ZESZYTY NAUKOWE POLITECHNIKI ŚLĄSKIEJ 1996
Seria: GÓRNICTWO z. 231 Nr kol. 1349

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INFLUENCE OF SOME FACTORS ON THE SINTERING OF BAHARIA IRON ORE

Summary. This article describes and discusses the effect of amount of sinter return fines and the time of ignition on the sintering of El - Baharia Iron Ore.

The results arrived can be referred to the optimum amount of return fines and the optimum time of ignition.

WPŁYW NIEKTÓRYCH CZYNNIKÓW NA PROCES SPIEKANIA RUDY ŻELAZA ZE ZŁOŻA BAHARIA

Streszczenie. Przebadano wpływ dodatku różnych ilości spieku zwrotnego i czasu zapłonu na uzysk, wydajność, wytrzymałość, reaktywność i własności technologiczne spieku wytworzonego z rudy żelaza ze złoża Baharia. Ustalono, że optymalny dodatek spieku zwrotnego wynosi 35% a optymalny czas zapłonu mieszanki 3 minuty.

Introduction

A higher amount returns in the sintering mixture enhances the sintering process and at the same times increases the sintering machine output due to a better gas permeability of the mixture. This favourable effect of returns of the gas permeability of sintering mixture is due to granularity of returns[1]. Returns uniformly distributed in the sintering mixture serve as a base that prevents an excessive compacting of the sintering mixture in loading in on to the machine and a shrinkage under the action of vacuum[1,2]

Returns includes the mineralogical constituents with low melting temperature accelerates the fusion of the sinter mix, promotes the amount of melt on the combustion zone, increases the amount of the binder matter after crystallization.

With increased content of return the temperature regime of sintering varies. Return decreases the heat capacity of the sinter mix due to decreasing of the heat available for water evaporation, decomposition of limestone and iron hydroxides[3,4].

Raush and other[5] indicated that as a return content in raw mix is increased, strength of sinter produced is faster increased and the oxidation degree improves.

Sckluter et al[6] found that the sinter productivity was a maximum at return fines percentage of 20-25 where a maximum cold and hot strength was obtained at 60-85% return fines.

Wendeborn and coppel [7] noticed that sintering was improved by addition of sinter return, since the gas permeability of the charge increased. Several authors [7-10] found that the optimum amount of sinter return which must be added was 40 -60 % Beyond this limit, the sinter strength began to decrease. This improvement was explained on the premises of the fact that the sinter return did not consume coke as much as the iron ore and consequently higher temperature was reached on applying higher contents of sinter return.

Lysenko , et al [11] found that the vertical sintering speed varied extremely with increasing the heating time from 1.3 to 3.8 min. Maximum sintering rate and specific productivity were achieved with heating time = 2.8 min. and a heating temperature of 1170 °C.

The greater prime out put given by increasing the heating time beyond 3.3 min. was not offsetby a slower vertical sintering rate, the specific productivity being thus reduced. A marked increase in the mechnical strength of the sinter was given by an increase inheatingtime at any temperature.

The increase in FeO content with increase in external heating time due to the lower oxidizing potential of gaseous phase as compared with that of atmospheric air, and to the lower sintering rate.

Experimental work

Raw Material

The raw material used in these experiments were iron bearing material (EL- Gedida 0 iron ore and sinter return , limestone, and coke breeze. The chemical analysis of the raw materials are given elsewhere.[12]

Sintering Procedure

The raw mix with basicity CaO / SiO2 = 1.14 was moistened by the optimum amount of water (9%). and through mixing was carried out to give good green granules.Then the charge was ignited for a certain time under suction of 5.88 Kpa. After the ignition hood was removed and the suction was increased to 11.75 Kpa . The ready made sinter, vertical velocity, shatter test, productivity of sintering machine and the productivity at B .F. yard were evaluated.

Results and discussion

1. EFFECT OF RETURN SINTER ADDITIONS

Fig.1. illustrates the relationship between the amount of return sinter in the raw mix and the amount of ready made sinter and its strength. It is clear that both of ready made sinter and its strength (+ 7mm) increases with the increase of the amount of return sinter within the investigation range (20 % up to 50 %). This improvement in amount of ready made sinter and its strength may be due to the following facts:

1- The increase of the return sinter , leads to improve the permeability of the raw mix up to 35 % return sinter, thus the utilization of heat during the sintering process is improved. [1,7,13]

2- In contact with flux the return fines react with it in the solid phase forming low melting compounds calcium ferrites type which melt first during sintering of the mix. [14]

3- Return sinter did not consume coke as much as the iron ore and consequently the temperature in the zones of sinter bed increased [7-10], which leads to the increase the amount of melt in the sintering process.

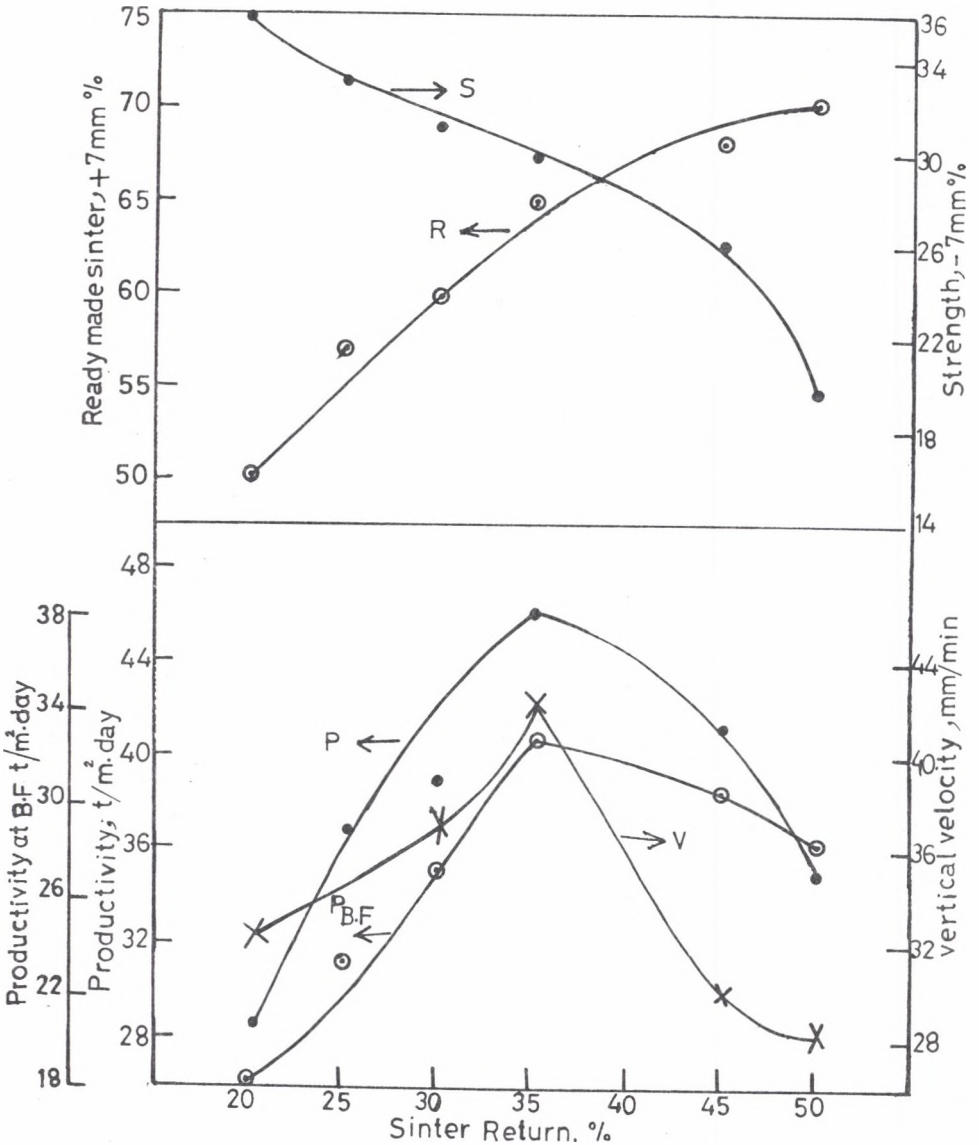

Fig.1. Effect of the amount of sinter return on the technical parameters of the sintering process
Rys.1. Wpływ ilości zawrotu spieku na parametry procesu spiekania

Fig. 1.shows also that the optimum value of return sinter which gives maximum vertical velocity, productivity of sinter machine and productivity at B.F. yard is 35% . The increase of vertical velocity up to 35% return sinter is due to the fact that the permeability of the sinter charge increased . [1,7,13] Using return sinter beyond 35 % leads to a decrease in the vertical velocity which may be due to the formation of more melt [7-10] and subsequently the permeability ddecreased. The maximum value of the productivity of the sintering machine and the productivity at blast furnace yard is at 35 % return sinter is due to the combination factors of ready made sinter , vertical velocity and sinter strength.

Table 1 . Shows that as return sinter increases the amount of FeO, Fe_{metal} and the degree of metallization increases, while the amount of sulphur content decreases when return sinter increases up to 35%, beyond 35% return sinter the amount of sulphur increases. The increase in FeO , Fe metal and the degree of metallization and the decrease in sulphur when the return sinter increases to 35% is due to the fact that the permeability of sinter charge increased and subsequently the combustion of the fuel increases and thus the conditions becomes more favourable to the decomposition of hematite to lower oxoides and favourable also to the desulphurization . [13,15] The increase of the FeO in the sinter beyound 35% sinter return may be due to the more of CO which is formed during the sintering process which leads to more reduction of Fe_2O_3 to Fe_3O_4 , FeO and Fe metal . While the increase in the amount of sulphur beyound 35% sinter return is due to more melt which decreased the permeability, subsequently the amount of free oxygen in waste gases of the sintering process is decreased, thus these conditions are not favourable to the desulphurization . [13,15]

Table 1

The effect of return sinter on the chemical composition of the produced sinter

Amount of sinter return,%	chemical composition of the produced sinter, %						
	Fe total	FeO	Fe_{metal}	SiO_2	CaO	S	Degree of metallization
20	53.60	11.84	0.60	8.35	9.60	0.130	1.10
25	53.20	13.00	0.90	8.29	9.55	0.120	1.70
30	53.15	13.45	1.00	8.30	9.60	0.110	1.88
35	53.40	14.41	1.20	8.30	9.54	0.088	2.20
45	53.35	15.18	1.30	8.28	9.55	0.122	2.40
50	53.4	15.90	1.36	8.32	9.60	0.140	2.54

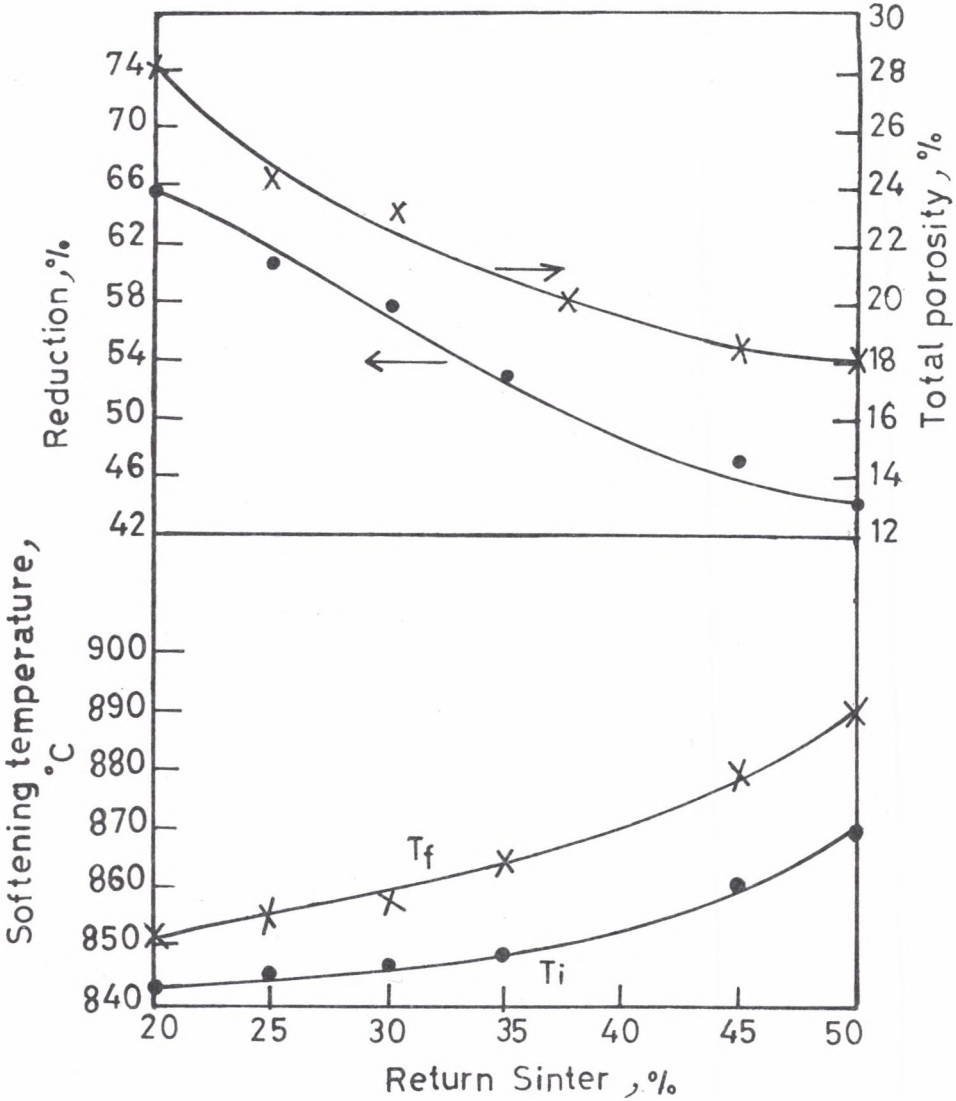

Fig. 2. The effect of amount of return sinter on the degree of reduction, porodity and softening temperature of the produced sinter

Rys.2. Wpływ ilości zawrotu spieku na porowatość, temperaturę mięknięcia produkowanego spieku

The decrease in the reducibility of the produced sinter in Fig. 2 with rising the amount of return sinter from 20% to 50% could be related to the following two reasons :

1. 1- decrease of the porosity of the produced sinter (Fig 2)which leads to increase
2. the resistance to the diffusion of H_2 gas through solid particles.[16-18]
3. - increase of FeO content in the produced sinter (Table 1).

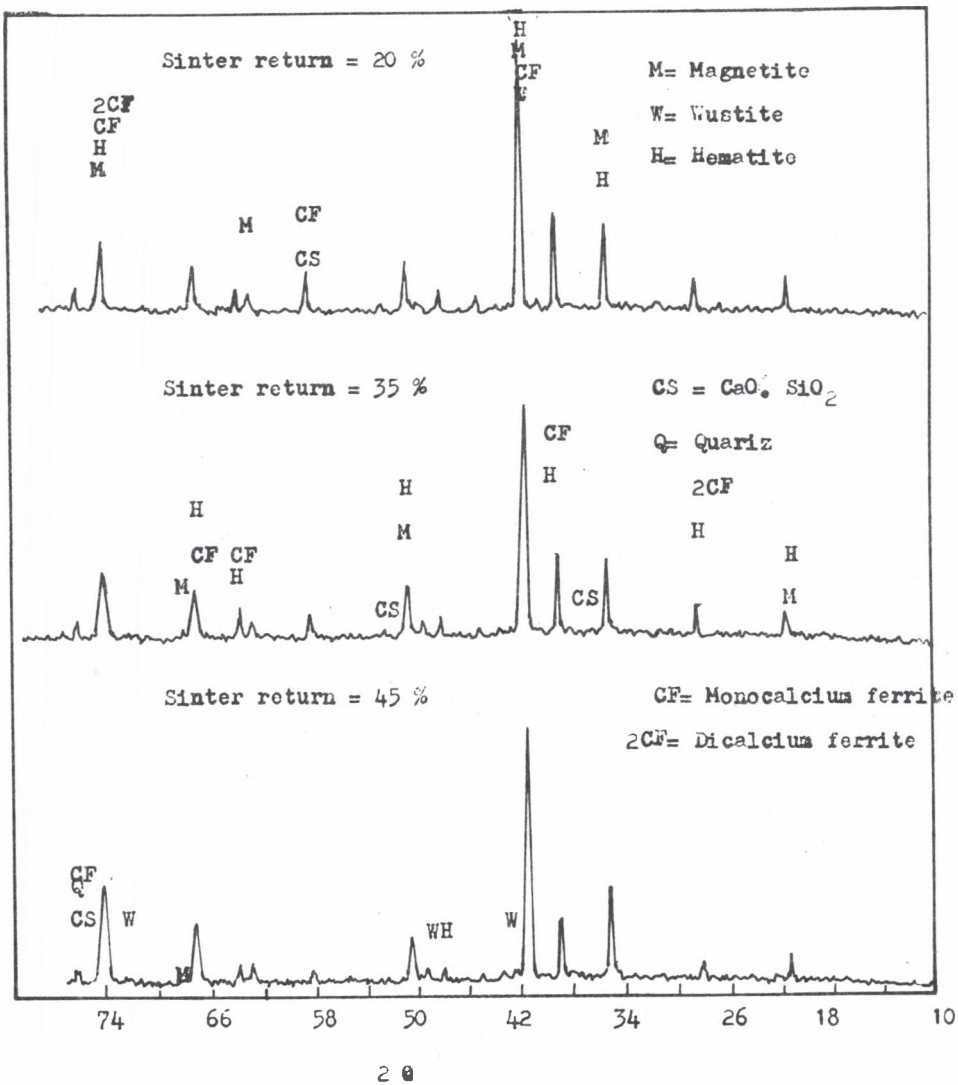

Fig.3. X-Ray diffractograms show the effect of amount of return sinter on the phases of sinter products

Rys.3. Dyfraktogram wpływu rodzaju spieku na skład fazowy spieku

Fig 3.12 shows the relationship between softening temperature and amount of sinter return in the produced sinter. From this figure it is clear that the softening temperature increased with the increase of amount of sinter return. This fact may be due to the decrease of porosity, increase of FeO [19] and may bealso due to the decrease in the glassy phase in the produced sinter [3,20,21]

X-ray diffractograms of the studied produced sinter (using different amount of sinter return) are shown in Fig.3 From this figure it could be seen that the main minerals of iron oxides are hematite α,γ Fe_2O_3, magnetite and wustite.

2. EFFECT OF IGNATION TIME ON THE TECHNICAL PROPERTIES OF IRON ORE SINTER

Fig 4. illustrates the relationship between the amount of ready made sinter (+7mm) , its strength , linear velocity of the sintering process, sinter productivity and the productivity at B.F. yard with the ignition time. From this figure it is evident that the increase of ignation time from one minute to 3 min . improved the amount of ready made sinter and its strength, this may be referred to a sufficient amount of heat which leads to complete the reaction between different minerals. [13]

As shown in Fig. 4 it is clear that the vertical velocity of the sintering process decreased from ~ 46 mm / min. to ~ 32.5 mm / min . when the ignation time increased from one min. up to three min. This fact may be due to the formation of more melt of the sintering charge.

Fig 2 shows also that the increase of ignation time, the productivity of sintering machine reaches maximum value ~ 47 t/ m^2.day at 2 min. beyond this value of the ignation time the productivity slightly decreased due to the decrease of vertical velocity of the sintering process . Also from Fig. 4. it is clear that the productivity at B.F yard increased up to ~ 37 ton / m^2. day at 3 min. of ignition. This is due to increase of the strength of the sinter.

Table (2) shows that the amount of FeO and Fe metal and the degree of metallization in the produced sinter increase with the increase of the ignition time. The increase in FeO, Fe metal and the degree of metallization may be due to the excess heat which is produced during the sintering process leads to the increase of the decomposition of Fe_2O_3 to Fe_3O_4 and FeO and Fe. This may be also due to the lower oxidizing potential of gas phase as compared with that atmospheric air, and to the lower sintering rate. [11] The amount of sulphur in the produced

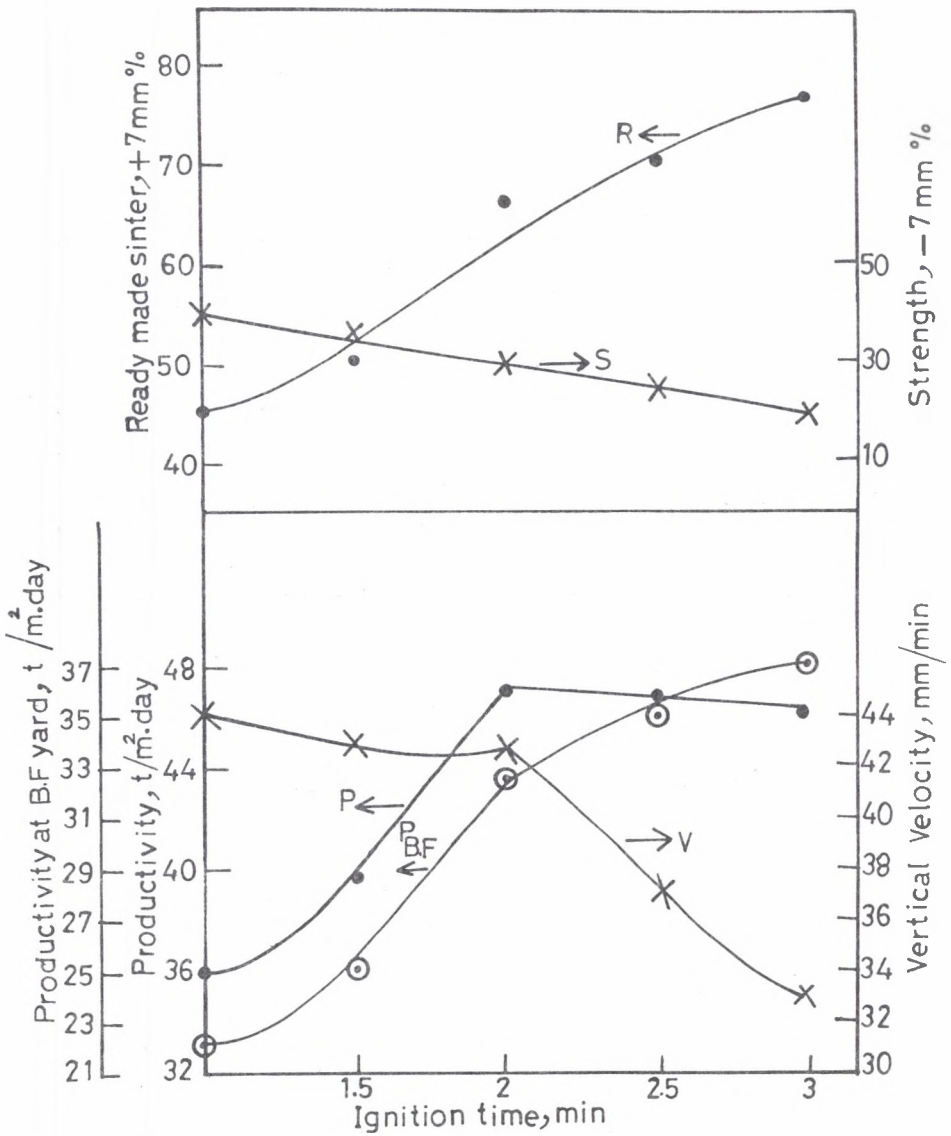

Fig.4. Effect of ignition time on the technical parameters of the sintering process
Rys.4. Wpływ czasu spieku na parametry procesu sipekania

sinter decreased with the increase the time of ignition up to 2 min. Table(2) This may be due to the favourable condition for desulphurization. The increase of ignition time more than 2 min. leads to a slight increase in the amount of sulphur. This may be due to the lower oxidizing potential of gas phase. [3,11,13]

Table 2

Effect of ignition time on the chemical composition of the produced sinter

Time of ignation,min	Chemical composition, %						
	Fe total	FeO	Fe_{metal}	SiO_2	CaO	S	Degree of metallization
1.0	52.8	11.32	0.80	8.48	9.67	0.128	1.50
1.5	53.6	13.21	1.20	8.42	9.60	0.120	2.20
2.0	53.4	14.41	1.25	8.30	9.54	0.088	2.30
2.5	53.2	16.21	1.30	8.45	9.69	0.090	2.40
3.0	53.6	19.17	1.40	8.50	9.70	0.100	2.60

Fig. 5 shows the effect of varying time of ignition of raw mix on the degree of reduction of the produced sinter. It indicates that the reduction degree was decreased as the time of ignition increased. This mainly attributed to the decrease of porosity of the sinter Fig . 5 and also due to the increase of FeO content (Table 2).

Fig. 5 shows also the relationship between the softening temperature of the sinter and the time of ignition of sinter raw mix. From which it is clear that as the time of ignition increased the softening temperature also increased.

X-ray diffractogram of the studied produced sinter when varying time of ignition are shown in Fig 6 From which it is clear that as the time of ignition increased the amount of wustite in the produced sinter increased . Also it is clear that the main minerals in the produced sinter are hematite, magnetite,calcium ferrite and calcium silicates.

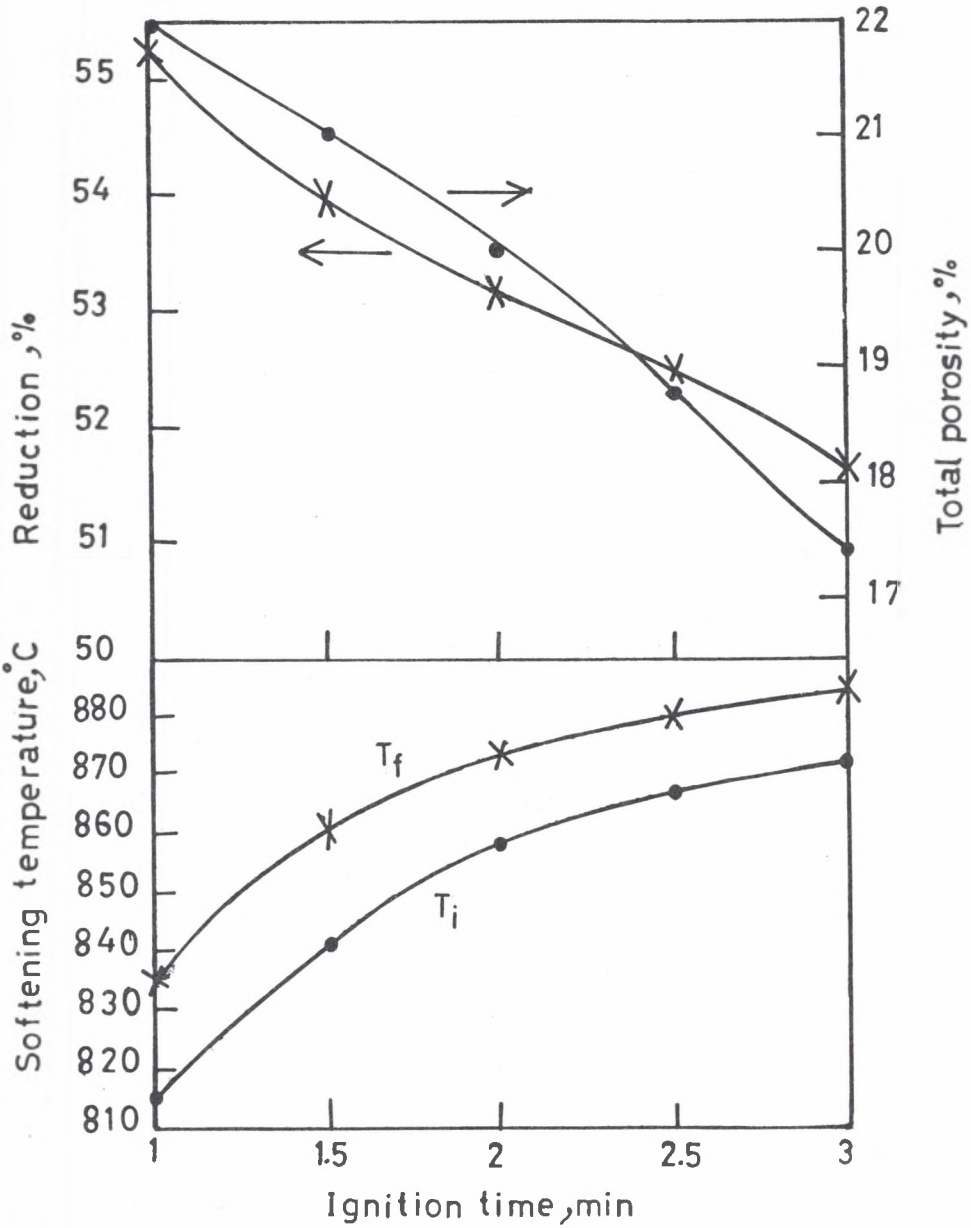

Fig.5. Effect of ignition time on the percent of reduction of the produced sinter, porosity of sinter and the softening temperature of the produced sinter

Rys.5. Wpływ czasu spiekania na parametry produktu

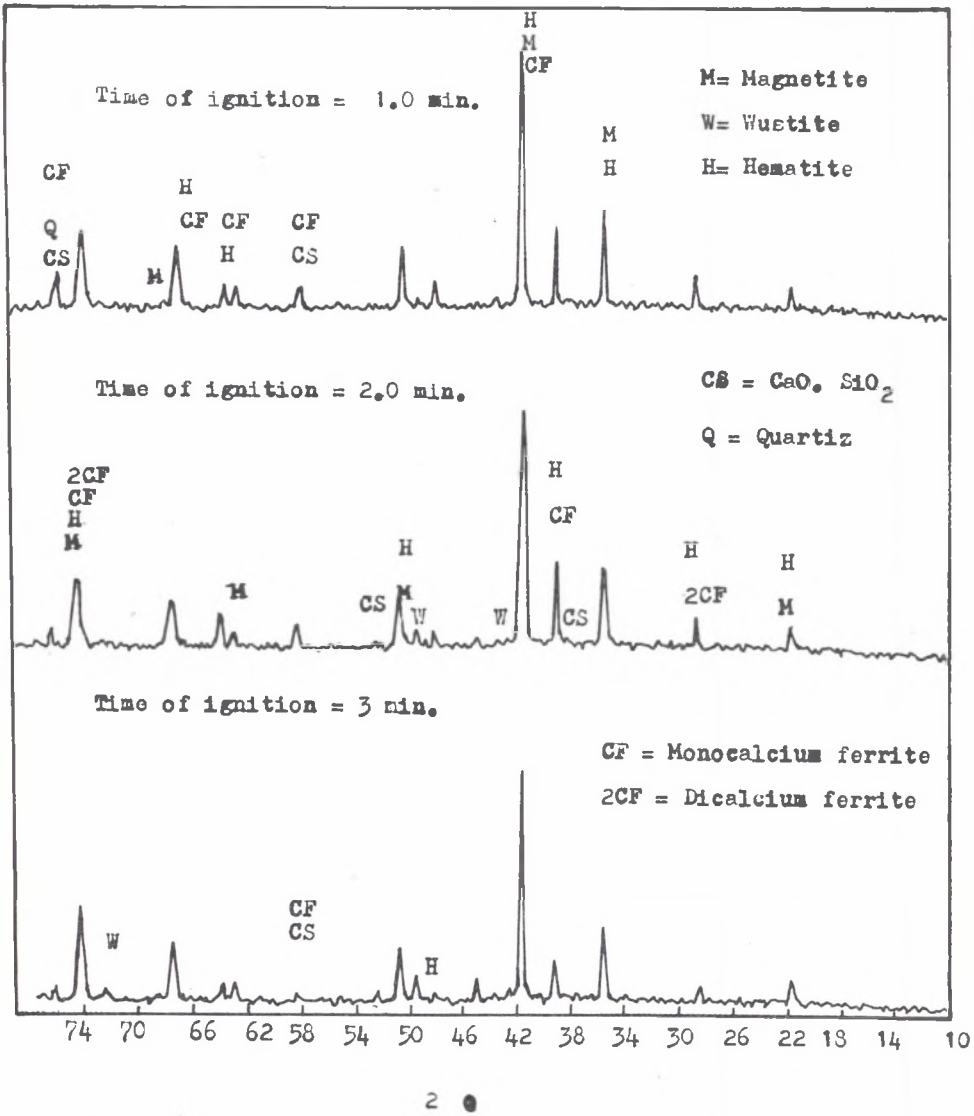

Fig.6. X-Ray diffractograms show the effect of ignition time on phases of the sinter products
Rys.6. Dyfraktogram wpływu czasu spiekania na skład fazowy

Conclustion

1) The return sinter addition on the raw mix and the time of ignation has a great effect on the technical parameters of the sintering process.
2) The optimum value of return fines added to the raw mix of Baharia iron ore ~ 35 %.
3) A decrease in the reducibility of produced sinter while increasing the amount of sinter return from to 50% is observed . This might due to the probable decrease in porosity and the increase of FeO.
4) The optimum ignation time of Baharia iron ore sinter = 3 min a t which the productivity at B.F. yard is higher.

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Recenzent: Doc. dr inż. Maciej Kowalewski

Wpłynęło do Redakcji 25.09.1996 r.

Streszczenie

Przebadano wpływ dodatku różnych ilości spieku zwrotnego i czasu zapłonu na uzysk, wydajność, wytrzymałość, reaktywność i własności technologiczne spieku wytworzonego z rudy żelaza ze złoża Baharia. Ustalono, że optymalny dodatek spieku zwrotnego wynosi 35% a optymalny czas zapłonu mieszanki 3 minuty.

Określono:

- wpływ ilości zawrotu spieku na parametry procesu spiekania.
- wpływ ilości zawrotu spieku na porowatość, temperaturę mięknięcia produkowanego spieku.
- wpływ rodzaju spieku na skład fazowy spieku.
- wpływ czasu spieku na parametry procesu spiekania
- wpływ czasu spiekania na parametry produktu.
- wpływ czasu spiekania na skład fazowy.