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Managing Manufacturing Disruptions During COVID-19

Mitigating Risks Associated with Process Tuning and Raw Material Substitutions

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The ongoing COVID-19 pandemic has led to supply chain challenges across industries as disparate as performance plastics, concrete, and precision hardware. Low supply chain redundancy and constrained inventories devised under lean manufacturing principles have only exacerbated the disruptions. Supplier process engineering teams confronting weeks-long order backlogs are faced with multiple challenges: balancing the needs of large and small customers, meeting tight deadlines, and procuring limited materials from their own suppliers. While process tuning and material substitutions can help suppliers accelerate production or cut costs, extra attention should be paid when implementing these changes concurrently with what will likely be one of the largest global manufacturing ramp-ups in recent history.

Potential Risks Associated with Process Tuning

During good times, it is common for manufacturers to modify processes to reduce their unit costs while operating within agreed-upon design tolerances. For example, suppliers may adjust heating and cooling cycles in their injection molding processes to achieve a greater number of injection cycles and more units per machine hour.

While this modification may help suppliers accelerate production, reducing manufacturing cycle times without proper process verification can potentially introduce a range of imperfections that may lead to performance issues in the field. For example, the optical clarity of injection molded transparent components can be compromised by haze if the resin is injected at slightly too low a temperature. Parts with complex geometries including bolt-holes or screw counterbores processed at suboptimal conditions may exhibit pronounced weld lines in locations where the flow fronts converge. Distinguishing between cosmetic imperfections and structural imperfections that could compromise the component's mechanical integrity often requires x-ray or ultrasonic imaging or mechanical cross-sectioning to fully assess the extent of weld lines into the bulk.

Potential Risks Associated with Material Substitutions

Material substitutions are another common way for suppliers to offset costs, recycle resin, or make use of existing inventory. However, nuanced differences between materials can often have unintended consequences in product performance. Changes in regrind content or quality may significantly influence mechanical strength, especially for composites. Variations in molecular weight can potentially modify the crystallization kinetics and processing times of certain resins, and resin substitutions may also result in viscosity changes that impact mold filling, reduce adhesion or compatibility with adjacent materials in the assembly, or decrease resistance to UV weathering.

Roll-to-Roll Coating Sensitivities

Plastic thin film products can be particularly sensitive to small changes in material or processing conditions. For example, multilayer films found in food packaging and mobile displays must maintain adhesion between several dissimilar materials, such as gas and moisture barrier layers. To accomplish this bonding, manufacturers may rely on corona treatment before wet coat application or employ films with adhesion-promoting hardcoats.

One important parameter when evaluating substrate film substitution is temperature rating. Substituting a substrate film for one with a lower rating can lead to film warping in the coating line flotation dryer, potentially resulting in variable thickness across the film or a buildup of in-plane stress that prevents the converted film from lying flat. Mismatched or missing hardcoats may reduce the wetting of coated films, causing film beading or poor adhesion to the film substrate that can only be ameliorated with additional surface pre-processing or adhesive interlayers to achieve suitable bonding. Similarly, marginal web speed increases during in-line corona treatment reduce the average time of the corona discharge on the film, yielding a lower surface energy that may yield inconsistent surface wetting in subsequent processes.

Successfully Managing Manufacturing Disruptions

Successfully managing manufacturing disruptions requires balancing acceptable delays in the existing process flow against the benefits and risks associated with material substitutions or process modifications. Organizations that face larger-than-planned disruptions can proactively review tolerances, material compatibility, and product failure mode and effects analyses (FMEAs) to evaluate potential tradeoffs without impacting user safety and product reliability. Communication with suppliers' process engineering teams, early and often, can help identify potential materials compatibility or process issues before they are implemented on a product line. Coordination between manufacturing and failure analysis teams can not only help prevent downstream failures but also help failure analysis teams better predict where future issues might arise.

Exponent's Expertise

Exponent's multi-disciplinary global support team is well equipped to help companies navigate manufacturing disruptions during the COVID-19 pandemic. We can guide manufacturers working with a wide array of raw materials and goods-in-process through effective process tuning and materials substitution, evaluate materials from multiple suppliers, and assist with planning, monitoring, and rapid failure analysis throughout the manufacturing process.

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