From our Engineering Team to Yours…

In a new series on common processing issues and preventative measures, Polymer Resources' Henry Sorgen, lead technical development engineer, walks us through three common processing issues seen in the field. The intent of this information is to not only help during an issue, but to also prevent one from happening.

As always, we encourage anyone interested in more information or seeking assistance with a processing issue to reach out to a local Polymer Resources account manager, to our manufacturing plant by phone (1-800-271-0496), or visiting www.prlresins.com and filling out an information form.

- ## Material Drying and Adequate Dryer Sizing:
  - When processing Hygroscopic Resins (polymers that naturally absorb moisture- such as our Nylon, ABS, PBT, and PC products) it is very crucial to ensure proper drying of the material ***prior*** to processing of the material. In doing so, you will help prevent the following (not to mention enable a more repeatable/robust process while ensuring maximum polymer performance):
    - Hydrolysis- defined by "the chemical breakdown of a compound due to reaction with water." Meaning that the molecular weight of the resin degrades due to breaking down of covalent bonds, shortening the molecular chains of the polymer. This will result in significantly reduced mechanical properties.

        - Cosmetic Defects- Splay (or silver streaking) are cosmetic blemishes that appear on the surface of a molded part. This defect appears most commonly when there is a form of "gas", usually water (steam), within the melt. This can also be caused by unmelts, dirt/contaminations, or excessive volatile gasses from additives – (a result of degradation). It is important to remember that resins subject to hydrolysis (Hygroscopic resins) should not be "re-ground" and "re-used" ***IF*** they show signs of splay. Reintroducing and mixing polymers that have been degraded due to hydrolysis with virgin or non-degraded material will not produce a good representation of the materials intended properties.
        - Part Failure- If the appropriate level of moisture content is not reached prior to processing, giving the potential for degradation by hydrolysis to occur, structural defects or even premature part failure may be observed.
    - Drying Process- Requires: Dry Air, Temperature and Time.
        - Most effective and common type of dryer used in industry: Desiccant Bed Dehumidifying Dryer
            - Dries air to required dew point level
            - Heats air to specified temperature
            - Circulates airflow within its own closed loop system
            - Moisture migrates out of the polymer and is removed from circulating air via desiccant bed
                - The desiccant bed is a cartridge type "filter" made up of moisture absorbing desiccant beads
                    - Very important to ensure maintenance and proper working function of desiccant bed.
                    - Dew point level is one way of monitoring the desiccant bed performance (nominal dew point is typically -20°F)
    - Dryer Sizing- Ensuring adequate dryer capacity is another crucial part of the drying procedure. The dryer should be sized large enough to provide adequate resin residence time within the dryer. This can be determined based on two things: Throughput and Material Suppliers Recommended Drying Time. Throughput can be calculated by determining total shot weight multiplied by total cycle time. *A good rule of thumb to calculate dryer size that is used in industry is equal to Throughput multiplied by Drying time.* For example (using PC-GP1-D): 1lb shot weight ran at a 30sec cycle equals a throughput of 2lbs/min or 120lbs per hour. Per our data sheet our recommended drying time is 4 hours. 120lb/hr multiplied by 4 hours is equal to a 480lb dryer. If a dryer with a capacity of less than 480lbs was used in this instance, there would be a high potential to "out run" the dryer and eventually allow material into the system that exceeds the appropriate level of moisture content. This can also be looked at by the opposite manner- having a dryer that is too large for the job at hand. Having a dryer too large would enable the possibility for material to dry for a time much greater than our recommended drying time which can lead to a form or thermal degradation, resulting in reduced mechanical properties.

- **Suggestions to avoid Moisture related issues:**
    - Ensure dryers are working as intended and proper drying temperatures and times are being used and not exceeded. Use timers to turn on and off the dryers to prevent over drying.

- Ensure proper sizing of Dryer. (Ref the rule of thumb above)
- Confirm and note moisture content levels of dried material prior to processing with use of Moisture Analyzer. For most accurate results, it is recommended to use moisture specific method instead of weight loss method.

- **"Pressure Limited" Process:**
  - Understanding the importance of pressure and timing. The name of the game is controlling viscosity- it is our number one challenge as molders. If viscosity is controlled within ideal limits, then producing parts will be repeatable and consistent shot after shot. Two main variables that effect viscosity are temperature of the melt throughout the process and injection speed- the rate at which the melt is being injected. Every injection molding machine has a control to where a pressure value set point can be entered to allow for maximum injection pressure limit. It needs to be understood that this is a "limit" and it does exactly that: "limits" the amount of injection pressure allowed to fill the cavity, a cutoff point. The injection molding machine will not allow the injection pressure needed to fill the cavity to exceed this set limit as a means of safety. Having a peak injection pressure that is meeting/exceeding this limit is a "pressure limited" process. With a pressure limited process, the slightest shift in viscosity can go unnoticed by the process tech or operator, potentially resulting in short shots (viscosity increase) or overfilled/flashed parts (viscosity decrease). A non-pressure limited process, having the machine's max pressure limit set above the actual maximum injection pressure, will allow the processor and machine to observe/detect any fluctuation of injection pressures or fill times that would indicate a shift in viscosity.
    - If an increase in viscosity occurs while running a pressure limited process, the maximum injection pressure limit setpoint will be reached sooner, still being pressure limited and potentially decreasing the 1st stage fill volume, putting less material into the cavity prior to 2nd stage pack and hold- possibly causing a short shot or non-fill.
    - If a decrease in viscosity occurs while running a pressure limited process, the maximum injection pressure limit setpoint will be reached later in time or not at all. Regardless if the limit has been met or not, the 1st stage fill volume may have increased, putting more material into the cavity prior to 2nd stage pack and hold- possibly causing an over packed or flashed part.
    - If an increase in viscosity occurs while running a non-pressure limited process, the maximum injection pressure limit may not be reached if there is a minor shift in viscosity (more common), this variance can also be observed and recorded on the machine, notifying the process tech of the shift.
      - Though it is also possible that the limit may be reached if the viscosity increase is significant (less common) and can be noticed/observed on the machine, informing the process technician of a major change or shift in viscosity allowing them to investigate further.
      - The same, yet opposite effects would be applied to a decrease in viscosity on a non-pressure limited process.

- **Suggestions to avoid a "Pressure Limited" Process:**
  - Utilize Decoupled Molding

        - Remove 2nd stage "pack & hold" and confirm 1st stage fill volume is in a non-pressure limited state and within an acceptable % volume filled range- (adjust transfer position if needed to achieve desired % volume filled cavity)
        - If pressure limited, adjust these values independently to achieve a non-pressure limited state:
            - Melt Temp (increase temp to decrease pressure, reference Manufacturers Recommended Melt Temp Range)
            - 1st stage fill rate (injection speed - Slow speed to decrease pressure)
            - Conduct Pressure Loss Study to determine restriction points within the Nozzle, Sprue, Runner and Gate. (increase sizes to decrease pressure)
            - Move to a different injection molding machine that enables a higher injection pressure range/limit

- **Clamp Tonnage:**
    - Understanding how to calculate required minimal clamp tonnage of a tool based on projected surface area.
        - Calculation to find total surface area is equal to surface area of one cavity multiplied by the number of cavities plus total surface area of the runner. Multiply this value by a factor of ~3tons/in^2 (depends on material type)
        - Not having enough Clamp tonnage
            - Potential flash issue at parting line and any tooling shut offs.
            - Potential of blowing mold's parting line open
        - Having too much Clamp tonnage
            - Potential influence on venting - preventing air to escape to atmosphere, causing gas burns due to sealing off vents, not allowing the tool to breathe
            - Potential tooling damage on shut off surfaces of delicate tooling
            - Potential damage/ warpage to platens

- **Suggestions to avoid Clamp Tonnage related issues:**
    - Calculate tonnage based on 2D surface area of total cavities including runner system.
        - Input Calculated Tonnage value
            - Reset AutoDie-Height
    - If calculated Tonnage is too low and part shows sign of flashing, increase tonnage to eliminate flash at shut off areas, ensure no tool damage.

Need more information?
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