Determination of Moisture in Acrylonitrile/Butadiene/Styrene Polymer

SUMMARY

Moisture content in acrylonitrile/butadiene/styrene (ABS) is important because it affects processing of the material. Moisture evolution analysis (MEA) provides a quick and easy method for determining water at levels as low as 10µg/g in ABS.

INTRODUCTION

ABS copolymers are a widely used series of polymers possessing high impact resistance, high heat-distortion temperatures, moldability, and moisture and chemical resistance (1). They can be injection molded or extruded and find many uses, particularly in automobile and aircraft applications, as a replacement for metal.

ABS is a mildly hygroscopic resin whose moisture content varies with the relative humidity of the atmosphere to which it is exposed (2). High moisture content in the resin at the time of molding or extrusion can cause bubble formation, splay and/or surface craters (2, 3, 4). For this reason, most fabricators dry their resins prior to molding.

The TA Instruments 903 Moisture Evolution Analyzer can be used to quickly and accurately determine the moisture content in ABS molded parts, resin pellets and powders. Water levels as low as 10mg/g can routinely be determined. With special care (e.g., dry box environment) levels or accuracies as low as 1µg/g are possible.

EXPERIMENTAL

The experimental conditions used depend to some extent upon the form of the sample and the moisture level. In the example given, powder samples containing 0.1 to 1.0% moisture, were analyzed.

- Sample weight: 0.1-0.4g
- Temperature: 130°C
- Time: 20 minutes
- Flow Rate: 50mL/min

1. The sample is placed in a tared sample boat and rapidly placed in the instrument.
2. The sample is analyzed under the conditions shown above and the "count" recorded.
3. The sample is removed from the instrument and weighed.
4. The count thus obtained is compared with a blank count previously obtained with no sample in the chamber, but otherwise identical conditions (including opening and closing of the sample chamber.
5. Using a calibration factor obtained by running a standard of known moisture content (e.g., sodium tungstate dihydrate), moisture level in the sample is calculated using the following equations.
CALCULATIONS

Water level (%) = \frac{K(C_{\text{sample}} - C_{\text{blank}})}{W_{\text{sample}}} x \frac{F \times W_{\text{std}} x 100}{C_{\text{std}} - C_{\text{blank}}}

Where:
- $C_{\text{blank}}$ = count obtained for blank
- $C_{\text{sample}}$ = count obtained for sample
- $C_{\text{std}}$ = count obtained for standard
- $F$ = fraction of standard material attributable to water
- $K$ = calibration factor in milligrams water per count (should be near 0.1)
- $W_{\text{sample}}$ = weight of sample in milligrams
- $W_{\text{std}}$ = weight of standard in milligrams

RESULTS

Since the sample is weighed after analysis (to avoid rapid moisture exchange between the sample and room humidity), this method of calculation results in a percent moisture level on a "dry sample" basis. If results are to be reported on a "wet sample" basis, the following correction should be applied.

Wt. % moisture (wet) = \frac{\text{Water level } \% \text{ (dry)}}{1 + [0.01 \times \text{Water level } \% \text{ (dry)}]}

It is apparent that this correction is significant only at moisture levels greater than 1%.

Using this procedure, four samples containing 0.1 to 1.0% moisture were analyzed in quadruplicate. A pooled deviation of 0.016% (abs.) was obtained.

Moisture is evolved from powder samples much more rapidly than from pellets and molded parts. It is necessary, in this situation, to reduce the purge gas flow rate from its factory set rate of 100 ± 20 mL/min to 50 ± 10 mL/min to obtain optimum precision and accuracy.

If rapid analysis times are required, higher temperatures can be used to increase the rate of moisture evolution. Temperatures as high as 150°C have been used.

This type of test method is applicable to many other polymers including polyolefins, polyamides, polycarbonates, polyesters, and ionomers (5).

Sodium tartrate dihydrate (F = 0.1566) and sodium tungstate dihydrate (F = 1.1092) are acceptable gravimetric standardization materials. Water itself (F = 1.000) can also be used in the microcapillary technique described in the Operator's Manual.

REFERENCES

5. ASTM Test D4019-81.

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