THE INFLUENCE OF A LADDLE FURNACE OVER THE GENERATORS FROM THE GRID AT WHICH IT IS CONNECTED

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Abstract: The paper presents the influence of a laddle furnace over the generators from the grid at which it is connected.

Keywords: laddle furnace, generators

1. INTRODUCTION

The constructional ascent of electric arc furnaces powered in alternance three-phased current lead to the reduction of the melting time, of the electrichal energy consume and of the consume of electrodes per ton of melted material. The use of oxi-gas burners, the blast of carbon and oxygen into the furnance, the barbotage of the melted bath, the eccentric exhaust of steel and using the long arc, practically transformed alternance three-phased current arc furnaces in highly performant melting aggregates. Using also the pre-heated chargement it can climb up to special performances regarding the melting period and the real use of the furnace; this way charges are made in periods of maximum 75 min. at furnaces with big capacity (100 tons capacity and bigger) and 22 charges in 24 hours when we reffer to medium furnaces (50 tons capacity), these results are obtained during a year.
By transforming the electric furnace into a melting aggregate (reducing the melting period of a charge as we said), the other phases of the steel elaborating process have been transferred to the laddle furnace. The laddle furnace takes the molten metal from the electric furnace at temperatures around 1500°C, it raises the temperature with his own three-phased electric furnace at the level requested for alloying ≅1500°C and it keeps the temperature during this process. The period of time needed is about 40 min. depending on the quality of the steel being made. The laddle furnence is powered from the 6 kV (10 kV) or 30 (35 kV) depending on the power of the transformer.

2. THE LADDLE FURNACE SOURCE OF DEFORMANT REGIME

As in the case of the electric furnace powered in alternance three-phased current, laddle furnaces are sources of deformant regime for the grids which they are connected to, mainly, because of the non-linear arcs. Unlike the electric furnaces, the laddle furnaces have more stabil arcs because it settles between the electrodes and the melted material (the temperature is about 1500°C), there is no risk of chargement caving and after the ignition, the arc impedance is much more stabil.
With all this, working with synthetic cinder, adding the alloying material and raising the melting temperature up to the alloying one, modifications of the arc impedance appear and by that of all previous electric values. These modifications determine the propagation of the deformant regime of functioning into the grid.

3. THE EFFECTS MADE OVER THE POWERING LINE

The laddle furnace studied is powered from his own grid of 6 kV (using a transformer of 12.5 MVA, 6/0.3 kV), which consists of 4 interlinked stations, two of them being powered from 2 water-generators, and the other 2

from 2 turbo-generators with unitary powers of 5.6 MW and 7.2 MW. From the fourth station 3 synchronous engines with P_n=1.2 MW each, are powered. The first station poweres the laddle furnace, and stations 2 and 3 are powered from the previous sources (water-generator, turbo-generator). Both water-generators, and turbo-generators are sensitive to perturbations produced by the function of laddle furnaces, and the measurements taken revealed both the characteristic quantites of the deformant and non-symetric in 6 kV stations regime and the effects over the functioning of the sources powered from them.
The results are presented in the following tables.

Table 1
The distortion coefficient in the four stations.

6 kV Station	Medium value	95% Value	Min. Value	Max. Value
Station 1	1,26 – 1,60	1,93 – 2,87	0,63	3,62
Station 2	0,82 – 1,09	0,93 – 1,21	0,66	1,28
Station 3	1,01 – 1,13	1,23 – 1,32	0,70	1,50
Station 4	1,04 – 1,18	1,16 – 1,34	0,83	1,48

Table 2
The voltage dissymetry coefficient in the four stations.

6 kV Station	Medium value	95% Value	Min. Value	Max. Value
Station 1	1,13	1,57	0,66	1,97
Station 2	1,47	1,54	1,35	1,56
Station 3	0,91	0,96	0,72	1,21
Station 4	0,62	0,70	0,38	0,78

Table 3
The voltage asymetry coefficient in the four stations.

6 kV Station	Medium value	95% Value	Min. Value	Max. Value
Station 1	0,19	0,21	0,18	0,23
Station 2	0,62	0,63	0,62	0,63
Station 3	0,86	0,87	0,84	0,87
Station 4	0,56	0,56	0,55	0,56

Table 4
Harmonics dominated by voltage in the four stations.

6 kV Station	Medium value	95% Value	Min. Value	Max. Value
Station 1	0,86 – 1,14	1,26 – 1,99	0,17	2,71
Station 2	0,74 – 0,98	0,83 – 1,10	0,55	1,19
Station 3	0,77 – 0,92	1,01 – 1,11	0,30	1,33
Station 4	0,86 – 0,95	1,01 – 1,17	0,58	1,32

Table 5
The variation of alternance voltage of 50 Hz frequency on the 6 kV bar of station nr. 1 which powers the laddle furnace.

The variation of the powering voltage on the 6 kV bar of station nr.1 which powers th ladde furnace [%]	Medium value during measurement [%]	The value with 95 [%] probability [%]	Maximum value [%]	Critical level admitted by standard 930/89 [%]
–8,65 ÷ –2,17	–6,27 ÷ 6,88	–4,43 ÷ –5,45	–3,53 ÷ –3,96	±10

Table 6
The characteristic parameters of the voltage deformant regime on the 6 kV bar from the station nr. 1

The characteristic parameter of the deformant regime	Medium value during mensuration [%]	The value with 95 [%] probability [%]	Maximum value [%]	Critical level admitted by RE – 143/94 [%]
The distortion coefficient	1,26 – 1,6	1,93 – 2,87	3,62	8,00
Harmonics of voltage, odd, nonmultipled by 3				
Harmonic 5	0,85 – 1,09	1,28 – 2,08	2,64	6,00
Harmonic 7	0,46 – 0,76	0,59 – 1,13	1,34	5,00
Harmonics of voltage, odd, multipled by 3				
Harmonic 3	0,44 – 0,57	0,87 – 1,47	2,11	5,00
Harmonic 9	0,07 – 0,17	0,21 – 0,48	0,66	1,50
Harmonic of voltage, pare				
Harmonic 2	0,08 – 0,20	0,13 – 0,31	0,44	2,00
Harmonic 4	0,05 – 0,11	0,09 – 0,19	0,23	1,00
Harmonic 6	0,03 – 0,05	0,06 – 0,09	0,14	0,50
Harmonic 8	0,02 – 0,03	0,04 – 0,07	0,12	0,50

Table 7
The characteristic parameters of the current deformant regime on the 6 kV bar from the station nr.1

The characteristic parameter of the deformant regime	Medium value during mensuration [%]	The value with 95 [%] probability [%]	Maximum value [%]	Critical level admitted by RE – 143/94 [%]
The distortion coefficient	1,32 – 1,43	3,26 – 3,73	6,13	5,00
Harmonics of voltage, odd, nonmultipled by 3				
Harmonic 5	0,82 – 1,02	2,08 – 2,76	3,32	4,00
Harmonic 7	0,30 – 0,40	0,82 – 1,03	1,31	4,00
Harmonic 11	0,07 – 0,09	0,20 – 0,29	0,46	2,00
Harmonics of voltage, odd, multipled by 3				
Harmonic 3	0,70 – 0,92	2,37 – 3,27	5,76	4,00
Harmonic 9	0,06 – 0,07	0,23 – 0,31	0,70	4,00
Harmonic of voltage, pare				
Harmonic 2	0,22 – 0,43	0,58 – 1,32	1,60	4,00
Harmonic 4	0,11 – 0,12	0,30 – 0,37	0,50	4,00
Harmonic 6	0,03 – 0,05	0,09 – 0,14	0,22	4,00
Harmonic 8	0,01 – 0,02	0,05 – …	0,11	4,00

4. CONCLUSIONS

- The meaured values of the characteristic parameters of the deformant regime and the non-symetrichal one, coefficients of: dissymetry, asymetry of voltage and the voltage deformant harmonic do not exceed the critical values admitted. The own frequency of resonance of the diagrams at the bars of 6 kV of the four stations is almost 2000 Hz, corresponsive with the harmonic 50.
- The voltage dissymetry coefficients analysis in the four stations doesn't notice a difference between the perturbating receiver and the other tree stations because of the special construction of the powering transformer of the laddle furnace.
- The voltage asymetry coefficient in the four stations is smaller in the station that powers the laddle furnace.

- The measurements confirm that this receiver, the laddle furnace, is perturbatory but its function isn't affecting the equipment and other installation mentioned before.

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