

► Flame-based carbon coating with Linde's Carboflam technology is said to be more advantageous than oil-based systems.



## Transitioning to automated mould lubrication

Rainer Mieth\*, Matthias Görisch\*\* and Stephanie Englert\*\*\*, explain why glass producers have adopted Linde's Carboflam technology.

**G**lass manufacturers today are exploring ways of transitioning from manual lubrication to automated systems with a view to increasing process efficiencies and productivity.

Many producers of container as well as art and tableware glass use Linde's Carboflam technology. This solution is not only highly automated but also offers further advantages compared with oil-based systems.

The key drivers for converting from manual lubrication to a highly automated process are:

- The main reason is that repeatable lubrication results are difficult to realise during continuous manual production.
- Manual swabbing is a time-intensive and highly repetitive task, tying up operators who are no longer free to perform other value-adding tasks.
- There is a general desire to minimise workplace pollution – in other words, organic compounds and steam.
- Customers are keen to reduce the effort required to clean machines and components of oil-based lubricants.
- Safety legislation within the EU is increasingly strict, accentuating the need

for alternatives to manual lubrication.

The answer to these manual lubrication challenges can be found in solutions originating from industrial automation and electrification. Other industries such as automotive have also redefined and optimised manufacturing processes. These automation solutions are reshaping the glass industry, especially the container glass segment – which typically relies on production lines with individual section (IS) machines.

## Automated lubrication solutions

There are three main automated lubrication systems on the market with the ability to replace manual lubrication.

The first is a swabbing robot. With this method, an oil-based lubricant is sprayed or brushed into the blank mould by a robot.

The robot works with precision and uses a spray nozzle or brush to repeatedly apply only a small amount of the special lubrication oil to the surface of the mould of each section in the production line.

Nearly 100% of the lubrication oil is then deposited as an even, thin layer on the blank mould surface.

This solution can be fully integrated into the glass forming process flow without interrupting production (depending on the speed of the IS line). The swabbing robot moves fully automatically to the required section of the production line.

The second option is a fixed installation on every section of the production line.

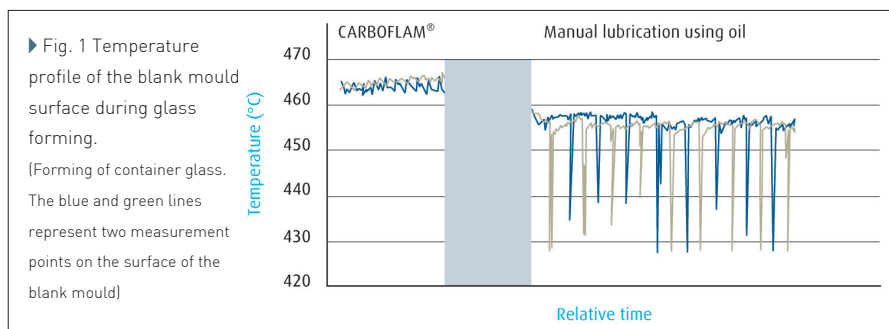
This automatic lubrication system uses a nozzle to automatically spray a special lubrication oil into the mould of each section. The fixed spraying unit/system precisely applies only a small amount of lubricant oil, depositing nearly 100% of the oil in an even, thin layer on the blank mould surface.

This solution can also be fully integrated into the glass forming process without stopping production (again depending on the speed of the IS line).

The third option is Carboflam technology, a flame-based carbon coating solution. With Carboflam, acetylene is combusted under precise and reproducible conditions and thus separated into hydrogen and carbon.

Nearly 100% of the carbon created is then deposited as an even, thin layer on the blank mould surface. This coating step is fully integrated into the glass production process and does not require any stoppages (depending on the speed of the IS line). The acetylene is combusted with a post-mixing burner based on an under-stoichiometric acetylene/oxygen flame mixture. When the magnetic valves in the Carboflam burner gas supply line are opened, the gas streams out to the burner head. The acetylene stream is shielded by an oxygen stream.

A pilot flame or electric ignition mechanism at each burner head automatically ignites the gas stream. The carbon coating process for a blank mould takes just 0.1 seconds per coating.



## Benchmarking technologies

How effectively do the different automated lubrication technologies address the manual lubrication challenges that glass manufacturers face – as outlined above?

Looking at the repeatability of lubrication results, one can say that, in general, all automatic lubrication solutions provide superior results to those achievable with manual lubrication and thus minimise the reject rate related to lubrication repeatability.

Furthermore, an automated solution eliminates the time-intensive and highly repetitive task of manual lubrication, leaving the operator free to focus on more valuable tasks. Automation also reduces operator interaction with running machines and this mitigates the risk of crushing and other hazards.

There is an important difference between Carboflam and both the manual lubrication approach and the two automated lubrication technologies outlined above, namely product quality.

This quality gain is attributable to the absence of oil with the Carboflam process. Swabbing robots and fixed oil-spraying systems use a special oil-based lubrication agent for the glass forming process. Manual lubrication is also based on oil.

Carboflam applies a pure, thin carbon layer and is totally free of oil.

This key feature ensures that the temperature of the blank mould surface remains more stable and homogeneous during glass forming compared with oil lubrication (**Fig 1**). A stable temperature profile is important.

It leads to a more homogeneous – and thus higher-quality – glass surface and reduces the reject rate attributable to variations in the mould temperature profile to zero.

The automatic design in combination with an oil-free process increases the pack-to-melt ratio of industrial-scale installations by 1 to 2% and even more in some instances.

Reaching beyond the quality and

productivity gains outlined above, one can also note distinct differences in cost between the different approaches to automation. Looking at the up-front investment costs, Carboflam Capex is similar to that of fixed oil-spraying systems but much lower than that of swabbing robots. Over time, it also offers potential to optimise operating costs and total cost of ownership. The higher pack-to-melt ratio, for example, has a positive impact on the operator's bottom line. Gas consumption can be further reduced by switching from a pilot flame to electric ignition as the ignition source.

In addition, the lack of oil and optimal adjustment of process parameters with Carboflam extend the lifetime of moulds and reduce cleaning effort – also of adjacent components.

Carboflam can also help to avoid the costs associated with unnecessary downtime. Because each section of an IS line is operated independently, the operator is free to access individual sections. So if the operator needs to handle a specific mould, the moulds in the other sections remain operational.

Finally, it can enhance productivity through ease of operation. Its new and advanced features keep glass manufacturers abreast of the latest industry automation trends. One such feature is the touch panel with an integrated database of all parameter settings per product program. The operator can easily select the desired product via touch panel and it automatically adjusts the process parameters and thus the thickness of the carbon coating. ■

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