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Application of Custofloat® Carbonate Collectors in Beneficiating Phosphate Ores in China

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Abstract

Custofloat® 813 (CF-813) is a collector specially designed and manufactured by ArrMazz for reverse flotation of phosphate ores with carbonate impurities. It was used to process phosphate ores from several mines in China with great success. The paper will present the process flowsheets and flotation results of phosphate ores in three commercial beneficiation plants.

Key words: phosphate ore, carbonate collector, reverse flotation

Introduction

As one of the largest chemical suppliers for mining industry in the world, ArrMaz has made great efforts in designing, manufacturing and supplying highly efficient reagents for processing all types of phosphate ores. Based on the characteristics of phosphate ores in China, such as low P_2O_5 grade, high impurities, finely dissemination, etc., ArrMaz has developed a new carbonate collector, CF-813, for separating dolomite from phosphate through reverse flotation in acidic pH. It was used to process different types of ores from several phosphate mines in China, and satisfactory results were achieved. Three plant application examples were provided and discussed.

Flotation Results and Discussions

1. Phosphate beneficiation plant in Hubei Province

CF-813 was tested in a phosphate beneficiation plant in the capacity of 1.2 mt/a of phosphate concentrate. The feed rock was purchased from different sources and blended in the plant. The blend feed ore contains 24.5-27.0% P_2O_5, 3.5-4.5% MgO. The concentrate of the plant is used for manufacturing DAP. The MgO in the concentrate product is required to be lower than 0.6%. In the plant, H_3PO_4 is used as a phosphate depressant. The flowsheet includes one rougher and two scavenger flotation as shown in Figure 1.

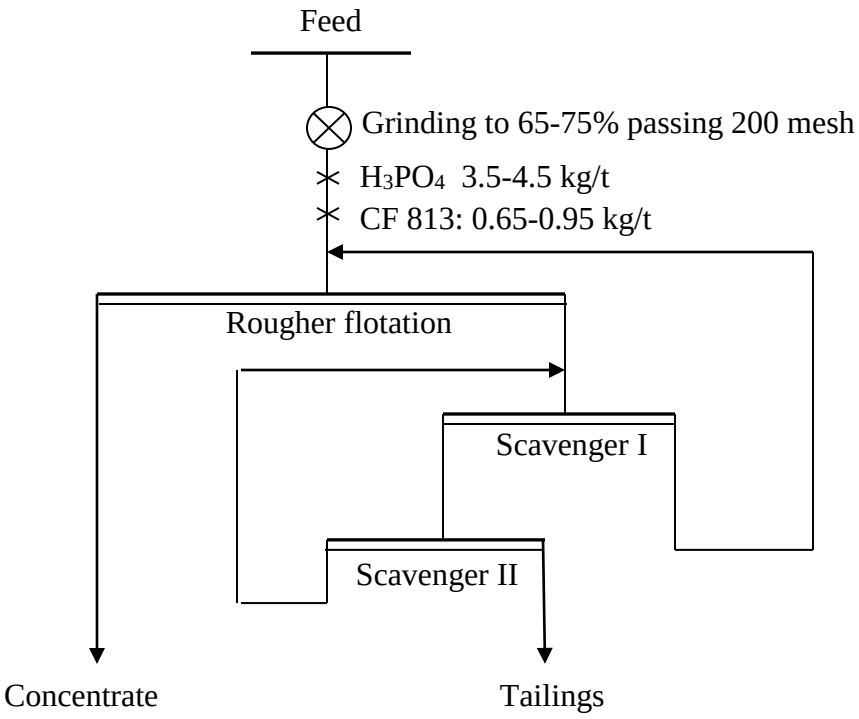

Figure 1. Flowsheet for processing phosphate ore in Yichang, Hubei Province

Table 1. Plant test performance of Yichang phosphate ore using CF-813

Date & time	Feed		Shift data		Conc. tank		Tail tank		Recovery (%)
	P_2O_5 (%)	MgO (%)	CF-813 (kg/t)	MgO (%)	P_2O_5 (%)	MgO (%)	P_2O_5 (%)	MgO (%)	
July 15, 2013									
16:00	27.13	2.49			30.16	0.40	3.00	12.56	98.77
22:00			0.69	0.21					
July 16, 2013									
02:00	26.41	2.56	0.69	0.39	30.36	0.46	2.87	16.10	98.44
08:00	26.64	2.66			30.04	0.40	1.53	17.55	99.32
10:00			0.63	0.34					
15:00	26.60	2.93			29.84	0.56	2.25	15.65	99.00
18:00			0.69	0.28					
July 17, 2013									
02:00	25.92	3.00	0.69	0.42	29.85	0.65	2.07	17.16	98.87
10:00	25.96	2.98	0.69	0.32	29.70	0.47	1.83	16.35	99.05
16:00	25.92	2.92			29.70	0.46	3.57	15.55	98.00
18:00			0.69	0.39					
July 18, 2013									
02:00			0.69	0.33					
08:00	26.33	2.92			30.10	0.40	3.98	15.72	97.81
10:00			0.69	0.30					
18:00	25.42	3.40	0.69	0.46	29.99	0.52	3.35	16.18	97.74
July 19, 2013									
08:00	25.8	3.44	0.69	0.55	30.10	0.44	3.60	15.00	97.74

The plant production data showed that CF-813 was successfully applied in plant scale for separation of carbonate impurities from phosphate by reverse flotation. At the dosage of less than

0.7 kg/t, the concentrate containing about 30% P_2O_5 and less than 0.5% MgO was obtained at the overall recovery of higher than 97%.

During plant test, it was found that appropriate froth depth was generated in flotation cell with homogeneous foam size and low viscosity. The overflow of concentrate thickener was recycled within the plant for grinding and flotation.

2. Phosphate beneficiation plant in Yunnan Province

The ore body has three recoverable phosphate beds. The average P_2O_5 grade is about 24%. The MgO content of the feed to the plant fluctuates widely, from 6.5% to 9.0%. The majority of the impurity is carbonate, such as dolomite, calcite, etc., and silica content is less than 2%. In order to obtain high grade concentrate from this high MgO ore, a very strong and selective carbonate collector is required.

In beneficiation plant, sulfuric acid was used as pH modifier and phosphate depressant. The process flowsheet involves one rougher and one scavenger as shown in Figure 2.

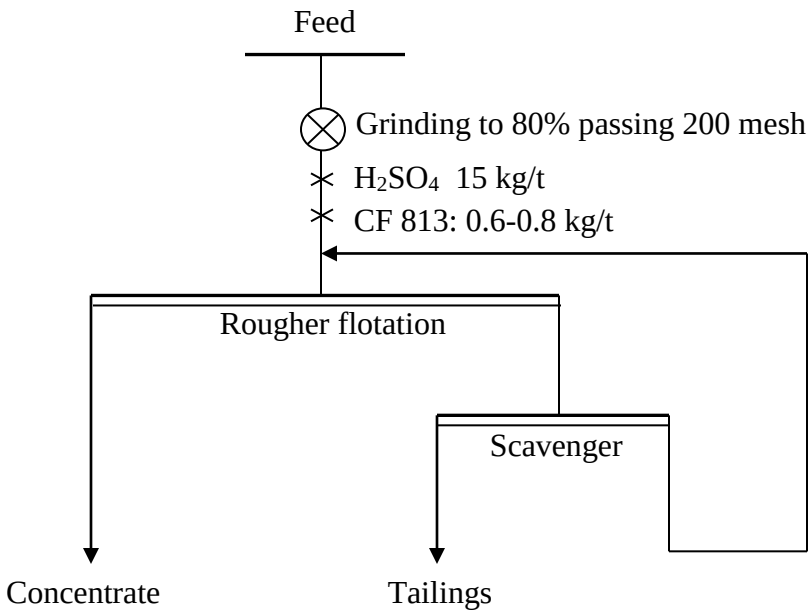

Figure 2. Flowsheet for processing phosphate ore in Yunnan Province

The feed rock to the plant had had a wide variation in MgO content. The plant flotation results with three different feed are summarized in Table 2.

Table 2. Plant flotation results of three phosphate ores in Yunnan Province

Ore body	Feed		Concentrate		Tail		Recovery	
	P_2O_5 %	MgO %	P_2O_5 %	MgO %	P_2O_5 %	MgO %	P_2O_5 %	MgO %
Ore A	26.79	5.90	36.93	0.86	5.11	18.59	93.92	10.43
Ore B	23.19	7.86	35.18	0.73	4.71	19.57	92.01	5.77
Ore C	19.14	9.18	33.62	0.88	4.44	22.15	88.49	5.85

The plant flotation results show that CF-813 is a very strong carbonate collector with good selectivity. The concentrate with less than 1% MgO and over 33% P_2O_5 can be obtained after one rougher and one scavenger flotation at relatively low consumption of CF-813 collector. The final P_2O_5 recovery can be 88.49 to 93.92%.

3. Phosphate Beneficiation Plant in North of China

There are abundant phosphate resources in China, but most of phosphate deposits are located in southern, western and central regions of the country. The feed ores processed by the phosphate beneficiation plant in North of China are supplied from different locations, such as Yunnan, Guizhou, Sichuan, Guangdong, etc., which leads to wide fluctuation in the characteristics as well as the floatability of feed rocks to the plant. In order to achieve stable operation performance without any change in the process, the carbonate collector used should have good adaptability to the characteristics changes of the feed rocks.

Sulfuric acid was used as pH modifier and phosphate depressant. The process flowsheet includes one rougher and two scavenger flotation. First scavenger float was combined with rougher float as final concentrate product, and second scavenger float was recycled to rougher flotation as shown in Figure 3.

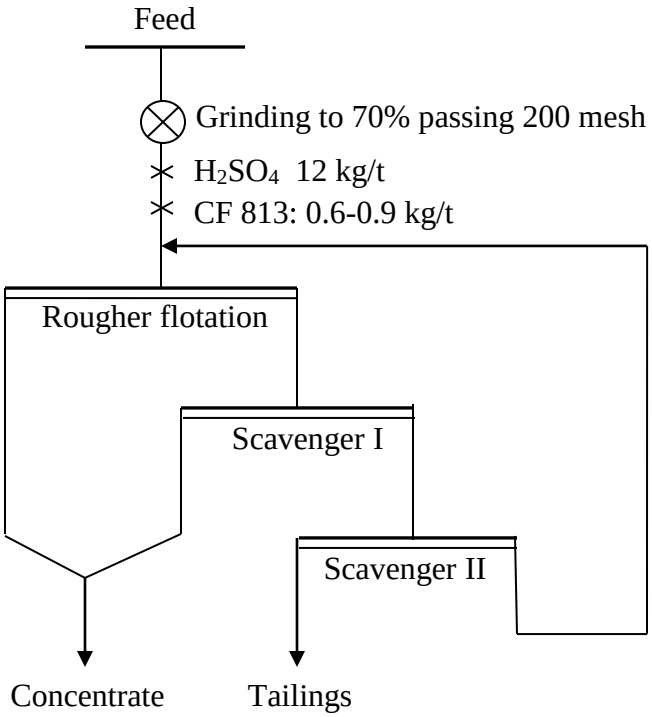

Figure 3. Flowsheet of the phosphate flotation plant in North of China

Although the characteristics of the feed rocks fluctuate due to the sources of supply, relatively stable production performances were achieved. The concentrate containing 30 to 32% P_2O_5, 1.1 to 1.5% MgO can be obtained at over 96% P_2O_5 recovery. The product can meet the requirement of downstream chemical plants. When the feed contained extra clay during operation, CF-813 worked well without any problem like high viscosity, voluminous foam, etc.

In order to demonstrate good adaptability of CF-813 carbonate collector to the variation of feed rocks, a series of laboratory flotation tests were conducted by blending the rocks of different sources at various ratios as flotation feed. One rougher flotation data was used to compare the separation performance with the flotation conditions shown in Figure 4. The flotation results of different feed are summarized in Table 3.

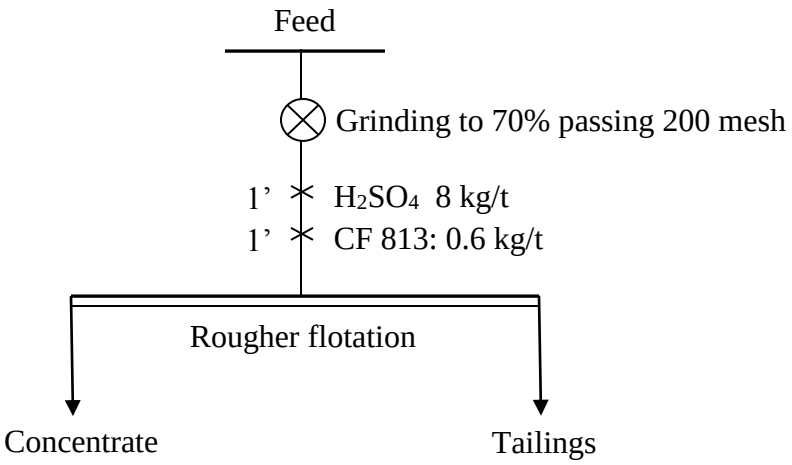

Figure 4. Laboratory flotation flowsheet for different feed

Table 3. Laboratory flotation results of different feed

Feed rock	Product	Wt	Grade, %		Recovery, %		Flotation
		%	P_2O_5	MgO	P_2O_5	MgO	efficiency, %
Yunnan:Sichuan:Guizhou 50:50:00	Conc.	80.03	29.45	0.57	92.75	13.14	12.72
	Tail	19.97	9.22	15.10	7.25	86.86	
	Feed	100.00	25.41	3.47	100.00	100.00	
Yunnan:Sichuan:Guizhou 30:50:20	Conc.	80.00	29.99	0.44	93.62	10.32	13.61
	Tail	20.00	8.18	15.30	6.38	89.68	
	Feed	100.00	25.63	3.41	100.00	100.00	
Yunnan:Sichuan:Guizhou 50:30:20	Conc.	80.35	29.42	0.69	94.23	15.47	13.87
	Tail	19.65	7.36	15.42	5.77	84.53	
	Feed	100.00	25.09	3.58	100.00	100.00	
Yunnan rock	Conc.	78.50	29.04	0.82	93.85	16.68	15.35
	Tail	21.50	6.95	14.96	6.15	83.32	
	Feed	100.00	24.29	3.86	100.00	100.00	
Sichuan rock	Conc.	82.39	31.48	0.76	93.19	19.52	10.81
	Tail	17.61	10.77	14.66	6.81	80.48	
	Feed	100.00	27.83	3.21	100.00	100.00	
Guizhou rock	Conc.	84.45	27.74	1.14	96.43	27.55	11.97
	Tail	15.55	5.57	16.28	3.57	72.45	
	Feed	100.00	24.29	3.49	100.00	100.00	

The flotation results in Table 3 demonstrate that CF-813 carbonate collector can be used to process the feed from different sources with good adaptability. After one rougher flotation,

acceptable phosphate concentrate can be obtained at high P_2O_5 recovery. During flotation test, it was also found that well mineralized froth layer was formed with homogeneous foam size, low viscosity and good flowability.

Conclusions

1. CF-813 has good adaptability to feed changes. It can be applied to process phosphate ores from different sources with satisfactory flotation performance.

2. CF-813 is a very strong carbonate collector with fast flotation rate. High quality phosphate concentrate can be obtained at low consumption.

3. CF-813 is a very selective collector for carbonate flotation. High P_2O_5 recovery can be achieved from different types of high MgO phosphate ores in plant operation.