Improvements in performance and energy usage will encourage electric melting

Better efficiency and changing relative energy costs will make electricity much more competitive for glass melting and conditioning, says Richard Stormont*.

The performance of today’s best cold-top all-electric glass melting furnaces is very different indeed from the furnaces of the 1960s and 1970s, the period when widespread commercial use of electric melting became firmly established. Many of the more important advances have been the result of development work in the past 15-20 years. That work is still continuing and we can expect to see even better results in the future stemming directly from deeper understanding and optimisation of design variables.

Glass melting is an energy-intensive process and maximising energy efficiency will continue to be of prime importance. We already have all-electric melters for soda-lime container and tableware glasses with energy consumption figures of around 0.76 kW-hours per kilogram of glass—lower still for some lead crystal or high-cullet applications—equivalent to a melting energy efficiency of more than 85%. Even relatively small electric melters for special glasses, for example 15 tonnes/day of borosilicate glass, are running at 0.87 kW-hours per kilogram. Consumption figures like these are perhaps 30% lower than typical furnace designs of just a decade or two ago, and indeed than some designs still being used today.

Understanding

These improvements have been achieved progressively through better understanding of energy release and temperature distribution, convection currents and flow paths through the furnace as influenced by different electrode arrangements and other design features. On-going research and development, much of it model-based, will bring more improvements.

Historically cold-top furnaces had a very limited turn-down ratio. Reducing pull to less than around 70% of the nominal design pull risked melting out the batch blanket. In a well-designed furnace today that figure is now around 50% and can be lower still depending on cullet percentage used. This is a direct result of improved energy distribution and minimised convection currents in the melt and can only further improve.

Furnace shape, depth and internal design features, coupled with the number, position, shape, immersion and connection arrangement of electrodes, all play a major role in determining the temperature distribution and glass movement patterns in the furnace. Study and understanding of the effects of each of these variables enables the furnace designer to minimise high refractory/glass interface temperatures and avoid strong convection currents, greatly increasing furnace life. In many applications today we can expect a
furnace life that is close to twice
what was considered usual for many
electric furnaces just 15 years ago.

**Soda-lime glass**
A recent advance has been the
development of successful
techniques for cold-top electric
melting of reduced soda-lime container glasses, traditionally
considered impractical due to
foaming and gas eruptions causing
often severe disruption of the
batch blanket.

However successful results have
been demonstrated in a large
Electroglass-designed furnace over
the last year and a half, producing
high quality carbon-sulphur amber
glass. This success is attributed to a
combination of the furnace design and
adapting batch compositions to
suit the electric melting process.

What else for the future? The
changing balance of costs of
different sources of energy and the
high electric furnace energy
efficiency now available, coupled
with environmental concerns and
regulations in many areas, has
focussed attention on electric
melting for glass product types and
furnace sizes previously considered
either uneconomic or impractical.
All-electric melters of around 180
tonnes/day capacity for container
glass production already exist, and
design work is well under way on a
substantially larger one. Special
design considerations must be taken
into account where large all-electric
furnaces are concerned.

**Large scale**
The result can be a quite different
energy and temperature distribution
to the smaller furnace, resulting in
excessive energy consumption,
unstable or unbalanced operation
and limits to glass quality in terms of
refining and homogeneity. However,
there are proven successful
technologies for large scale electric
melters, and an increase in such
installations is likely.

High-capacity all-electric
forehearths, with 48-inch channel
widths and greater, are already
available but will be further
developed both for use with large
electric melters, and for use as low
energy cost alternatives to gas
forehearths on fuel-fired furnaces.

The same changes in the costs of
different sources of energy that will
drive future interest in new electric
melting applications will also mean
continued expansion in the use of
electric boosting in fuel-fired and
oxy-fuel-fired furnaces. This is not
just to increase furnace output, but
also to improve glass quality and as
an economic partial substitute for
fuel energy input.

Today’s best all-electric furnaces
are already characterised by stable
batch blanket conditions, freedom
from hot spots and eruptions,
genuine cold-top operation with
superstructure temperatures of
100°C to 150°C, low energy
consumption, low and even
refractory wear resulting in long
furnace life, and high glass quality
from thorough refining with good
chemical and thermal homogeneity
derived in turn from consistent
thermal history. Continued research
and development will further
advance all aspects of design and
performance of electric furnaces, as
well as electric forehearths and
electric boosting technologies.

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