam sample through a holder mounted at the upper edge of the BFC 200.

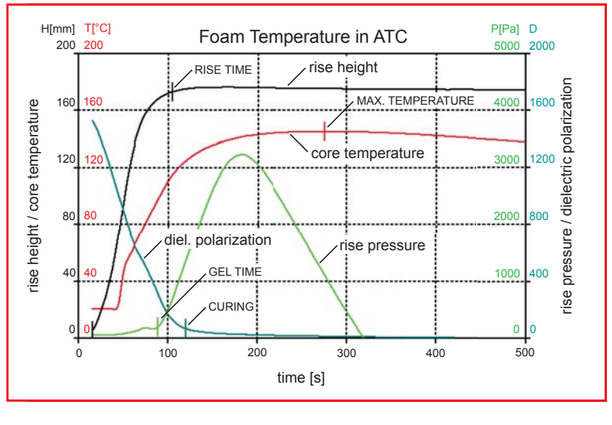

Fig. 2: Core temperature T of a rigid PU foam formulation, measured in the Advanced Test Container ATC. Additional parameters such as rise height H, rise pressure P and the dielectric polarization D are acquired simultaneously by the Foam Qualification System FOAMAT®.

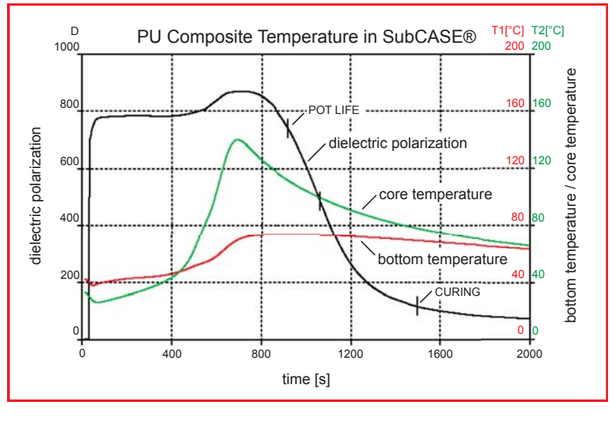

Fig. 3: The bottom temperature T1, and the core temperature T2 of a PU composite is measured by the Temperature and Curing Monitor SubCASE®. The dielectric polarization D reveals the pot life and the curing of the test sample.

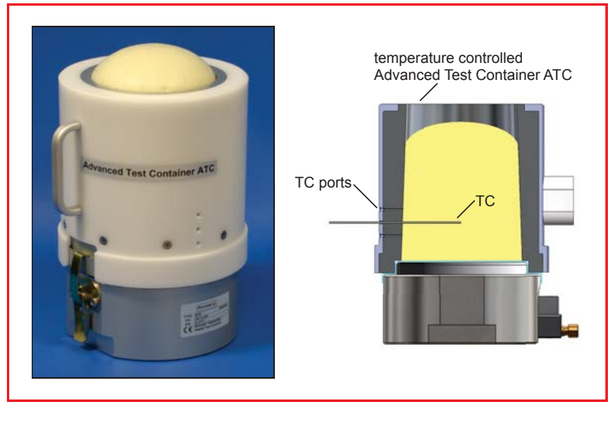

Fig. 4: The core temperature of a reactive foam sample is measured with a thermocouple, inserted through fixed ports in the mantle of the temperature controlled **A**dvanced **T**est **C**ontainer (ATC). ATC is part of the Foam Qualification System FOAMAT®.

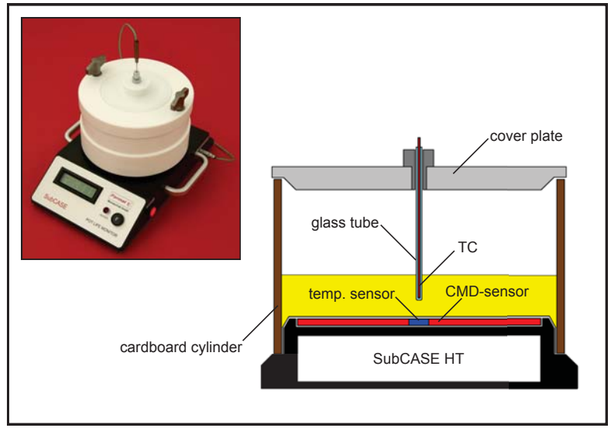

Fig. 5: The test device **SubCASE® HT** measures the temperature and the dielectric polarization of C.A.S.E. samples. The thermocouple (TC) is inserted into a disposable glass tube; the tip of which is centered in the probe.