SKILL BUILDER

QUAKER HOUGHTON DIE CASTING PRODUCT SELECTION: INTERPRETING A DIE LUBRICANT EVALUATION REPORT

Overview

Due to the complexities of the die casting production process, proper die lubricant selection can be a laborious task. Such variables include, but are not limited to:

- Type of part casted
- Type of alloy
- Die temperatures
- Alloy temperatures
- Cooling method
- Spray volume
- Cycle times

Variables outside of the direct die casting production process that affect lubricant selection include secondary process compatibility, wastewater treatment methods, and local health, safety, and environmental policies.

Since die casting production trials typically require significant equipment and resources, and involve time investments and casting loss, Quaker Houghton has established a 4-part laboratory test method for chemical testing to evaluate die lubricants and generate product recommendations. This chemical testing method is an effective approach to obtain baseline data, which is used in context of the customers objectives to determine an appropriate replacement product.

Quaker Houghton's testing methodology greatly streamlines the lubricant selection process, assists in optimization, and can be completed within hours. This eliminates the need for extensive, time-consuming process surveying.

This lab evaluation method consists of four tests:

- Solids content
- Visual analysis
- Thermogravimetric analysis (TGA)
- Infrared Spectroscopy (FTIR)

Solids Content

Solids content is one of the most important aspects of the die lubricant. This is a measure of the active content, or non-water components, in the die lubricant. Solids content analysis involves the use of a solids meter, which consists of a heat source and scale. The measured weight differential as the water is dried from sample is the solids content. Expressed as a percentage, solids content is a quantitative measure of active contents of the product.

Solids content is an important consideration for determining the correct dilution ratio, or concentration, to run a die lubricant. For instance, if two products were considered of similar chemical composition but differed in solids content, the lower solids content product must be ran at a higher concentration to match the performance of the more robust product. While typically higher solids can allow for higher dilution ratio, this could result in too much water being applied to die. Adjustments to the process beyond concentration may be required, such as spray time and spray volume to accommodate products of significantly different solids content.

Sartorius Mark 3 moisture meter to determine solids content

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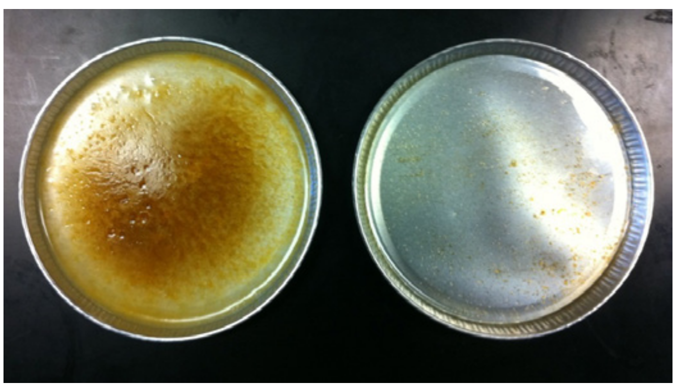
Visual Analysis

Visual analysis is a qualitative observation of the non-water components in a die lubricant formulation. This can be conducted immediately following solids content analysis, which yields a dried sample on an aluminum pan. Since water in the die lubricant formulation, as well as dilution water, evaporate and carry off heat from the die face during the spray cycle, observation of the dried sample gives a visual representation of what is actually being sprayed onto the die face. Important evaluations of lubricant synergy and wetting can be observed, as well as observations relating to wax and other additive content. This allows for a proper assessment of how effectively a lubricant can provide a homogeneous barrier coating on the die face and whether a lubricant may have a tendency to build-up on the die or stain parts.

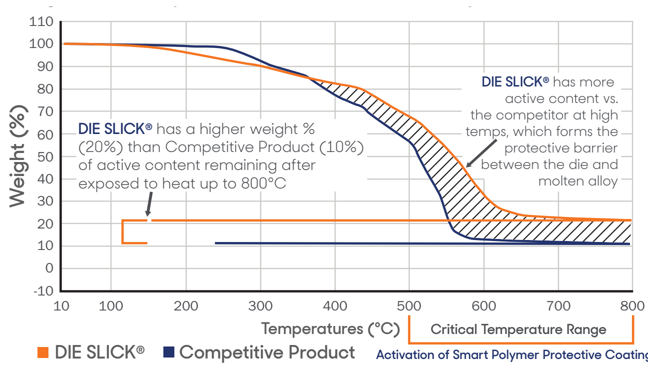


Example of dried sample for visual analysis. Left product yields significant residue while product on the right dries clean.

Thermogravimetric Analysis (TGA)

TGA is used to evaluate the thermodynamic stability of the active content (non-water material) of a die lubricant. This is a measurement of how much heat a lubricant can tolerate before decomposition, which is graphed as weight percent versus temperature. To perform a TGA, a dehydrated lubricant sample is placed on a scale or balance surrounded by a furnace within the instrument, then heated up to 800°C over a determined amount of time. The ability of a die cast lubricant to release a part and protect the die from solder is directly related to thermodynamic stability, so TGA is essentially an evaluation of die lubricant performance. Since the die lubricant must be able to perform at molten alloy temperature, the most significant area of the graph is the critical temperature range, which is the weight percent remaining at the molten alloy temperature, such as 650-700°C for aluminum alloys. When multiple products are compared, the product with a higher percentage of mass remaining at the critical temperature range would be considered more thermodynamically stable and exhibit better solder resistance.

TGA Spectrum of DIE SLICK® vs. Competitive Product



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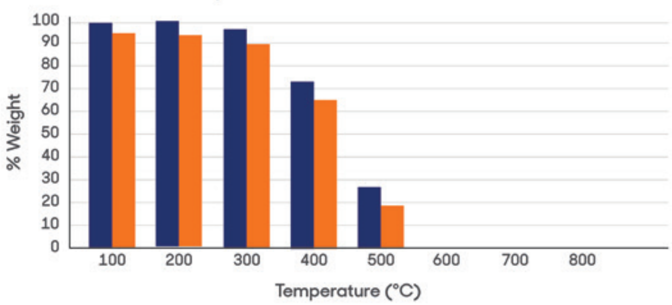
TGA as a Function of Solids Content

While we can use TGA to analyze the thermodynamic properties of the active components within each product, it must be noted that the test is performed with a dehydrated sample, meaning that all of the water has been removed from the product. Since not all die lubricants contain the same amount of active components, the TGA results must be interpreted in context of the solids content. In reports in which multiple products are compared, a graph of TGA curves with solids factor is included to show an adjusted curve that considers the robustness of each product. This is essential in many cases where a lower solids content product may outperform a higher solids content containing product on a TGA curve.

Graph of TGA Curve With Solids Factor

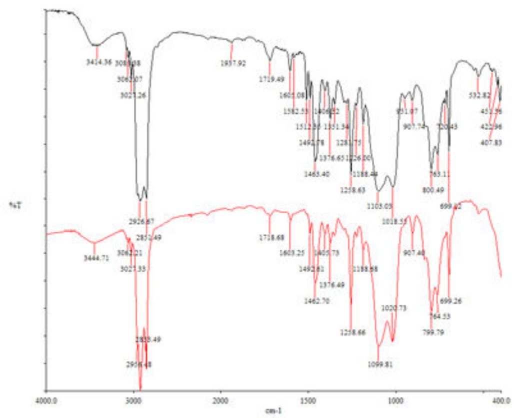


Infrared Spectroscopy (FTIR)

Fourier transform infrared spectroscopy is a laboratory technique that is used to obtain an infrared spectrum of a material. For die lubricant analysis, this provides data about the composition of a product. Since the infrared spectrum allows us to confirm whether certain functional groups exist within a formulation, FTIR is essentially an assessment, or fingerprint, of characteristic components within a given product.

For example, FTIR can indicate the presence of common die lubricant components such as polysiloxanes, esters, and waxes. FTIR may also be used to identify components of a product which may interfere with secondary processes.

FTIR Comparison of Two Products



Summary

Quaker Houghton has established a highly effective laboratory method to appropriately determine replacement products. When taken into consideration of the customers objectives, Quaker Houghton uses these tests to accurately predict the performance of a product in a customer's die casting process and takes into account downstream operations. To summarize, Quaker Houghton's test methods determine the following:

- **Solids Content Evaluation** – How much active content is in a die casting lubricant?
- **Visual Analysis** – What will a lubricant look like on the die face; is it more prone to stain or build-up?
- **TGA** – How much protection will a die lubricant offer at critical temperatures?
- **TGA as a Function of Solids Content** – How can be compare the performance of multiple products by accounting for solids content in TGA results?
- **FTIR** – What functional components are in a particular die casting lubricant?