Hydroxyl Value and Isocyanate Content in Polyurethane

Description

It is nearly impossible to imagine a day in your life when you did not encounter a plastic object. Ever since polymer, the first synthetic plastic, was invented in 1907, plastics have become an integral part of modern industry. Everything from food packaging to aerospace parts uses plastics as critical components in their construction. Even many liquid products, such as adhesives and paints, contain plastics as main ingredients. The popularity of plastic as a raw material stems from its high degree of customization. Adjustments to plastic formulations allow the product to be soft, hard, colored, transparent, flexible, or adhesive. This means there is a type of plastic for virtually every application.

One commonly used type of plastic is polyurethanes. Polyurethanes are produced by reacting raw polyols with isocyanates. Polyols are a type of alcohol with multiple hydroxyl groups (-OH); isocyanates are chemicals that contain a nitrogen, carbon, and oxygen double bonded in a chain (N=C=O). The two ingredients react to produce a polymer with a wide variety of characteristics, such as heat resistance. Other ingredients can be added to create a soft foam or a hard coating. Due to its versatility, finished polyurethanes are used in a wide range of applications, from roller coaster wheels to Spandex.

One of the most important parameters in polyurethane production is the isocyanate content index. This index is the ratio between isocyanates and hydroxyl groups. In most polyurethane production facilities, the ideal ratio is just over 1.00, meaning that isocyanates are in slight excess. The excess allows manufacturers to account for the loss of isocyanates due to side reactions. If the isocyanate content is too high or too low, drastic changes in the properties of the finished product can occur. Further, due to the toxicity of isocyanates, both industry and environmental regulators are making efforts to minimize isocyanate use.

The isocyanate index is determined by measuring both the isocyanate content and hydroxyl value. Titration is an acceptable method for both of these parameters. Isocyanates are determined by dissolving the material in toluene and reacting the isocyanates with a known amount of dibutylamine present in excess. The excess dibutylamine is then back-titrated to an equivalence point with tetrabutylammonium hydroxide (TBAOH). A pH electrode is the potentiometric indicator in both titrations.

Application

A polyurethane manufacturer contacted Hanna Instruments for an automatic titrator to replace their aging system in the Quality Control department. The customer was familiar with the titrations and wanted a unit that could perform both hydroxyl number and isocyanate content. Hanna Instruments recommended the HI902C Automatic Potentiometric Titrator. The customer was accustomed to the modular nature of many other potentiometric titration systems on the market, but appreciated the all-in-one nature of the HI902C. This meant that they did not have to keep track of various components in the small testing lab. Further, the customer enjoyed the ability to export titration reports in a delimited file format using a PC and the included HI900 software.

The HI902C is equipped with a precision dosing system comprised of a 40,000 step dosing pump and options for 5, 10, or 25 mL burettes. Because of the slow reaction time associated with non-aqueous titrations, the customer appreciated the extremely small minimum dose of 0.001 mL they could achieve by combining the high precision pump with a 10 mL burette. Hanna Instruments recommended the HI1048 pH Electrode with Clogging Prevention System (CPS) for their titrations. The HI1048 electrode is refillable and has a PTFE and ground glass junction that permits a high flow rate of electrolyte. This junction design allows electrolyte to diffuse rapidly into the sample, providing stability to measurements. The refillable nature of the electrode meant that the internal electrolyte could easily be exchanged for a non-aqueous electrolyte more suitable for their application.

Hanna Instruments’ service was a big benefit to the customer. Sales were instrumental in ensuring that the customer received everything they needed to perform the method. After the sale, they appreciated how quickly and easily the Technical Support and Applications Teams answered any questions regarding the application. Overall, the customer found that Hanna’s titration system offers value and ease of use in their quality assurance program.