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The Re-Use of Calcareous Mud in the Sintering Plant of Hadisolb: A Techno-Economic Study

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Abstract

The chemical analysis of the calcareous mud (CM) was the corner stone behind the idea of replacing the limestone (LS) used in the sintering of el-Bahareya iron ores in the Egyptian Iron and Steel Company (Hadisolb) by the calcareous mud produced as a waste from the sugar beet companies. The aim of this investigation is to examine the possibility of replacing the limestone used in the sintering plant in the Iron and Steel Company at Helwan by the CM of the sugar beet companies. Several experiments were performed in the pilot plant of the company. The pilot scale experiments covered replacement of the limestone in the sintering process by CM for ranges starting from zero % CM, i.e. 100% LS, and up to 100% CM and zero % LS, at an increment of 10% each time. The chemical analysis and testing of the mechanical properties were performed to characterize each run of experiments. The results of the pilot scale experiments performed in the Egyptian Iron and Steel Company proved that 10% reduction in coke consumption in the sintering plant can be achieved as a result of the replacement of LS by CM Taking into consideration both the productivity of the sintering machine and the quality of the produced sinter, the annual return for the Egyptian Iron and Steel Company (Hadisolb) as a result of using CM in the sintering plant instead of Limestone was estimated to be about 100 million Egyptian pounds every year, in addition to the gains of the sugar beet companies as a result of getting rid of its waste material, i.e. the CM.

Keywords: Calcareous mud; Sintering; Fluxed sinter; Limestone; Coke consumption

Introduction

In Egypt nowadays, there are about eight sugar beet factories. Beside sugar they produce several byproducts. The calcareous mud (CM) is one of these products and is the only unused byproduct among the other byproducts. It is considered as a waste material which is accumulated year after year; consequently, it has a negative impact on both the environment and the economy. As a matter of fact, the amount of CM from the eight sugar beet factories is estimated to be about 800,000 tons/year, i.e. it represents 8-12 w/o of the processed beet [1]. It may be worth it to mention that in Europe the CM is reused in several aspects, such as:

a. As an additive to animal feed.

b. As a filling material in some industrial products (e.g. rubber, plastic, paper, ...) In the building industry.

c. In water treatment.

However, in Egypt the CM is still unused by-product, in spite of the fact that the sugar beet factories offer to give it for no charge. In this investigation, a scientific approach for reusing the CM is adopted. This approach is based on considering some important facts about the CM, the complete chemical analysis of the CM is the most important of them. The chemical analysis for a representative sample of CM was performed using XRF – 9800 ARL technique. The results of the chemical analysis are given in Table 1. The chemical analysis given in Table 1. shows that the CM is composed mainly of CuCO3, MgCO3 and a significant amount of organic matter – given as organic CO2 – which varies between 8-15 %, and its value obviously depends on the beet juice composition [2]. The presence of the organic matter in the CM should be considered by all means an added value to the CM, and this ought to be taken into consideration when searching for its reuse. Based on the chemical analysis of the CM given in Table 1. We can assume that the annual production of the eight sugar beet factories in Egypt, which is estimated to be about 800,000 tons, will contain about 80,000 tons of combustible organic matter (taking it as 10% content). Accordingly, it was suggested to reuse the CM in pyro-industrial applications, such as Portland cement production, or in the Iron & Steel making as a substitute for the limestone used in any of them.

It was found that about 5% in the charge of the furnace will save about 1% of the consumed energy/ton of clinker. However, this amount of energy saving was not enough to make the reuse of CM in this respect feasible. The conclusion may be attributed to the fact that the cement companies in Egypt are using highly subsidized raw material. In many cases, sintering is considered as an essential step in ore preparation for the blast furnace operation. Sintering may be defined as the agglomeration of fine particles into a strong porous mass. The process is carried out by heating the sintering charge at a temperature approaching its fusion. The sintering charge usually includes, beside the iron ores, the required amounts of LS, coke and water to produce sinter of a specific composition and quality. In this investigation, several pilot scale experiments were performed in which LS was replaced by CM to produce the self-fluxed sinter.

Table 1: Chemical analysis for a representative sample of CM.

$\%CaCO_3$		$\%MgCO_3$		Elements %						Organic CO_2
%CaO	$\%CO_2$	%MgO	$\%CO_2$	Al_2O_3	Fe_2O_3	P_2O_5	SiO_2	SO_3	L.O.I.	
36.19	28.5	5.7	8.3	0.24	0.17	1.3	4	0.56	50.09	5

Material and Experiments

The Egyptian Iron & Steel company (Hadisolb) is the only company among all the other steel making companies which adopts blast furnace/sintering route. The blast furnaces in Hadisolb use selffluxed sinter in its burden. Self-fluxed sinter, as was mentioned before, requires an iron ore, a fluxing material such as LS or CM, of course in addition to coke and water.

Material

The Iron Ore

The iron ore deposits at El-Gedida are the only ores used now in Hadisolb. These ores are located in three different localities. At El-Gedida mines, ores from the three localities are extracted and blended according to predetermined program to meet the previously agreed upon composition, which is Fe > 51%, Cl < 0.6%, MnO < 2.4%, SiO2 < 8%, CaO > 0.5%, and Al2O3 < 2%.

Limestone (LS)

The Limestone used as a flux in the pilot-scale experiments is that brought from Bani-Khalid quarries nearby Samalut. The quarry is owned by Hadisolb and is one of the highest quality limestone in Egypt. The Limestone was crushed and sieved up to -3mm size.

Calcareous Mud (CM)

The idea of replacing LS by CM in the sintering process is based on the chemical composition of both materials given in Table 2 [3] (Figure 1).

Table 2: The Chemical analysis for representative samples from Bani-Khaled quarries LS used as a flux material in the sintering plant of Hadisolb and that of CM from Dakahleya sugar beet company.

Compound %	Limestone	Calcareous mud
Moisture	0.42	~2
CaO	54.71	36.19
Al_2O_3	0.06	0.24
Fe_2O_3	0.12	0.17
MgO	0.5	5.7
SiO_2	0.17	4.0
SO_3	0.17	0.56
P	0.008	0.01
Organic CO_2	-	~15
L.O.I.	43.78	50.09

Experimental Work

Sintering of different mixtures under investigation is conducted in a pilot scale unit of 20 kg capacity, as shown in Figure 1.

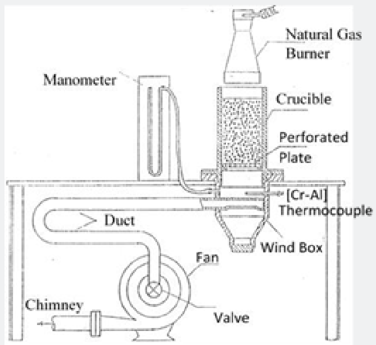

Figure 1: Pilot Scale Sintering Unit.

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The following steps should be carefully fulfilled prior to the sintering process:

- Separate weighing of the different constituents of the charge.
- Dry blending the charge constituents.
- Spray water carefully and slowly into the charge till the required moistening is reached.

The well-mixed charge then should be transferred into the sintering crucible, after putting enough coarse sinter return at its bottom on the perforated plate. A thin layer of fine coke should be added on the surface of the charge to initiate the combustion process. After the sintering is completed, suction of air was continued for a few minutes to cool the sinter cake. The cake was then punched out of the crucible, weighed, analyzed, and tested for strength (the drum test (DT) was the only test performed in all experiments). One of the experimental sheets is given in Appendix I [4].

Results and Discussion

In order to investigate the effect of replacement of LS by CM in the sintering process, several sintering experiments were performed, using different percentages of replacements, as mentioned previously. Representative samples were taken from each three similar experiments (replacement percent), for chemical analysis. for each three experiments of similar replacement ratio. Table 3 gives the average chemical analysis calculated for each degree of replacement (CM %). From Table 3, it is noticed that the CuO % in the sinter decreases and the MgO % increases as the CM percent increases, which is in favor for the blast furnace operation. In Table 4, the savings in the coke consumption in the sintering process as the result of replacing L.S. by CM is given. From Table 5, it is clear that the saving in coke increases as the CM % in the sintering charge increases. It can be concluded from the Table 4, that the total saving of coke in the sintering plant of Hadisolb may reach a value of about 35 thousand tons/year, beside saving the amount of L.S. replaced by the CM, which is equal to 250,000 thousand tons/year (Figure 2).

Table 3: Shows the average chemical analysis for different sinters with different CM%.

No.	C.M.%	Total Fe%	FeO%	Fe_2O_3%	SiO_2%	CaO%	MgO%
1	0	52.2	13.6	59.35	8.82	9.69	1.12
2	10	52.15	13.6	59.2	8.8	9.55	1.2
3	20	52.09	14.18	58.62	8.44	9.1	1.36
4	30	52.05	14.8	57.5	8.3	8.95	1.68
5	40	52.05	16.68	55.57	8.06	8.88	2.2
6	50	52	15.56	57.29	7.43	7.83	2.35
7	60	52.04	13.92	58.41	7.86	7.51	2.6
8	70	52	16.87	55.35	7.78	7.4	2.8
9	80	51.82	14.29	58.67	7.6	7.3	3.1
10	90	51.78	15.87	55.75	7.48	7.27	3.2
11	100	51.57	15.12	56.88	7.2	7.2	3.3

Table 4: Savings in the coke consumption in the sintering process as the result of replacing L.S. by CM

No	Calcareous Mud (%)	Saving in Coke (%)	Drum test (%)
1	0 (100 % L.S.)	0	12
2	10 (90 % L.S.)	2	12.3
3	20 (80 % L.S.)	4	12.5
4	30 (70 % L.S.)	6	12.8
5	40 (60 % L.S.)	8	13
6	50 (50 % L.S.)	9	13.2
7	60 (40 % L.S.)	10	13.5
8	70 (30 % L.S.)	11	13.8
9	80 (20 % L.S.)	12	14
10	90 (10 % L.S.)	14	14.2
11	100 (0 % L.S.)	15	14.5

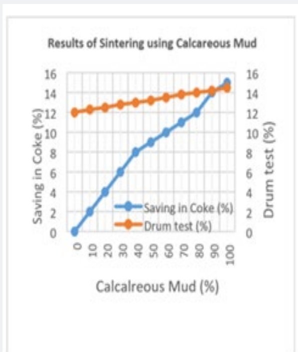

Figure 2: Savings in the coke consumption in the sintering process as the result of replacing LS by CM.

Conclusion

i. The unused calcareous mud (CM) produced as a waste by-product in the Egyptian sugar beet companies can be

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successfully used as a flux material instead of L.S. in the Egyptian iron & steel company (Hadisolb) at Helwan [5].

ii. Pilot-scale experiments for sintering using 100% CM instead of L.S. had similar chemical and mechanical properties as that for the sinter which is using 100% L.S. in the charge.

iii. The saving achieved by using CM instead of L.S. was empirically estimated and was found to be equal to about 35,000 tons/year of coke, and 250,000 tons/year of L.S.

References

1. Elsayed MA Rassoul (2008) A research Project on the Reuse of the Calcareous Mud of the Sugar Beet Companies in the Sintering Plant of the Iron and Steel Company at El-tebbin.
2. Elsayed MA Rassoul (1996) Egypt's Natural Resources Management. Published in the Proceedings of the Fifth International Symposium.
3. Pokhfesnef AN, Rassoul SA and Vegman EF (1962) Isv Vish Uch Chornia Metalurgia 7: 30.
4. Elsayed MA Rassoul, Wilder D (1985) Towards Better Utilization of Raw Materials and Energy in the Metallurgical Industry in Egypt.
5. Elsayed MA Rassoul (2017) A new charge mix using the Calcareous mud from the sugar beet companies in the sintering of the Iron ores. Academy of Scientific Research and Technology, Egypt.

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