glass WORLDWIDE

Ultra-thin TFT glass - indispensable in digitisation

Glass screen displays are among the surfaces most frequently used in everyday life. Manufacturing them is a complex industrial application, requiring particular precision. To achieve perfect reproducibility, the optimum target temperature window must be adjusted continuously in process control, since even the smallest deviations would impact product quality. It is precisely in this uncompromising environment where thyristor power controllers from Advanced Energy are the preferred choice for temperature control. Andreas Breitkopf reports.

The glass screen forms the user interface for almost all computerised systems in this highly technical world. Consequently, the demands on a typical display are very high. It must not break nor scratch - even in difficult environments - and the images displayed must always be crystal clear, unaltered and undistorted. All this seems obvious but what processes are necessary to produce such versatile and thin materials?

In a current joint project, Siemens and AEI have designed and commissioned a plant for one of China's leading manufacturers to meet growing global demand for special glass.

Flat glass surfaces have been produced in float processes for decades. Since the invention of the required processes, consumers have been looking through windows that are plane-parallel and do not distort images. In extremely thin glass as described above (minimum thickness 0.5mm), classic float baths in huge tanks filled with tin are unsuitable. Instead, a process called down-draw or overflow fusion is used for such flat glass. Although invented in 1964, it has only recently been used on an industrial scale since demand has increased rapidly as a result of digitisation. ▸

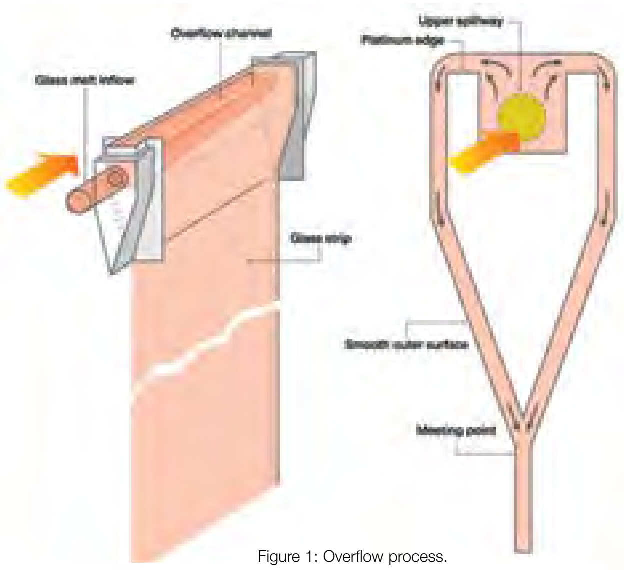

Figure 1: Overflow process.

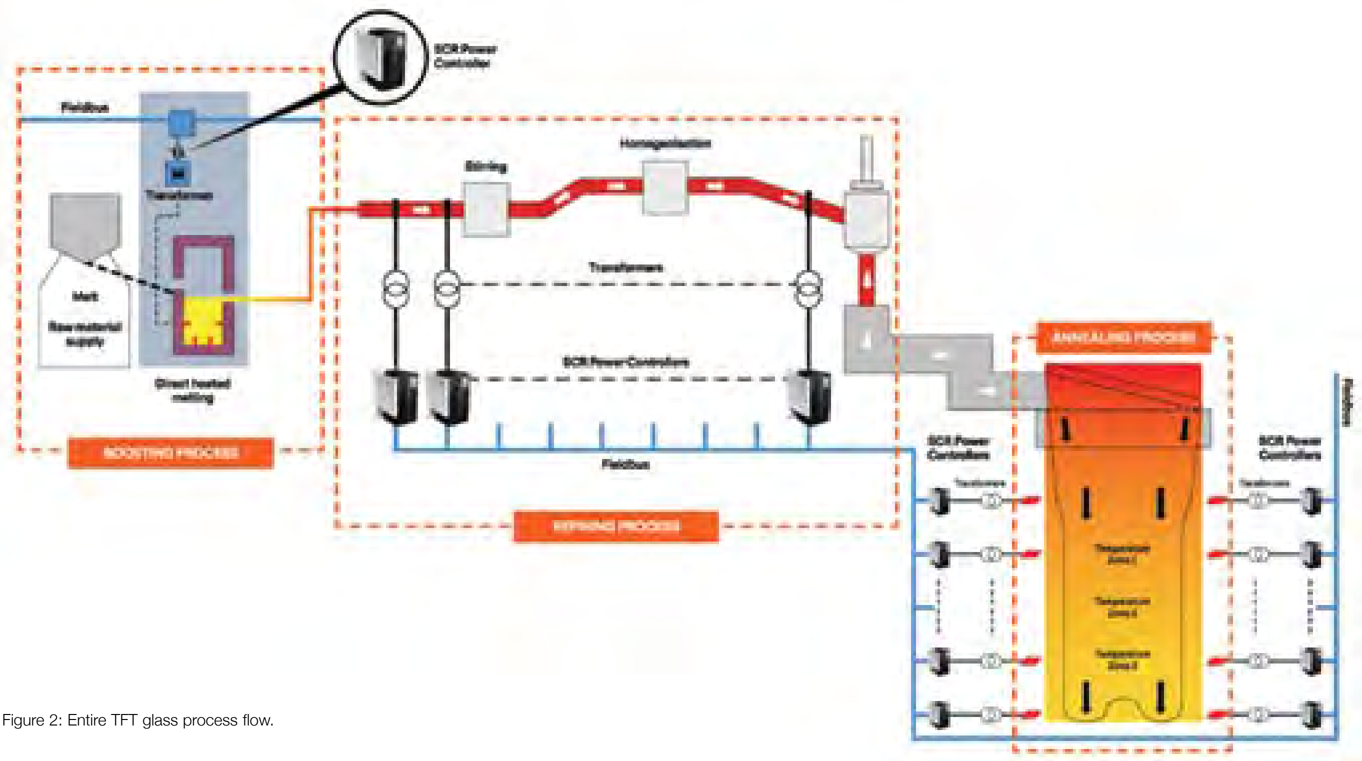

Figure 2: Entire TFT glass process flow.

The principle is simple...

At approximately 800°C, glass becomes electrically conductive. Since the glass melt must always be kept between approximately 1100°C and 1500°C, depending on the glass composition, it is possible to heat it using electrodes installed directly in the melting tank.

The temperature difference between the raw material and the already molten glass provides for circulation in the tank. The liquid raw glass then forms a homogeneous mass, whose specific weight is higher than that of the batch. It then settles at the bottom of the tank, from where it is transferred to production.

Liquid glass is fed from the electrically-heated melting tank to the overflow fusion process from below via a piping system. Then it runs off in thin strips from an overflowing platinum channel to the outside. To achieve an even thickness in the range of a fraction of a millimetre, the liquid glass is allowed to overflow on the longitudinal sides of the platinum channel. The two glass streams flow down the downward tapered outer side of the channel and merge again at its lower tip to form a homogeneous glass strip - hence the term overflow fusion. The still fluid glass becomes thinner and thinner as it stretches due to its own weight. Devices are installed at the end of the process to stop the running and cool the glass panel into pieces and deposit them for further use. Figure 1 shows the overflow process.

...but the process is complex

To produce glass with certain properties, its composition is also important. Ultimately, the decisive factor in the process described above is on the one hand the composition of the mixture of raw materials, which is melted in a large tank with a capacity of 40 tons. On the other hand, glass production is a thermal process. It is primarily a matter of processes and process control for 20 tons of glass per day. And this is exactly where the partners Siemens and AEI are playing a special role (see figure 2).

"At initial temperatures well above 1000°C, a tolerance of < 0.2°C must be maintained during the process" says Bernhard Saftig, Head of Vertical Glass at Siemens. "This is not possible with fossil-fueled systems. That is why we have carried out all steps of the project from the melting tank to the last annealing lehr with electric heating. And for fast and precise control, we have relied for many years on thyristor power controllers from AEI, which can be optimally integrated into our process control systems via a faceplate."

"The faceplate and the associated module are the driver or interface to Siemens automation systems" adds Andreas Breitkopf, Director, Power Control Modules at AEI. "We have developed this module especially for the Siemens Simatic PCS 7 process control system. In other words, the required data can be provided, controlled and received by any number of power controllers via control software."

Precise control from the outset

The process begins in the melting tank, which is heated electrically in several sections. The electrodes used in the glass bath are controlled by multiple Thyro-PX power controllers, which communicate with each other and with the central process control via the fieldbus.

The AEI model Thyro-PX is the next evolution of the successful digital power controller Thyro-P, which acquired from AEG Power Solutions. These devices are used mainly where very high control accuracy, high efficiency (>99%) and safe soft start for downstream transformers are required - as in this project.

In addition to the communication capability with leading process control protocols, each individual power controller also has its own long-term error memory and event logging with time stamp. A reliable separation between the control unit and the power unit has always been standard in this segment of high end thyristor power controllers. In addition, the Thyro-PX is able to operate in a multi-zone control system - as is the case in this project. The advantages are space savings in the control cabinet and reduced installation costs. For example, one 'smart' control unit controls up to three power units.

The resulting increased risk in the event of a failure is countered by the ingenious monitoring solution. The Thyro-PX communicates permanently with the process control, allowing even short-term or emerging problems to be reported and rectified immediately.

In the next step, the glass melt is homogenised as it flows through the electrically-heated platinum tube, via which it is fed to the actual drawing process. This process begins as soon as the liquid glass flows over the edge of the platinum channel and then tapers due to its own weight. The slow but controlled cooling of the glass strip is all about perfect temperature control until it is separated. It not only regulates the flow velocity but also the thickness of the resulting glass, where every hundredth of a millimetre counts.

"Ultimately, it was clear from the outset that only the Thyro-PX power controllers would be considered for the project in China" adds Bernhard Saftig from Siemens. "As a long-standing partner, AEI is in a position to adapt the systems to specific project requirements, so that we could put them into operation quickly via the customised faceplate. The phase-fired control method is used for fast, dynamic process control."

Conclusion

The plant for TFT glass in China is a testament to the capabilities of project partners Siemens and AEI. Why did the customer choose Advanced Energy? Andreas Breitkopf comments: "I think it is the absolute commitment to project implementation and quality that convinced the customer in China. After all, the company serves customers who place extremely high demands on thin film glass products. Faults, deviations or rejects must be avoided at all costs. Siemens has brought together various automation solutions and modules from different suppliers - including AEI – and is in a position to cover the entire value creation chain. By using the higher level process control technology, no further in-depth knowledge of the control tasks of the Thyro-PX are required. The thyristor power controllers are pivotal for process success, as they control the interaction of the individual areas. In addition, we are already working on an integration into the Siemens Industry 4.0 solution, in order to enable customers to access the process parameters controlled by thyristor power controllers directly from the Siemens environment."

Bernhard Saftig, Siemens, sums it up: "Data-based Industry 4.0 applications open up new avenues to increase productivity. In this plant, we implemented the system architectures TIA (Totally Integrated Automation) and TIP (Totally Integrated Power) together with AEI, which are based on the Simatic PCS 7 process control system. This enables customers not only to control and monitor the automation of the plant centrally but also to use it simultaneously as a 'power meter', thus minimising process breakdowns and planning preventive maintenance." ●

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