Following are excerpts from "Why Molds Stick" by Bob Lacovara, originally published in February 1991 issue of **FABRICATION NEWS** *(now* **Composites Fabrication***). All typographical errors are the sole responsibility of REXCO.*

WHY MOLDS STICK: The Phenomenon Explained

by Bob Lacovara, FFA Technical Services Director

Why Do New Molds Stick

While conducting a series of Tooling and Mold Making Seminars during 1988-89, the Fiberglass Fabrication Association conducted a research study concerning the industry's experience with mold sticking. The survey was completed by 524 individuals involved in fiberglass tooling operations.

Research Survey Results

Here is a summary of the compiled data:

Question:	Have you ever stuck a mold on a plug?
Response:	Almost 15% … reported they had stuck a mold on a plug, at least one time.
Question:	Have you ever stuck a part in a new mold?
Response:	Over 90% … reported they had stuck parts in a new mold, at least one time.
Question:	Of all the molds you've built, how many have stuck one of the first three molded parts?
Response:	About 13-15% of all initial parts stick in new molds.
Question:	What brand and type of mold release had been used on the molds that stuck?
Finding:	The brand and types of release agents were evenly distributed according to market share. All major mold release brands were reported to stick 13-15% (+/-1%) of new molds.

The Smokeless Gun

One of the presuppositions of the survey was that certain types of mold releases would perform better than others. In closely examining the data it was found that 13-15% of ALL new molds stick, regardless of the type or brand of mold release used. All of the mold release types were reported to stick approximately the same number of new molds (within +/-1% of each other). The conclusion is that the type of mold release has very little bearing on mold sticking.

So Why *Do* Molds Stick?

Let's examine the curing process of polyester gel coats. The cross-linking … takes place when a free radical, provided by the catalyst, breaks a carbon-carbon double bond of the polyester molecule. The double bond is reduced to a single bond plus another free radical. This second free radical can then react with any other carbon-carbon double bond, usually provided by the styrene monomer. When the bonding is complete we have an interconnected network of polyester polymer molecules in which styrene serves as the bridge between polymers.

There is one minor catch to this process. Polyester chemists tell us that in a properly cured resin or gel coat about 94-96% of the cross-linking sites are reacted. This means 4-6% of these bonding sites remain reactive.

What is the difference between a new or "green" mold and one that has been in service for a while? Why do new tools have a tendency to hang up when an older mold will not normally stick even if a wax cycle is missed? The answer is … SURFACE REACTIVITY.

The new mold has a reactive surface, on which the 4-6% of the polymer molecules exposed on the surface would like very much to stick to something. That something is one of the initial molded parts in 13-15% of the cases.

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Reducing Surface Reactivity

The goal of new mold initialization or break-in is to reduce the surface reactivity to create the most INERT surface possible. When just wax or semi-permanent mold release is used, the reduction in reactivity is facilitated through interaction between the production gel coat and the tooling gel coat. That's right, wax or semi-permanent release agents do not form an impervious barrier between the mold and the part. The actual function is to lower the surface energy of the mold, demonstrated by lower surface tension, or in simplistic terminology a "slippery surface." It is in this case the 13-15% sticking rate comes into play.

How Much Wax is Enough?

Let's examine the facts. First, fiberglass folklore says, "The more wax the thicker the barrier." This is not necessarily true. For example, if one coat of wax is one micron thick, ten coats might only be one and a half microns thick, a very marginal difference. With semi-permanent release agents, which utilize a polymer bonding film, the thickness does increase to a certain extent, but not in direct proportion to the number of coats.

Why then do we insist on multiple coats of wax? The answer is coverage. It is extremely easy – and likely – to miss small areas on a mold surface on a single application. While one coat of mold release is sufficient for releasing purposes, multiple applications ensure adequate and thorough coverage. So, how many coats is enough? The statistics show a range of 2-20 coats, with the average falling in the 4-6 range. Interestingly, a greater number of coats does not seem to lower the mold sticking percentage.

Is There a Foolproof Way?

Yes, there is a method to avoid the chance of sticking on mold initialization. In a word…PVA. Polyvinyl alcohol (PVA) is a parting film which forms a physical barrier between the mold and the part. PVA has been around since the beginning of the fiberglass industry and certainly is not considered new technology. PVA functions not just as a mold release but more importantly as a surface reactant which accelerates creation of an inert molding surface.

Creating an Inert Mold Surface

What has developed from … research is a mold initialization procedure that is as foolproof as we have at this time. The procedure is as follows:

1. Prep the mold with a PVA compatible mold release agent.
2. Apply PVA.
3. Apply production gel coat (and optional laminate).
4. Fully cure gel coat.
5. Pull gel coat and clean mold.
6. Repeat steps 1 through 5.
7. Once 2 pulls with PVA are completed, prep the mold with the production release agent and run first production part without PVA.

This procedure applies to cosmetic gel coated parts and avoids having to sand and polish the initial pieces. If parts do not require a high gloss finish, simply run the first 2 parts with PVA and eliminate the PVA for the 3rd pull. The reported sticking rate following this procedure is less than .1%, assuming proper PVA application. After 2 applications of PVA it appears that tooling surfaces become sufficiently inert.

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PVA – The Good, the Bad and the Ugly

We've seen that with the proper application of PVA the mold break-in period can be accelerated and sticking frequency greatly reduced. However, PVA in itself can cause problems. The two most common problems are the PVA etching into the mold surface and polystyrene hazing on the surface. Both problems are a result of *thin* PVA. Remember, it is better not to PVA than to spray thin PVA.

The problem with thin PVA is that the polystyrene from the production gel coat penetrates the film and becomes trapped between the film and the mold surface. The etching occurs when the tooling surface actually softens and deforms. Hazing of a mold surface is in reality microscopic sticking, which will tend to be chronic in that area of the mold.

It is imperative to spray PVA in a film thick enough to be peeled off the mold in sample areas. When holding the film up to the light, no pinholes or porosity should be present. Proper PVA application involves using a siphon cup gun and gradually building up a number of thin passes to form a continuous thick film.

The Logical Conclusion

Here is a summary of the information:

- Polyester molds stick because of the surface reactivity of the tooling gel coat.
- Properly cured tooling gel coat is essential to reducing surface reactivity.
- A mold that has been initialized (broken in) has an inert surface.
- If mold release without PVA is used for the initialization, between 13-15% of molds will stick.
- The type of mold release has very little bearing on sticking of new molds.
- Assuming adequate coverage, the number of coats of release agent has little bearing on mold sticking.
- PVA accelerates the reduction of surface reactivity, creating an inert state relatively quick.
- The outline PVA initialization procedure has a significant effect on successful commissioning of a new mold.
- PVA must be applied in a continuous film. *Remember, no PVA is better than thin PVA.*