

## **Furnace Design Characteristics and Operation Experiences of Efficient Container Glass Furnaces**

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### **1. Vetropack Group**

Vetropack is an independent, listed and family-owned company with Group management based in Switzerland. As one of Europe's leading manufacturers of container glass Vetropack has its own production facilities in Switzerland, Austria, the Czech Republic, Slovakia and Croatia.

### **2. Vetropack Straza**

Vetropack Straza is located in the town of Hum na Sutli on the Croatian-Slovenian border. It has been part of the Vetropack Group since 1996.

The plant was in a bad technical condition at the take-over by Vetropack. Only with extensive investments in furnaces, production technology and infrastructure, it was possible to continue to operate the Straza plant in an economical way.

In 1996 four furnaces were in operation.

Flint glass was molten in furnace 63 and 64. These two furnaces had the following characteristics and dimensions, see Fig. 1.

Fig. 1 – Furnace characteristics old 63 and 64

Characteristics and dimensions	63	64
Furnace type	cross fired	end fired
Melting area in m <sup>2</sup>	63	65
Max. furnace pull in t/d	180	180
Spec. energy consumption in kcal/kg	1.422	1.390

### 3. Rebuild Furnace 63

The container glass market was collapsed in Croatia in 1999 due to the war. Therefore furnace 63 had to be stopped in December 1999. Flint container glass was molten only at furnace 64. During the following years, the container glass market improved. The demand increased to previous level. Therefore it was decided to increase flint container glass melting capacity in 2001. Instead of operating two small furnaces, it was decided to build one large furnace to replace furnace 63 and 64. The target was to reduce fix and variable operating costs. The new furnace should accomplish the following criteria:

- less energy consumption
- less investment costs
- long furnace campaign
- low NOx emissions

These criterias were taken into consideration to evaluate different types of furnaces. The first option was a cross fired furnace. The second option was an end fired furnace and the third option was a unit melter type furnace.

Evaluation of different criteria showed, that the best furnace type for Straza plant was an end fired furnace.

### 4. Design Characteristics of Furnace 63

Influencing factors for the furnace layout out were:

- glass colour
- expected furnace pull
- glass composition und cullet ratio
- number of production lines
- product range at various production lines

- furnace pull variations due to job changes

These criteria determined

- melting area
- specific furnace pull
- glass depth in melting and refiner area
- position and height of wall
- electrical heating system
- use of bubbling
- working end
- length of forehearths

Following specific requirements were valid for new furnace 63:

- flint glass colour
- furnace pull without electrical boosting 280 t/d
- furnace pull with electrical boosting 320 t/d
- cullet ratio 15 %
- natural gas for heating
- seed count less than 60 per 100 g glass
- specific energy consumption less than 1.080 kcal/ kg glass
- five production lines
- good glass quality, even with furnace pull variations
- good stability of gob temperatures and less weight fluctuations

Vetropack decided to do engineering and construction in close cooperation with Horn Company in Plössberg, Germany. Computer simulation tools were used to verify first layout assumptions. Horn Company used models from Glass Service Company. Studies of combustion in the furnace combustion space, flow pattern in the furnace and working end had been studied with these models.

The furnace layout can be seen in Fig. 2.

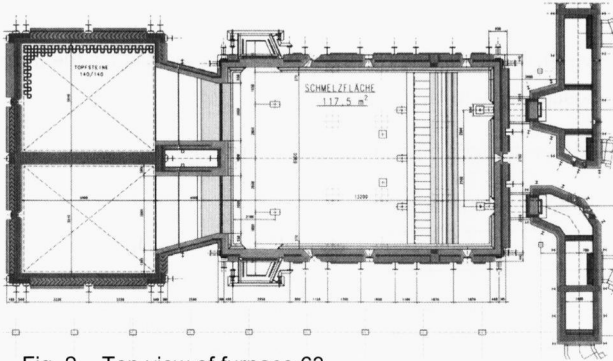


Fig. 2 – Top view of furnace 63

Fig. 3 shows the longitudinal section of furnace 63. The wall and deep refiner part can be seen.

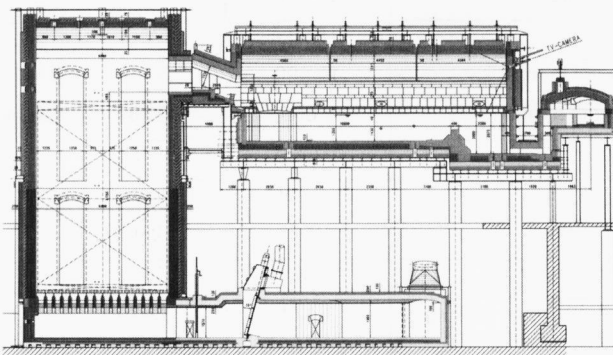


Fig. 3 – Longitudinal section of furnace 63

The dimensioning of the checker chamber is very important for a good heat recovery. The rider arches were made in shape bricks to ensure good stability of checker chamber. The checker work and the top of the regenerator were made in Magnesite refractory material. Shape and port angle have great influence on NOx emissions and heat transfer to the glass bath.

The optimal geometrical arrangement of throat blocks is very important to protect critical parts. A special throat cover block was used to extend the furnace life time.

In this way the critical parts are protected from wear and tear. The throat was placed back.

Eight side-electrodes were installed. Also two electrodes were installed in the throat. Maximum power of boosting system is 1.500 kW.

The key data of old and new furnace 63 can be seen in table 4.

Fig. 4 – Key data of old and new furnace 63.

Furnace data	63 OLD	63 NEW
Furnace type	Cross fired	End fired
Glass colour	flint	flint
Melting area in m <sup>2</sup>	63	117.5
length in mm	11.250	13.200
Width in mm	5.600	8.900
Glass depth in melting area in mm	1.300	1.355
Glass depth in refining area in mm	2.400	2.000
Height of wall in mm	650	750
Checker chamber width in mm	10.000	5.440
Checker chamber depth in mm	2.000	6.700
Checker chamber height in mm	10.250	9.750
Bubbling	not installed	not installed
Pull without boosting in t/d	150	280
Pull with boosting in t/d	180	320
Specific energy consumption in kcal/kg	1.422	1.010
Boosting in kW	600	1.500
Location of electrodes	bottom	side
metal line in mm	5.400	5.625
Fuel	gas	gas

### 5. Operation Experiences of Furnace 63

Start-up of new furnace 63 was without any problems. After few days, it was possible to produce at the various IS-machines sellable glass containers. A comparison of target and actual data shows that the actual values meet the target values, see Fig. 5.

Fig. 5 – Comparison of target and actual data

Data	Target	Actual
Furnace pull in t/d	320	316
Cullet ratio in %	15	16
Energy consumption in kcal/kg	1.080	965
Boosting in kW	1.500	936
Glass quality in seeds/100 g glass	< 60	< 40
NOx emissions in mg/Nm <sup>3</sup>	< 800	< 800

The energy consumption in dependence of various furnace pulls can be seen in table Fig. 6. Cullet ratio was in the range of 15 to 17 %.

Fig. 6 – Energy consumption in dependence of various furnace pulls

Pull in t/d	Specific pull t/m <sup>2</sup> /d	Energy consumption in kcal/kg	Energy consumption in kJ/kg	Energy consumption kWh/t
325	2.8	948	3.969	1.103
289	2.5	988	4.137	1.149
278	2.4	1.017	4.258	1.183
244	2.1	1.036	4.338	1.205

Glass quality keeps being good. Big furnace pull variations are possible without losing glass quality. NOx values are less than 800 mg/Nm<sup>3</sup>.

Glass conditioning of all forehearth, especially on line 633, is very good. These are very important preconditions for efficient narrow neck press and blow production with constant gob weights. It has been proven, that the working end layout with two throats was the right choice.

## 6. Summary

Furnace rebuild of furnace 63 in Straza showed, that it is possible to

- reduce specific energy consumption by approx. 30 %
- reduce also melting costs by more than 30 %
- reduce NOx emissions by 65 %

- ensure good glass quality and conditions for container glass production

Important criteria to achieve these parameters were:

- conversion from cross to end fired furnace
- efficient choice of melting area in dependence of expected furnace pull
- wall
- deeper refiner zone in comparison to melting zone
- efficient dimensioning of regenerator and burner ports
- installation of boosting system to melt maximum pulls
- two throats to serve five forehearth
- computer simulations to evaluate expected flow and temperature patterns and to optimize final furnace layout