Single-use plastic for composite infusion moulding – no excuse

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The awakening of the public's awareness that single-use plastic is damaging our environment and oceans gathers more belief than world climate change. It has galvanized and established its place firmly in the national consciousness as never before writes UK's Sunday Telegraph writer Jillian Ambrose. That is because unlike "climate change" discussions, plastic waste requires no study and challenged interpretation of centuries of historic records as found in ice cores, rock strata, tree trunk rings and the like. No - single-use plastic is a very new and real phenomenon, a waste problem which has developed within our living memory and has become our number one environmental challenge.

Figure 1: Over 20 million plastic bottles are single use daily in the UK alone

The single-use plastic waste problem is so great that the act of recycling waste has been overwhelmed by sheer volume and complexity of plastic types. A much more radical solution needs to be found and found with a degree of urgency. Our throw away attitude to waste wrappers, packaging and containers must go through a 180-degree direction change meaning that packaging becomes biodegradable and or reusable.

This single-use plastic waste problem also knocks loudly at the door of today's composite moulder. As many have moved away from open mould production methods the surge in closed mould application is now well established and apart from the more costly RTM and LRTM methods Infusion moulding has increased tenfold both for liquid infusion and prepreg in or outside the autoclave. Referred to as vacuum bagging, few give much environmental concern of the hectares of single unsound use of consumable bagging materials which fill waste skips daily. figure 2 A waste skip single emptying cost in excess of £800 are a painful reminder which moulding companies have to put up with whilst assuming there is no real alternative.

The growth of reusable vacuum "bagging" has however increased in the last 8 years to the extent that it would be unwise for any composite moulder to discount this clean and very environmental and commercially sound alternative to the single-use consumable bagging approach. Of course, there is resistance from the traditional vacuum bagger technician and it is sad to hear qualified engineers reject the reusable approach. This rejection is always on the grounds that, as reusables are made from silicone, their introduction into the moulding shop would jeopardise the production through silicone contamination. This fear appears entirely

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based upon emotion of the word ”silicone” and not on any form of real case history or study. Our approach to this argument is to offer independent test results using x-ray and infrared spectrometry showing no cross contamination of free silicone to the shop environment or moulded part. Furthermore, the anti-reusable silicone bag lobby cannot continue to ignore the increasing thousands of moulders now successfully using the system with many costs and quality benefits without any issues of silicone contamination.

The number one reason reusable vacuum membrane application is increasing is primarily due to their more favorable economics over not only traditional consumable bagging infusion but in many ways as a cost effective alternative to the Light RTM process.

It is now a well established fact that infusion consumable bagging materials cost added to the cost of skilled labour employed to position and seal them over the dry reinforcement (or prepreg) prior to infusion proves the alternative reusable approach pays for itself within 4-7 cycles.

In terms of resin wastage, reusables commonly achieve a staggering 20% plus reduction over the same part made by LRTM. The fact that they are self sealing and need zero maintenance or need any form of release agent is also factored into their considerable production cost saving benefits.

A notable development feature reusables have brought is to simplify and speed up the method of resin input. Many will agree that traditional infusion under conventional vacuum bags is a relatively slow production method, however, reusables have changed all that. It is now perfectly acceptable to dispense the entire resin shot under the membrane over the reinforcement in one single pouring action. This eliminates the tiresome slow vacuum infusion from a bucket or machine feed system. The result is not only that the operator dispense operation is completed in seconds but also this frees them up for new tasks whilst the infusion takes place automatically. The infusion fill time is dramatically reduced allowing quicker gel and cure bringing faster cycle times.

There are some who voice a note of caution over this new departure of resin dispense suggesting it brings greater air inclusion in the laminate which sounds a reasonable concern. However, it is not founded on any proven study but is tabled by the resin

injection machine manufacturers lobby. Supposedly they are obviously concerned that their sales may be impacted by the method. Fortunately many moulders using reusable vacuum membranes in the last 8 years have no issues with air entrapment and prove such concerns are invalid.

The reason such radicle resin dispense methods where not appropriate when using traditional disposable bagging is because they are laid over the fibre pack with many pleats, folds and wrinkles to ensure their flat shape is tailored to fit the three dimensional contours of the moulded shape. Pouring resin en bloc under such would simply un-pleat the folds and allow the resin to flow unpredictably in any direction leading to dry fibre unfilled areas. Reusable membranes, on the other hand are moulded accurately to all the three dimensional shape of the mould and have no pleats or folds thus allowing the resin flow to progress in an orderly and predictable manner.

A more recent development and now established as a welcome advance in optimized resin delivery is the “morph” resin runner. So called as the smooth moulded membrane surface morphs into predetermined flow channels directing resin rapidly from a given inlet zone to the mould cavity far reaches ensuring optimized fill speeds. These temporary “morphing “ resin channels will, on resin fill, morph back to a flat surface once more eliminating any fixed resin runner cure exotherm or the need of single use peel ply.

Figure 3: Morphing resin runners rapidly distribute infusion resin but leave no mark on the cured part and eliminate the need for single use peel ply

The two times innovation winner for the German ICE train flooring product from November 2018 JEC , Korean show and AVK award Composites Europe employed reusable vacuum membranes. These had multiple arrays of resin morphing runners built into several production membranes made by SMT, Forst, Germany.

Figure 4: Composite award winning new low weight ICE TRAIN flooring made with reusable membranes

Longevity of reusable membranes has recently become a hot topic with established suppliers claiming up to 350 cycles.

Platinum addition cure silicone materials used for the manufacture of reusable vacuum membranes (bags) for composites vary enormously in quality. Generally, they are all able to achieve the necessary vacuum sealing function and have good temperature resistance. Tear resistance also varies but remarkably this has little impact upon their daily use. The main issue is their self-releasing reusable longevity performance. In other words, how long they last.

A reusable membrane, which can be reused for say 300 moulding cycles is impressive only until one learns that there are high-quality silicones which achieve 1000 cycles and more.

Figure 5: Illustration of ACC Silicone membrane condition after 1200 plus uses with polyester resin moulding

A silicone material, which achieves four times the life without any need for maintenance and recoating is seriously impressive. One would

be forgiven in thinking such higher quality silicones like ACC Silicone's VBS26 would be much more expensive, however, to pay only another 20% more for potentially 400% greater longevity is extremely attractive.

Reusable membranes, often referred to as reusable vacuum bags, have now been marketed for over 10 years and in that time case histories of longevity have come to light and have been repeatedly proven. Clients are reporting excellent longevity performance with some silicone grades whilst achieving far less with others. The only difference between them is the original silicone-manufacturing source.

It is now apparent that the choice of silicone grade is a very important commercial decision and it would be false economy, as unfortunately is so often the case, to simply go for the cheapest with no regard to longevity.

Figure 6: A different European silicone supplied illustration of a riding helmet membrane after only 160 cycles using polyester resin. Note the surface peeling where the part has stuck and rendered the membrane unserviceable after such a short production run

Although the focus here has been upon reusable membranes being used for liquid resin moulding processes, they are equally beneficial with the prepreg moulding process whether used in or outside the autoclave. Unlike consumable bags they can feature built in intensifiers, an attractive characteristic often used in prepreg but are traditionally separately positioned rather than built in.

Although reusable membrane technology could be said to be in its relative infancy the march toward much greater use within composite manufacture has a strong growth future if based upon nothing more than their production cost saving features alone.

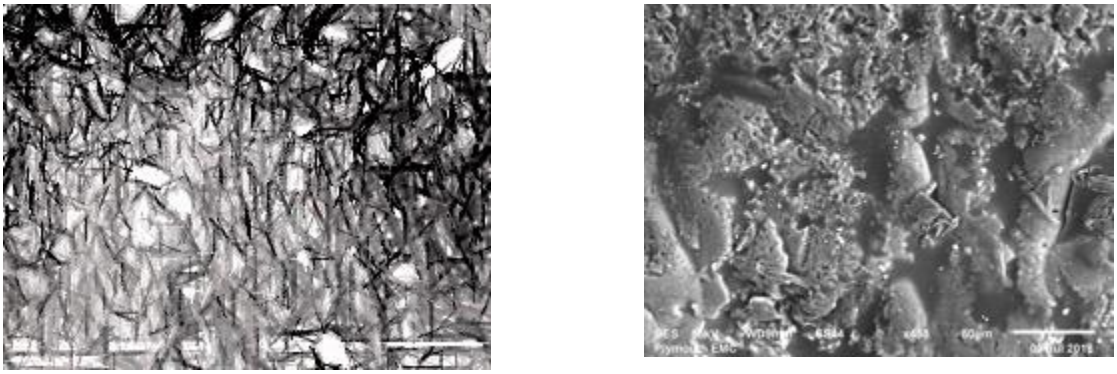

Figure 7 – Above is an electron microscopic image of a worn-out silicone surface through styrene attack.

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