RESEARCH ON REDUCING ENERGY CONSUMPTION IN THE TECHNOLOGICAL PROCESS OF GLASS MANUFACTURING

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Abstract: *The present tendencies in glass industry are reduction of energy consumption in glass manufacturing, considering that the highest expenses are the energy used to reach the high temperatures in the furnace. The paper presents the research on the furnace work condition, with direct glass melting flow in SC STAR GLASS SA Tg. Jiu.*

Key Words*: glass, energy, furnace, thermal condition, temperature gradient.*

1. INTRODUCTION

The lowest technical-economic direct flow furnace index is efficiency, which requires a detailed analysis of their operating condition. A heat engineering study has been performed only on the direct flow furnace of Medias Plant so far.

Its aim was to improve that furnace from the point of view of its design. For the other direct flow furnaces in the glass industry no heat engineering studies have been performed. In this sense, the authors of this paper have studied the thermal conditions of the direct flow glass melting furnaces in “Medias” and “Star Glass” Plant, as well as of a regenerative glass melting furnace, similar to direct flow furnaces regarding the size of the melting basin and its design.

2. RESEARCH ON THE THERMAL CONDITION OF DIRECT FLOW GLASS MELTING FURNACES

The particularities of measuring glass past temperatures have been studied, the glass paste temperature levels in each area of the direct flow furnace have been determined, as well as the temperature gradient down the depth of the glass paste and the through the width of the furnace; the average temperature variation characteristic has been established down the melting and along the length of the furnace, the particularities of the thermal flow size variation along the direct flow furnace length have been highlighted.

The dependence is given, which characterizes the glass paste temperature variation down the aeration zone depth and smelting channels of direct flow furnaces. The temperature gradient down the depth and through the width of the furnace in “Medias” Plant is 11 - 36°C, decreasing at 0,1 m depth down to 8°C. Down the thin layer depth it varies from 4 to 10°C in the furnace of “Star Glass” Plant and from 13 to 23°C in the furnace of “Medias” Plant, which proves the necessity of limiting the depth of this zone to 100-150 mm.

Evaluating the data characterizing the variation of temperature gradients down the depth and through the width of “Star Glass” furnace , conclusions can be drawn regarding the satisfactory thermal homogeny of the glass paste in all the zones of this furnace’s melting basin The temperature gradient down the depth of the glass depth is not higher than 12°C , and through the width of the furnace it varies from 2 to 28 °C , that is it is approximately in the same range as in “Medias” Plant’s furnace.

Table 1 Temperature gradients down the depth and through the width of direct flow furnaces.

Plant	Temperature gradients through the width of the furnaces in the superficial glass paste layer °C		Temperature gradients down the depth of the furnaces °C		
	Melting basin	Smelting channel	In the depth of the glass paste layer		
“ Medias”	13 - 23	1 - 16	150	13 - 23	15 - 23
“Star Glass”	2 - 28	19 - 62	150	3 - 10	26 - 52
			200	5 - 12	25 - 56

Another image was noticed in the smelting channel of the “Star Glass” Plant. The temperature gradients down the glass paste depth are quite high there – from 26 to 100 °C. This is explained by the fact that during pyrometry, the channel was not heated in depth, and was not insulated, thus the glass cooled down rapidly, therefore its temperature on the surface was much lower than in its depth (subsequently this disadvantage was eliminated by fixing injectors). Temperature gradients down the glass paste in the channel which is warmed up in the furnace of “Medias” Plant are much less and usually are not higher than 20°C

The better thermal homogeneity of the glass paste in “Star Glass” Plant’s melting basin is due to the safer insulation of the basin and of the upper part design of the furnace. The low thermal homogeneity of the glass paste in the smelting channel of this furnace (compared to the furnace of “Medias” Plant) shows the necessity of insulating the direct flow furnaces’ smelting channels concurrently with their heating.

The temperature of the glass paste’s superficial layer in the area of heating in the studied furnaces is 1220-1270°C . Its maximum value (1460-1480°C) is reached at the beginning of the aeration cells, and before the channel, at the end of the aeration pipe, it goes down to 1420°C.

The level of glass paste temperatures in the direct flow furnace melting basins is under the level of traditional furnaces’ melting basin temperatures, therefore the glass melting temperature increase in this area of the direct flow furnaces is a resource of improvement of their operation.

The glass paste temperatures in the area of aeration of the direct flow furnaces approximately match the conditions maintained at present in the usual glass melting furnaces for the smelting of windowpanes and packages, but it is significantly less than the temperatures characteristic to better glass melting furnaces for smelting windowpanes.

The data found match the calculation results of the dependence of the furnace efficiency on temperature, which have shown that the efficiency resource for the respective temperature condition is missing in the direct flow furnaces. The decrease of the direct flow paste temperature begins in the second half of the melting basin (same as in the usual furnaces with glass melting tub). When however there is already finite glass paste in the usual furnaces in this area, then in those with direct flow, only the aeration process takes place. The temperature gradient in the superficial melting layer along the furnace of “Medias” Plant is 16-20°C/m, along the furnace of “Star Glass” - 8°C/m. Its magnitude depends on the cooling intensity of the glass paste.

Direct flow furnaces do not have deep channels (0, 1 – 0, 2 m). Measurements show that temperature gradients along their length are 100-260 °C/m.

	“ Medias” Plant	“ Star Glass” Plant
Temperature, °C		
-beginning of the aeration zone	1470/1475	1478/1480
-end of the aeration zone	1438/1440	1430/1420
-before the channel	1456	1420
-after the channel	1353	1155

Gradient		
- of temperature reduction in the superficial layer of the aeration zone, °C	16/20	8/8,5
- of temperatures in the furnace channels, °C	265	103

Remarks: the numerator shows the magnitudes characterizing the left side of the aeration zone, the denominator those characterizing the right size.

Temperature gradients in the channels of the same design are explained by their different depth. The depth of the direct flow furnace channel of Star Glass Plant is 0,1 m, of the Medias furnace is 0,15 m, the channel of the first furnace being deepened. The reduced temperature gradient in the Medias Plant furnace channel leads to the necessity of using part of the thin layer zone under the cooling zone. Therefore, to provide much higher temperatures at the end of the aeration zone, the direct flow channel furnaces must have a better design.

3. CONCLUSIONS

To increase efficiency of this type of furnaces it is necessary to increase the glass paste temperature in the area of the aeration cell. The following means of solving this problem are known:

- Selection of the optimum size of the furnace zone (depth and width of the melting basin) to provide a normal burning process and a high radiant capacity of burners;
- providing electrical heating in the homogenization and aeration zone;
- attaining a superior quantity of heat due to irradiation of bridges, cantilevers specially built over the glass paste;
- using the heat of exhaust gases.

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