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TMG News

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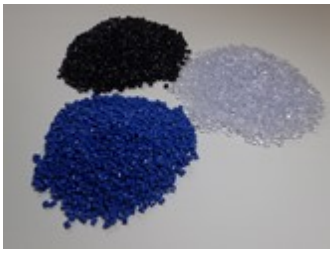
Do Not Get Caught Without a Backup Material

Paul Gramann, Ph.D., P.E.

Choosing the correct material for a part is a significant step—perhaps the single most important step of the design process. The material chosen will greatly influence the part's performance, its cosmetic appearance, the cost, and how well the part will mold. Typically, a tremendous effort is put into selecting the correct base resin, as well as its additives, fillers, and reinforcements. Once the ideal material is chosen and the part is molding seamlessly and performing as expected, the work is not yet done. Finding a backup material is the next critical step. Expert engineers will consider this step during the initial design stage.

What happens if your material supply is suddenly cut off? Do you have a backup material? If so, have you put the alternative material into action to ensure parts can be made with no interruption? Molders are being informed at an accelerated rate that the material they are using will suddenly not be available for the unforeseeable future. This is happening with many different types of resins, from lightly used to very popular ones. This leaves many molders scrambling at the 12th hour to find a replacement to meet their client's production demands. This article will discuss how this very real situation can be avoided.



A popular credo from motivational speaker Denis Waitley can help molders: "Expect the best, plan for the worst, and prepare to be surprised." Molders take it in stride when they receive the call that a material is being discontinued or has become unavailable for an extended period of time. These same molders put into practice Waitley's mantra, "Change the changeable, accept the unchangeable, and remove yourself from the unacceptable." These molders have another suitable material to substitute at a moment's notice, as they have previously done the work to verify it as a replacement.

Do you have a plan in place in case you were to receive that call? At the very least, you need to know if there is (or is not) a replacement material for what you are currently using. If you do not, you are playing Russian roulette with your molding operation. I challenge you to examine some of your most important products and play the "what-if" scenario. Perform a risk management routine when you receive the notice, "We are inflicting a force majeur and your firm will not be receiving ***XYZ*** material for the indefinite future." Do not kid yourself. These calls are occurring at what appears to be an increasing rate. Expect a notice like this at some point in your plastics career.

Reasons why materials become in short supply or get discontinued:

- The resin manufacturer decides the material is no longer profitable.
- Two resin manufacturers decide to merge. A major reason mergers occur is that someone has decided that major savings can be realized by cutting repeat or similar products. You can also expect that one of the similar products will be cut and a substitute material will be offered.

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Do Not Get Caught Without a Backup Material (cont.)

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Reasons materials become in short supply or get discontinued: (cont.)

- Resin manufacturer declares force majeure preventing the fulfillment of the contract. This could be caused by a sudden shutdown at the resin manufacturer due to some emergency situation, such as a hurricane, fire, software issue, or logistical issues.
- One or more of the raw ingredients, additives, or fillers the resin manufacturer requires becomes in short supply.
- Planned or unplanned shutdown for plant repair.

Typically, the resin manufacturer or your supplier is going to provide replacements. These options should be weighed heavily. In most cases, you will not be able to simply substitute a new material. Molds are made, and processing conditions are set, for a specific material. If the material needs to be certified to a standard or approved by an agency, such as UL or the FDA, the problem becomes more daunting. If this is the situation, your options for a replacement material are extremely limited, making the need to have a substitute in place even more critical. If you are faced with a material being in short supply or discontinued, it is likely, you will need to recertify the part. This could be a torturous process if the material is not UL or FDA certified. Who then, is responsible for the costs involved with having the material certified under these agencies? It is noted that because the FDA requirements are some of the most stringent, many resin suppliers will explicitly state that the resin can be used for food contact in all countries, but the United States.

Identifying Alternative Materials:

Waitley's expression, "Expect the best, plan for the worst, and prepare to be surprised," means that things should be put into place early to ensure that there is a backup material. This is done by the OEM, the molder, or a collaboration of both parties. This process involves many of the following steps that were taken when the original material was chosen:

- Review certifications required for the material. If they are required, this is the first place to start because quite a few materials will be eliminated right away.
- Review materials in the same class of the original resin. This will give you the best opportunity to meet the required mechanical properties and moldability.
- Review specific additives, colorants, and reinforcements. Understand why they are in the resin and how they affect the performance of the part (e.g., UV protection).
- Review how the material arrives from the resin manufacturer or supplier. Does it arrive clear, natural, or pre-colored?
- Review how the material is delivered: rail-truck, gaylord, or bag. Make sure that your facility has the ability and capacity to accept the material.
- Review material data sheets for properties such as modulus, strength at yield, elongation at yield, elongation at break, melt flow rate (at same conditions), notched izod strength, and density/specific gravity.

Do Not Get Caught Without a Backup Material (cont.)

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Identifying Alternative Materials: (cont.)

- Review multipoint material property data (temperature and time), if available.
- If the part is used at an elevated temperature, it is recommended that the modulus of the material be evaluated over a temperature range via dynamic mechanic analysis (DMA) in order to determine how the stiffness decreases as the temperature increases. Also, test samples following ASTM D 638 "Standard Test Method for Tensile Properties of Plastics."
- Mold both materials.
- Understand the nuances of molding the alternative material.
- Keep a number of molded "golden standards" for both materials that you can refer to. This will allow you to test a new part to the "golden standards" properties.
- Determine a method to mark the mold so that you know what material is being molded.
- Ensure that the part with the backup material performs as well as the original material.
- Continue to monitor the availability of the backup material. You want to prevent the situation where you have taken all the necessary steps listed above to only find out that the backup material has been eliminated.
- It is not necessarily recommended that you keep a large amount of backup material in stock. However, it would be excellent planning/foresight if another product being molded in your facility, used the backup material. Thus, if something was to occur with either product, you readily have a supply of material, a current source, you understand how to condition and mold the material, and how the part will behave after molding.

If the material you are molding is cut off and you do not have a backup material, you will likely have to follow the same procedure, but at a more rapid pace. You may expect to be told that there is an immediate substitute. However, this is *rarely* the case. By using the steps provided above, you can immediately put into place a replacement material and avoid a production interruption.

Molders are more frequently facing the situation where the material they are molding, is suddenly cut off with no insight as to when the supply will be continued. This situation is occurring with a wide range of resins. You may expect a substitute material to be recommended, but do not be fooled. This is *rarely* the case. It is strongly encouraged that you have a backup material identified in which you have full confidence. At the very least, begin to review your most critical parts/resins and start the "what if" scenario.

This article appeared in Plastics Today on July 19, 2018.

The Madison Group Teaches Failure Analysis, Design & Prevention

Monday-Wednesday, October 14-16th, 2019—UW-Milwaukee at Milwaukee
Presenters: *Jeffrey A. Jansen, Dr. Antoine Rios, Dr. Javier Cruz, and Erik Foltz*
Plastic Part Failure: Analysis, Design & Prevention

The University of Wisconsin—Milwaukee School of Continuing Education is offering a 3-day course entitled, **"Plastic Part Failure: Analysis, Design & Prevention"** taught by The Madison Group Engineers. The course will cover a broad range of topics essential to understanding and preventing plastic failure. Get introduced to the strategies behind analysis, design and prevention with course material that includes:

- Learn the essentials of why plastic components fail
- Understand the five factors affecting plastic part performance
  - Material, design, processing, installation, and service
- Learn the process of conducting a failure investigation
- Know the importance of ductile-to-brittle transitions and their role in plastic component failure
- Understand how and why a product has failed
- Explore approaches to more quickly respond to and resolve plastic component failure
- Learn methods and techniques to avoid future failures

Course Outline:

- **Introduction to Plastics**
  - -Overview of Plastic
  - -Composition
  - -Properties
  - -Plastic Part Failure
- **Failure Correction and Prevention**
  - -Part Design
  - -Mold Design
  - -Material Selection
  - -Processing
  - -Validation Testing
- **Failure of Plastics Overview**
- **Failure Mechanisms**
- **The Roles of Multiple Factor Concurrency and Statistical Distribution in Plastic Part Failure**
- **Failure Analysis**
  - -Problem Solving / Investigation Techniques – FA and RCA
  - -Failure Analysis Test Methods
  - -Case Studies

Plastic Part Failure: Analysis, Design & Prevention
Monday-Wednesday, October 14-16th, 2019
8:00 am to 4:30 pm
Note: Class ends at 4:30 pm on Days 1 and 2
Class ends at 3:00 pm on Day 3
Location: University of Wisconsin – Milwaukee School of Continuing Education
CEUs: 2.0/PDHs: 20
Program No. 4830-11769

For more information:
https://uwm.edu/sce/courses/plastic-part-failure-analysis-design-prevention/

From the TMG Solutions Archives: Runner Balance Analysis

Keywords - Family Mold, Runner Design, Moldflow Evaluation

What Went Wrong?

An injection molder needed to determine how to design the runner system to achieve a balanced fill pattern of a family mold for three different polycarbonate parts.

The molder was in the initial design stages of a three-cavity family mold. The mold was to produce three unique parts that would be assembled together after molding. Using the family mold reduces the manufacturing cost for the parts and ensures color uniformity. The design of the runner system is critical for manufacturing quality parts in this type of mold. A well designed runner allows all mold cavities to fill and pack uniformly, and increases the size of the processing window.

An initial runner layout pattern was developed by the molder that provided the initial cavity spacing and a rough runner layout. An initial injection molding simulation revealed the proposed runner system did not fill the cavities uniformly, which resulted in a pressure spike during injection. This pressure spike led to non-uniform pressure distribution in the cavities and reduced the size of the processing window. Additionally, the runners were undersized, which required excessive pressure to fill the mold.

After the initial simulation, The Madison Group altered the size of the runner, and reposition the cavities relative to the injection location. This manipulation produced a runner system that filled the cavities uniformly. The final design allowed for a lower pressure requirement and tonnage requirement to manufacture the parts.

Conclusion

It was the conclusion of the evaluation that the original runner design would not produce a balanced fill pattern and would likely result in a narrow processing window. A series of simulations were performed that resized the runners and repositioned the cavities to provide a uniform filling pattern of the cavities. This runner balancing allowed for a wider processing window to be achieve during manufacturing.

***Information** regarding additional case studies can also be found at:*
https://www.madisongroup.com/case-studies.html

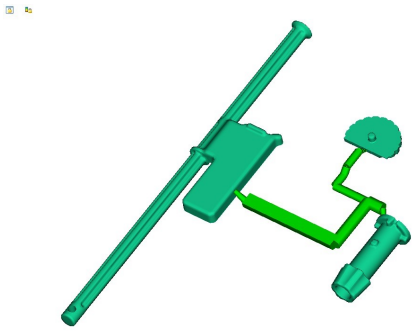

Figure 1: Original runner system design

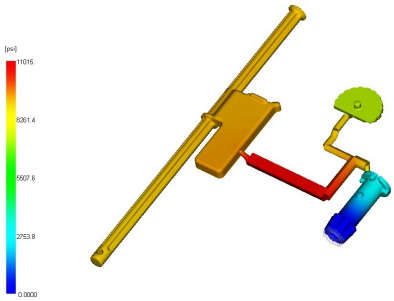

Figure 2: Original runner design led to excessive injection pressures and a non-uniform fill of the cavities.

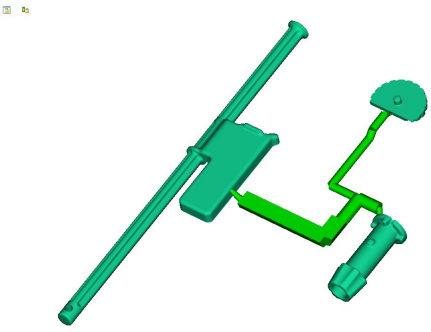

Figure 3: Modified runner system design as determined through simulations

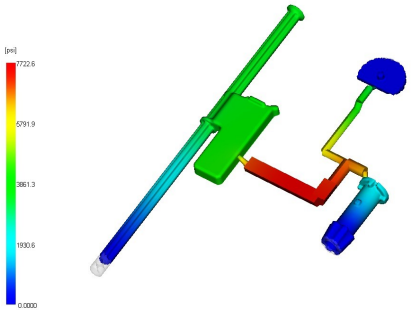

Figure 4: Redesigned runner system produced a more balanced fill pattern and reduced the required injection pressure to fill the mold.

Upcoming Educational Webinars

Thursday, August 29, 2019 – *Jeffrey A. Jansen – Special Chem*
FTIR Made Easy for Better Identification of Plastics

Master FTIR to efficiently characterize your plastic materials and better analyze failures by learning the tips and tricks to better analyze the graphs.

The webinar will include:
- **Plastics characterization** (identification, contamination...) with real life examples.
- **Failure analysis** by identifying the root cause & how to minimize them.
- How FTIR can be complemented with other **techniques** like DSC, TMA, TGA...

Fourier transform infrared spectroscopy (FTIR) is a powerful analytical technique for the development of polymer materials. Mastering FTIR can not only enable you to characterize materials (through changes in molecular structures), but also ease problem solving and minimize failures.

Join this course to:
1. Extract more value *(extent of oxidation, crosslinking, ingredient inclusion...)* out of complex spectra/data obtained from FTIR on your plastics.
2. Ease failure anlysis by identifying the root case and recognizing clearly polymers, contaminants, degraded forms and unknown molecules in a mixture with FTIR and other techniques (DSC, TGA, TMA…).
3. Save time characterizing your material with practical guidance to overcome sample preparation issues (solids analysis, additive tracing…)

Registration Information Coming Soon.

Thursday, September 12, 2019 – *Jeffrey A. Jansen – Society of Plastics Engineers*
Understanding Plastic Failure Rate
11:00 AM – NOON (EDT)

When a plastic part fails, a tough question is often asked, "Why are a limited number of parts failing?" This is particularly true with seemingly random failures at significant, but low, failure rates. Two aspects are generally linked to such low failure rates; multiple factor concurrency and the statistical nature of plastic failures. Failure often only takes place when two or more factors take effect concurrently. Absent one of these factors, failure will not occur. Plastic resins and the associated forming processes produce parts with a statistical distribution of performance properties, such as strength and ductility. Likewise, environmental conditions, including stress and temperature, to which the resin is exposed through its life cycle is also a statistical distribution. Failure occurs when a portion of the distribution of stress on the parts exceeds a portion of the distribution in the strength of parts.

This webinar will illustrate how the combination of multiple factor concurrency and the inherent statistical nature of plastic materials can result in seemingly random failures.

Click here to register.

Information regarding upcoming educational opportunities can also be found at:
http://www.madisongroup.com/events.html

Upcoming Educational Webinars (cont.)

Wednesday, October 9, 2019 — *Jeffrey A. Jansen – Special Chem*
Understanding Structure—Property Relationship for Effective Polymer Selection
Time: (TBD)

Avoid plastic part failure in demanding applications by making better decisions with the right material selection and component design.

The webinar will explain in detail how different aspects of the polymer structure alter the physical properties of thermoplastics including *mechanical, thermal, chemical resistance and environmental characteristics.*

Being increasingly used in demanding applications, plastic materials often have to endure *aggressive chemical contact, elevated temperature exposure and demanding mechanical stresses*. Choosing the right material in these applications is critical to avoid part failure! *B*ut often, limited understanding of the interrelationship between molecular structure and properties acts as a roadblock.

Join this course to:

1. Meet evolving needs of demanding applications by making informed decisions related to plastic material selection and component design.
2. Improve performance by gaining an understanding of how polymer structure of thermoplastics *(polyethylene, polyesters, sulfones, polyaryletherketones…)*relates to final part performance.
3. Avoid failure and other costly problems.

Registration Information Coming Soon.

Thursday, October 10, 2019 — *Jeffrey A. Jansen – Society of Plastics Engineers*
Degradation Failure of Plastics
10:00 AM (CST)

Plastic materials offer a unique balance of strength and ductility associated with their inherent viscoelastic nature. However, they are susceptible to molecular degradation through a variety of exposures. Molecular degradation is a permanent change in molecular weight that reduces the mechanical properties and integrity of the plastic material. This degradation can occur during compounding, processing, storage, or while in service. Such degradation mechanisms include:

- **Thermal Oxidation**
- **Hydrolysis**
- **Ultraviolet Radiation**
- **Chain Scission**
- **Destructive Crosslinking**

The various forms of molecular degradation account for approximately 20% of plastic part failure, and an understanding of the nature of degradation can help to prevent failure.

Topics covered during this session will include:

- Introduction to plastic molecular degradation, including the various mechanisms.
- Material susceptibility to degradation.
- Stabilizers to prevent degradation.
- Testing to assess the level of degradation.

Click here to register:

Information regarding upcoming educational opportunities can also be found at:
http://www.madisongroup.com/events.html

Upcoming Educational Webinars (cont.)

Thursday, December 12, 2019 - *Jeffrey A. Jansen – Society of Plastics Engineers*
Failure Associated With Injection Molding
11:00AM–NOON (EDT)

The injection molding process is one of the key characteristics that determines how a plastic part will perform in service. Manufacturers certainly attempt to avoid failure, but often unanticipated factors result in unexpected problems. The chances for a successful application can be significantly increased through preventative measures, including appropriate material selection, proper mold design, and process development. Even when appropriate actions are taken, failures can still occur. The evaluation of these failures provides an opportunity for learning. By understanding how and why a plastic component failed, steps can be taken to prevent future occurrences. Case Studies will be presented to illustrate failures associated with the deficiencies from the injection molding process. The presented cases will illustrate how the failure analysis process was used to identify the failure mechanism, as well as the primary factors responsible for the failures.

Click **here** to register.

Information regarding upcoming educational opportunities can also be found at:
http://www.madisongroup.com/events.html

Training

If you are interested to have The Madison Group come and speak or provide training to your team, please feel free to contact us at info@madisongroup.com.