A clean path

What is the best way to clean a multilayer blow die head in an era of increasingly complex film structures? **Steven Pacitti** finds out

Complex multilayer blow die heads producing up to 11 layers are becoming increasingly important in the production of high-quality plastics films in the food industry.

Films also are becoming more complex, from both a use and cost perspective. In this way, they offer many types of protection in terms of strength, UV stability, guaranteed separation, and sterility, which is of particular interest to the food and packaging industry.

To combine different properties in a film, it is helpful to introduce layers of various qualities between the cover films. But what if the film quality diminishes and the blow die head needs cleaning?

Thomas Schwing, managing director of Schwing Technologies in Germany, says that production loss and rejects after a system restart can easily reduce productivity by eight to ten per cent a year.

In addition, companies like Schwing, which provides systems for large and heavy blow die heads up to 1.7m in diameter, have to consider the visible ramifications of inadequate cleaning quality in the form of carbon residues and a degradation of the tool's surface finish. These problems are the order of the day when cleaning by hand and using chemicals or in inappropriate burnout furnaces.

For Schwing, conventional cleaning is a financial pitfall. If it is necessary to stop the blow die film system and clean the head, Schwing says that a considerable number of man-hours are needed to clean the entire head depending on its size and complexity.

"More time is needed for disassembly, testing and reassembly of the nozzle since each layer of the blow die head has to be cleaned and disassembled individually. Besides the known disadvantages associated with cleaning by hand, such as damage from scratches or material distortion, compromised surface smoothness and sufficient tool cleanliness if applicable, several days of production loss is a considerable burden," he explains. "A blow die film production system that costs several million dollars to purchase therefore represents a significant cost factor."

The German company's answer to this challenge is thermal vacuum pyrolysis, which takes only two or three days.

"Costs attributed to maintenance, system standstills and production loss are therefore greatly reduced," emphasised Schwing, adding that smaller blow die heads and machine parts can even be cleaned in a single working day.

The thermal cleaning process for Schwing's Vacuclean System loads the complete multilayer blow die head into a cleaning system.

"Our system cleans blow die heads with a diameter of up to 1.7m and a weight of up to 12 tonnes in a gentle but effective way by carefully melting the remaining plastics inside the blow die head under a vacuum," he says.

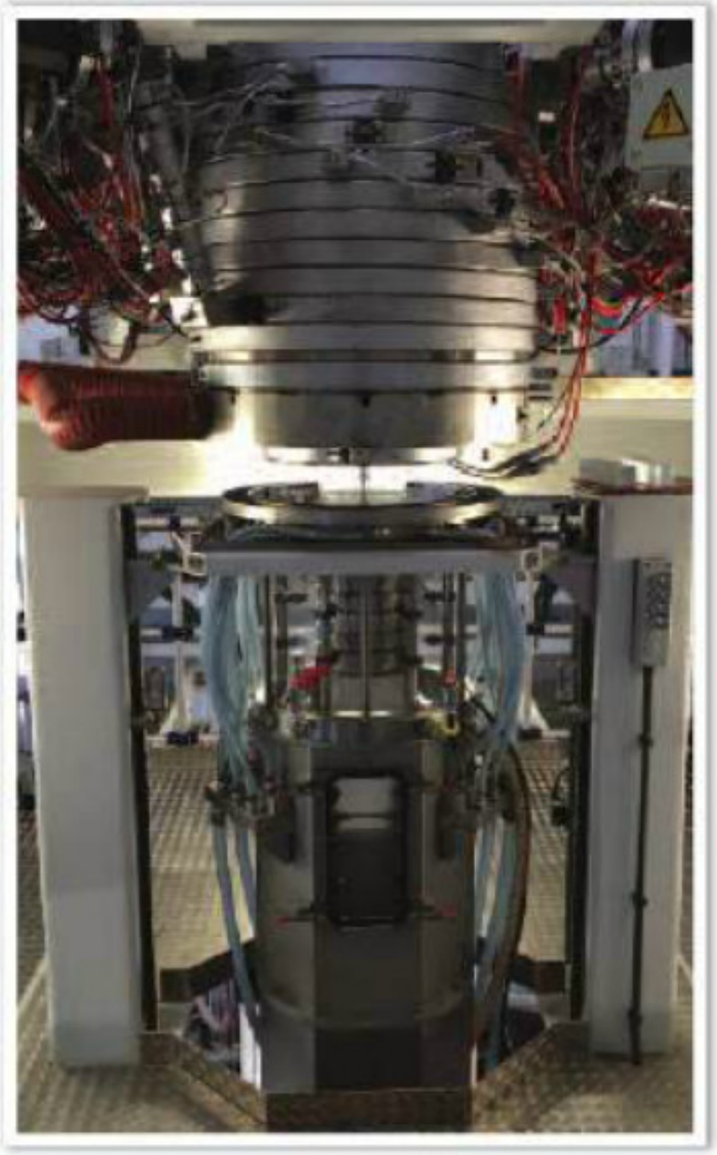
In a second cleaning phase, the remaining plastic material that is still stuck is exposed to more heat and corroded in an electronically documented pyrolysis process with fully-automatic monitoring and then oxidised with more oxygen. It takes a maximum of about 30 hours to clean a blow die head consisting of five layers, which is disassembled before cleaning.

Another company that recommends a thermal technique to the cleaning of multilayer dies is Kuhne Anlagenbau. In this instance the die is placed inside an oven with a vacuum for a few hours to burn off all the polymers left inside it. After coming out of the oven the die is dismantled, all its component parts are cleaned by hand and it's reassembled with new bolts.

"This process is feasible only in those dies where the component parts have been properly heat treated during manufacturing, otherwise warping or distortion of the steel can occur causing serious problems during re-assembly," says Adolfo Edgar, vice president of Blown Film Systems for US & Canada at Kuhne.

"Our latest die design is our Mo-Con [Modular Concept] die, which is used exclusively for 9-, 11- and 13-layer dies. It is a stackable die, similar to the pancake style dies that have been around for a long time. The main difference between the Mo-Con die and the others is that its modules or plates, instead of being completely flat as in a pancake die, have a cone in the centre, the inner part of the module, where the spirals are machined. As with pancake-style dies, the Mo-Con is side fed, and the binary splitting of the melt is done on the flat [outer] part of the modules. The modules [plates] are machined on both sides to keep the die compact in height."

Hosokawa Alpine offers die treatment in a pyrolysis oven, followed by mechanical cleaning actions. Below right. Die cleaning at Hosokawa Alpine



Kuhne's latest die design is the 13-layer Mo-Con (Modular Concept stackable die)

The Mo-Con can be designed with 5- to 17-layers, although the highest number of layers produced so far is 13 for Triple Bubble lines sold to European customers. Because of its modular concept, the number of layers can be increased in the future. For example, if a customer buys a 9-layer Mo-Con die, they can later expand it to 11 layers. The Mo-Con die can be used on any type of blown film line: triple bubble, water

quenched or conventional air-cooled.

Design and conquer

Another approach to die cleaning is through the design of the die itself. In an ideal situation the die head should require only minimal cleaning of the die lip set and a once-a-year preventative and inspection cleaning during a pre-defined shutdown period.

"It is possible that a Dual Spiral Systems (DSS) die will run many years without a die cleaning," explains the Canadian company's president Rafael Castillo. "What is an ideal situation? When the die channels are designed according to the intended resin formulas and layer structures the die cleans itself as it is operating."

This, he says, is possible as a result of the polymer melt flow within the die channels flowing at a shear rate high enough, and a residence time low enough to not cause degradation or break down of the polymer. This would then prevent degraded material from adhering to the inner channel walls, producing black specs in the extrudate, and require complete die disassembly and cleaning.

"Melt residence time and shear rate are design parameters chosen during the die design phase, but it is not enough to minimise residence time or maximise shear

Schwing Technologies illustrates the cleaning of a blow film die head (from dirty to clean)

rates within a die," Castillo explains.

"The selection has to be balanced with the generation of back pressure as a result of channel size determination during die design. A narrow channel will definitely have a low residence time, but also a high back pressure. This high back pressure will limit the production output of the line, and in the end profitability.

"Achieving a balance between residence time, shear rate/melt velocity and back pressure are essential components to die design and are particularly important to coextrusion die design."

With 7- to 11-layer dies becoming more prominent, a successful die design approach is of vital importance in an effort to maximise profitability while minimising down time due to cleaning or prevention of process related problems, believes Castillo.

"This is the reason why DSS does not offer a pre-designed coex die system, what we refer to as an 'off-the-shelf' die design," says Castillo.

During the mechanical disassembly for cleaning on a conventional cylindrical die, the entire die would require dismantling even if only one layer requires cleaning, says Castillo.

"On a DSS die, being a side fed stackable die, the individual layer can be disassembled without taking the entire die apart, resulting in a substantial times savings. The flow paths within the die are also readily accessible when the die modules are disassembled, resulting in a faster turnaround when the die is down for cleaning."

Likewise, Germany's Hosokawa Alpine has designed its die heads in a way such that they are balanced between high output/melt pressure and min/max residence time of the resin.

Alexandra Endres, project manager for marketing in the Film Extrusion Division of Hosokawa Alpine, explains: "Residence time is crucial for film quality as resins have certain processing windows. They pass the die head within this certain, specific time. Every die head has a minimum output that leads to maximum allowed residence time of the resin. With this minimum output the degradation of resins and contamination within the die and channels is prevented.

"With the die head of generation X, Hosokawa Alpine took care that the surface finish of the die head fulfils highest standards and the head is produced at highest manufacturing accuracy. Additionally, all channels within the die head are designed precisely round and without dead zones. Material changeover times are the result of min/max throughput through the channel and its design. Hosokawa Alpine guarantees that melt flow through every channel's diameter is optimised (fluid dynamic calculation). This extends die head's service intervals between two cleaning actions and shortens material changeover times in production."

Thanks to that design, in daily production simple line purging with standard resins is more than enough, according to Endres. Special purging compounds are not required.

The MacroPack-FP blown film co-extrusion die, manufactured by Macro Engineering, boasts short purging time during transition, with customers able to clean one module at a time, claimed Ali Ali, sales and marketing coordinator for the Canadian firm.

"Customers can choose to have targeted layer cleaning instead of cleaning the whole die. Each layer is heated separately so the operators can take time to clean each module and not afraid of the die cooling down," says Ali. "Our MacroPack-FP design is best suited for any barrier film applications. The residence time of the polymers in the spirals are all the same, which minimises degradation of temperature-sensitive resins."

The type of application is crucial to the cleaning requirements, adds Hosokawa Alpine's Endres. "Depending on the film application and its requirements, die cleaning is necessary in different intervals: while customers with less-demanding applications clean their die heads every few years – for example at HDPE production, because the resin itself cleans the die in daily production – customers with very demanding products, for example for food packaging, attach even greater importance to more often die head cleanings.

"At barrier film lines kind of 'cocktails' of resins can lead to earlier cleaning demand. The resins are more influenced by heat from neighbour layers (for example, EVOH by PA, ties by PA, PEs by PA). This can lead to degradation and contamination over the weeks and months of production. Resins in barrier film productions have low viscosity and high stickiness. They lead to only a little self-cleaning effect within the die, so it's even more important to efficiently purge the line in daily production."

Hosokawa Alpine does offer die head cleaning services and besides the traditional, fully manual die head cleaning, it too can provide treatment in a pyrolysis oven. After pyrolysis, additional mechanical cleaning actions take place using special tools.

Germany's Schwing Technologies claims that an increasing number of blow die film manufacturers are starting to regularly clean their tools to ensure the productivity of their production plants.

Thomas Schwing adds: "It is always more economical to opt for the comparably short production stoppage for blow die head cleaning since improved productivity only comes from a longer blow die head lifetime and less production loss thanks to more stable quality."

It is claimed by Schwing that the replacement of manual cleaning processes with a thermal system can provide a return on investment within a year.

More information from:	
Dual Spiral Systems	dualspiralsystems.com
Hosokawa Alpine	hosokawa-alpine.com
Kuhne Anlagenbau	kuhne-ab.de
Macro Engineering	macroing.com
Schwing Technologies	schwing-technologies.com