Dielectric Polarization Measurement with CMD Provides New Insight into the Foaming Process

BERND H.W. HOFMANN
Format Messtechnik GmbH
D-76187 Karlsruhe
Germany

JEFFREY D. GROSS
Electrotech Industrial Inc.
Northfield, Ohio 44067
USA

Abstract:

Standard laboratory methods for foam testing are mainly concerned with the measurement of mechanical and thermal parameters. The linear expansion of foam samples are determined by rise height tests. Pressure measurement has been significantly improved by replacing normal test cups with the FPM system. The temperature is commonly measured by thermocouples inserted into the foam.

The dielectric polarization is a new key parameter that provides more insight into the electro-chemical processes during the transition from the liquid mixture of polyoles, additives, and isocyanates to finished PU foam with the desired properties. The dielectric polarization of liquids is measured simply by inserting surface capacitors into the sample. Though the foam components polyoles and diisocyanates have a strong electric dipole moments, this method cannot be applied to foaming materials because of their increasing volume and the formation of a solid sticky bulk. Format Messtechnik GmbH, Karlsruhe, Germany developed a new approach in polarization measurement technique. Introducing the Curing Monitor Device* (CMD) by meeting both simple handling and high polarization sensitivity, the invention combines polarization measurement with routine foam testing methods avoiding any additional recovery needs for the testing equipment.

The CMD comprises two comb shaped electrodes on a plane circuit board forming the polarization sensor. This sensor is integrated into the pressure measurement device FPM, where it completely covers the base plate at the bottom of the test volume. The rise pressure makes close contact between the foam sample and the CMD sensor, thus ensuring unspoiled penetration of the electric field. As the CMD sensor is covered completely by the liquid mixture, polarization data can be obtained from the very beginning of the foaming reaction.

Measurements made with flexible and rigid foams have shown a significant correlation between the water content of the formulation and the resonance structure in the polarization curve (fig. 1). This is caused by polyurea generation as an intermediate before it is bonded to the polyurethane matrix. The effects of catalysts, water, and additives including formulation changes can be seen most effectively in the polarization curves (fig. 2). The negative slope of the polarization curve represents the curing behavior of the foam which can be correlated to rise height, shrinkage, pressure and other data provided by the Foam Qualification System FOAMAT.

*Patent pending

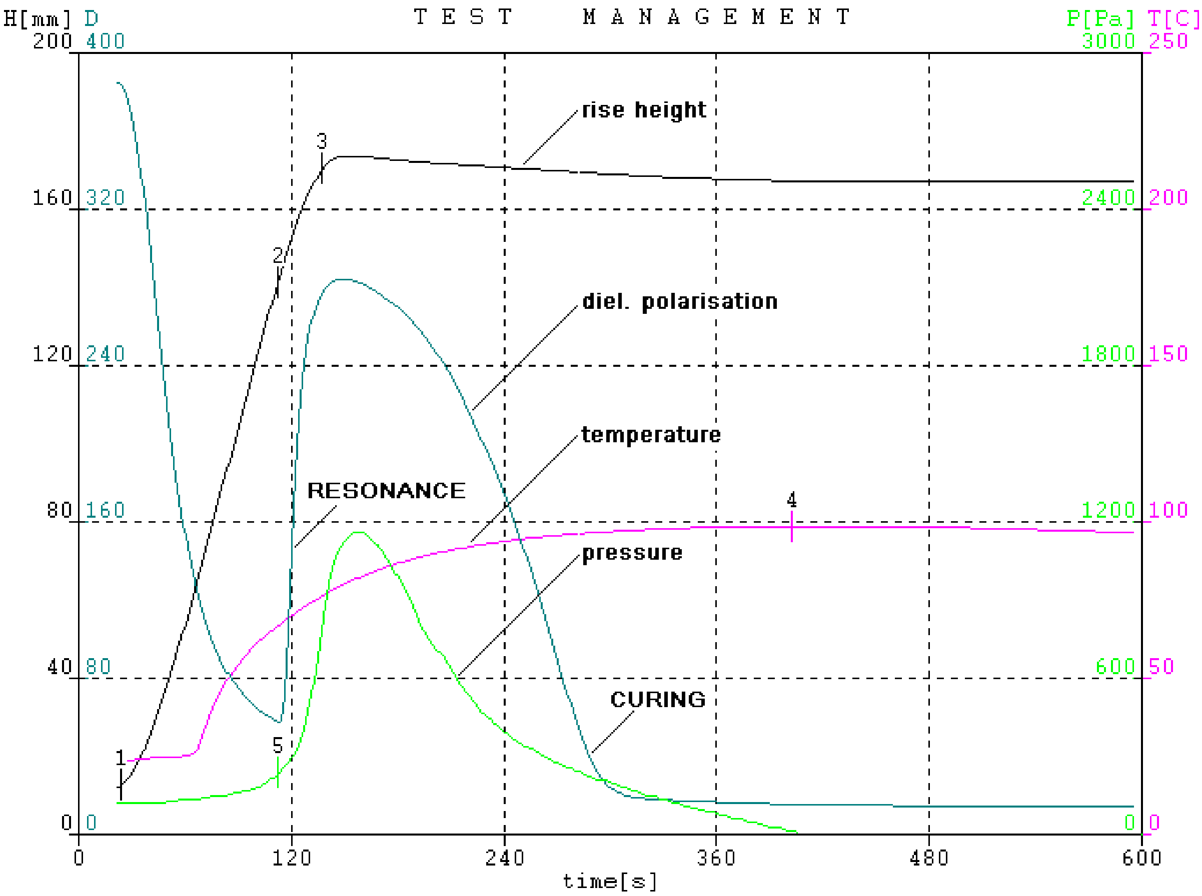

Figure 2. *Dielectric polarization measured with CMD, and other physical data obtained for a molded foam. The polarization curve shows a significant resonance structure and the curing behavior.*

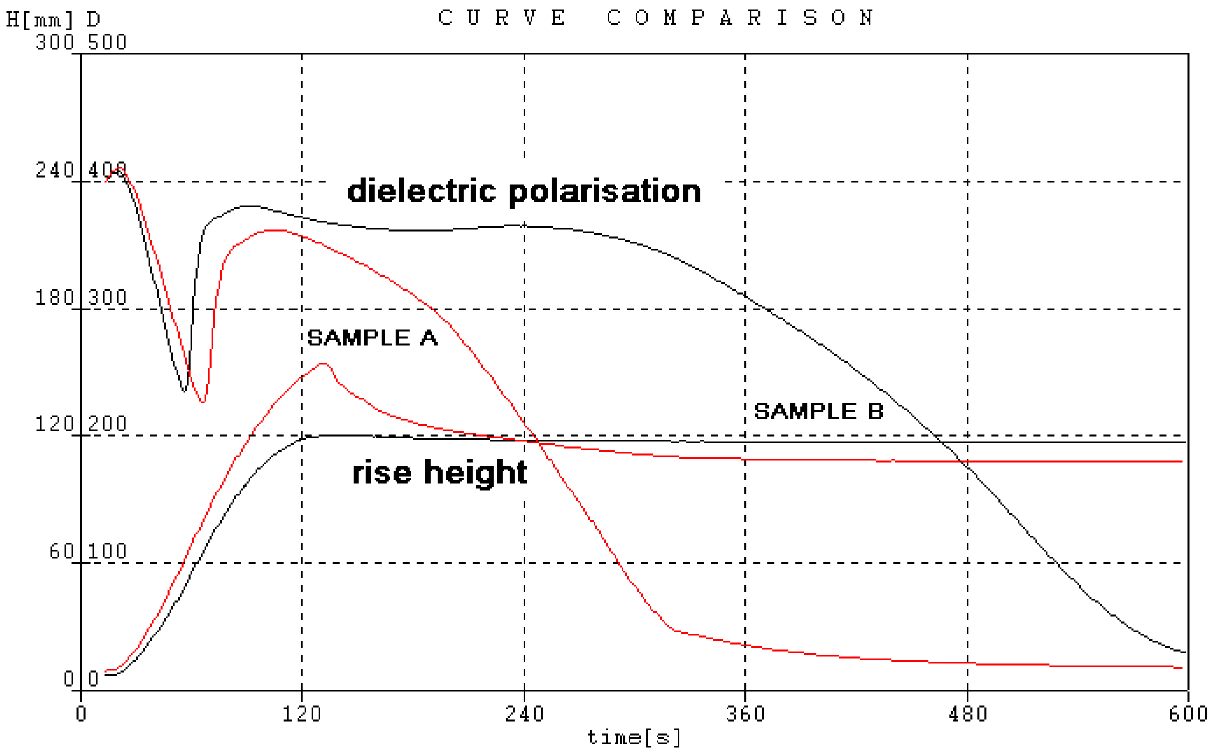

Figure 2. *Comparison of the rise height and the dielectric polarization for two flexible foam samples with different isocyanate content. Sample B was made with 5/3 of the isocyanate amount of sample A.*