Crack Knacker© PS-2 - Instruction Manuel

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Introduction

The Crack Knacker© PS-2 is a chemical solution to test plastic parts. With the help of this solution it is possible to determine part defects like, weld or meld lines, air streaks and residual or surface stress cracks. The colour system of this chemical surfactant contains a special combination of chemical agents which reacts micro cracks or other type of residual stress morphologies. In connection with the developer agent EN-1 the intensive red colour has the advantage and make possible to test plastic parts having dark or black colours.

Through its moderated effect in comparison with traditional stress cracking media, such as glacial-acetic-acid or toluene and n-propanol, the threshold records of time dependent cracking can be documented by applying Crack Knacker© and set as the quality criterion for plastic part.

With the new formulation of the Crack Knacker© PS-2, the recipe is now a little more aggressive than its predecessor, so that cracks can be observed in short times, but without being so strong that a distinction between good and bad parts was no longer be possible.

The Following pages illustrate the applying method of the new Crack Knacker© PS-2 and the interpretation of its possible results.

1. Stress Cracking

Cracks are mainly due to high stress conditions in the molded part. Several factors are crucial for the cause of the stress cracking failure in injection molded parts:

- an increased residual stress and / or mechanical stresses
- wetting with a stress-crack-inducing medium
- exposure of parts in stress cracking mediums or environments

In this context the residual or mechanical stresses can be understood which are present during the injection molding process itself and the cooling process inside mold cavity without any external load on the molded part. Further, mechanical stresses are introduced by the assembly of the individual structural components of a complete part.

By higher stress conditions the positions of morphological residual stress areas of molded part introduce micro-cracks or crazing under the exposure of stress cracking mediums or environments. The stress cracking favours to reduce the influence of media through the cohesion of micro-molecules and thus a local relaxation of the material is facilitated by micro-cracks. This phenomenon is strongly influenced by wetting, diffusion and swelling properties of the medium. Some polymer materials can experience stress cracks in contact with certain media at lower tensile stress conditions against which they prove to be chemically resistant under unloaded condition.

The stress-cracking medium experiment can be used to determine the amount of residual stresses present in molded part. The experiment time usually depends upon the rate of reaction

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and present residual or mechanical stresses inside the molded part. The stress-cracking test is primarily used to assess the fitness for use and control of the processing conditions of molded parts.

2. Functioning Principle

The Crack Knacker© PS-2 is a mixture of different chemical agents and additives including an intensely red coloured fluorescent dye. After applying the Crack Knacker© PS-2 on the test object, the diffusion of medium takes place into the free space of molecular chains of matrix material and weakening of molecules chains bonding forces occur through the physical effects (e.g.; swelling, softening) and the areas of higher residual stresses appears with micro-cracks. The colour composition penetrates deeper into the test part surface and stays inside the cracking areas after washing or cleaning which can be easily noticed optically and is even applicable for dark or black test parts under florescence UV-light using developer agent EN-1.

The specially adapted formulation according to the requirements of the plastics industry has the effect that an assessment of present residual stresses can be determined by the course of micro-cracks development.

The Crack Knacker© PS-2 test is applicable for variety of different polymer materials:

- Polystyrene PS
- Polymethylmethacrylate PMMA
- Polycarbonate PC
- Polyethylenterephthalat, PET (amorphous)
- Styrene-Copolymer / -Blends ASA SAN ABS PC/ABS PC/ASA
- Polysulphone PSU
- …

With regard to the stress-cracking test, the medium is particularly suitable for amorphous synthetic materials. The medium is also suitable for the detection of surface defects such as weld-lines, streaks, etc. and considering the phenomenal background also deemed to be suitable for many semi-crystalline materials.

3. Application

Preparation

Since the Crack Knacker© has an intense colouring effect on almost all surfaces, therefore it is recommended to use a protecting foil (e.g.; aluminium foils) to keep the work surface or place clean.

Even if the Crack Knacker© poses no immediate danger to the user, the colouring effect is very intense and long lasting therefore, for personal safety use hand gloves and laboratory gowns. Please take into account the points included in the Safety-Data-Sheet.

The Crack Knacker© should not be used to make visible any sort of production dirt or impurities which are not visible to naked eyes on molded parts.

Application of Crack Knacker© on Test Part

Apply the Crack Knacker© by using the supplied brush on the complete surface of the test part or on the areas of interest where defects are being assumed. The colour system must act on the test surface. This depends upon the polymer material type being tested. For more detail see table 1.

Figure 1: Application of Crack Knacker© using brush (source: Kunststoff-Institut Luedenscheid)

Due to the variety of different types of polymers the values presented in table 1 may only represent an approximation. In individual cases may be significantly longer exposure time is required.

The exposure response can thus be determined, which reflect a quality assurance statement about the location and intensity of existing residual stresses in the part. This can be interpreted as shorter the response time, the higher the magnitude of residual stresses in the tested part was.

Failure image	Polymer material type	Response/reaction time
Detection of existing cracks e.g. by climate change tests or other functional tests	For all polymer material types	0,5 to 3 Minutes
Test for residual stresses	Polystyrene, Polycarbonate	5 Minutes to 6 hours
Test for residual stresses	ABS, ASA, etc.	4 to 12 hours
Visualisation of surface defects	Amorphous Thermoplastics	12 to 18 hours
Visualisation of surface defects	PET und PBT	>18 hours

Table 1: Response or reaction time of Crack Knacker© PS-2 (selection criteria)

Cleaning

To evaluate the stress cracking the testing fluid can be cleaned using e.g. cleaning paper or cloth. If the excessive testing solution is removed with water make sure that this water cannot be drain out to the sewer. After removing test fluid dry out the remaining water in this case thoroughly with a cleaning paper or towel. Water residues can hinder the application of the developer. In white or transparent test parts stress cracks or other surface defects are already recognizable at this point.

Application of Developer Agent EN-1

To improve the test results for black or dark colour parts the developer agent Crack Knacker© EN-1 should be used by spraying it evenly onto the test surface from 15 to 30 cm distance. After drying in approximately 30 min. the surface or residual stress defects will appear as red marks on the white surface of the developer agent. This colour system formulated with fluorescent colourer which make defects clearly noticeable under UV-light. This can significantly increase the detection sensitivity again.

4. Example of CD Stack-box

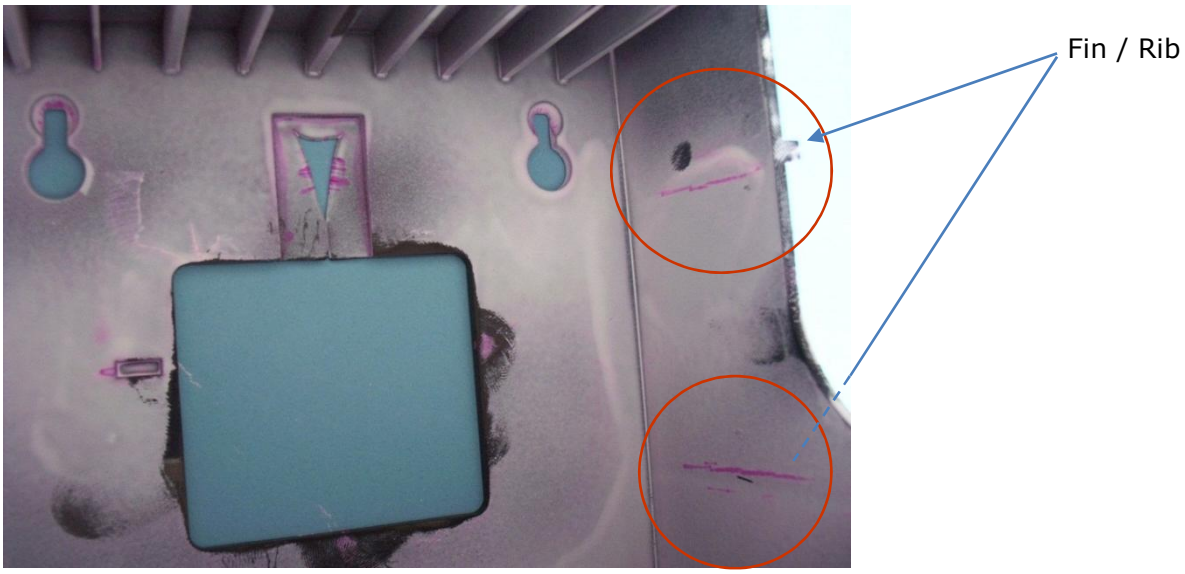

Figure 2: „CD-Stack-box", residual stresses in the area of fins or ribs (source: Kunststoff-Institut Luedenscheid)

Figure 2 represents CD-stack-box manufactured by injection molding process in black colour using polycarbonate material treated as detailed in previous section. The objective of this test part was to determine the high residual stressed areas. The response time of Crack Knacker© PS-2 was approximately 20 min. The residual stress cracking is clearly visible in the areas of ribs by red coloured contrast.

Physical description:
The larger cross-section in the transition from the rib to the molding wall leads to an accumulation of material. Consequently, these areas are expected under the influence of non-uniform temperature distribution which leads to higher residual stresses or morphological distortions. In addition, the process parameters, such as low mold wall temperature, holding pressure profile and injection speed or profile also affect the formation of residual stresses.

Remedy:
Large wall thickness distribution must be avoided which leads non-uniform cooling of molded part or this must be adjusted through optimized mold cooling channel concept. In this particular case the wall thickness distribution of ribs must take under consideration which should be for amorphous material with in the ratio of maximum 1:2. Additionally the defects can be minimized through processing parameters (i.e.; variation in injection speed or profile, reduction of holding pressure or increase in mold wall temperature or increase of cooling time for molded part inside mold cavity). However, higher response time of Crack Knacker© PS-2 is an evidence of reduced residual stresses and other related surface defects in molded parts.