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# Analyze Moisture Before Processing

If you want a stable process and parts that function properly, you must monitor the water content of the resin before molding.


Gravimetric moisture analyzers are a common and relatively inexpensive means to determine the percentage of moisture in resin. The instrument is essentially a sensitive balance contained within an oven. It is not, however, moisture-specific and its measurements can be distorted by other volatiles in the plastic. (Photo: Teel Plastics)

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When presenting training seminars, I encourage attendees to ask questions. I even offer rewards for participation. During my December class, this question came up: What

is the difference between moisture-specific and weight-loss moisture analysis? It stunned me, as I never had thought to explain it—a foul-up on my part. It is an important question, as it has to do with drying plastics to make acceptable parts from moisture-sensitive resins. It is critical in understanding the tests you use for moisture analysis at your shop. Why is this so?

Resin drying is a crucial part of most molding operations. It has been a topic of several articles by fellow Plastics Technology columnist Mike Sepe, and by frequent PT contributor and drying expert Pete Stoughton, and by me (see *Plastics Technology*'s special drying supplement for more). We write about drying because many of the part problems we deal with are a result of improper drying. These problems include process variations, premature part failures, returned parts, lawsuits, etc., all of which add up to significant dollar losses. Profits suffer and you as a processor pay the price in time and sweat to remake all those parts to fill the orders.

Moisture analysis is central to knowing if the resin is dried properly. You know that certain hygroscopic resins such as nylon, PC, and PET have to be dried before processing. The resin manufacturers tell you to dry it and provide a maximum level of moisture appropriate for correct processing. Unfortunately the reason why drying is so important is sometimes overlooked. So to ensure we are on the same page, the principal reason you need to dry these plastics is to prevent degradation of the polymer chains through hydrolysis. Yes, splay due to moisture is an issue but it is not the gorilla, it is a side issue.

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If you do not dry these resins correctly, the moisture, even at extremely low levels—above about 200 ppm for many resins—will react with (chop up) the polymer chains. Chopped-up or short polymer chains mean molecular-weight degradation that causes the problems previously stated. To provide a perspective on how small 200 ppm is, let us talk in terms of a very dry martini: 200 ppm would mean 200 drops (about 10 g) of vermouth in 13 gal (50 liters) of gin or vodka. That is indeed a “dry” martini. So when we analyze a resin sample for moisture, we are looking for a very small amount of water. This tells us that our analytical method must be accurate down to very low levels of moisture.

How accurate? For example, 200 ppm is equivalent to 0.0200%. That is 0.02 lb (a mere 9.1 g) of water in 100 lb (45,360 g) of resin. My old pal, Crusty Sr., says he can tell if the resin is wet: “Just look for splay on the parts or bubbles in the purge.” Sorry, these levels of moisture will not produce splay because the water is consumed in the hydrolysis of the polymer chains. Parts will look great, but the molecular weight is compromised and the parts will fail when stressed. Neither the operator nor quality control will see any visual hint of a problem.

Therefore, we are back to the requirement of analyzing for moisture—i.e., testing the resin before processing. And, by the way, please understand that if you do make parts with wet resin and find out afterwards, you cannot grind up the parts and redry the resin to fix the problem. The resin properties are destroyed and the material must be discarded, burned, or sent back to the manufacturer. Further, do not blend it with good or virgin material to make parts; they too will have reduced physical and chemical properties.

Unfortunately, a low dewpoint on the dryer does not guarantee dry resin. To know the proper moisture level before processing, you must use a “moisture-specific” (not a weight-loss) test method. Why, and what is the difference?

Let’s start with the explanation of weight-loss testing. Weight loss involves getting a sample of resin from the dryer or hopper and it placing on a pan, which is heated during the analysis. After you load the pan with pellets and before the heating begins, the instrument weighs your sample. Then the once you push start, the pan is heated to a temperature specific for that particular resin. As the resin is heated, the moisture and anything else that is volatile at the test temperature vaporizes and leaves the sample. The sample gets lighter as volatiles are driven off.

So how does the instrument know how much of the weight loss was water and how much was other volatile components such as mold release, stabilizers, antistats, or any other additives that may be in the polymer?

It doesn’t. Often, when you heat up a resin you can smell it. Water has no odor, so you are detecting something else that vaporized. Therefore, if your sample weighed 50 g with 0.0200% water content, there would be a mere 0.010 g of moisture to volatilize. A dollar bill weighs a gram so this is only 1/100 of the weight of a dollar bill. Additives, if present, are at higher levels. Therefore, you can imagine how easily other volatiles could skew the analysis.

A moisture-specific analysis starts the same way: You obtain an appropriate sample and weigh it. Then the sample is put into an apparatus where it is usually heated, similar to weight-loss analysis. Again, moisture and other volatiles are driven off, but under a dry nitrogen atmosphere. The big difference is that there is a special detector sensing these volatiles and it only measures the amount of moisture vapors coming off, not any of the other volatiles. We get an accurate account of how much moisture is present, nothing else. That’s what we mean by “moisture-specific.”

Bottom line: If you want a stable process and parts that function properly, you must monitor the water content of the resin before processing. Moisture/water reacts with certain resins and breaks down the molecular weight through hydrolysis. Analysis must be moisture-specific so you know whether the resin is properly dried. I will admit that moisture- specific methods are more expensive than weight-loss methods, but we have no choice.

We need better technology for moisture analysis. There ought to be a technology that allows us to place a small probe in the feed throat that lights up green if the resin is dry and red if it is too wet. It would be nice to if it could handle larger samples and provide results in less than 60 sec. There are, in fact, at least two instruments that are relatively new on the market and whose suppliers promise those very benefits. I myself don't have sufficient experience with them to comment on their performance.

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