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Plastics — Determination of resistance to environmental stress cracking (ESC) —

Part 1: General guidance

Plastiques — Détermination de la fissuration sous contrainte dans un environnement donné (ESC) —

Partie 1: Lignes directrices générales

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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ISO 22088-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

ISO 22088 consists of the following parts, under the general title *Plastics — Determination of resistance to environmental stress cracking (ESC)*:

— *Part 1: General guidance*

— *Part 2: Constant tensile load method* (replacement of ISO 6252:1992)

— *Part 3: Bent strip method* (replacement of ISO 4599:1986)

— *Part 4: Ball or pin impression method* (replacement of ISO 4600:1992)

— *Part 5: Constant tensile deformation method* (new test method)

— *Part 6: Slow strain rate method* (new test method)

Introduction

When a plastic material is stressed or strained in air below its yield point, stress cracking can occur after a period of time, which may be very long. These stresses may be internal or external, or a combination of both. Simultaneous exposure to a chemical environment and stress or strain may result in a dramatic shortening of the time to failure compared to that in an inert environment. The phenomenon is referred to as environmental stress cracking (ESC) and is exhibited by many materials, including plastics. The permissible long-term stress or strain may be reduced considerably by this phenomenon.

It is generally believed that ESC occurs via the following processes:

1) Formation of microvoids in specimens by microscopic stress concentrations after applying stress.

2) Formation and subsequent growth of macrovoids caused by the breakdown of intermolecular bonds in intervoids that is produced by the action of a chemical environment, and formation of crazes which are composed of interconnected voids and fibrils.

3) Growth of the crazes caused by the break-down of the fibrils due to the applied stress and contact with a chemical environment.

4) Finally, a crack starts at the tip of the craze, leading to brittle failure.

The cracks may penetrate completely through the thickness of the material, separating it into two or more pieces, or they may be arrested on reaching regions of lower stress or different material morphology.

The determination of ESC is complex because it is influenced by many parameters, including:

— test specimen dimensions;

— test specimen state (orientation, structure, internal stresses);

— specimen preparation;

— thermal history of specimen;

— stress and strain;

— temperature of test;

— duration of test;

— chemical environment;

— method of application of stress and strain;

— failure criterion.

By keeping all but one parameter constant, the relative influence of the variable parameter on ESC can be assessed. The main objective of ESC measurements is to determine the relative effect of chemical media exposure on plastics (test specimens and articles).

The measurements may also be used to evaluate the influence of the moulding conditions upon the quality of an article when the failure mode corresponds to that obtained in actual service.

It is almost impossible, however, to establish any direct correlation between the results of short-duration ESC measurements on test specimens and the actual service behaviour of articles, because the behaviour of the latter is likely to be more complex than that of test specimens.