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Test method

Evaluation of the influence of testing parameters on the melt flow index of thermoplastics

Sérgio D.C. Guerreiro [a], Isabel M. João [a], L.E. Pimentel Real [b,*]

[a] Área Departamental de Engenharia Química, Instituto Superior de Engenharia de Lisboa, IPL, Rua Conselheiro Emídio Navarro, 1 1959-007 Lisboa, Portugal
[b] Departamento de Materiais, Núcleo de Orgânicos, Laboratório Nacional de Engenharia Civil, Av. do Brasil 101, 1700-066 Lisboa, Portugal

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ABSTRACT

The main goals of the present work are the evaluation of the influence of several variables and test parameters on the melt flow index (MFI) of thermoplastics, and the determination of the uncertainty associated with the measurements. To evaluate the influence of test parameters on the measurement of MFI the design of experiments (DOE) approach has been used. The uncertainty has been calculated using a "bottom-up" approach given in the "Guide to the Expression of the Uncertainty of Measurement" (GUM).

Since an analytical expression relating the output response (MFI) with input parameters does not exist, it has been necessary to build mathematical models by adjusting the experimental observations of the response variable in accordance with each input parameter. Subsequently, the determination of the uncertainty associated with the measurement of MFI has been performed by applying the law of propagation of uncertainty to the values of uncertainty of the input parameters. Finally, the activation energy (Ea) of the melt flow at around 200 °C and the respective uncertainty have also been determined.

1. Introduction

Polyethylene (PE) is one of the most widely used thermoplastics [1]. Its main qualities are the desirable balance between its physical properties in the solid state and its chemical inertness. The combination of these qualities together with its low cost and ready processability makes PE the material of choice for a wide variety of uses [2].

Melt flow index (MFI) is a parameter that plays an important role in the plastics industry and is likely to remain a dominant tool for quality control [3], mostly due to the ease of operation, good repeatability of results and low cost [4]. It fulfills a requirement for rapid material characterization, specifically for checking against specification and for assessing processability in terms of the material's ease of flow [3], which depends on its molecular mass and viscosity.

MFI is basically quantified by the measurement of the melt mass flow rate (MFR) or melt volume flow rate (MVR), being defined as the weight (g) or the volume (cm^3) of the polymer extruded in a specified period of time (usually 10 min) through a capillary of specific diameter and length by the pressure applied by a dead weight under prescribed temperature conditions [5,6].

Over the years, it has been observed that MFI correlates well with a number of useful parameters, such as reaction temperature and catalyst activation temperature during polymer manufacture [7].

However, when reporting the results of the measurement of a physical quantity, it is necessary to provide a quantitative indication of the quality of the results so as to give some information on their reliability. Without such an indication, measurement results cannot be compared, either between themselves or with reference values given

* Corresponding author. Tel.: +351 218443737; fax: +351 218443023.
E-mail address: lpimentel@lnec.pt (L.E. Pimentel Real).

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