Tech Article

Switching to a New Fluid: How to Measure Debinding Success

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Weight loss analysis is simplest and most commonly used method to measure debinding success.

For many MIM (metal injection molding) companies, sustainability is impacting the way they do business. They must minimize negative environmental impact, conserve energy and protect natural resources all while safeguarding the well-being of their employees. Meanwhile, these same companies need to stay profitable without compromising product quality. One way companies are achieving sustainability is by changing the solvents used in their MIM debinding operations. They are opting for better choices. Ones that are more efficient, easier to maintain and less hazardous for workers and the environment.

Debinding with Vapor Degreasing

In some shops, primary backbone binder removal uses a solvent inside a vapor degreasing machine. By either dunking the parts into the liquid solvent or by holding them inside the solvent vapors, the binders dissolve and evaporate from the green parts. The solvent has a low surface tension and low viscosity to penetrate the parts, ensuring thorough debinding. The solvent evaporates out of the part almost completely before sintering, preventing damage by gasification of the trapped solvent.

Historically, legacy solvents like n-propyl bromide (nPB), trichloroethylene (TCE), perchloroethylene (PERC) and terpenes and hydrocarbons were the chosen solvents used for MIM debinding. However, companies are now moving away from those solvents due to their serious health, safety and environmental concerns. Environmental agencies are implementing strict regulations in an effort to reduce the solvents' negative impact to the planet and to workers. Debinding fluids must now comply with an increasing number of environmental laws regulating their use and disposal. In the US, the EPA added TCE, Perc and nPB to the environmental watch list. Canada and Japan are severely restricting, and are on the verge of banning, these solvents altogether.

So, companies are now faced with the challenge of changing to alternative debinding solvents. However, many are concerned how the change to a new fluid will impact their MIM production. And ultimately, their bottom line. They are concerned that changing their solvent will negatively impact operations by either slowing production or damaging parts. They are also worried that the switch to a new debinding fluid requires major expenditures. Extra costs for new equipment or for retraining employees on new processes. Not to mention the fear that the new fluid will not debind as effectively as the old one.

Finding a Better Alternative

Fortunately, there are a number of next-generation MIM debinding fluids on the market that will debind just as well, if not better than the legacy solvents. They are aggressive enough to selectively remove just the right amount of binder. Yet they are yet gentle enough to maintain the integrity of the formed parts and not damage delicate, uncured substrates. In many instances, the modern debinding fluids do not require a large investment in new equipment. Often, after emptying and cleaning their existing vapor degreaser, the new debinding fluid is dropped in without any significant down-time or appreciable change to the cleaning process. This eliminates the need for employee re-training. Plus, the new fluids do not require any scavengers, acid acceptance testing or stabilizer maintenance processes.

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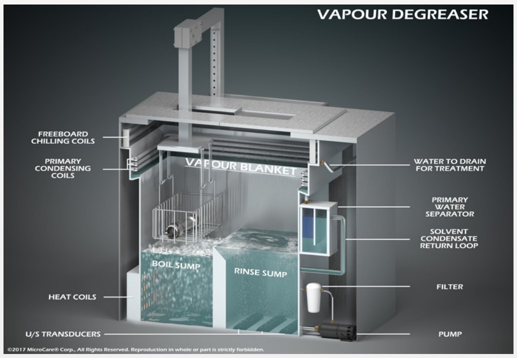

Primary removal of backbone binders can be done with a debinding fluid inside a vapor degreasing machine.

Legacy solvents are being replaced by safer, sustainable next-generation MIM debinding fluids.

Modern debinding fluids are also safer for workers to be around. They are low-boiling, thermally stable, nonflammable and do not require fire or explosion-proof equipment. For the new fluids, the PEL (Permissible Exposure Limit) or OSHA-designated time limit that workers should be exposed to a chemical, is about 200-250 ppm. Compared with TCE which has a 100-ppm PEL or nPB that is US EPA rated at just 0.1 ppm, the modern debinding fluids are significantly better for exposed workers. Plus, most next generation debinding fluids have a GWP (Global Warming Potential) under 10. They also have a zero ODP (Ozone Depleting Potential), making them better from an environmental perspective.

But What About Performance?

Many of the new debinding fluids have been lab-tested and analyzed to ensure their debinding results are reliable, consistent and just as good as the legacy solvents. However, to ensure debinding parameters are maintained or improved, some MIM part manufacturers conduct debinding performance tests of their own.

Density Testing

Density testing allows manufacturers an easy way to measure how much binder has been removed from their parts. This demonstrates the debinding fluid's overall debinding success or failure. The feedstock supplier typically provides companies with the "minimum brown density" to measure the brown parts debinding success. With this theoretical density of the brown parts, MIM manufacturers have a tool to validate the percent of debinding that has been achieved.

"Minimum brown density" must be reached before the green parts can be moved into a furnace for final debinding and sintering. After primary debinding, the density of the brown parts should match the "minimum brown density" of the feedstock. This is equal to the density of the feedstock minus the primary binders. The "minimum brown density" accounts for the maximum amount of primary binder allowable which can be present during secondary debinding and sintering operations without causing part deformation. Two of the most common types of density testing are weight loss analysis and pycnometer testing.

Weight Loss Analysis

Some MIM parts manufacturers use weight loss analysis to verify that both the correct primary debinding and the desired sintering density is achieved. The percentage of binder removal can be determined through a comparison of the part mass before and after the debinding process. Manufacturers start by recording the initial weight of a single part or batch of parts. Then they debind the part(s) using their chosen debinding fluid. They allow the part(s) to dry completely before recording the final weight. Weighing them before they are completely dry can result in inaccurate weight measurement. The amount of binder removed is determined by calculating the percentage of weight loss.

% Binder Removed = (Initial Mass – Final Mass) / Initial Mass x 100%

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Pycnometer Testing

Weight monitoring is the simplest and most commonly used measurement for accounting for primary binder removal. However, this measurement does not take into account unwanted loss of feedstock powder or secondary binder removal that occurs during the debinding process.

Although a part shows a 4% decrease in weight, this measurement alone does not indicate whether that loss is due entirely to binder removal or if it is caused by damage to the part surface. A density measurement using a pycnometer provides a more accurate account. A pycnometer measures the volume of the brown part in order to calculate the actual density of the material. It ultimately determines the overall debinding fluid success.

Conclusion

Many companies are looking for better debinding fluid alternatives to the older legacy solvents that will be sustainable, more efficient, easier to maintain and less hazardous for workers and the environment. But, the change to a new debinding fluid can be full of uncertainty. For many companies looking to make the switch to a better debinding fluid, it is imperative that they maintain their debinding performance with minimal impact to throughput and productivity.

By testing various debinding fluids, they can validate performance and success. Working with a specialty fluid supplier experienced in vapor degreasing debinding is advantageous. These specialists can recommend the fluids and methods to help companies operate in the most efficient and environmentally sound ways while still producing high-quality MIM parts to keep their company competitive and profitable.

About the Author:
Venesia Hurtubise is a Technical Chemist at MicroCare which offers precision cleaning solutions. She has been in the industry more than 6 years and holds a MS in Green Chemistry from Imperial College. Hurtubise researches, develops and tests cleaning-related products that are used on a daily basis in precision cleaning and medical applications.
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