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USE OF CEMENT AS A BINDER MATERIAL IN PELLETIZATION OF CHROMITE ORE CONCENTRATE

Summary. The results of granulation of chromite concentrates were presented - dependently on different amount of water and cement. some physical parameters of obtained pellets were tested.

WYKORZYSTANIE CEMENTU JAKO LEPISZCZA PRZY GRUDKOWANIU KONCENTRATÓW CHROMITOWYCH

Streszczenie. Przedstawiono wyniki procesu granulacji koncentratu chromitowego w zależności od dodatku zmiennych ilości wody i cementu. Przedstawiono niektóre fizyczne parametry otrzymanego granulatu.

1. Introduction

The green ball formation of chromite concentrate in disc pelletizer is influenced by the following factors :

a - Operation factors such as (disc slope, disc rotating speed, residence time of material in the disc pelletizer[1-4] .

b - Process influencing factor on the green ball formation (feed size, amount of water added to the feed)[2&4-7].

c- Binders and additives.[1]

In very few cases it has been possible to use green balls directly in metallurgical processes despite their low mechanical strength , pellets must have a substantially higher strength primarily to withstand their transportation and stress occurring in metallurgical operations . Such a strength can be achieved by thermal treatment under a controlled atmosphere. [1]

Due to the world-wide fuel crisis the alternative route to pellet hardening without heating and used cold bonded pellet process assumes great importance, particularly for Egypt.
Therefore the main object of this work is to study the effect of cement added as a binder material on the pelletization of chromite ore concentrate and production of ferrochrome silicon alloys.

2. Experimental work

2.1. Materials

The chromite ore concentrate having the chemical composition, Cr_2O_3 42.25%, FeO 13.2% , SiO_2 6.86 , CaO 1.34% ,Al_2O_3 16.84% and MgO 19.5%.
Nut coke, having the following composition, Fe_2O_3 3.2%, SiO_2 9%, MgO 1%, Al_2O_2 6%, CaO 0.8% and fixed carbon 78%.
Quartzite, containing 1.13% Fe_2O_3, 97% SiO_2, 0.1 MgO ,1.5%Al_2O_2 and o.27 % CaO.
Cement, the cement which used having the following chemical composition : Fe_{total} 1.75%, Fe_2O_3 2.5%, SiO_2 22%, CaO 63%, Al_2O_3 7.5%, MgO 3%, S 1%.

2.2. Equipment and Procedure

A 40cm diameter and 10 cm depth laboratory disc pelletizer was used in this investigation. It was provi- ded with controlling devices in adjusting the inclination angle and speed of motors. The chromate concentrate sample with cement fed to the pelletizer then the predetermined water was sprayed onto the rolling bed of the material in disc pelletizer. At the end of the test the sample was collected and screened to collect the -16 +10 mm pellets which were taken as a measure for the productivity of the pellets.
The green balls was hardened in air atmosphere for 25 days after which the crushing strength was determined.

The smelting experimental heats of ferrochrome silicon were done in 100 kVA laboratory submerged electric arc furnace.[8]

3. Result and discussion

The effect of cement as binder on the pelletization of chromite ore concentrate was studied with different amount of water under the following conditions :
(feed size -200 mesh, weight of the charge = 500 gm, tilt angle of disc pelletizer 60°, residence time of the raw material in the disc pelletizer = 15 min. and the disc rotating speed 15 rpm).
The result of these studied is as follows:

3.a. The effect of cement addition on the production of green pellets and its properties

Fig.1 shows the effect of cement added on the productivity of the green pellets at different amount of water, from which it is evident that at any constant amount of water (10-13%) the productivity of green pellets (-16 +10 mm) decreased with the increase of amount of cement. This is due to the addition of cement needed water, and this is clear from the same figure (i.e. at any constant amount of cement the productivity of the green pellets increased as the amount of water increased).

Figs. 2-3 show the relationship between the average drop number, crushing strength of green pellets and the amount of cement added at different amount of water. From these figures it is clear that the maximum average drop number is 6 when the amount of water added was equal 10% in case of 2% cement while the drop number is = 5 in case of 11% water and the amount of cement equal to 4%. In the presence of 10% and 11% water the addition of 2%, 4% cement respectively increased the binding effect and consequently the average drop number. Increasing the amount of cement beyond 2 & 4% cement in case of 10% &11% water decreased the average drop number due to the insufficient water.
While the average drop number of green pellets increased as the amount of cement increased up to 12&13% cement when 12&13 % water was used respectively. This may be due to the addition of cement needed more water.
From Fig.3 it is clear that the crushing strength of green pellets reached to maximum value at 2%,4% and 10% cement added when the amount of water used was 10% , 11% and 12% respectively, while in case of 13% water added the maximum crushing strength is at 16% cement addition.

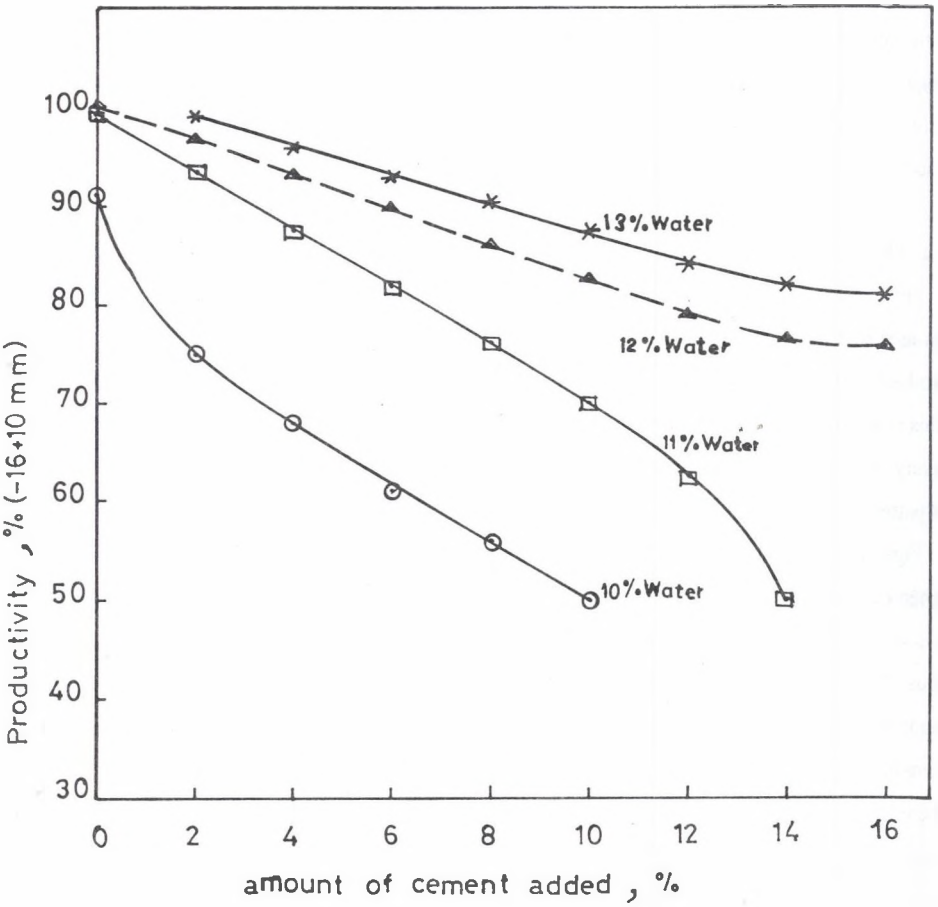

Fig.1. Effect of cement addition on the productivity of green pellets
Rys.1. Wpływ dodatku cementu na produkcję grudek manganonośnych

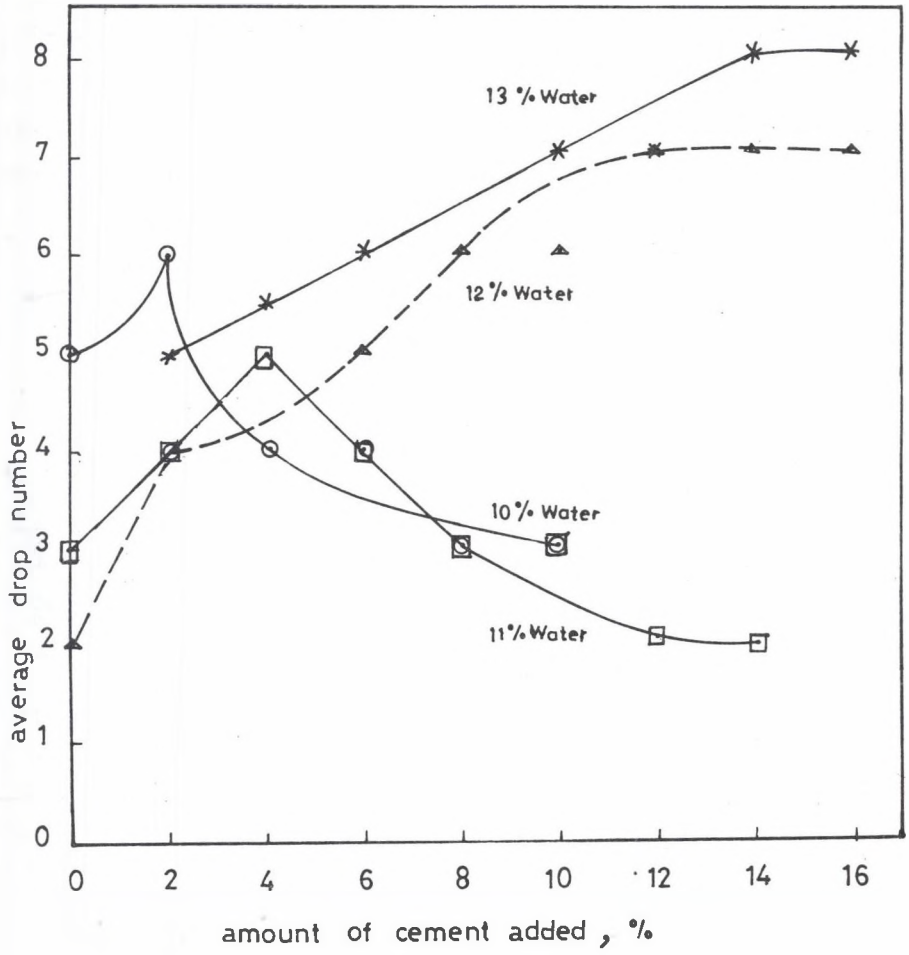

Fig.2. Effect of cement addition on the average drop number of green pellets
Rys.2. Wpływ dodatku cementu na średni stopień opadania grudek manganonośnych

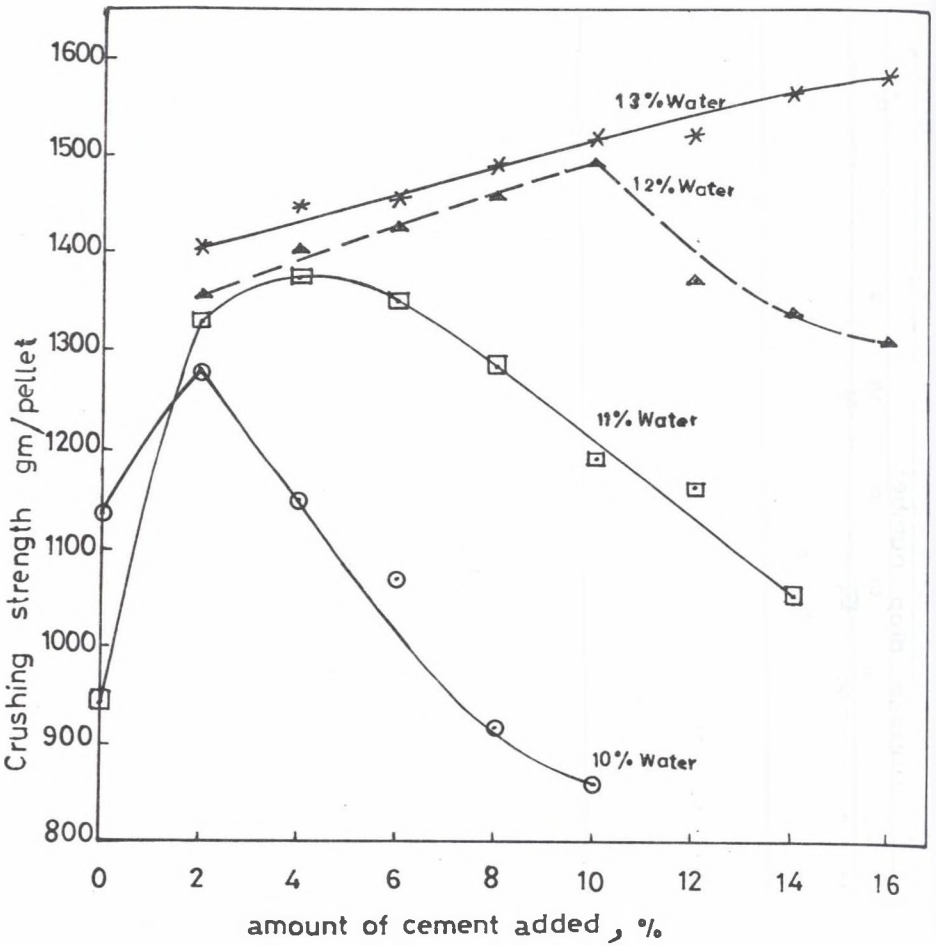

Fig.3. Effect of cement addition on the crushing strength of green pellets
Rys.3. Wpływ dodatku cementu na wytrzymałość na ściskanie grudek manganonośnych

3.b. Effect of addition of cement on the crushing strength of the produced pellets after 25 days in air at room temperature

From the above mentioned Figs. 2&3 it is clear that at 13 % water added the produced pellets have higher average drop number and average crushing strength thus the pellets contains 6% to 16% cement were hardened in air atmosphere at the ordinary temperature for 25 days. The results of investigation showed that the strength of the pellets increased as the amount of cement increased, Fig.4. This may be due to the consequence of the reaction be

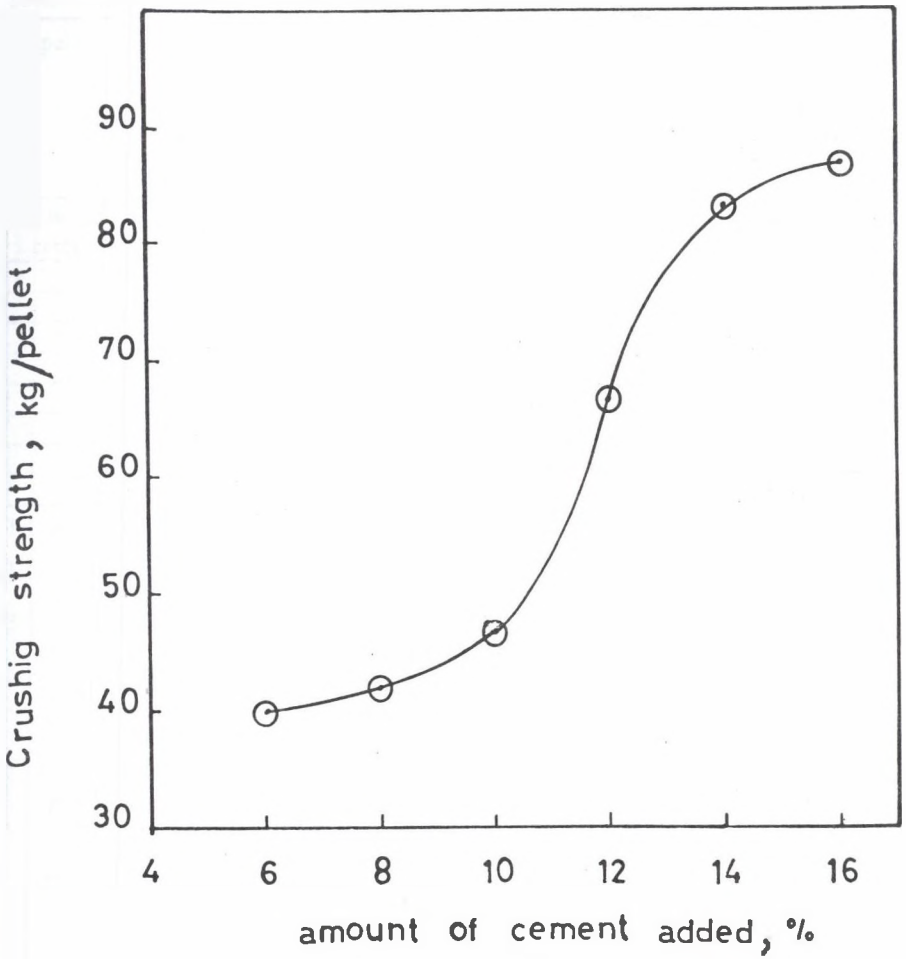

Fig.4. Effect of cement addition on the crushing strength of the pellets after 25 days in the air at the room temperature

Rys.4. Wpływ dodatku cementu na wytrzymałość na ściskanie grudek manganonośnych po 25 dniach

tween cement powder and aqueous solution, mechanical strength develops with time, having a high initial velocity which gradually decreases. It early ages strength values are very important for setting the hydrated products ($2CaO.SiO_2.H_2O$, $3CaO.SiO_2.\alpha H_2O$,$2CaO.Al_2O_3.8H_2O$,-$3CaO.Al_2O_3.8H_2O$ and $CaO.Al_2O_3.10H_2O$). The strength reached to ~ 30% after 3 days and at 7 days about 60%. A further increase of 30-50% of the compressive strength is registered in up to about one years [9)ÿÿ]. Bogue and Lerch[10] indicated that the highest strength value is that for $3CaO.SiO_2.\alpha H_2O$, $2CaO.SiO_2.H_2O$.

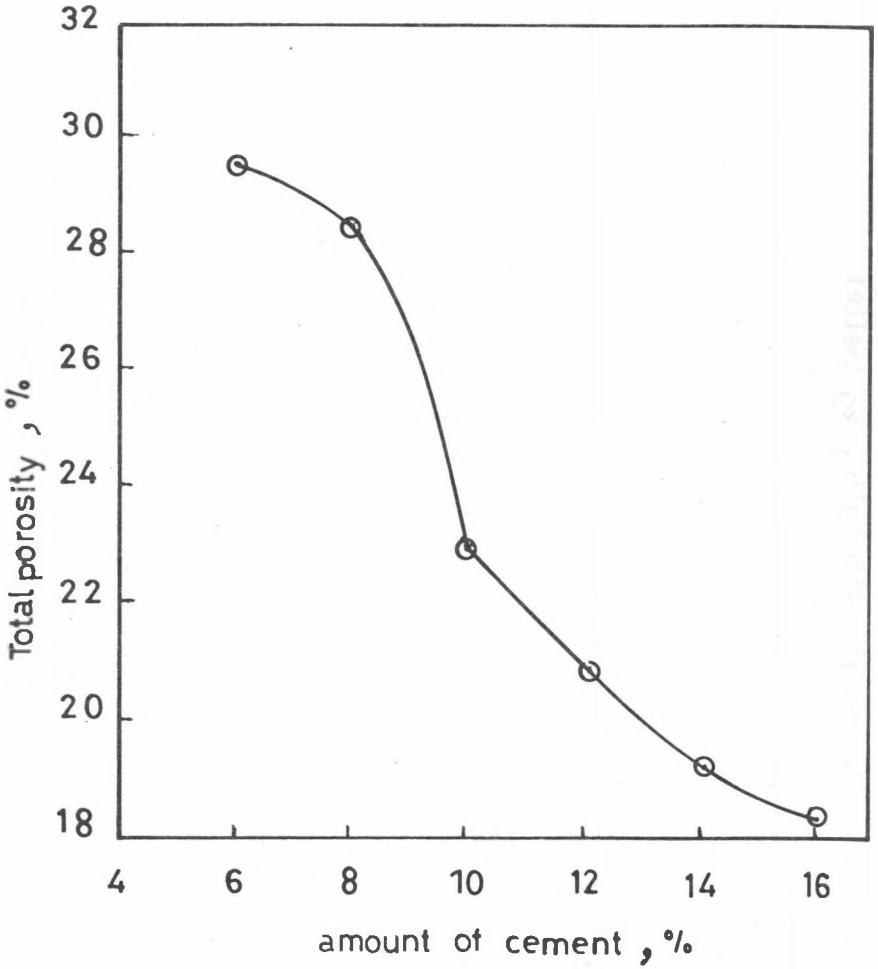

Fig.5. Effect of cement addition on the total porosity in the indurated pellets
Rys.5. Wpływ dodatku cementu na porowatość całkowitą

Also the increase of pellets strength is due to the fineness of the cement[11]. Moreover may be due to the decrease of the voids between particles[12-15], Fig. 5 and due to the compression strength is a powefunction of the volume of hydration products per unit volume of hydrated paste (the hydration products present different binding capacities, inversely proportional to the amount of bound water [16,17].

3.c. Effect of cement addition on the chemical composition of the produced pellets

Table 1 shows the effect of the addition of cement on the chemical composition of the produced pellets.

Table 1

Chemical analysis of the cold hardening pellets
when different amount of cement was used (dry base)

Amount of cement, %	Chemical composition , %					
	Cr_2O_3	FeO	SiO_2	CaO	Al_2O_3	MgO
2	41.40	12.93	7.16	2.57	16.65	19.17
4	40.56	12.67	7.50	3.81	16.47	19.06
6	39.70	12.40	7.77	5.04	16.28	18.51
8	38.87	12.14	8.07	6.27	16.09	18.18
10	38.00	11.88	8.37	7.50	15.91	17.85
12	37.18	11.61	8.68	8.74	15.72	17.50
14	36.30	11.35	8.98	9.97	15.50	17.19
16	35.50	11.08	9.28	11.20	15.35	16.86

From this table it is clear that the amount of Cr_2O_3, FeO, MgO, Al_2O_3 in the cold hardening pellets decreased as the amount of cement increased while the amount of SiO_2 and CaO increased in the produced pellets.

3.d. Effect of cement addition on the production of fe-cr-si alloys

Table 2 shows the effect of cement on the yield of Fe-Cr-Si alloys and its chemical composition.

Table 2

Effect of cement on the yield of Fe-Cr-Si alloys and its chemical composition

Cement, %	Yield, %	Cr %	Fe %	Si %	C %	Cr/Fe
6	82.00	53.90	25.94	14.56	5.60	2.08
8	83.60	54.70	23.38	17.12	4.80	2.34
10	84.00	57.20	20.87	17.43	4.50	2.73
12	84.00	59.70	17.63	18.87	3.80	3.38
14	85.00	58.00	17.60	21.20	3.20	3.29
16	85.00	54.00	21.60	21.40	3.00	2.50

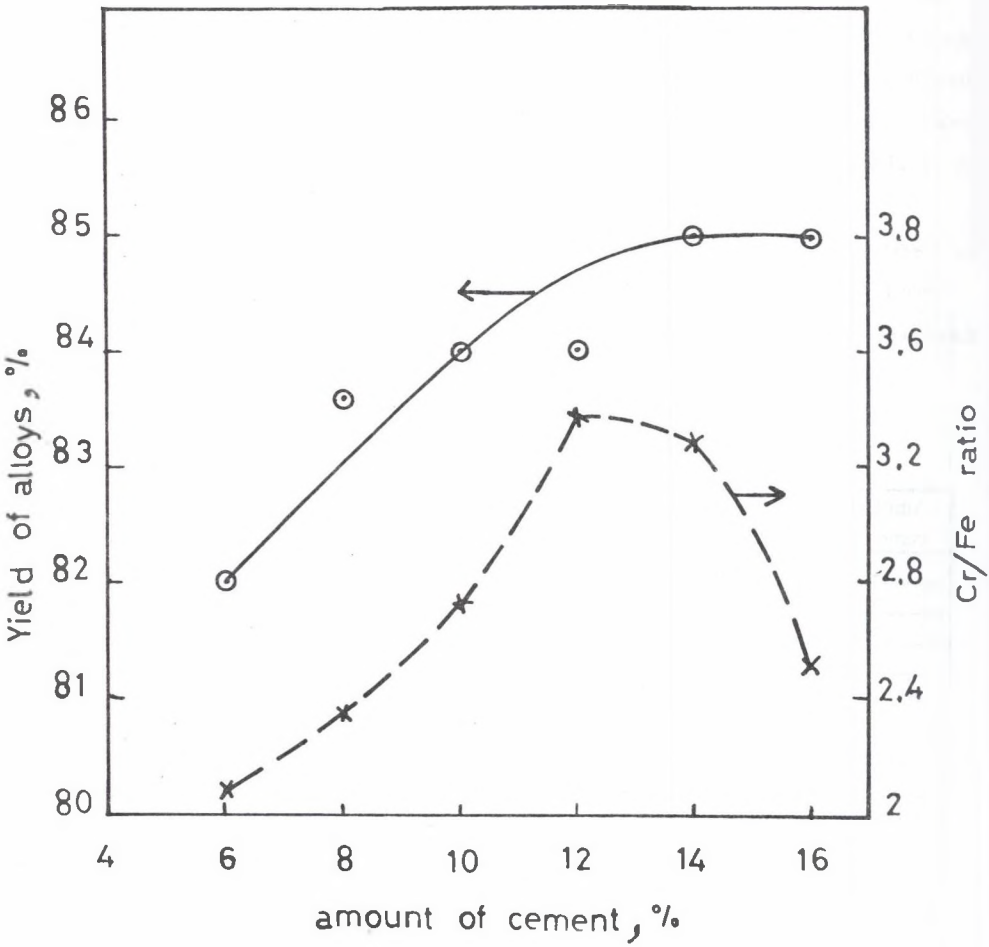

Fig.6. The relationship between the yield of Fe.Cr.Si alloys, Cr/Fe ratio and the amount of cement in the green pellets

Rys.6. Zależność pomiędzy wychodem stopów FeCrSi, stosunkiem Cr/Fe i ilością cementu w grudkach manganonośnych

From this table and Fig. 6 it is clear that at 12%-14% cement added the Cr/Fe ratio reached to 3.38-3.29 respectively and the amount of Cr = 59.70 - 58%. Also from this table all the produced alloys fall within the Russian specification.[18]

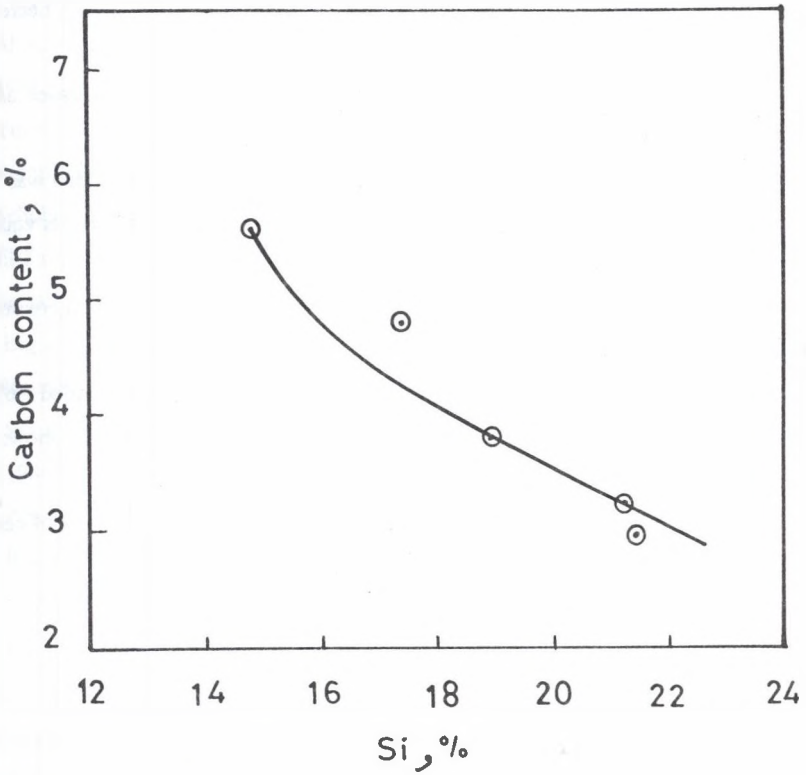

Fig.7. The relationship between carbon content and amount of silicon in the alloys which produced by using cement as a binder

Rys.7. Zależność pomiędzy zawartością węgla i ilością Si w stopach przy użyciu cementu

Fig. 7 shows as the amount of Si content in the Fe-Cr-Si alloys increased the amount of carbon decreased.

Conclusions

1. The effect of cement as a binder material on the pelletization of chromite concentrate was studied and the results of its as follows:
   a- At any constant amount of water (10-13 %) the productivity of green pellets decreased with the increase of amount of cement added to the chromite ore concentrate.
   b- At any constant amount of cement the productivity of green pellets increased as the amount of water increased.
   c- The average drop number of green pellets is 6 when the amount of water added was 10% in case of 2% cement added while in case of 11% water the average drop number equal to 5 in case of 4% cement.
   d- The average drop number of green pellets increased as the amount of cement increased up to 12% & 13% cement was used when 12&13% water was added.
   e- The pellets which produced from 13% water added with different cement added (6% to 16%) was hardened in air atmosphere at the ordinary temperature for 25 days shows that as the amount of cement increased the crushing strength increased.
   f- The alloys produced from the chromite ore concentrate with different amount of cement gave alloys similar to the Russian specification.
   g- The yield of alloys increased with the increase of amount of cement.

2. To produce Fe-Cr-Si alloys from the chromite ore concentrate (either used 10% water in the pelletization and indurated at 1250 °C for 50 min. or used or used 12-14% cement as a binder material or used 2-3% Ca-bentonite as a binder materials. In case of 2.5-3 % molasses the yield of Fe-Cr-Si alloy is very high therefor we recommended to use molasses as a binder material

Note 1 : The productivity of the green pellets (-16 +10 mm) = $W_1 x 100/W_2$.

where : W_1 is the weight of green pellets (-16 +10 mm)

W_2 is the weight of charge material.

Note 2 : The yield = $\{(Cr + Fe + Si)_A / (Cr + Fe + Si)_C \} \times 100$

where : $(Cr + Fe + Si)_A$ is amount of Cr,Fe & Si in the alloys.

$(Cr + Fe + Si)_C$ is amount of Cr,Fe & Si in the charge.

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Streszczenie

Przedstawiono wyniki procesu granulacji koncentratu chromitowego w zależności od dodatku zmiennych ilości wody i cementu. Przedstawiono występujące współzależności pomiędzy dodatkiem wody, cementu, czasu leżakowania, wytrzymałością grudek i ich składem

chemicznym. Podano również wyniki przetapiania wytapianych grudek w laboratoryjnym piecu elektrycznym.

Określono:

- wpływ dodatku cementu na produkcję grudek manganonośnych,
- wpływ dodatku cementu na średni stopień opadania grudek manganonośnych,
- wpływ dodatku cementu na wytrzymałość na ściskanie grudek manganonośnych,
- wpływ dodatku cementu na wytrzymałość na ściskanie grudek manganonośnych po 25 dniach,
- wpływ dodatku cementu na porowatość całkowitą,
- zależność pomiędzy wychodem stopów FeCrSi, stosunkiem Cr/Fe i ilością cementu w grudkach manganonośnych,
- zależność pomiędzy zawartością węgla i ilością Si w stopach przy użyciu cementu.