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SPECIAL FEATURE:

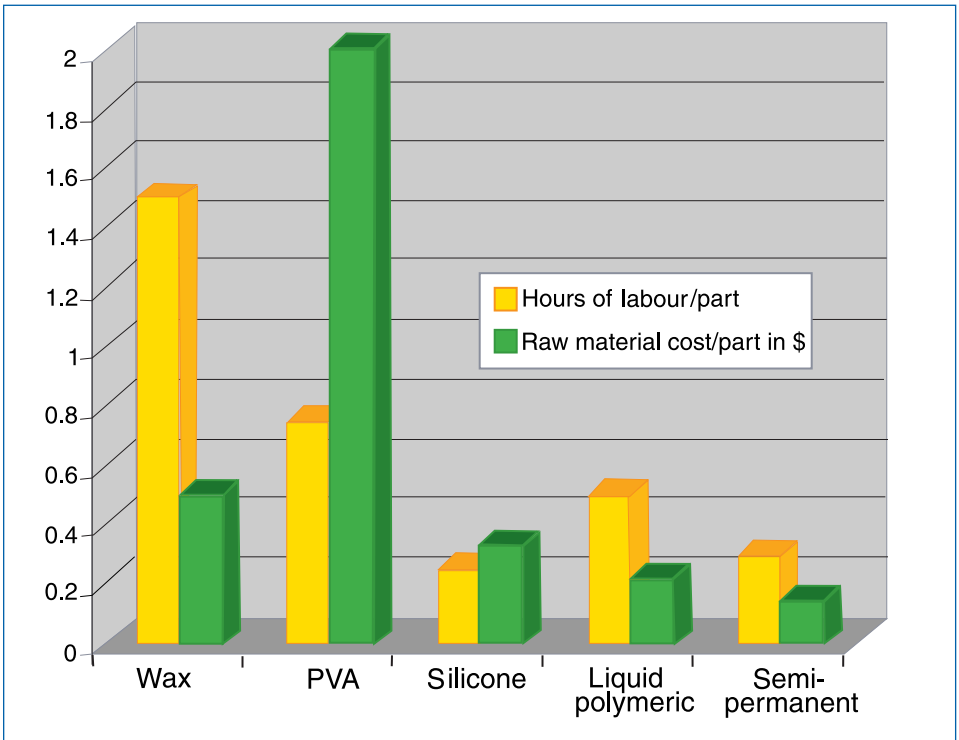
## CHOOSING THE CORRECT MOULD RELEASE

## SENSORS AND SURFACES

# Choosing the correct mould release

**Nowadays customers of the composites industry are demanding components that are of a higher quality, and which can be produced quicker. Frank Axel, president of Axel Plastics Research Laboratories, USA, discusses the production benefits that companies can attain by choosing the correct mould release agent.**

Mould release agents have come a long way in the past 50 years, certainly in parallel with development in other advanced manufacturing techniques in the reinforced plastics industry. In the past, the industry standard was to continuously apply coat upon coat of wax and allow long periods of drying time in between coats and polishes. This long and labour intensive method originated when fibre reinforced plastic (FRP) production was less intense and the pressure to produce the higher volumes that present day competition and the market demands did not exist. Today, despite the fact that manufacturers acknowledge the need to produce mass quantities at high speed, one major element is constantly overlooked by even the most sophisticated manufacturers, namely mould releases. The consensus amongst many shops is simply to use a wax that's "going to do the job". The cost and amount of mould release used in daily production in the composites industry is relatively insignificant compared with gel-coat, resin and reinforcement. However, as many composites manufacturers eventually learn, no matter how good the mould design may be or how advanced the moulding process or resin system, it is all in vain if the mould release agent does not perform its function properly.



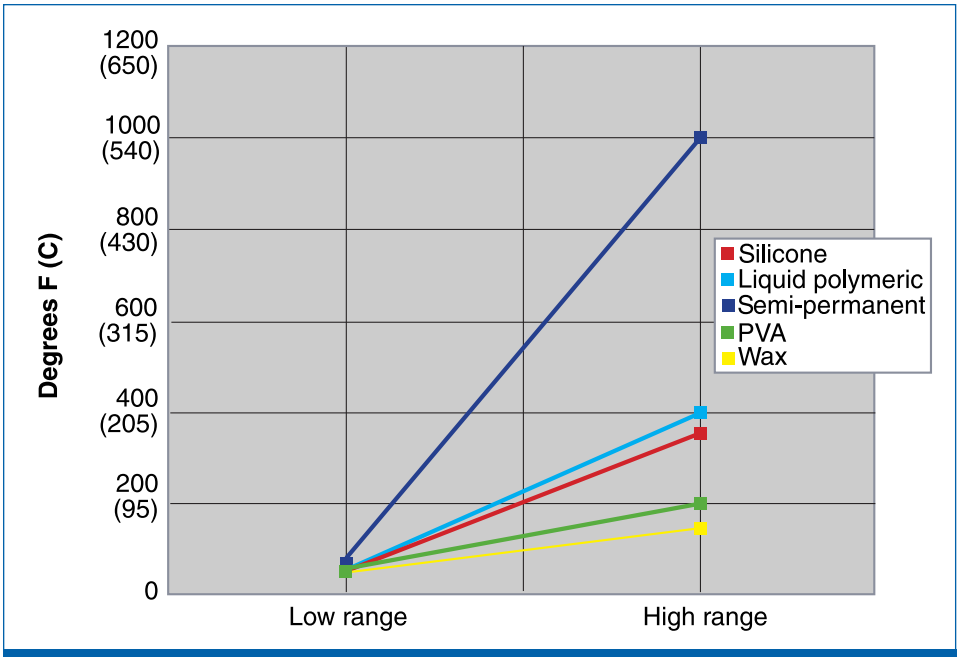

*Comparison of labour and raw material costs for a theoretical component.*

**Despite the fact that manufacturers acknowledge the need to produce mass quantities at high speeds, a major element is constantly overlooked - mould releases.**

### Effective mould release

Considering how important the role of a mould release agent is in the production process, we must be sure that we know what to look for in selecting one. An effective release should have the following.

- Chemical inertness to both mould surfaces. This is essential to counter the adhesion that commonly occurs between the two surfaces. It is influenced by factors such as penetration, chemical reaction and compatibility, surface tension, and




***Temperature resistance of commonly used mould release agents.***

the surface configuration and polarity between two materials.

- A low surface tension so that it wets out the mould forming a continuous film.
- Insolubility.
- Heat resistance, to avoid being melted by the curing or processing temperature.
- A strong attraction or bond to the mould surface, while having a similar polarity with the wet resin so that it separates easily. Adhesion is often caused by the opposing polarities of the two surfaces.
- Resistance to other factors that can cause adhesion such as high static charges, vacuum formation between two smooth and glossy surfaces or if one of the surfaces remains tacky.

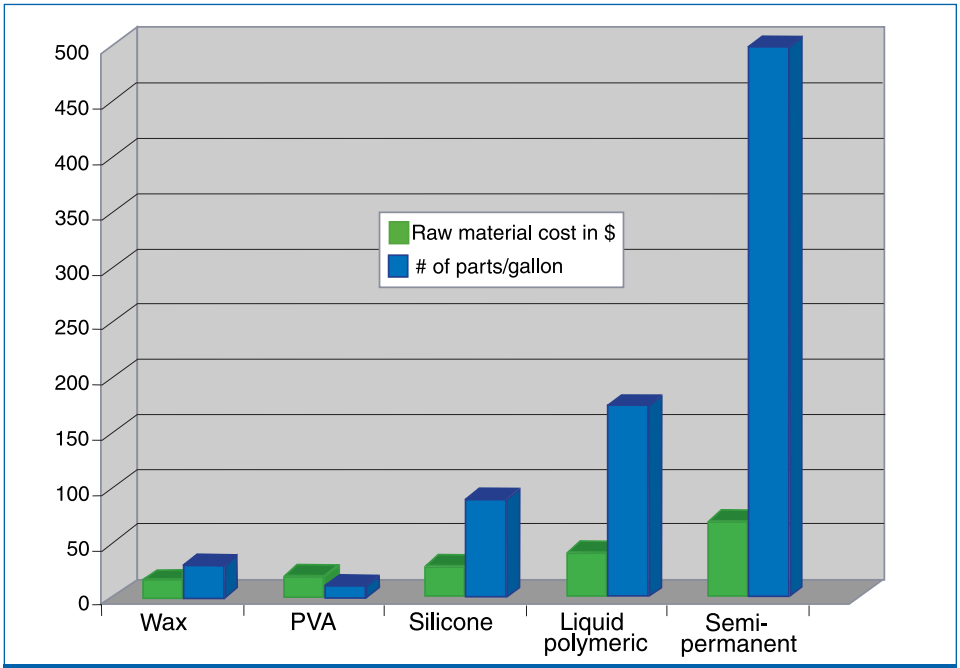
## What to look for

Although following the above criteria when selecting a mould release agent is helpful and is likely to make the manufacturing process go faster, cleaner, and easier, there are other elements that should be considered. It is the moulder's natural instinct to place all the blame on the mould release if a part sticks. However, various other conditions should be investigated before automatically condemning the release agent.

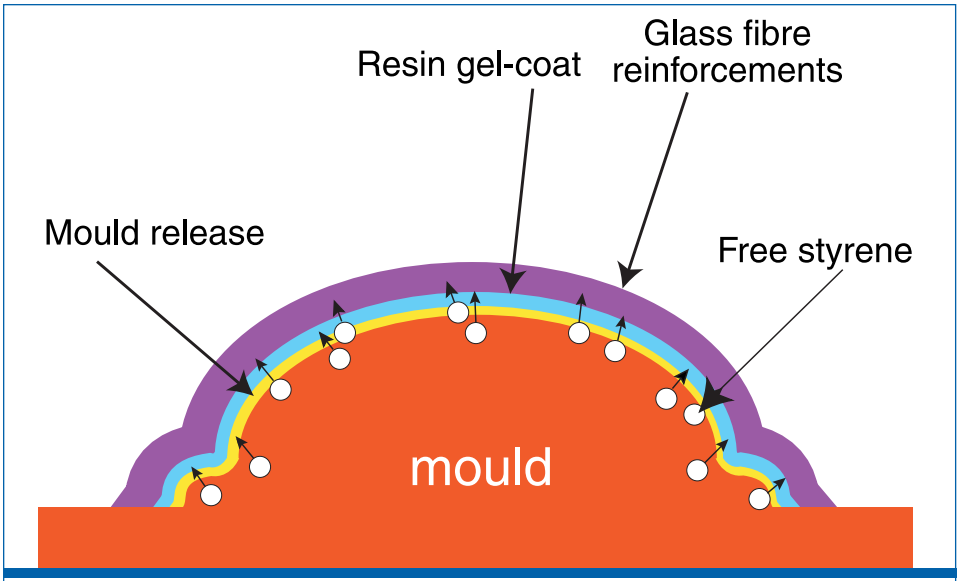
One important contributing element that can be overlooked is the climate. In colder climates, if the mould surface is colder than the shop temperature, there may very well be an earlier cure on the outside surface of the resin or gel-coat. This would leave the interface surface under-cured or tacky. In effect, this phenomenon will not only cause a significant resistance to easy release, but it may also prevent free styrene monomer from vaporizing. Furthermore, if there is residual, uncured styrene, it could act as a solvent to dissolve the mould release film.

Another possible factor is a delayed cure at the interface. The same styrene monomer, which is often used as a mould stripper, slowly dissolves the mould release film. Although a good mould release agent will have some resistance to the styrene, the fact remains that the longer the residence time before gelation the better the opportunity for the styrene to adversely affect the mould release film. Furthermore, many shops experience sticking, most notably during the change of seasons. At this time, it may be a result of an inadequate catalyst that results in a slower, longer cure. Or, the exact opposite may be true, i.e. too quick a reaction time, which raises the exothermic temperature. A fast, hot cure can melt the wax release film if it has a low temperature tolerance, consequently causing the part to stick to the mould.

Another consideration is gel time. Gel-coat and laminating resins contain a large amount of styrene and a styrene monomer can be used to strip a mould. So, whenever




***Comparison of raw material costs and the number of parts moulded from a particular release agent.***




*Unreacted or free styrene can penetrate the mould release if good resistance does not exist.*

a gel-coat sprayed on a mould, a potential stripping agent is applied. Therefore, it is important that the gel time is not too long. Whereas a gel time of approximately 11 to 20 minutes is good, a 30 to 50 minute gel time may dissolve the mould release surface because of the presence of the styrene monomer. To our knowledge, every release on the market, with the exception of polyvinyl alcohol (PVA), is soluble in styrene.

### New and green moulds

It is impossible to accurately measure the amount of unreacted styrene remaining in the gel-coat or laminates of a new mould. Therefore, there is no way of knowing if the residual styrene in the mould will affect the first release. In light of this, it is ideal to post-cure a new and green mould to minimize the free styrene, which comes through the gel-coat surface during the cure of a mould. New moulds can be simply placed outside to bake in the hot sun for two to three days. This allows the majority of the free styrene in the laminates and gel-coat surface to evaporate, giving better release properties to the first few parts during the break-in period of a new mould. However, new moulds that have rested inside for two weeks can potentially have residual styrene remaining, leading to an array of problems.

And, even a new mould that has had ten coats of wax applied to it can still experience some form of sticking because of styrene monomer burn-through if the mould is not fully cured. Considering that we do not yet have the technology to conclusively determine whether or not a mould has been built under ideal conditions, we always advise using PVA for releasing the first few parts. PVA is generally resistant to the residual styrene, which is driven up through the mould surface during the first exposure to the curing part. PVA should be applied over the mould release, which has already been applied on the surface. After the first demoulding, the PVA should be removed with a damp cloth and reapplied along with the mould release. This procedure should be continued until all of the PVA releases cleanly from the mould and sticks on the moulded part.

## Mould release agents - the basics

### Why things stick

- Mould design/construction
- Porosity
- Chemical reaction at the mould face
- Under-cured resin

### How mould releases work

- Vacuum/static attraction
- Chemically inert
- Good heat resistance
- Surface tension - low enough to wet-out on mould, no interference with resin flow

### Selecting a mould release

- Type of resin and catalyst
- Process
- Type of moulds (metal or FRP)
- Temperature conditions
- Type of parts/special requirements
- Current mould release
- How will the release be applied?
- Who will prepare and maintain moulds?

### Basic trouble shooting

***Problem:*** poor release and particles from moulding material remain on the mould.
***Cause:*** microporosity in the mould.
***Solution:*** thoroughly clean mould, apply sealer and reapply the release.

***Problem:*** unable to achieve multiple release.
***Cause:*** poor release in high draft areas.
***Solution:*** apply one to two extra coats of release in high draft areas.

***Problem:*** complete release failure.
***Cause:*** poorly cleaned mould surface prevented release from adhering to the mould or release applied improperly.
***Solution:*** strip part, thoroughly clean the mould and ensure that release is fully cured before moulding.

***Problem:*** poor release and white patches on parts
***Cause:*** poorly cleaned mould surface prevented release from adhering to the mould or excess styrene.
***Solution:*** thoroughly clean the mould and reapply release, reduce styrene/adjust catalyst.

***Problem:*** build-up or release agent on the mould or transfer of release to the moulded part.
***Cause:*** over application of the release agent
***Solution:*** thoroughly clean the mould, reapply release and carefully follow application instructions.

## New release agent means less mould maintenance for RTM parts

A maker of body components for a major automotive manufacturer has successfully tested and converted to Axel's XTEND 19W semi-permanent release for resin transfer moulding (RTM) applications. One application utilizes a tough Modar® resin to produce FRP body and chassis components. The aluminum and epoxy tooling is heated and maintained at approximately 55ºC for the female cavity and 45ºC for the male plug. The previous mould releasing agent used resulted in extensive mould maintenance such as dry ice blasting and compounding and buffing to prevent resin residue build-up. This process to prepare the moulds for next day production was time consuming and labour intensive. Furthermore, after cleaning a minimum of three coats of sealer had to be applied, followed by a minimum of three coats of the release at the moulding temperature.

According to Axel, using XTEND 19W will mean a better release performance in both open and closed mould processes. Four applications of XTEND 19W are wiped on the clean mould, and no sealer is required. In general a 30 minutes dry/cure time is recommended between each coat and after the final coat. The release is applied to the moulds at the moulding temperature. The parts release cleanly and easily from the moulds with a minimum of residue and scumming. Applying a light coat of the XTEND 19W between moulding ensures an even better release and reduces build-up. In addition, because XTEND 19W does not require a sealer there are significant time savings in mould preparation.

The switch to XTEND 19W has significantly decreased the labour requirements for mould maintenance, says Axel.

### Mould release categories

#### PVA

One of the oldest release agents used by the reinforced plastics industry, PVA is still one of the safest, most efficient, and most reliable agents for breaking in new and green moulds. PVA's advantageous quality is that it resists being dissolved by styrene monomer, which usually vaporizes in excessive amounts during the break-in period of a new and green mould. When the PVA film completely comes off on the part, it can be discontinued and subsequently replaced with another more convenient and easy to use mould release agent.

#### Waxes

These were the earliest mould release agents used by the composites industry. It is for this reason that many shops prefer to have a supply of cans of hard paste wax around the shop to use for release. These old fashioned release agents have been somewhat modernized for faster and easier application, by being manufactured in paste and liquid forms. While some still have low temperature resistance others are suitable for high temperature applications. Nevertheless, be aware that many waxes have silicone added to them to promote high luster and easy application, as this is usually the reason for "fish eyes" when you spray up gel-coat. Furthermore, there is the danger of pre-release.

#### Polymeric mould releases

Polymer mould releases are based on fluorocarbon chemistry and include polytetrafluorethylene (PTFE). Some suppliers formulate proprietary polymeric-based releases, which do not contain fluorocarbons. These types generally have a strong bond to the mould, do not transfer and offer multiple releases from a single application. Parts moulded with polymeric release agents are the easiest to achieve secondary bonding or painting without adhesion problems.

#### Internal mould releases

These can either be based on vegetable oils or other refined types of proprietary polymer chemistry. They are used as additives mixed with resin or gel-coats in a range of 0.5% to 1.0% by resin weight. In the case of vegetable oils, the release mechanism is achieved by exudation because of complete incompatibility of the oils with the resin.

#### Silicones

Silicones are rarely used in their pure state as mould releases. As mentioned in the discussion of waxes, liquid mould, release products containing high amounts of silicone can cause pre-release and fish eye formation.

### In the future

In the fast-paced and competitive world of composites manufacturing, engineers need to use every advantage they can get on their competitors. Quality alone is no longer what customers demand, but rather higher quality along with the ability to produce in larger quantities and at great speeds. It is therefore essential to eliminate every factor than may be slowing down production, and one of the easiest ways to remove inefficiencies is by choosing the proper mould release agent.

Whether your application requires a wax, silicone or external or internal release agent, it is important to make sure that the most effective one is selected. It is for this reason that it is essential for those in the industry producing and engineering mould releases to be careful in their research and development, and in their respective manufacturing processes. Once aware of the needs of high performance composites, you can select from the many lines, types and varieties of mould release agents - especially from those manufacturers that are constantly coming up with the new and improved ways to achieve better, faster and more efficient release performance. ■

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