



The RGE 4011 mixing and injection unit.

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Low pressure mixing of PU

Although there have not been any major developments in footwear soling systems announced recently (there are several ongoing but not yet ready for publication), this does not mean there have been no advances in specific areas. As far as polyurethane soling is concerned, the key aspect has always been the accurate mixing of polyol and isocyanate to produce the chemical reaction that creates the finished sole.

At the UTECH Conference held at Charlotte, North Carolina, in June, Bjoern Dormann manager of the technical department at DESMA, presented a paper outlining advances the company has recently made in this respect. The new RGE 4011 mixing and injection that was the subject of the

paper should be of considerable interest to all footwear manufacturers using polyurethane as their chosen soling material.

One of the most important factors in the production of PU soling is the stability of the processing conditions. Desma's new-generation mixing and injection unit appears to fulfil this demand both rapidly and extremely accurately. The processing technology that has been developed to do this uses a combination of highly accurate gear pumps, a newly structured automatic screw changer, a sophisticated cleaning device and a brand new graphic user interface that enables manufacturers to achieve even greater product accuracy and consistency than ever before.

The new gear pumps in particular

open up fresh possibilities. Throughput capacity has been increased by approximately 35% and it is now no longer necessary to change the gear pumps when a product change is called for. This, in turn, means that a wider product range can be produced on one moulding machine. One of the most exciting elements of the new unit, however, is the user-friendly graphical interface, which provides the user with an enhanced overview of processing conditions as well as a new algorithm for calculating the most precise mixing ratio, including extremely accurate additive dosing.

RGE 4011

The new reaction injection unit shown in the title image is capable of processing all main polyurethane

systems within a temperature range of 25°C up to 60°C. The viscosity of the liquids involved can run from 800 to 3,000 mPas in the standard configuration. It will mechanically combine the polyol and isocyanate components to create the most homogenous mix possible in order to maximise the subsequent chemical reaction and achieve high quality foaming. It is designed rather like a toolbox kit, where many different valve configurations are possible. These start at two component valves, one for polyol and one for isocyanate. This base configuration can then be expanded through the use of four component valves and four further additive valves (*Figure 1*).

The unit employs low pressure mixing technology, where an auger is used to mix the polyol and isocyanate. As a result, all variations of material can be processed whether ether- or ester-based as well as additional solid fillers even when they comprise a large proportion of the formula. The technology involved is in fact able to handle such a huge variety of different polyurethane components that it could be considered to have set a new benchmark for efficiency and versatility.

One of the main advantages of the new mixing technology is the consistency it can achieve. This means that the user does not have to worry about the mixing ratio as the machine is equipped with patented controlled component valves that ensure that they open simultaneously and so guarantee exactly the same mixing ratio all the time. This is particularly important where a footwear manufacturer is required to deliver products of a totally consistent quality to its customers. Desma says that no other existing low pressure mixing technology can really compare to the RGE 4011 in this respect as the alternatives employ two independent actuators for opening the component valves which can result in less precise valve actions and a possible loss of quality.

If the gel time of the material to be moulded exceeds the cycle time, the mixing chamber has to be cleaned. This is done by a special self-cleaning system. The mixing screw is designed in several different geometries based on the type of material to be processed. Furthermore, the combination of three component valves and four additive valves while appearing to be complicated is in fact totally practical in operation. For instance, the four-component mixing head can handle two different polyurethanes with total different chemical configurations while the three-component head is able to handle two different polyols and one isocyanate.

FLEXIBILITY AND PRECISION

The technology also has the ability to change the complete mixing ratio as well as moulding parameters such as throughput and component combinations from shot to shot without interrupting the production cycle. The use of precise gear pumps enables the shot weight to be kept stable every single time, regulated by the control database where data on every moulding is stored.

All liquids are delivered to the mixing unit by high precision gear pumps which are in turn driven by servos to ensure a precise and constant flow of the various individual components. All materials are kept circulating inside the feeder hoses again to ensure consistent processing conditions. The liquids are distributed into the mixing

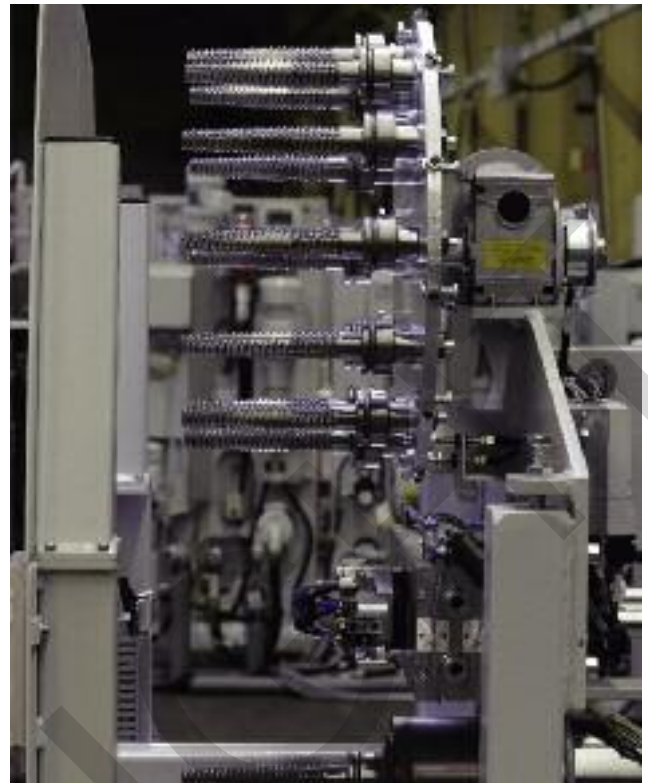


Figure 1 - The multi-valve mixing head is able to handle a variety of different chemical configurations.

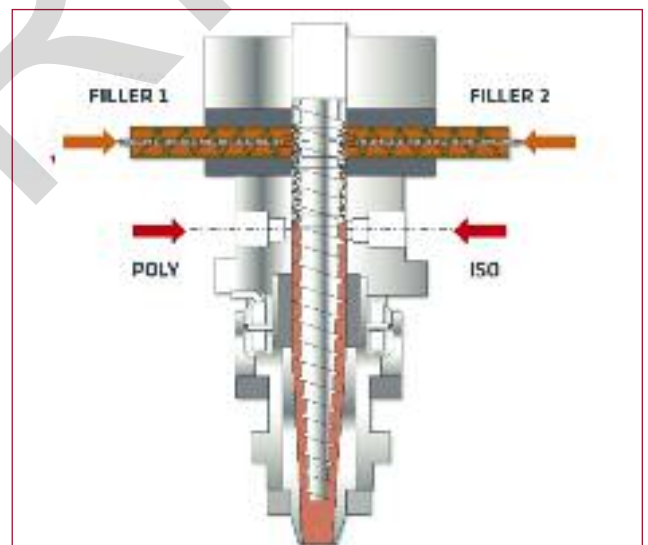


Figure 2 - The specially designed mixing auger ensures a highly homogeneous mix.

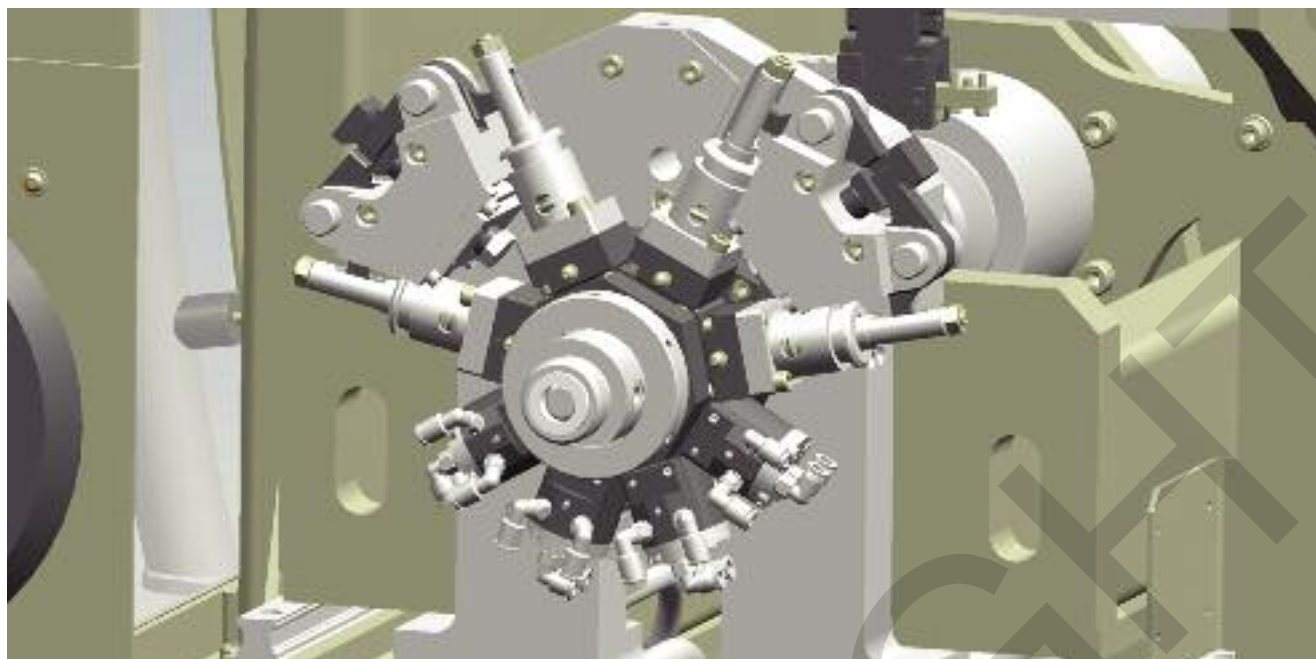


Figure 3 – Self-cleaning mixing head with up to eight component/additive valves.

chamber via an auger which is capable of revolving at up to 18,000 rpm (*Figure 2*). This auger then combines the polyol and isocyanate components to form a highly homogeneous mix, deliver it to the mouthpiece and then force it out into the mould cavity.

The exact design of the selected auger is a major factor in achieving a successful mix. Once the correct auger is chosen, the optimum mixing speed can then be determined. This can be varied from zero to 18,000 rpm continuously. The equipment is designed to be used in a continuous or discontinuous production cycle and is able to deliver a throughput of 60 grams per second with standard polyurethane systems.

The self cleaning mixing head (*Figure 3*) is able to handle up to eight valves based on a minimum configuration using the component valves for polyol and isocyanate. Final configuration depends on the specific nature of the product to be produced and whether there is a need to add any colours, catalysts, stabilisers or water. To achieve the desired final result, the additives are added as required and then mixed by the auger.

As a general rule, precise dosing is an essential requirement for producing a high quality polyurethane moulding. If exact dosing cannot be guaranteed, there is no possibility of this always being achieved. It was for this reason that Desma says it chose precise gear

pumps fed by gear metering pumps to ensure the weight of each moulding can be maintained at exactly the same level for every single shot. A further advantage is that maintenance work is kept very low, thus saving on downtime and maximising throughput.

GRANULATE FILLER

It can be quite a difficult task to handle a solid filler if there is no solid filler dosing system available. In these circumstances, the filler must be premixed into the polyol before being transferred into the material tanks. Unfortunately, there is always a potential risk of processing issues arising that could have an immediate impact on the quality of the final product.

For instance, if the product calls for a high loading of solid filler, the filler itself can either settle on the bottom of the tank or remain 'swimming' on the surface of the polyol depending on the relative densities. A truly homogeneous final mix requires the filler to be thoroughly mixed all the way through the polyol and this can never be fully guaranteed. A further disadvantage lies in the fact that if more than one level of filler needs to be added to the polyol, there is no possibility of varying the filler content during actual production.

Desma says it has been able to solve these negative aspects directly with a new filler dosing system. This can handle a large variety of fillers, starting

from very thin powders up to fillers with a diameter of approximately 5mm. A second auger is used to introduce the filler into the mixing chamber. This auger is driven by a servo motor, which enables the user to vary the content of filler inside the product from 0% up to 100% during production without causing any down time.

The addition of powdered or granulated PU or other materials can also be used to produce specific physical properties or appearances. For example, special additives can be used to reduce flammability or increase acoustic damping. Special effects are possible by the use of fluorescent powders or other additives for visibility on safety footwear or as a specific design feature.

The addition of powders has often led to problems in the feeding equipment as the pumps normally used for liquid processing with dosing in exact values are very sensitive to the use of abrasive additives or granules in the liquid phase. The wear and tear on parts increases enormously and the process becomes less stable. This now appears to have been overcome by enabling the dosing of hard components to be carried out in a precise manner directly into the mixing chamber. The RGE 4011 would therefore seem to offer a significant step forward in the manufacture of more consistent quality footwear. 