

Monitoring of Various Minerals of Flash Furnace Charge and their Impacts on Furnace Operation

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Abstract. One of the most common copper concentrate smelting furnaces is Flash smelting furnace which smelts over the half of the world's copper concentrates. The copper concentrate, air or oxygen enriched air and auxiliary fuel oil are charged into this furnace. Due to pyrolysis of copper concentrate, and reaction the decomposed products with oxygen intake, a large amount of heat release that causes the melting of copper concentrate. Since the copper concentrate, contains various minerals, and each of their reactions with atmospheric oxygen in the furnace creates certain conditions; by varying the percentage of minerals in the concentrate charged into the furnace, many problems are raised. In order to fix the problems, and also recognizing the proper actions at the time of changing minerals; within 6 months, inlet concentrate were mineralogically and chemically analyzed and the effect of concentrate minerals on-air and fuel consumption as well as the dust production were studied and The most appropriate concentrate which creates the best conditions in the Khatoon Abad Flash Furnace is obtained.

1.Introduction

Now a day, the Flash smelting process involves half of the copper production factory in the world. This process, which is an autogenously process, uses copper concentrate that involve sulfide minerals such as chalcopyrite, Covellite and pyrite and the like .Due to the charging sulfide copper concentrate, preheated air with 450 °C or oxygen-rich air and fuel to flash furnace with a temperature of 1250 °C; (because of concentrate reaction with oxygen the copper matte, slag, and sulfur dioxide exhaust gas will be produced.. In this process, matte molten droplets and slag are settled at the bottom of the furnace, where create the matte phase consists of a copper-rich phase and the slag phase consists of a silicon-rich phase. The exhaust gas containing sulfur dioxide with a temperature of about 1280 °C and some of the dust caused by the reaction of the concentrate with air, are transferred to the boiler for dust settling and reduce the off gas temperature and also produced steam in boiler will be send for various uses, oil & air pipes and etc.

However, it is important that how much(%) of each minerals must be in the concentrate until the furnace reach to the optimal conditions, because the combustion temperature of some minerals is low (Chalcopyrite and pyrite) and some minerals (Chalcocite) are very high and close to the furnaces operating temperature. This case Further can cause some problem in the melting process of the concentrate. Since using of different concentrate is one of the main advantages of the flash furnace, attended to the change concentrate minerals changing its necessary to adjust the furnace input in order to keep the furnace stable. Therefore, by performing chemical and mineralogical analysis of the



various concentrate and studying the furnace conditions, the most stable conditions were determined and by applying this information arrive to optimizing the combustion process in the furnace, improving productivity, reducing costs and protecting the environment.

2.Theory

According to table 1, the copper concentrate with 100% chalcopyrite, has a copper content of 35%, iron 30% and sulfur content of 35%. If the percentage of pyrite in the concentrate is increased, the percentage of copper in the concentrate decreases and the amount of iron and sulfur is increased.

Table 1. Comparison Of Concentrates Contain With Various Percent Of Mineral Chalcopyrite And Pyrite; And Its Effect On Air Consumption, Matte, Slag And Off Gas.(NM3: Normal Cubic Meter).
(Ton: Metric Ton, Equivalent 1000 Kilogram)

Table Head	Concentrate				Matte(Cu ₂ S,FeS)			Air consumption		Slag (FeO) ₂ SiO ₂		SO ₂ Gas	
	Ton	Cu	Fe	S	Ton	Cu: 51.6%	Fe: 22.6%	S: 25.8%	NM3	Ton	Fe	SiO ₂	NM3
CuFeS ₂ (100%)	100	35	30	35	67	35	15	17	76049	28	15	8	12168
CuFeS ₂ (80%) FeS ₂ (20%)	80 20	28	34	38	54	28	12	14	107536	39	22	12	17206
CuFeS ₂ (50%) FeS ₂ (50%)	50 50	17	39	44	34	17	8	9	154710	56	31	17	24754
FeS ₂ (100%)	100	0	47	53					233333	85	47	25	37333

For example, the concentrate include 50% Chalcopyrite and 50% pyrite have a copper content of 17%, iron 39% and sulfur 44%.

If desired, by concentrates with different minerals in the table (1) want to produce matte with constant copper grade (copper 51.6%, iron 22.6% and sulfur 25.8%); 100 tons of copper concentrate contain 100% Chalcopyrite needed 76049 Nm³ air that produced 67 tons of copper matte(It contain 35 tons of copper, 15 tons of iron and 17 tons of sulfur). If the copper concentrate contains 20% pyrite and 80% Chalcopyrite, then for the production of copper matte according to the table (1), required 107536 Nm³ air and produced 54 ton of copper matte(which produces 28 tons of copper, 12 tons of iron and 14 tons of sulfur). As it is known, when the amount of Chalcopyrite in the concentrate decrease and instead the amount of pyrite in the concentrate increase, the percentage of copper will decrease and the percentage of iron and sulfur in the concentrate will increase, which brings the following results:

A) for the production of matte with a specific grade (according to the table (1)) iron and sulfur burning need more combustion air (air consumption is indicated in the preceding paragraph and shown in table).

B) Sulfur burning of concentrate will increase with increasing of combustion air in flash furnace, and more SO₂ gas will be produced (according to the table (1), proportionally to increased pyrite, the SO₂ gas produced will be increased).

C) Because of dust mechanical conveying from flash furnace to boiler the rate of output dust from the furnace increase proportion to increase output gas,(increasing losses and reducing productivity).

D) Proportion to increase the furnace air consumption, increases the combustion iron of concentrate, and more silica(SiO₂) should be consumed in order to carry out slag treatment (Fe/ SiO₂ ratio in slag is

about 1.2), which results in more slag production (according to table (1) produced slag increases-increasing costs).

E) Since the slag is blocked some of the copper and exhausted from the furnace, with increasing slag production, the amount of copper losses in the slag will also increase (increasing losses and decreasing recovery).

3. Investigation Steps

According to the above, for investigate in effect of parameters such as concentrate copper grade and concentrate mineralogical composition on air consumption and dust composition; is evaluated the actual performance of the flash smelting furnace (which uses a preheated air of 450°C for concentrate combustion) on a monthly basis. Its complementary resources are as follows:

According to Figure 1 (a,b), proportional to increasing the percentage of chalcopyrite mineral in the concentrate, the percentage of copper in the concentrate increased and also proportional to increasing of pyrite mineral in the concentrate, the percentage of copper in the concentrate has decreased (copper content has a direct relation with chalcopyrite and has a negative relation with the amount of pyrite in the concentrate).

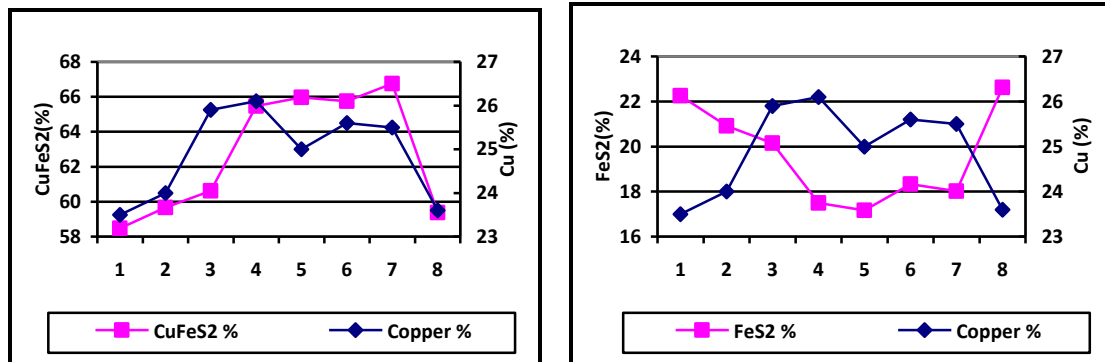


Figure 1. (a) Compar percentage of copper with chalcopyrite mineral in concentrate. (b) Compar percentage of copper with pyrite mineral in concentrate.

According to Figure 2(a), proportional to increasing the percentage of chalcopyrite mineral in the concentrate, the amount of air consumed per tone of concentrate by the furnace decreased (to product a certain grade of copper matte, air consumed with the percentage of chalcopyrite had a inverse ratio). Also, according to Figure 2(b), proportional to decreasing the percentage of pyrite, the amount of air consumed has decreased.

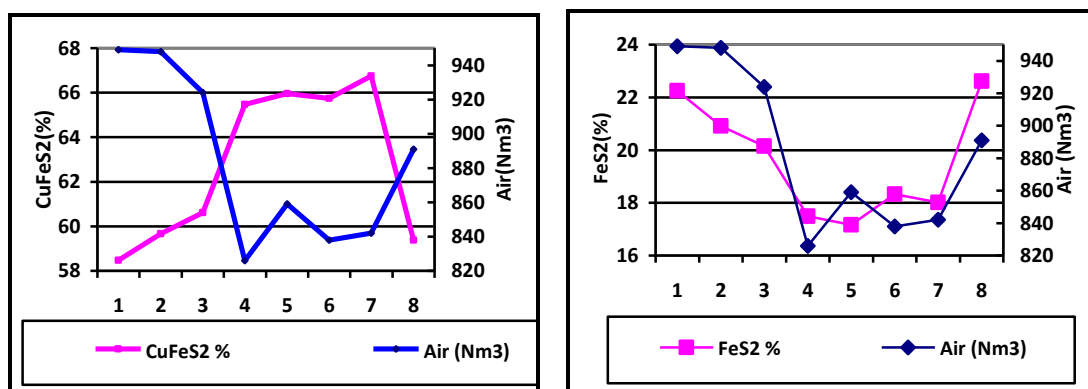


Figure 2. (a) Compar chalcopyrite mineral percentage in concentrate with consumed air. (b) Compar pyrite mineral percentage in concentrate with consumed air.

According to Figure (3), at the months that the concentrate had the highest copper percentage, the consumption air of flash furnace per tone of concentrate was minimal, and when the concentrate copper percentage was reduced, the air consumption has increased.

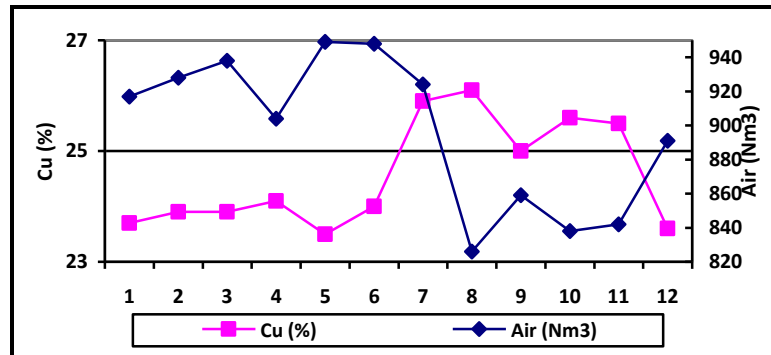


Figure 3. Compar copper percentage in concentrate with consumed air.

According to Figure (4), the dust production in months of flash furnace when low-grade copper concentrates are charged to the furnace is more than months when higher-grade copper concentrate are charged. so that is shown, when the concentrate with the highest copper grade(26.06%) is charging in furnace, The dust production was minimum by at least 12.6% and When the concentrate has the lowest grade (23.6%), the dust production is maximum (14.7%).

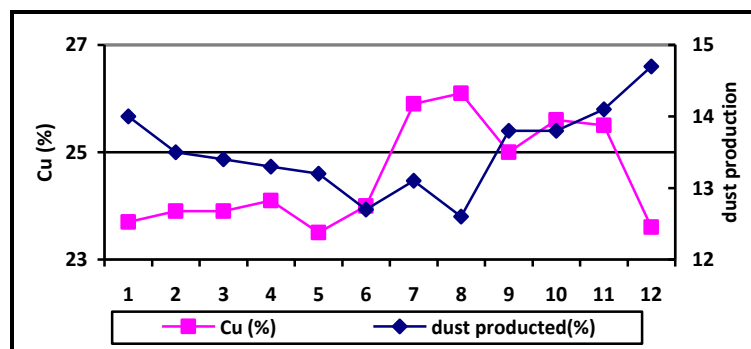


Figure 4. Compar copper percentage in concentrate with Dust production percentage.

According to figure (5), the dust production of the flash furnace associated with the air consumption.

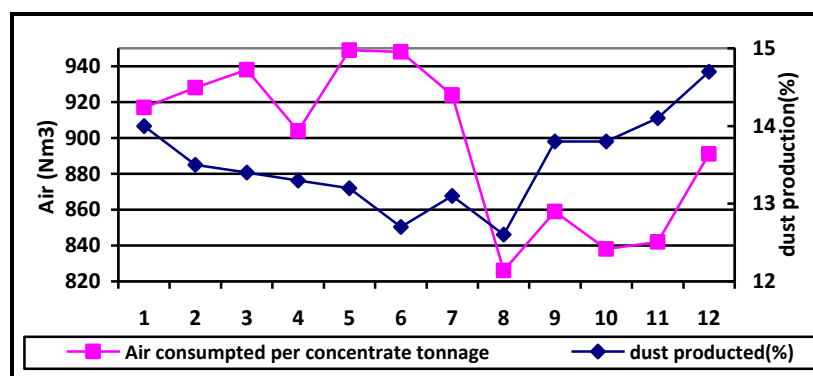


Figure 5. Compar air consumed per concentrator tonnage with Dust production percentage.

The amount of iron in the copper concentrate increases With increasing the pyrite, which requires iron more oxidation of the copper concentrate to produce the specific matte content. As a result of more oxidation of iron, more magnetite is produced in the furnace. With producing more magnetite created many problem such as separation between copper matte and slag in the settler of flash furnace.

4. Conclusion

The best performance of a Flash smelting furnace in addition to continuous and uniform smelting operations of copper concentrate, suitable separation of the matte and slag produced, is the time when, and also have the least amount of dust exhaust from the furnace, and the furnace output temperature (matte, slag and gas) is also appropriate. This matter is possible that a number of input and output factors of the furnace are controlled. According to studies and diagrams, the best performance of the Flash furnace is when the lowest consumption of the combustion air per ton of concentrate is entered into the furnace.

The lowest consumption combustion air was due to concentrates with higher chalcopryite and lower pyrite, that way the concentrate have higher grade of copper. So that the concentrate with higher copper grade consumes less air and produces less dust.

Chalcopryite and pyrite minerals are major minerals in copper concentrate, and higher percentage of copper at concentrate have more chalcopryite and less pyrite. At the same temperatures, Pyrite releases more heat energy than chalcopryite.

Therefore, to produce the matte with a specific percentage of copper, if the higher copper grade concentrate (due to the lower pyrite) are used, therefore the lower heat released. In this case, for complete the smelting operation in the furnace, it is necessary that when charging a concentrate with a higher copper grade, the heavy oil was increased (proportional to the heat released is lower) until there was no disturbance in the smelting operation of the concentrate.

Therefore, since the amount of heat released from the combustion of the heavy oil in the reaction shaft of Flash furnace is very high (compared to the heat released from the reaction of the air with the concentrate), the increase of the heavy oil in the reaction shaft of Flash furnace causes to accelerates the particle temperature of the concentrates, and smelting to be faster and also makes easier agglomerate of the molten concentrate particles. As a results, settling of the formation melting particles in the floor zone of the furnace increases, and the production of dust decreases.

Since a higher grade copper concentrate (than to lower grade copper concentrate) consumes lesser air for produce a copper matte with certain grade, it also consumes less silica and produces less dust; therefore, to reduce costs and better protect from devices and the environment, concentrates with high Percentage of the chalcopryite is more appropriate.

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