

Examining the Fusion and Degradation Behavior of PVC Dry Blends with the HAAKE PolyLab QC

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Key words:

- Mixer Test
- PVC Dry Blend
- Fusion & Degradation Behavior

Abstract

PVC dry blends often have the tendency to exhibit greatly differing melt and degradation characteristics after undergoing comparatively small alterations in the recipe. This can lead to variety of problems during processing such as e.g. reduced impact strength or the coloring or degradation of the extrudate.

The PolyLab System offers a quick and reliable method of examining these material characteristics.

Introduction

The test aim was the differentiation between two PVC compound formulations, which only differ with respect to 0.1% stabilizer content.

Test sample

PVC Dry Blend compound with:
PVC19STB = 1.9% Stabilizer
PVC20STB = 2.0% Stabilizer

Test equipment

Torque rheometer system Thermo Scientific HAAKE PolyLab with:

- Thermo Scientific HAAKE PolyLab QC
- Laboratory mixer Thermo Scientific HAAKE Rheomix 600
- Roller rotors
- Thermo Scientific HAAKE PolySoft mixer software

Test conditions

Mixer temperature: 170°C
Rotor speed: 60 rpm
Sample weight: 65 g

Test Result & Evaluation

Fig. 2 illustrates the results of the mixer test of the PVC compound formulation with 1.9% stabilizer.

Basic curve discussion

The initial filling of the mixer results in the First Torque Peak or Loading Peak (MA1). This peak serves as the starting time for the calculation of the various substance characteristics.



Fig. 1: HAAKE PolyLab QC with Rheomix 600

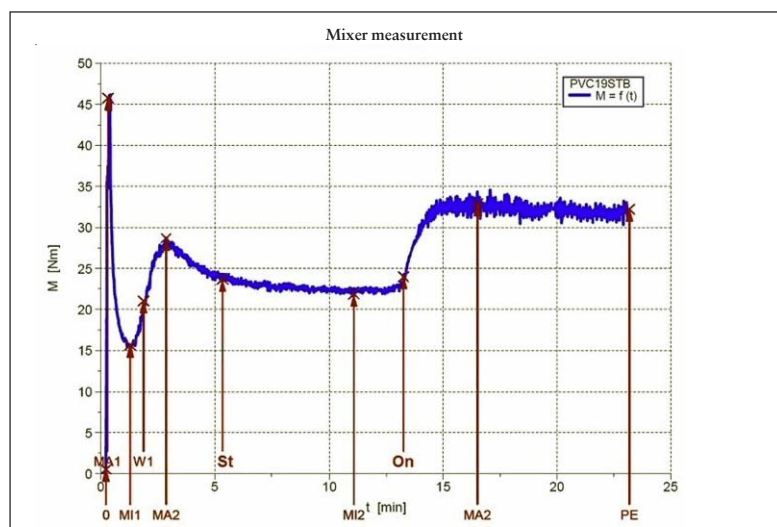


Fig. 2

The sample is now distributed in the hot mixer chamber and additives with a low melting point do melt. Because of this, the torque value drops to a minimum value known as the Valley (MI1).

Due to friction and heat the PVC powder now starts to agglomerate. This increases the compound viscosity and causes a second rise in torque. The agglomeration process is finished, when the compound formed a homogenous melt. In the torque curve this can be seen as a

second maximum, the Fusion Maximum (MA2).

After the fusion the torque drops again until the melt temperature of the sample comes to equilibrium between the mixer temperature and the heat generated by shearing. The resulting second Minimum (MI2) is a relative value for the melt viscosity.

The stabilizers added to the PVC compound have the task to catch chlorine ions which were separated from the polymer chains. A stabilizer has a certain capacity to bind those

chlorine ions. After the stabilizer is saturated, the free Chlorine ions will cause the PVC degradation. This comes along with a crosslinking reaction which can be detected as a third rise of the torque curve.

The point where the torque value starts to rise again is called the Onset of Degradation (On). This characteristic point is usually defined as 10% of the increase of the torque signal after having passed the Minimum Torque Value. The so-called Stable Point (St) is reached by locating this 10% value before the Minimum. The time between the Stable Point and the Onset of Degradation point (Stable Time) is generally taken to be a relative measure for the compound stability against thermal degradation.

Results and Discussion

The torque/time curves of both PVC compounds are shown superimposed in Figure 3.

One can clearly see that the sample with a higher stabilizer content of 2.0% has a longer Stable Time.

The graph also shows, that the difference of 0.1% in stabilizer had no influence on the Minimum and so on the melt viscosity of the compound.

Very important is the fact, that the change in stabilizer content also shows a significant effect on the fusion behavior of the PVC compound. The compound with the higher stabilizer content needed a longer time to reach the fusion maximum.

In production this would have a significant influence on the degree of the compound gelation and so on the mechanical property of the final product.

Summary

As can be seen from this example, twenty minutes spent on prior sample testing can prevent subsequent time-consuming and costly production problems.

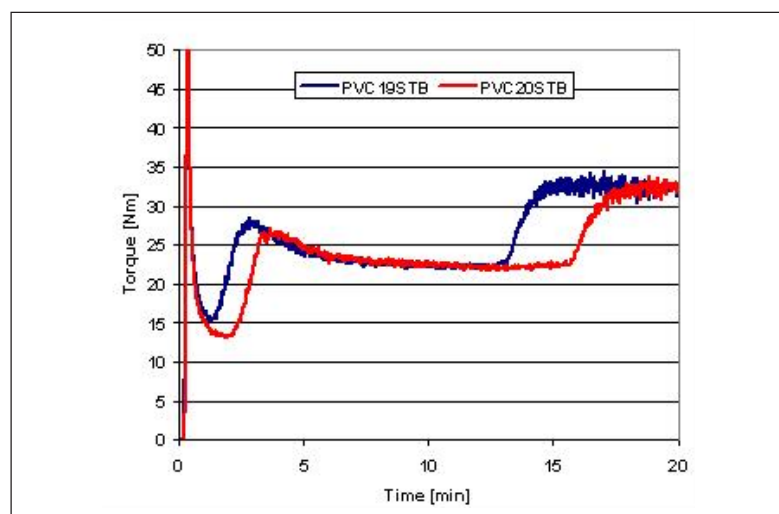


Fig. 3

Process Instruments

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