Practise of large scale hematite ore beneficiation

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Abstract

Shandong Province Metallurgical Engineering Co., Ltd. (hereinafter referred to as M/s. SDM) acquired EPC contract of 5 MTPA iron ore concentrate project of Mobaraheh Sangan beneficiation plant in Iran. This is the first EPC project of M/s. SDM in beneficiation industry, and also the new achievement of M/s. SDM in the international market.

Introduction

M/s. SDM acquired EPC contract of 5 MTPA iron ore concentrate project of Mobarakeh Sangan beneficiation plant by bidding competition in 2013. M/s. SDM has undertaken basic engineering, detail engineering, equipment procurement, and construction management, etc. of this project and will finally hand over the complete iron ore beneficiation plant with normal running and qualified parameters to the client.

Raw ore conditions

The raw ores of Sangan beneficiation plant are from 3 mines. The raw ore conditions are shown in table-1. The feed of iron ore beneficiation production line is the selective mixture of iron ore-A, B and C of Sangan mining area near Khauf and Sangan, KHORASAN RAZAVI, Iran.

Table-1 Raw ores chemical analysis

Ore sample	Fe	FeO	Fe/FeO	S	MgO	CaO	Al_2O_3
Iron ore-A	41.86	10.57	3.96	0.98	1.3	4.8	14.72
Iron ore-B	42.4	18.1	2.34	0.3	1.7	13.7	Low
Iron ore-C	41.86	10.57	3.96	0.98	1.3	4.8	14.72

Raw ore conditions for design: TFe: 42%, S: 0.3~1.2%, FeO: 10~20%;

Max. feed size: 1200 mm;

Work index of ball mill: 11~17Kwh/t;

Work index of rod mill: 12.5~15.5Kwh/t.

Design indices

The product of beneficiation plant is iron ore concentrate required as feed for production of pellets of direct reduction quality. The design indices of concentrate and plant are shown in table-2 and table-3 respectively.

Table-2 Concentrate design indices

Concentrate design indices	TFe (%)	SiO2 (%)	P (%)	S (%)	MgO (%)	CaO (%)	Al_2O_3 (%)
Grade of concentrate	68.50	≤1.31	≤0.04	≤0.07	≤0.22	≤0.31	≤0.26
Size	P80=38μm, specific surface area: 1950cm^2/g						
Moisture content of concentrate	≤8.5%						
Moisture content of tailing	≤20%						

Table-3 Beneficiation plant design indices

Item	**Iron grade (%)**	**Output (t/h)**	**Yield (%)**	**Iron recovery (%)**
Raw ore	42.00	1390	100	100
Iron ore concentrate	68.5	740	53.24	86.83
Tailing	11.83	650	46.76	13.17

The annual raw ore handling capacity is 10.26 million tons. The annual concentrate output is 5 million tons and the annual tailing output is 5.26 million tons. The design proposal can satisfy the requirements of Iran national environmental protection regulation and various emission indices are designed as per the requirements of client.

The effective water saving and return water measures have been taken to satisfy the requirement of reducing water consumption put forwarded by the client. The water consumption for handling 1t raw ore is 0.2 t only.

Brief on beneficiation process flow

According to the properties of raw ore and the client's requirement on concentrate indices, M/s. SDM adopted advanced process of stage grinding, stage magnetic separation with magnetic suspension classificator and reverse flotation based on advanced design philosophy from previous design experience.

Based on the properties of raw ore, the raw ore handling capacity is 10.26 MTPA and the iron ore concentrate output is 5 MTPA. 1 No. gyratory crusher is adopted for coarse crushing. The raw ore feed size is ≤1200mm. The size after coarse crushing is ≤150mm. After crushing, the crushed material is transferred to beneficiation plant through belt conveyor and stacked on raw ore stock yard by cantilever stacker and then picked up by overhead bucket wheel reclaimer and transferred to raw ore intermediate bin.

The grinding & separation process is composed of two series with same configuration. The configuration of each series include stage grinding composed of ¢ 9.75×5m semi-autogenous mill, ¢ 6×12m stage-I ball mill and ¢ 6×12m stage-II ball mill; 5 stages of magnetic separation adopt ¢ 1500×4000mm magnetic separator. The last stage adopts magnetic suspension classificator. Considering the increase of magnetic sulfide mineral caused by the variance in raw ore mineral combination, the reverse flotation process is adopted for design to ensure that the sulfur index can satisfy the requirement (refer to Diagram-1).

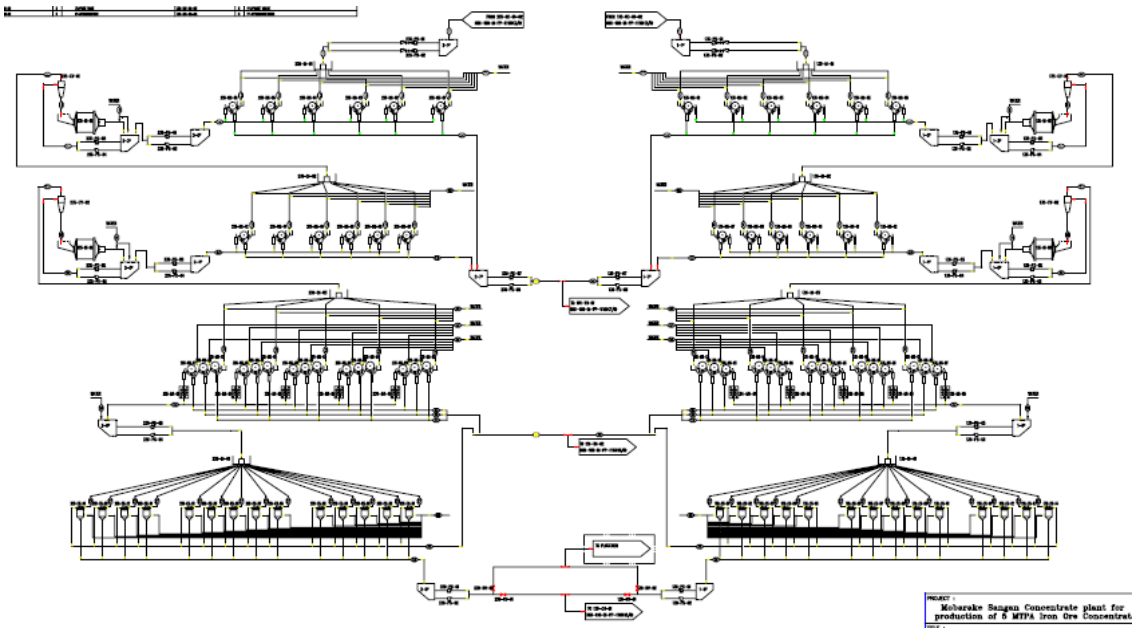

Diagram-1

The dewatering type of thickener with press filter is adopted for concentrate and the moisture content of concentrate is controlled below 8.5%. The dewatered concentrate is stored inside round silo having 110 m of diameter and the round stacker-reclaimer is provided inside for stacking and reclaiming.

The dewatering type of thickener with dewatering screen and press filter is adopted for tailing. The tailings with coarse particle from stage-I magnetic separation and partial tailings with relatively coarse particle from stage-II magnetic separation are entered into dewatering drum for direct dewatering. The moisture content of such tailings after dewatering is ≤16%. The other tailings with fine particle are entered into press filter after thickening by thickener. The moisture content of such tailings after dewatering is ≤20%.

The grinding & separation adopts 2 Nos. independent production lines. The raw ore handling capacity of each production line is 750 t/h. It adopts the process flow of stage grinding with stage magnetic separation and reverse flotation. Stage-I grinding adopts semi-autogenous mill and dewatering linear screen for classification. The feed size is F80=200 mm and the product grading qualified size is P80=1.2 mm. Stage-II grinding adopts ball mill and cyclone for classification. The feed size is F80=1.2 mm and the product grading qualified size is P80=0.18 mm. Stage-III grinding adopts ball mill and cyclone for classification. The feed size

is F80=0.18mm, and the product grading qualified size is P80=38 μm. The magnetic separation adopts 6 stages magnetic separation and the flotation adopts reverse flotation. The grade of concentrate is 68.5%.

The concentrate stock yard is one mechanized iron ore concentrate fines warehouse which is adopted to receive, handle, store and transport iron ore concentrate fines. It is provided with 2 Nos. round silos having 110 m of diameter and each silo can store 200,000 tons iron ore concentrate fines.

The iron ore concentrate is received from concentrate filtering workshop and conveyed to concentrate stock yard through belt conveyor and stacked inside silo through round stacker-reclaimer. The concentrate is taken onto belt conveyor through round stack-reclaimer and then conveyed to each consumer through belt conveyor.

Production capacity and working system

Design production capacity of annual iron ore concentrate output is 5 million tons and annual raw ore handling capacity is 10.26 million tons.

The working system is as follows.

Crushing: 300 days per year, 2 shifts per day, and 8 hours per shift; the equipment availability is 95%, the annual working time is 4560h;

Raw material stock yard: 300 days per year, 2 shifts per day, and 8 hours per shift; the equipment availability is 95%, the annual working time is 4560h;

Grinding & separation: 300 days per year, 3 shifts per day, and 8 hours per shift; the equipment availability is 95%, the annual working time is 6840h;

Concentrate filtering: 300 days per year, 3 shifts per day, and 8 hours per shift; the equipment availability is 95%, the annual working time is 6840h;

Concentrate stock yard: 300 days per year, 3 shifts per day, and 8 hours per shift; the equipment availability is 95%, the annual working time is 6840h;

Tailing thickening and press filtering: 300 days per year, 3 shifts per day, and 8 hours per

shift; the equipment availability is 95%, the annual working time is 6840h.

Major advanced technologies and equipments

Coarse crushing in semi-autogenous mill is adopted to decrease the process tache by utilizing the characteristics of semi-autogenous mill and improve grinding efficiency.

Picture-1 Semi-autogenous mill

Large-scale magnetic separation equipment is adopted to improve handling capacity of magnetic separation, concentrate grade and rate of recovery.

Picture-2 Φ1500×4000mm semi-reverse flow drum type magnetic separator

Advanced magnetic suspension classificatory, made in China, is adopted to ensure the production of high grade and superhigh grade iron ore concentrate.

Picture-3 Magnetic suspension classificator

High efficiency thickener and press filter is adopted to ensure 8.5% moisture content of concentrate directly conveyed to pellet plant for pelletizing. High efficiency tailing dewatering screen and press filter is adopted to handle the tailings with different size so as to ensure the lowest moisture content of tailing.