Innovating flat glass lehrs

The first flat glass lehr with a steel construction was built by CNUD EFCO in 1962. Nevertheless, after 53 years, innovation is still possible and even necessary.

Steel lehrs are using stainless steel heat exchangers for reasons of temperature and corrosion. Today stainless steel heat exchangers can be improved with a ceramic coating. This ceramic coating can also be used to extend the lifetime of electrical heating elements. Although the energy consumption in the convection zone is limited, a saving of 0.5% on the total primary energy consumption is possible by improving the design of convection zones. Changing production to a new load, ribbon width or thickness can be a difficult and costly operation. However, a confident lehr simulator can reduce the cost of these changes. On top of that, operators can train themselves with the simulator in the same way aviation pilots are trained. In the following, we discuss these topics in more detail.

In a previous paper in this magazine, we already discussed the fundamentals of the annealing of glass. In the first part of the lehr after the tin bath (float glass) or glass waltz (rolled glass), it is important to cool the glass as fast as possible to 540 °C (soda lime glass) with radiation to air cooled heat exchangers. This procedure gives the lowest residual stress and an improved surface because the glass touches the rollers in a harder state. Radiation between glass and heat exchanger depends on the emissivity of the (stainless) steel. Stainless steel is chosen for its corrosion and temperature resistance but it has a low emissivity, it behaves too much like a mirror instead of an absorber. Emissivity is a surface property, which can be changed by a thin (50 μm) coating on the steel. However, this coating must be a perfect match on the stainless steel, resisting minimum 15 years of temperature recycling and corrosion. EMISSHIELD® is such a ceramic coating, resisting perfectly the harsh environment of a lehr if applied according to strict procedures.

An improvement of double glazing is coating the glass panes with a thin low emissivity layer. This coating can be done off-line or on-line. In the latter case, the glass is a poor radiator in the lehr, inducing a serious lengthening of the lehr in the past. Today, we are able to compensate the low emissivity layer on the glass by applying EMISSHIELD® on the heat exchangers. In this way, a reduction in the investment for the lehr building can be obtained.

Producing ultrathin glass with the float glass process always induces a thick edge on the glass ribbon. As a consequence, the length of the lehr depends in the first place on the thickness of the edge. Improving the side heat exchangers above the ribbon edge with EMISSHIELD® reduces the length of the lehr. This is particularly interesting for the annealing of some electronic glasses with a higher thermal expansion coefficient. The above patented applications of improved heat exchangers are shown schematically in figure 1.
It is well known that float glass producers are injecting large amounts of SO$_2$ in the lehr to treat the glass surface. However, this SO$_2$ corrodes the heat exchangers and especially the heating elements. Even shielded heating elements, expensive and difficult to source, can have a limited lifetime in case of high SO$_2$ concentration up to 1200ppm for ultrathin glass. EMISSHIELD® coating reduces the temperature of the heating coil for the same radiated power and protects the heating wire against corrosion. In this way, coated heating coils (patented) can be an alternative for shielded heating elements. Figure 2 shows a typical application on an ultrathin glass lehr. It was also observed that even melted glass does not stick on the coated wire, showing another important property of this ceramic coating.
Below 400°C, natural convection to ambient air and forced convection are used to cool the glass down to 70°C. Forced convection is used to limit the length of the lehr but involves a lot of electrical power, needed for the fans. On top of that, these fans introduce a lot of noise on inlet and outlet. However, by an intelligent design, we are able to reduce the needed power and in that way the generated noise. By investing in somewhat more steel and labor, it is possible to work with larger ducts and in that way a smaller air velocity. According to Bernoulli, the pressure drop is generated quadratic by every air velocity change in magnitude and direction. By taking absolute care about the section of ducts, avoiding velocity changes, using curves and reducing turbulence at the nozzles to a maximum, it is possible to save 0.4% on the total primary energy needed to produce float glass. On top of that, after installing acoustic absorbers in the ducts, it is possible to construct lehrs with only 80 dB noise at 1m distance. Figure 3 shows a forced convection zone which is built according to the above specifications about energy saving and noise control.

Correct design of a lehr starts with a precise calculation of the temperature of the ribbon during the cooling down. Once the temperature evolution is known, residual and temporary stresses can be calculated. These programs, including the interaction with heat exchangers and forced convection on the glass are certainly not an innovation. But thanks to the Internet, it became easy to make the lehr calculation available with a browser for simulation. Indeed, the calculation, made to design and construct the lehr can be also available for simulations by the operators and production managers to prepare production changes. Figure 4 shows a typical example for a lehr, allowing changes of the
load, ribbon width, thickness, lehr entrance temperature and prediction of the used power of the fans.

Figure 4: Lehr simulator

Even after 53 years and the construction of 500 lehrs all over the world, it is still possible to improve glass quality, to reduce energy, to increase safety and to make a lehr more user-friendly by introducing technology currently available. Glass is a never ending story.

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2 EMISSHIELD® (www.emisshield.com) is represented exclusively for the glass industry beyond melting furnaces by CNUD EFCO International (www.cnudefco.com) and has all the certificates to construct and coat (stainless) steel constructions.