EXPERIMENTAL RESEARCH ON THE REFINING SYSTEM LF-VD STEELS

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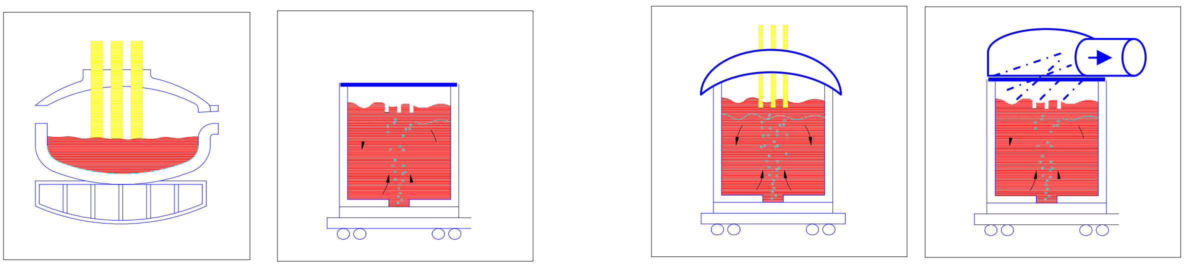
Abstract. The paper presents the main features of the system LF-VD used in experimental research, the results of trials conducted in the facility LF-VD with established technology and the results obtained after treatment of steel in a vacuum, given mainly gas content and harmful elements which are small, compared to only steel making electric arc furnace.

Keywords: plant LD-VD, technological, gas content

1. DESCRIPTION LF-VD INSTALLATION

LF-VD installation system is composed of LF and a right ventricular system connected to a vacuum pump with the steam ejection designed to perform more advanced degassing of the steel by treating them in vacuum. Typically, VD facility is LF-plant to reduce temperature loss during transport between the two facilities and increase productivity. Figure 1 shows the process of developing and refining steels studied.



a b c d

Fig. 1. The process of developing and refining steels
a) - drawing steels in CEA; b) - transport metal melt; c) - steels in LF refining; d) - degassing of the steel

In this system they have been released and the ten batches of slag formation, the deoxidation and the heating of the metal bath was made like fillers with only LF refining by adding to the beginning of the treatment in the pot, and that the 30 kg of the steel slag formed during the evacuation of the furnace.

Metal bath temperature increase was achieved gradually through repeated heating (for 10-15min), with pauses between them to homogenize temperature and chemical composition (about 5 minutes), and the amount of slag was increased by 5kg / t CaO and 3kg / t CaF2. The sample input for determining the chemical composition treatment was given after about 10 minutes, during which an heating to ensure uniform temperature of the molten metal more than 1580˚C and to streamline clay. Electric arcs formed between the working electrode and molten slag layer coating, which reduces the thermal radiation aspect and a better transmission of heat to the bathroom.

The fluidity and the degree of deoxidation of the slag are very important roles in the process of decontamination as viscous slag and a high oxygen content gas absorption swelling difficult and spillage. Table 1 shows the input parameters of the 10 batches of steel in LF-VD facility.

Table 1. Parameters input of steel in LF-VD facility

No charge	Temperature input, [˚C]	[P], [%]	[S], [%]	[Si], [%]	[Mn], [%]	[H] [ppm]	[O], [ppm]
1	1570	0,008	0,007	0,14	0,77	4,5	75
2	1586	0,008	0,006	0,17	0,97	4,5	70
3	1604	0,010	0,008	0,16	0,80	4,2	75
4	1595	0,010	0,008	0,17	0,83	4,8	80
5	1595	0,009	0,009	0,19	0,85	4,5	56

6	1597	0,009	0,007	0,16	0,76	4,5	65
7	1600	0,007	0,005	0,17	0,79	4,8	75
8	1579	0,009	0,006	0,24	0,79	4,2	62
9	1606	0,010	0,006	0,16	0,94	4,13	66
10	1587	0,008	0,006	0,13	0,84	4,32	73

Depending on the outcome of the sample taken to determine the chemical composition of the metal melt allied suitable for batches refined ferro be within the limits set previously by heating to high temperatures repeated until the threshold of about 1660˚C. When achieve the prescribed standard chemical composition and a well deoxidized slag and fluidity needed to get past the metal bath vacuum degassing. Table 2 shows the input parameters VD steel plant.

Table 2. Input parameters into steel in the plant VD

Charge	Vacuum inlet temperature, [˚C]	P, [%]	S, [%]	Mn, [%]
1LF-VD	1648	0,009	0,005	1,20
2LF-VD	1660	0,009	0,004	1,18
3LF-VD	1665	0,010	0,004	1,16
4LF-VD	1664	0,012	0,006	1,21
5LF-VD	1651	0,011	0,006	1,18
6LF-VD	1660	0,009	0,004	1,18
7LF-VD	1670	0,007	0,003	1,20
8LF-VD	1659	0,010	0,004	1,12
9LF-VD	1664	0,010	0,004	1,15
10LF-VD	1661	0,010	0,004	1,18

2. DESCRIPTION VD INSTALLATION

The pump is used to create a vacuum-type steam ejector ULVAC heated to a temperature of at least 200°C and a pressure of 20 bar to 6 bar before and after the gear reducer.

This type of pump is used to make a preliminary vacuum in the 760 to 0.5 torr and the actual flow rates are required when large refining plants DH, RH, VOD, VAD, ASEA-SKF, and others. Table 3 shows the characteristics of ULVAC vacuum pump.

Table 3. Characteristics ULVAC vacuum pump

Capacity [kg/h]	Ejectors	Condensers	Steam pressure [bar]		The minimum temperature steam [ºC]	Maximum vacuum [Torr]
			Min.	Max.		
650	7	3	10	20	200	0,250

Between the vacuum ejectors making up the capacitor are mounted, which causes condensation of the steam in counter-current washing with water, thus avoiding overloading the nozzle disposed downstream. Table 4 shows the operation of the steam ejectors to achieve the level ULVAC vacuum pump.

Table 4. Operation steam ejectors to achieve the level of vacuum pump ULVAC

Stage	Ejectors	The pressure at the beginning ejector, [Torr]	Minimum pressure reached , [Torr]
1	5 şi 7	760	200
2	5, 7, 4 şi 6	220	57
3	4, 6 şi 3	62	10
4	3 şi 2	11	1.7
5	3, 2 şi 1	1.9	0.5

The refining time of steel may vary from one batch to another depending on the temperature at which the metal bath are located at the entry in the LF system, the amount of ferro-alloys to adjust the added chemical composition, and the concentration of harmful components that are to be removed from the molten metal.

For measuring and recording the level of vacuum in the system using a digital camera that uses software DataChart 2000 Monarch placed in parallel with a gauge Cole Parmer 0-2000 millitorr, shown in Figure 2.Datele input retrieved from the vacuum sensors Honeywell 0-8517 torr (0-150 psig) and Cole Parmer 1-2000 millitorr accuracy of +/- 5% with duct mount installation.

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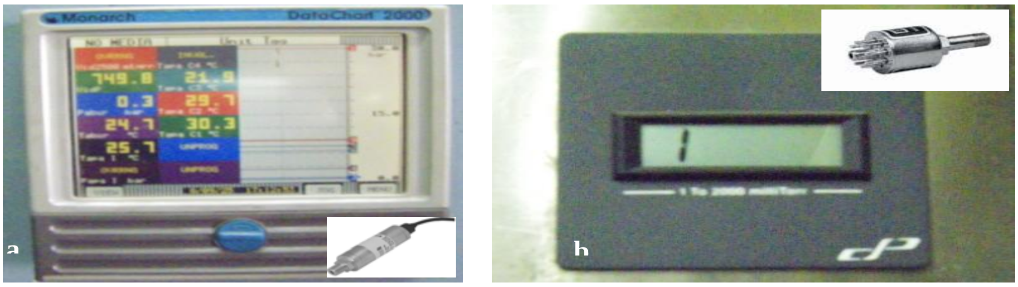

Fig. 2. Pressure measuring instruments: *a* - Monarch; *b* - Cole Parmer

VD plant scheme is shown in Figure 3.The formation of first vacuum is created in the vacuum pump line in which the flap 6 is in the closed position to the level of about 200 Torr. When the pot is ready and is sealed under one dome opens to equalize air flap (to visually monitored as long as slag overflowing not over heat shield 2), conducting the process in order to reach lower values 1 Torr.

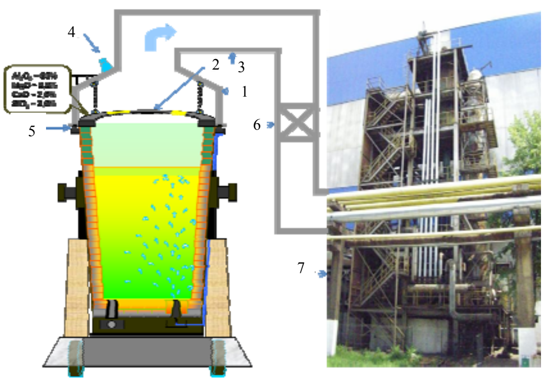

Fig 3. VD Installation

1- dome vacuum 2- heat shield; 3- pipe vacuum pump; 4- viewfinder; 5- Gasket; 6- flap; 7- vacuum pump.

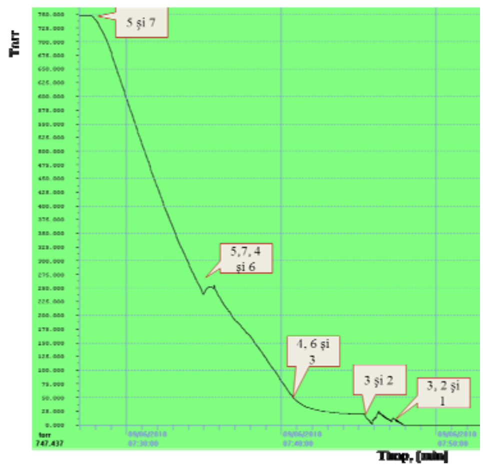

Fig. 4. Coupling vacuum ejectors and time

The residence time of the vacuum may vary depending on the degree of deoxidation of the slag and steel, but it is desirable to maintain more than 40 minutes due to the temperature decrease.

Degassing optimal yield remains at a level of vacuum under 1Torr therefore was monitored during the crossing this threshold and minimum vacuum level. Maintaining below 1 torr steel should not exceed 20 minutes due to lower temperature violent. Figure 4 shows how coupling vacuum ejectors and time needed to create the vacuum pump ULVAC

Table 5 shows the duration of treatment in vacuum, and the final parameters obtained from the batches studied.

Table 5. The duration of treatment and the finish vacuum fillers studied

Charge	Output temperature vacuum, [˚C]	While maintaining vacuum, [min]	Hold time under 1 Torr, [min]	Minimum vacuum, [Torr]	S, [%]	H, [ppm]	O, [ppm]
1LF-VD	1586	31	20	0,370	0,001	1,06	25
2LF-VD	1588	40	20	0,790	0,001	1,00	24
3LF-VD	1590	41	25	0,390	0,001	0,97	24
4LF-VD	1590	35	20	0,890	0,002	1,05	22
5LF-VD	1585	35	20	0,395	0,002	1,00	22
6LF-VD	1585	40	25	0,778	0,001	1,20	25
7LF-VD	1585	29	20	0,371	0,001	1,10	20
8LF-VD	1581	35	25	0,457	0,002	1,18	20
9LF-VD	1596	25	15	0,415	0,002	0,92	22
10LF-VD	1583	35	20	0,460	0,002	0,96	20

Depending on the temperature of the melt after degassing in vacuum, the duration of heating may vary from one batch to the next until reaching the 1630˚C. Meanwhile, the metal bath temperature homogenization was done by way of stirring declined to reveal and not reoxidize metal bath in contact with the atmosphere (5Nl / min).

3. CONCLUSIONS

In the following experiments we obtained a reduction in the sulfur content to an average of 0.0044% to 0.0015% an average value, that is, a degree of desulfurization of about 65%, a decrease in the hydrogen content at a average of 4.44 ppm to an average of 1.1 ppm, that is, a degree of dehydrogenation of about 74.5% and a decrease in the oxygen content to an average of 69.7 ppm to an average of 22.4 ppm, i.e. the degree of deoxidation of about 67.8%.

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