Technological innovations at FAMOR ENGINEERING herald fresh business opportunities

Having already gained much experience in the construction of machines and technologies for forming hollow glass, the team at FAMOR ENGINEERING has been hard at work over the last three years - delighted as ever to share the company's expertise, going forward, with both existing and potential customers.

For over two thousand years, before the advent of automation technology, iron gathering was the only way glass-makers could remove molten glass from their furnaces for further processing. As for Famor's contribution to the industry, the company's four technology solutions are Suction Robot Technology (SRT), Gatherer Robot Technology (GRT), Platinum Feeder Technology (PFT) and Gob Feeder Technology (GFT).

FAMOR AND BALL GATHERER ROBOT TECHNOLOGY

Founded in 1977, Famor Engineering was already involved in small machinery production, better known as semi-automatics, from early in its journey. One of its first machine developments was that of Ball Gatherer Robot Technology. The company then expanded its production range thanks to its investments in technology.

	Traditional manufacturing	Suction feeder
Advantages	Lowest investment costs extremely high flexibility suitable for shortest production runs suitable for pot furnaces and day tanks	High quality glass products reduction of reject level reduction of personnel costs reduction of energy costs glass maker exposed to fess heat

	Suction feeder	Platinum feeder + Billet Casting machine
Advantages	Lower investment costs lower personnel costs per article no waste glass between gathers utilisation of existing working ends	Highest product quality

SUCTION ROBOT TECHNOLOGY

Besides article quality, investment costs are a necessary consideration in Suction Robot Technology. These usually increase disproportionately when article quality improves. It may not be immediately clear why achievable quality with the Suction Robot Technology is better. In high quality glasses a depleted layer develops on the glass surface, with a slightly different chemical composition. This layer appears on the surface of articles produced with the suction feeder, is very thin and is usually removed by subsequent acid polishing. By contrast, when the glass is gathered manually, this layer becomes part of the parison and subsequently appears as a cord. When the parison gathers there is always the risk that bubbles get produced, or that bubbles floating on the glass surface are picked up. The suction feeder collects glass mostly from below the surface in the working end - where the glass quality is better. So far, the suction robot has only been installed on continuous melting furnaces, where the glass level may vary to a limited extent (up to approximately 50 mm). Should the glass level vary by more than 5 mm then the suction robot can be supplied with auxiliary equipment - allowing the suction head to follow the glass level automatically.

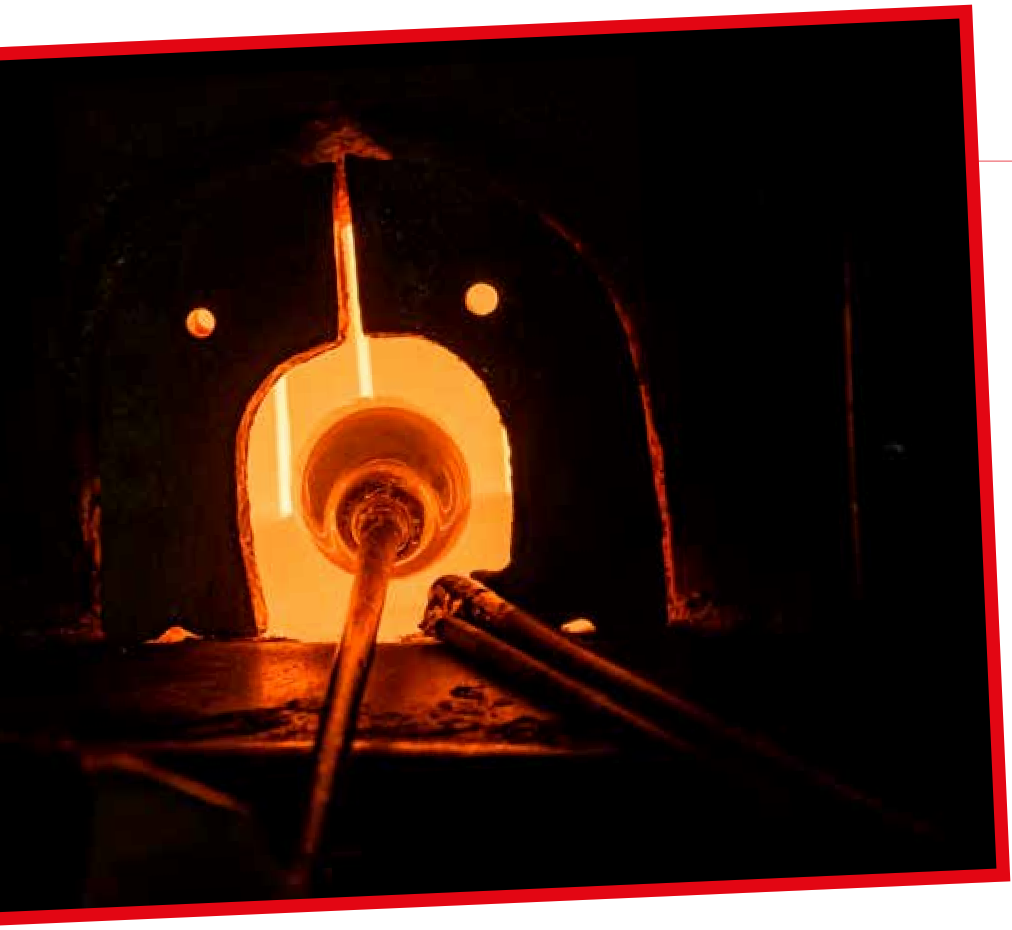
The new generation of Brushless Servomotor is used to lower the suction head in the right position. The software and set up will send the right information to Servo Drive to stop the lowering movement as soon as the mould touches the glass bath. However, the glass level must not be allowed to drop below a certain level as the suction feeder arm would otherwise rest on the tank sidewall block. This is one of the reasons the suction robot cannot be used with day tanks or pot furnaces. In addition, a special suction feeder for these applications would be technically complicated. It is also to be expected that the glass quality would be reduced as a result of the lock of currents in the glass bath. Finally, the suction robot is designed to remove large quantities of glass and this capacity is not required with day tanks or pot furnaces. A special design of this type would therefore be both technically and economically nonsensical. Good quality glass can only be attained with the suction robot when there is a current in the working end. This current is produced by stirrers' mechanism, but in tanks without stirrers' mechanism, the appropriate movement of the suction robot itself through the tank must produce this current. The shears of the suction feeder are relatively cold and form mould - a layer that then breaks when the shears cut (crack formation). These areas would produce seed in the glass when it is sucked in. A stirrer in the working end causes these faults to move in a spiral towards the outside. Cords, seeds, and blisters move to the outside and collect on the glass surface in the working end. Bubbles burst here and the cords dissolve without trace (one can see the spiral current by throwing a piece of cullet into the working end). The spiral current can be changed by altering the speed and height of the stirrer.

FACTORING IN THE STIRRER

If it is not possible to install a stirrer in the furnace, or if the quality improvements produced by a stirrer are not required, then the currents in the glass must be produced by a suitable operating procedure. Where a stirrer is being used the glass is cut off immediately after the vertical emergence of the suction robot head. If there is no stirrer the glass is cut-off during the travel to the outside. Here it is important that the cut-off end of the glass does not fall onto the glass bath. Bubbles and seeds would occur if this happened. It is much better if the cut-off end lands on the outwardly sloping surface of the tank sidewall block - or preferably in a so-called glass pocket, from where it can drain off. An additional, low, constant flow of glass through this pocket also helps reduce glass faults. The best solution is a combination of both systems. i.e. stirrer and glass pocket with a constant overflow.

THE INJECTION CHANNEL

When the glass is fed into the reservoir, either manually or from a ball gatherer, it tends to run some way into the injection channel and cool down. This effect can often be seen in the finished article. Where the injection channel is small this effect is reduced, but on the other hand the risk of folds forming during injection increases and as the injection channel freezes quickly there is also the risk of vacuum bubbles and/or sunken areas. The cold skin on the surface of the suc-



tion robot, gather means that much larger injection channels can be used, virtually eliminating the problems described above. The larger channel section means that much lower pressing forces are required. The reduced pressure in the glass causes less wear on the moulds, especially on the edges, prevents over-pressing of the articles and makes it possible to suck in more glass - possibly aided by compressed air. Furthermore, in the case of solid articles the virtually cord and bubble free glass quality from the suction robot is a definite advantage.

THE BALL GATHERER

One of the greatest advantages of the ball gatherer, as compared with the gob feeder. The ball gatherer lies between manual gathering and gob feeder. As is so often the case, no one system is ideal for all applications. Here the most suitable process must be selected for each individual application, which is why companies considering such an installation should first consult Famor Engineering in advance.

FURNACE DESIGN

Furnace design is an important aspect to consider. Is a suitable working end available? Does the gloss level leave enough height to deliver the gob into the forming machine to be used? What are the maximum and minimum cutting rates possible for the forming machine? Besides these important questions, other factors can be no less relevant, including production programme, factory layout, quality requirements, mould number per set, furnace melting capacity, direct gob drop or direct feed, etc.

MAIN APPLICATIONS AND APPLICATION LIMITS OF THE BALL GATHERER

The main area of application for the ball gatherer is for three-shift production, mostly for flat articles - with production rates of up to six items per minute and average glass quality requirements in soda-lime or lead crystal glasses. The equipment is also used at higher production rates and for borosilicate glass, but these applications are not common.

The main application limitations result from:

- the lack of flexibility about higher operating speeds
- glass extraction from the surface
- the impossibility of producing gobs to fit the moulds

To look at these three points in more detail, the gathering ball of the ball gatherer itself must travel relatively long distances of up to four metres during its operating cycle. The loading limits of the machine and gathering ball allow only limited values of acceleration and deceleration. Furthermore, the sum of the processing times, for example, for

the winding on, thermal homogenising and feeding of the gather, is relatively long. As a result, in practice only a few systems can operate at speeds higher than six articles per minute. In the case of blown articles, where higher quality is required, this operating speed cannot be reached.

VOLATILISATION

Various tests have shown that all types of glass suffer from volatilisation when in a molten state. This tendency to volatilise depends on several parameters, such as the glass composition, temperature, etc. As a result of this volatilisation the surface layer of the glass differs to a greater or lesser degree from the base glass composition. This surface layer with its different chemical properties (e.g. composition) and physical properties (refractive index, structure) is repeatedly picked up by the ball gatherer and is then present in the different areas of the glass on the gathering ball. This automatically results in inhomogeneities in the finished glass article. The ball gatherer is totally unsuitable for tall articles such as vases, as the glass flows off as a relatively thin stream at the end of the feeding. Folds occur in this stream when it has been cut off.

FOCUS UPON LIMITATIONS

The limitations described above for conventional ball gatherer technology are generally known. Great effort has always been made to overcome these limitations. However, as they apply to the principals involved, such efforts using conventional technology were only partially successful. In order to be able to make a definite step forward, it was logical that other technologies be investigated in the search for new development possibilities. From the many systems known and used, the gob feeder principle was regarded as the most practical. This principle does have certain disadvantages when compared with the ball gatherer - even if a modified gob feeding system probably remains the best system for most applications. An analysis of conventional feeders and their limitations indicates the various criteria which must be fulfilled by a new system. The conventional gob feeder becomes more difficult to control as operating speed decreases. Low glass viscosity is necessary or high-quality articles are mode using modern technology. However low glass viscosity cannot be retained between gobs in standard feeders at low production rates. Therefore, in order to achieve satisfactory results, the operator had to use various tricks, such as making a cleaning cut between two gobs.

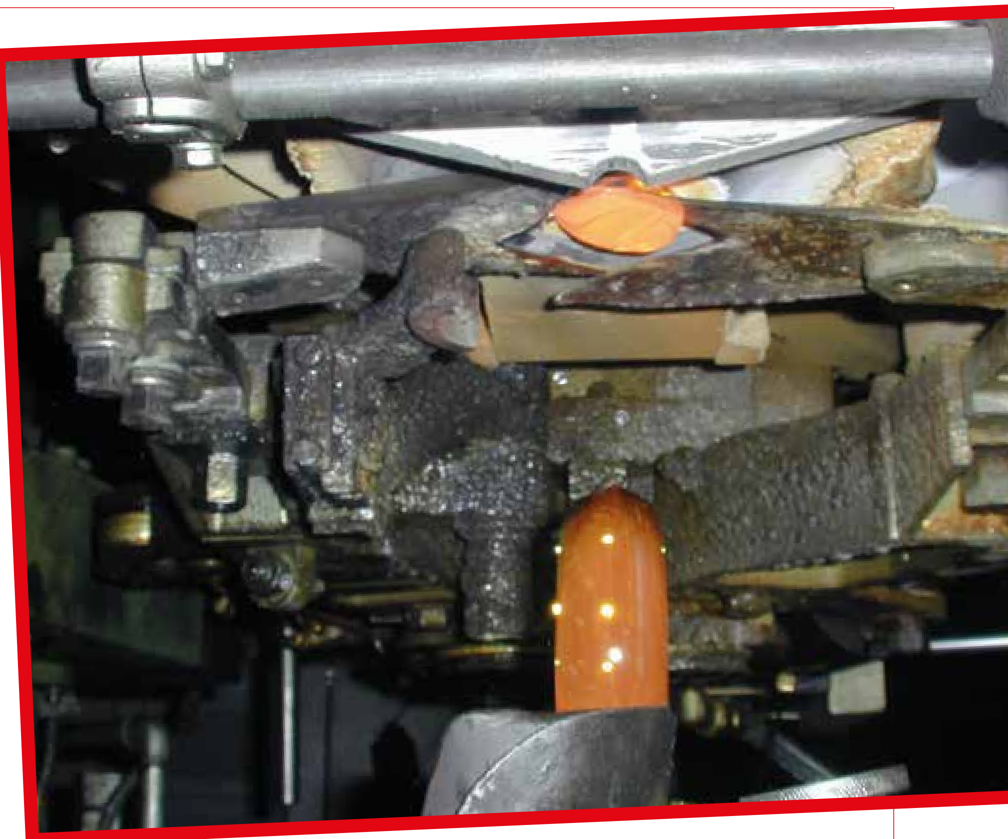
CONTROL SYSTEMS

Gob feeders are generally mechanically controlled by cams or electronically controlled by electronic cams. This is a very robust system, but adjustments are usually very time consuming. A modern electronic control system offers definite opportunities for reducing adjustment times. In conventional feeder's heat is continually transported to the surrounding refractory material by the gloss currents. The glass is therefore thermally inhomogeneous. i.e. thermally layered. An important requirement has thus been to achieve similar temperatures in the glass and the surrounding refractory material.

CONSTRUCTION AND OPERATING METHOD

The nucleus of the special feeder is a monolithic block made from highly resistant refractory material. The block is provided with horizontal and vertical holes. The glass enters the feeder from the forehearth channel (which should ideally feature a covered glass surface) through the horizontal hole. A ceramic screw plunger is installed in the vertical hole. The screw plunger controls the flow of glass from the orifice by means of a combined vertical and rotational movement. The feeder block is electrically heated and is maintained at the same temperature as the glass. The actual thermal insulation is installed outside the feeder block. This design assures the thermal homogeneity of the glass. The screw plunger has a double thread with a specific pitch and can be rotated both clockwise and anti-clockwise. Clockwise rotation of the plunger works against the natural glass flow, whereas when the plunger is rotated anticlockwise the natural gloss flow is assist-

ed. Relatively large quantities of glass can thus be fed to the forming machine in a relatively short time. The process is further supported by a programmable, plunger-like movement of the complete mechanism, like that used with conventional feeders.



GOB AND PLUNGER CONSIDERATIONS

A gob suitable for the forming machine in use can be produced. Smaller gobs at a relatively high cutting rate are produced as on a conventional feeder. However, the system provides greater influence on the gob shape through adjustment of the speed and direction of rotation - and the stroke of the plunger. The speed with which the glass flows out of the orifice ring can be greatly reduced by changing the direction of rotation and rotating the plunger clockwise as mentioned above. This capability is used for the provision of large gobs at low cutting rates, such as when the feeder is used as a down-draw system. In order to keep the amount of waste glass to a minimum two cuts are made within one operating cycle. The first cut is mode as a cleaning cut, immediately before the actual feeding process. The anti-clockwise rotation of the screw greatly increases the glass flow speed. When the required gob weight has been reached the glass - stream is cut again.

The small amount of waste gobs which run out of the orifice ring is removed from the forming machine via a chute and then fritted. The support frame for the electro-mechanical drive units is mounted above the vertical hole for the screw plunger in the feeder block. The drive units are low-inertia, electronically-controlled, high-power servomotors which enable precise and quickly-reversible movement sequences. The top end of the ceramic screw plunger, which is attached to the drive shaft for rotary motion, is cone-shaped - which guarantees exact centering of the plunger. During operation, a vacuum is applied to the plunger to prevent air from entering the glass from the plunger. In order to exchange the screw plunger, the whole drive unit for the rotary motion is moved to its uppermost position. The plunger is then outside the feeder and is freely accessible.

EASY ADAPTATION TO SUIT FORMING MACHINES AND AUXILIARY EQUIPMENT

The electronic control system can control any glass forming machines and the auxiliary equipment of such machines. By making use of suitable hardware adaptations and extensions it is possible to use different types of drive units, such as brushless servomotors. Famor Engineering supplies the software and hardware adaptations for controlling the forming machines. Therefore, the user has many options available which can minimise the total investment and simplify system operation. Many different versions of this feeder have already been supplied. For the standard version ER 1711 refractory material or similar is used. For applications where the glass colour is not an important factor ER 2162 is used, as this is more wear resistant. A platinum coated plunger and platinum lined feeder are also available for production of the highest quality.

EQUIPMENT DESIGN ACCORDING TO CUSTOMER NEEDS

Focusing upon some interesting technical details of the feeder, it operates with glass of a relatively low viscosity. The company always has complete feeder heads available in stock so it can offer some-day supply of a replacement. Any defective feeder head is returned, immediately refurbished and put into stock. Returning now to the main applications of Famor's special feeder, it's mainly used to produce high-quality articles with cutting rates of between two and 10/12 items per minute. A cleaning cut must be mode at low cutting rates, which results in glass losses. The application limits are determined by the glass throughput per 24 hours, the melting capacity of the furnace and the space available.

THE CONVENTIONAL GOB FEEDER

As the development of electronically-controlled feeders was only carried out for high-capacity feeders for the container industry, today's manufacturers of conventional gob feeders tend to concentrate progressively more on obtaining the highest possible cutting rates and throughputs for their feeders. Famor Engineering can now supply a feeder to fill this gap - a new feeder constructed much like traditional feeders, except that the vertical movement of the plunger and the shear movement are provided by high-capacity servo motors. These motors are typically controlled by the electronic control system of the forming machine, though a separate electronic control system can also be supplied. The stemware line, for example, can be fed by two identical feeders. The changeover times from one article to another will be drastically reduced once feeder setting parameters have been included in the data sets of the press. It is also possible to use this concept to convert existing feeders.

APPLICATION LIMITS OF STANDARD FEEDER WITH ELECTRONIC DRIVE

The lower limits are where the glass is too cold, or where it is not possible to form a clean gob. The upper limits are in the region where high-capacity feeders for the container industry come into use. ■