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SPECIAL REPORT:

Improving mould release in closed moulding

BETTER BOATS

Improving mould release in closed moulding

Understanding of closed moulding processes has significantly improved but one area that continues to cause problems is build-up on mould surfaces. Bill Burnham and Glenn Pfister of Axel Plastics Research Laboratories Inc discuss some of the solutions.

These days fabrications are showing a great deal more interest in closed moulding processes. This is partially a result of the desire to reduce volatile organic compounds (VOCs), but is also being driven by the demand for greater productivity, and better quality and dimensional control of moulded parts.

While primary risks and benefits of open versus closed moulding have been well established for several decades, it is only within the last ten years that resin transfer moulding (RTM) has truly been regarded as a viable manufacturing process, rather than just a "laboratory experiment".

Much of the growth within the closed moulding industry has been the result of the better understanding, and control, of processing parameters and tooling. This knowledge has enabled consistent parts production from composite tool surfaces - results previously restricted to matched metal die moulding. This low cost, high performance tooling has helped to spell success for some manufacturers and spur the interest of others.

As more manufacturers embrace closed moulding, process difficulties have been better defined, and in many cases (like cavity fill), resolved or significantly improved. Where mould release is concerned, semi-permanent release technology has also contributed to the success of composite tooling and hence the growth of the industry.

One area that continues to be problematic and to impair productivity is scumming or build-up on mould surfaces.

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The causes

What causes build-up or scumming on moulds? As we mentioned earlier, RTM and closed moulding processes are said to offer the opportunity to mould with low VOCs , particularly if gel-coating, where required, is done under controlled conditions. But do not construe "low VOCs" with "styrene free". Remember that although resin cures, the polymerization process is incomplete, with un-reacted styrene remaining. While this styrene may not be a big contributor to emissions, it is still a major concern in moulding and a major contributor to scumming.

Other factors that can contribute to scumming include resin formulation and catalyzation, mould construction, mould release and process temperatures.

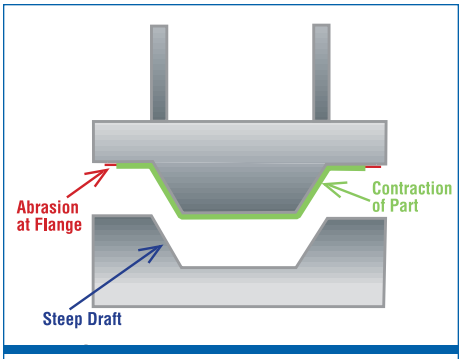
In open moulding applications, some of this styrene goes to the atmosphere and some to the mould surface. In RTM applications, 100% of this styrene is trapped within the mould.

With metal tool surfaces, un-reacted styrene gradually deposits on the mould surface where it creates a surface attraction for other styrene – or more build-up. When fibre reinforced plastic (FRP) tools are used, free styrene in the moulded parts will also be attracted to free styrene in the FRP moulds. Without a barrier of mould release tough enough to withstand this "styrene attraction" or "attack", part release can be difficult or incomplete, leaving behind significant residue. In the case of epoxy and other types of composite tooling, including poorly chromed or nickled tools, micro-porosity in these mould surfaces may actually provide physical sites for adhesion.

The solutions

What is the best way to counter the deleterious effects of free styrene?

One of the first considerations is mould construction. When FRP tooling is used, a good vinyl ester resin and thorough curing – checking Barcol hardness - is essential. Composite tooling should aim for the lowest surface porosity possible, and, if still present, moulds should be treated with a good sealer prior to use.



Other factors leading to poor release.

Where mould release is concerned, a good semi-permanent mould release should provide a dense and inert release barrier between the mould and part. This will reduce styrene attack on the mould and limit the potential sites for chemical bonding of residue.

Most semi-permanent mould releases are reactive resin solutions designed to cross-link and cure on the mould surface. In selecting these products, take into account the temperature that the mould will be when these release will be applied.

Many mould releases are available. Choose one that will wet-out on the mould surface and cure well at under your conditions.

Remember also, no mould release is immune to abrasion. If flange, shear or crimp areas abrade easily, these points much be touched up routinely. Failure to do so will only result in quicker build-up at these points. And, because some residue and build-up is inevitable during successive moulding cycles, how "self cleaning" a mould release is, will be a factor in productivity.

Self cleaning mould releases can come with a cost however, and that is solvent packages that may contain xylene, benzenes, toluene and other hazardous air pollutants (HAPS) solvents.

Three times more parts before maintenance

Axel's XTEND 800 semi-permanent mould release products are designed for RTM equipment with multiple insert technology (MIT) capability. The product has been shown to improve the moulding process of truck hoods for a major composite manufacturer.

In initial customer testing, three semi-permanent releases were evaluated on the Plastech MegaJet Pro RTM line producing 25 pieces per mould during an 8-hour shift. Moulds of REN 4005 laminating resin faced with REN 4026 epoxy surface coat were brought to the moulding temperature of 55ºC. Four coats of mould release were wiped on following the manufacturer's instructions. The results showed that XTEND 800 released 14 pieces before requiring re-application. While the competitive releases provided adequate multiple release, build-up and scumming on the moulds was evident as production proceeded. Unlike competitive products, XTEND 800 provided easy release with a minimum of build-up and the moulds only needed to be stripped after 80 to 100 parts. The XTEND 800 also offered easy application plus a streak-free, attractive appearance.

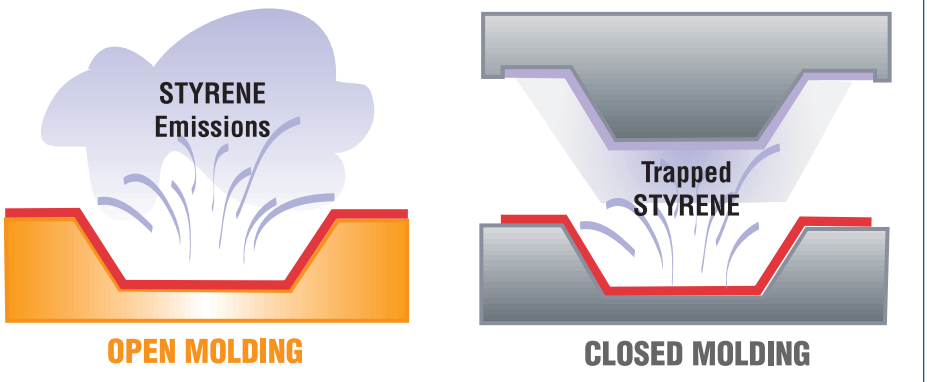
XTEND 800 improved the truck hood moulding process.

Long gel times or extended cure schedules pose a threat to even the best semi-permanent mould releases. Remember that styrene is an excellent solvent, and keep in mind that just as soaking a mould in styrene will soften polymerized resin, so too, long styrene exposure can penetrate, or compromise, the finest mould release.

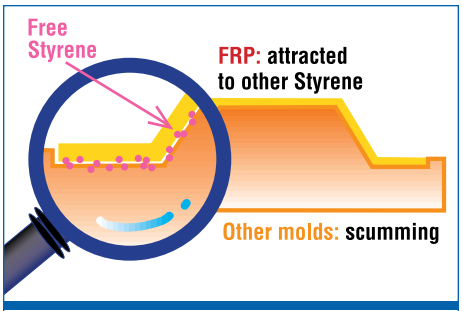
Cure also contributes to build-up in more insidious ways. We have often seen RTM applications which were running well suddenly suffer scumming so severe that moulds had to be pulled and cleaned 50% sooner. What changed? Cure Time. Somewhere along the way, someone decided that rather than pull parts at 25 minutes, they could be pulled at 23. While the parts released okay and had reasonable finishes, they had obviously left more residue behind on the mould.

One of the simplest ways to counter cure related issues is through controlled temperature. Ideally this extends to resin and catalyst storage and injection. Controlled mould temperature however, should be considered essential. It is possible to use composite tooling in a non-heated RTM process, but you can almost certainly expect the scumming and build-up to be worse.

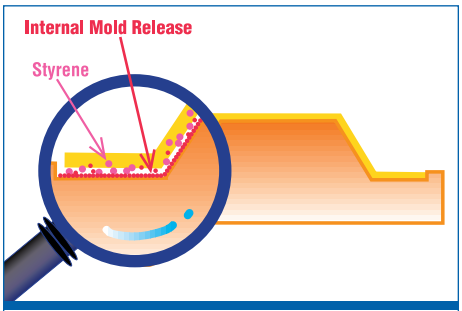
Other contributors to build-up and scumming include low profile additives.



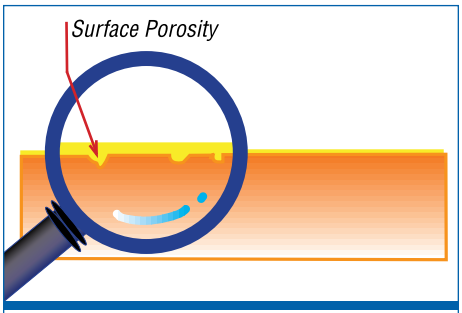
Resin never catalyses 100%; un-reacted styrene remains.



Free styrene will be attracted to FRP moulds.



Internal mould releases create an interface between the mould and the part.



Surface porosity may provide sites for styrene adhesion.

These thermoplastic materials are utilized to improve surface cosmetics on moulded parts. Unfortunately, these additives are also notorious for "plating out" on the mould surface. Similarly, glass sizing / binders utilized in manufacturing mat and performs may also flow out and end up on the mould surface.

Un-equal heat on the A and B sides of the mould will also have an impact on build-up. The warmer side, which is also frequently the gel-coated side of the mould, will cure better and release better, while the cooler and non gel-coated side will be cure more slowly and be more likely to trap residual styrene and moulding debris.

There is no quick solution for these problems, however an awareness of all the contributors may help you to make process decisions that will help control build-up. In this regard, it is also always necessary to recognize other factors that lead to poor release. These include abrasion at the flange area, steep draft, and contraction of parts that can cause sticking on plugs. Be aware that there is an optimum time after peak exotherm at which to pull parts. Attention and control of this variable can help deal with contraction.

Internal releases

Improving the ease of release will of course reduce scumming. To this end, you might like to consider utilizing an internal mould release. These are resin additives that ideally will not only enhance release, but can also improve wetting of fillers and reinforcements – creating a stronger composite matrix.

Internal mould releases are designed to come to the surface, creating an interface between the mould and the part. As such, these materials are partially, or totally incompatible with the resin, and range from commodity goods like coconut oil to proprietary formulations designed specifically to function in distinct resin and cure systems.

A good internal mould release should not significantly alter cure schedules nor should it have an adverse effect on physical properties. Similarly, it should result in improved parts cosmetics, by improving wetting and flow of the resin and should not leave any residue on the parts or tool surfaces.

Internal mould releases work best at elevated temperatures, making RTM applications with exotherms or processing temperatures above 55°C an ideal for application for these materials. When used with external mould release, internal mould release can be a useful adjunct to blocking styrene from building up on the mould surface.

A good internal mould release should not significantly alter cure schedules nor should it have an adverse effect on physical properties.

Maintenance

In closing, we need to also direct your attention to that all important topic: mould maintenance. Here, the old adage "a stitch in time saves nine" is certainly appropriate, and although we find that most manufacturers are aware that properly maintained moulds result in fewer headaches, they will still fail to adequately maintain their tools.

Here we can do little more than to caution or scold. You must re-orient your thinking and reward and encourage a routine cleaning and touch up procedure within the moulding process. The periodic brief scrub with a Scotchbright pad and fast touch up with release is a good protocol. Stop trying to see how many parts can be run before moulds are impossibly dirty. Back off and do some quick maintenance before that occurs and you will be compensated with shorter downtimes and better parts. ■