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Introduction of New Technologies in Sintering Machine Reinforcement

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Abstract

In July 2009 and February 2019, the New No. 1 and New No. 2 blast furnaces at Nippon Steel Corporation Wakayama Works were blown-in after the No. 4 and No. 5 blast furnaces as an investment in upgrading the upstream processes. In order to meet blast furnace requirements on sinter quantity, we reinforced the existing No. 5 sinter plant in January, 2009. The enhanced granulation process was designed to treat fine ores, and we also developed a new sinter cooler and installed a Dry DeSOx, DeNOx removal system for local environmental demands.

1. Introduction

The Nippon Steel Corporation Wakayama Works constructed, as an investment in upgrading the upstream process, the New No. 1 and the New No. 2 blast furnaces, and started operation in July 2009 and in February 2019 respectively to shift the production system from the No. 4 and No. 5 blast furnaces. As a result of the upgrading, the annual crude steel production was expanded from 3.80 million tons to 5.0 million tons. With respect to the sinter plant, in January 2009, the production capacity of the existing No. 5 sinter plant was expanded together with the installation of a new sinter machine to cover the production amount required by the new No. 1 and the new No. 2 blast furnaces, and a new type sinter cooler, and an exhaust gas desulfurization and denitrification system for regional environmental conservation were installed. The outline of the upgrading is described hereunder (**Fig. 1**, **Table 1**, **Table 2**).

2. Concept of Production Capacity Expansion

A new sintering machine and a cooler were newly installed utilizing the existing raw material supply system, product conveying system and the exhaust gas system of the existing No. 5 sinter machine (**Fig. 2**, **Fig. 3**, **Fig. 4**, **Fig. 5**). The annual production capacity expansion by 2.40 million tons was planned to achieve 5.0 million tons on a crude steel basis in the final stage of the investment for the upgrade of the upstream production system and to cover the then existing sintering capacity deficiency.

The Mosaic Embedding Iron Ore Sintering process (MEBIOS) was employed as a new major technology to cope with the possible future need for the use of fine ore in a great quantity in operation, and the selective granulation system consisting of an Eirich mixer and a pan pelletizer was introduced (**Fig. 6**[1], **Fig. 7**). Furthermore, upon implementing the upgrade, an exhaust gas treatment system for environmental conservation, and a new type circular cooler capable of suppressing the dust emission and recovering waste heat simultaneously and effectively were introduced. Thus the target of the sinter plant was global environmental conservation.

3. Countermeasures for Environmental Conservation

3.1 Countermeasures to suppress cooler dust emission

Upon selecting the cooler type, the circular table type was selected from the viewpoint of saving space. Furthermore, in the air flow through the high height thickness layer that lets in air by suction at the bottom layer and lets the air out by suction at the top layer, the cooling air from the side louver forms a heat transferring region over the entire area wherein the cooling air flows uniformly in a counter flow manner without causing any dead air, and exchanges heat uniformly with the hot sintered ore. Then, the reduction of the cooling air volume and the production of super-heated steam became possible. Owing to the complete suctioning of the entire air by an induction fan, the emission of dust to the neighborhood of the cooler became nil, and the exhaust gas after the recovery of the waste heat was discharged through the bag filter or returned to the sinter machine. Thus, the emission of dust to the open air is prevented.

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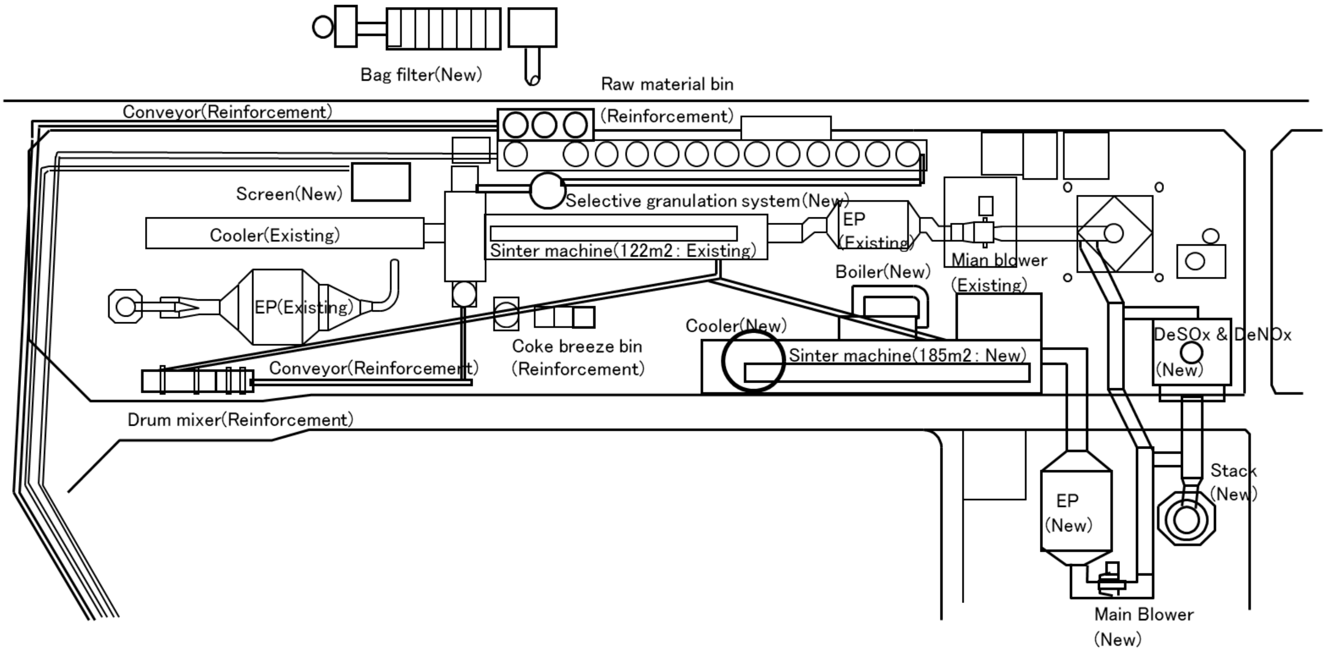


Fig. 1 Layout of Wakayama Works No. 5 sintering plant

Table 1 Contents of reinforcement

Newly-established part	Sinter machine (185 m^2), Cooler, Screen & crusher, Waste gas EP, DeSOx & DeNOx, Stack, Boiler, Selective granulation system, Bag filter, Main blower
Reinforcement part	Raw material bin, Coke breeze bin, Drum mixer, Conveyor

Table 2 Specification of main equipment

			4DL	5DL	
				5-1 (Existing)	5-2 (New)
Sinter machine					
	Capacity	t/24 h	9500	5200	6800
				12000	
	Pallet dimension	m	3.70 × 1.0	2.48 × 0.8	3.70 × 1.5
	Number of pallet		208	151	97
	Grate area	m^2	260	121	185
	Number of wind box		23	21	17
	Main blower	kW × kPa	8500 × 17.7	5800 × 15.7	6200 × 18.1
Cooler					
	Type		Semi-strand and subsidiary cooler	Straight	Circular table
	Dimension	m	2.0H × 5.8W × 2.0L	3.0W × 61.0L	18.0D × 4.0H
	Exhaust gas temperature	°C	420	400	360–410
Mixer					
	Primary	m	3.7D × 15L	4.3D × 11.6L	
	Secondary	m	3.7D × 15L	5.1D × 25.0L	
Selective granulation system					
	Type		Eirich + Drum	Eirich + Pan pelletizer	
	Capacity	t/24 h	120	150	

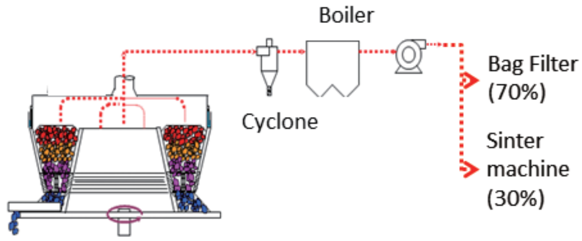


Fig. 2 Exhaust gas flow of circular cooler

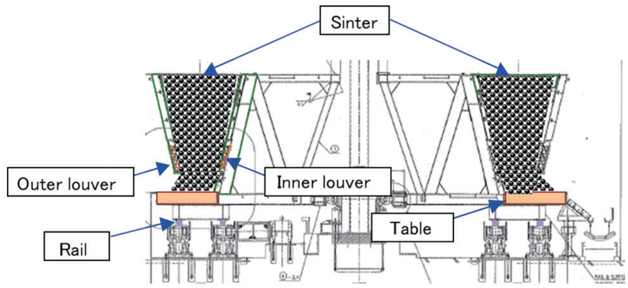


Fig. 3 Cross section of cooler

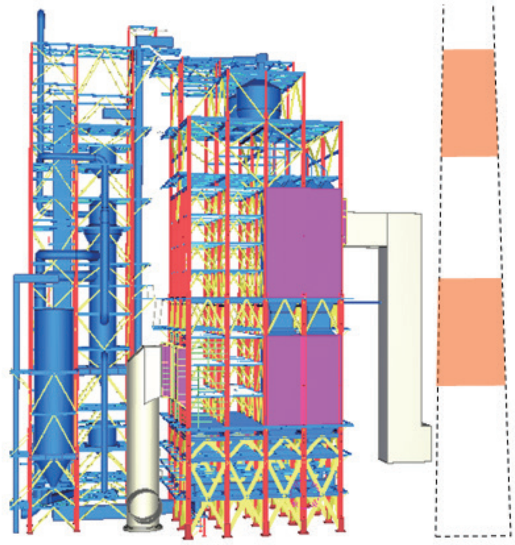


Fig. 5 General view of DeSOx, DeNOx system

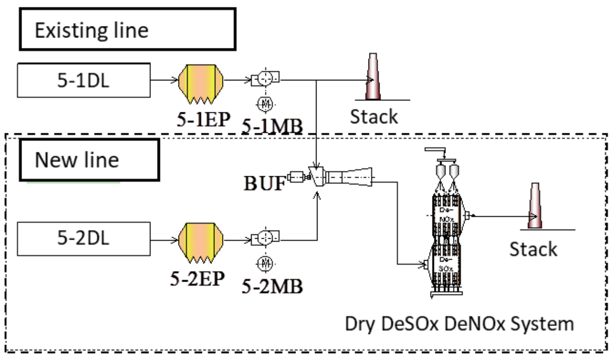


Fig. 4 Exhaust gas flow of No. 5 sintering plant

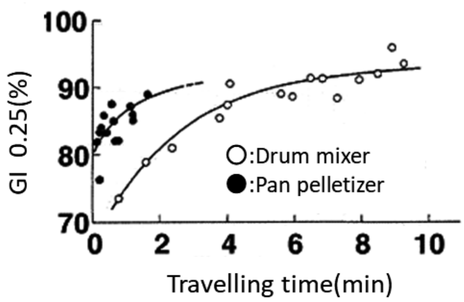


Fig. 6 Comparison of granulation index (GI) between drum mixer and pan pelletizer[1)]

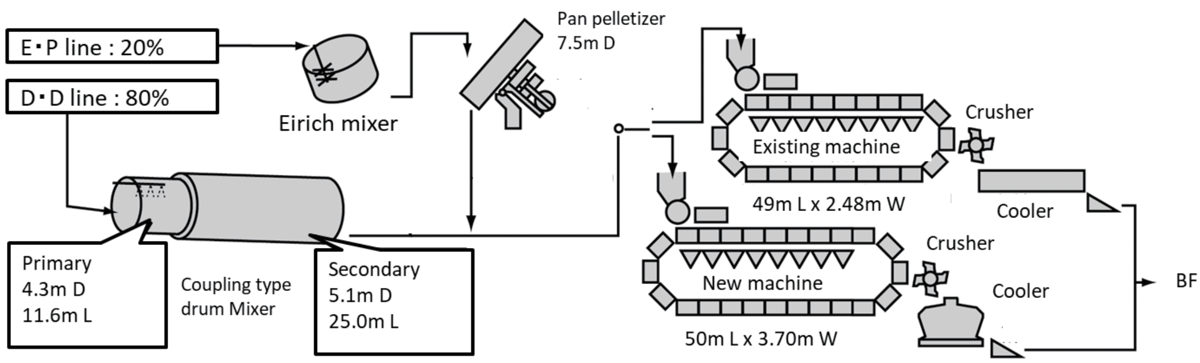


Fig. 7 Granulation flow of No. 5 sintering plant

3.2 Exhaust gas treatment system

As an investment in regional environmental conservation, an exhaust gas treatment system of the activated coke type capable of achieving a desulfurization rate of 80% and a denitrification rate of 70% was introduced. To enhance the denitrification rate and to achieve the highest level denitrification rate in the sinter exhaust gas treatment, a two-staged adsorber for desulfurization and denitrification was installed, and the system of adding ammonia to the desulfurized exhaust gas was employed. The sulfur adsorbed by the activated carbon is separated in the form of SOx rich gas (SRG) of about 20% concentration by heating the activated carbon at 450°C, and the gypsum that is formed by the wet type lime-gypsum desulfurizing equipment is recovered.

4. Reinforcement of Granulation

In order to enhance productivity, enhancement of the raw material layer permeability and reduction of the ungranulated fine ore are important. In addition, to cope with the foreseen future increase in fine ore material, a selective granulation system was introduced. Upon studying the equipment specification, the capacity was determined based on the information[2)] that, by the MEBIOS method, the permeability of the raw material layer is enhanced by mixing the pseudo particles of sizes larger than those of the conventional pseudo particles by 20% of the entire raw material, and a pan pelletizer was selected wherein the rotating velocity of the material is high and the granulating characteristic is excellent (**Table 3**).

5. Construction Process

The construction work was started in August 2006. The installation of the new equipment and the reinforcement work were carried out while maintaining the operation of the existing No. 5 sinter machine, and were completed in January 2009 after the trial run that started in October 2008. Then, the operation of the existing No. 5 sinter machine was suspended, and the renewal work for aging deterioration was carried out until the end of April. Upon reinforcing the material conveying line system and the drum mixer, the operation of the existing No. 5 sinter machine was suspended for 15 days to carry out the combining work.

Table 3 Specification of selective granulation system

		Eirich mixer	Pan pelletizer
Capacity	t/h	150	150
Dimension	m	2.3	7.5
Motor power	kw	132 (Agitating)	250 (Pan)
Rotation	rpm	13	5–9
Angle		20°	45°–60°
Travelling time	s	60	300

Table 4 Operation result of DeSOx DeNOx system

			Catalog	Result
Dry DeSOx DeNOx system				
	DeSOx	%	80	98
		ppm	≦ 39	≦ 30
	DeNOx	%	≧ 70	80
		ppm	≦ 68	≦ 50
	Dust	mg/m^{3}N	≦ 40	≦ 40
	DXNs	TEQ-m^{3}N	≦ 0.1	≦ 0.1
SRG-DeSOx				
	DeSOx	%	≧ 95	98

6. Commissioning

6.1 Operation state

After the commissioning in January 2009, the 5-2 sinter machine maintains a daily production of 6800 t/d or more (production rate 36.8 t/m^2). In addition, the sinter cooler achieved a recovery rate of 80 kg/t-s of super-heated steam, and has achieved a large energy-saving effect. Further, after the commissioning of the New No. 2 blast furnace in February 2019, the No. 5 existing sinter machine together with the new sinter machine continue to produce 12000 t/d as planned initially.

6.2 Commissioning of exhaust gas treatment system

When the in-plant activation of the activated coke in the adsorber was completed after the start of the exhaust gas passage, the performance of the system when the system processed all of the waste gases of the simultaneously operated existing 5-1 sinter machine and the newly installed 5-2 sinter machine was examined (**Table 4**). The suppression of the increase of the NOx discharge due to the expansion of the production of the blast furnaces and the sinter plant was crucial for this system. Regarding this issue, by employing a two-staged adsorber of the desulfurization adsorber and the denitrification adsorber, the stabilized denitrification became possible, and the actual denitrification efficiency of 80% for the initially planned 70% was obtained. Furthermore, the reduction of the operation cost similar to that of ammonia blowing was realized. In addition, the efficiencies of the desulfurization adsorber and the SRG desulfurization equipment exceeded the respective planned values, and the achievement of the required performance in both items was confirmed.

6.3 Effect of selective granulation equipment

The effect of the pan pelletizer on the granulation effect was examined when fine iron ore was added (**Table 5**, **Fig. 8**, **Fig. 9**). The true grain of −1 mm in size occupied an approximately 60% share. The pseudo particle of −1 mm in size dropped to a 2.7% share, being granulated by the addition of moisture, stirring and mixing in the Eirich mixer, and the granulation by the pan pelletizer. Further, the share of +2 mm increased and the mean grain size grew, and

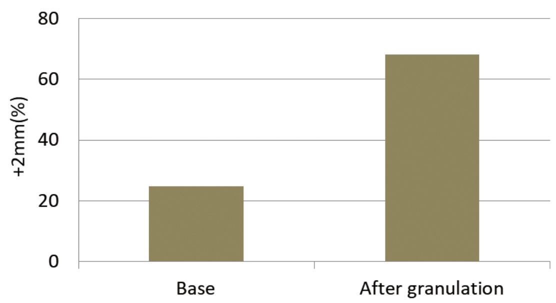


Fig. 8 Grain size of pseudo particle (+2 mm)

Table 5 Measurement result of pseudo particle

	+2 mm (%)		−1 mm (%)		Mean size (mm)	Moisture (%)
	True particle	Pseudo particle	True particle	Pseudo particle	Pseudo particle	
Before granulation	17.4	24.8	74.3	64.9	2.0	5.5
After granulation	29.4	68.2	64.6	2.7	4.1	10.2

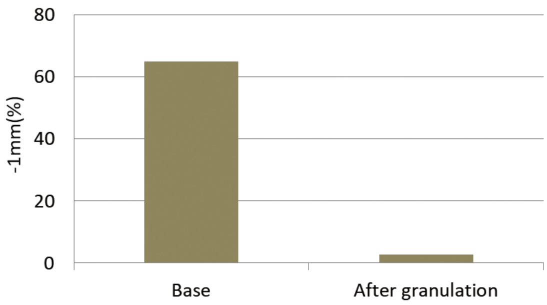


Fig. 9 Grain size of pseudo particle (−1 mm)

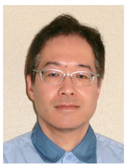
thus it was confirmed that the granulation equipment is effective for the operation that uses fine ore in a large quantity, compelled by the deterioration of the resource ore quality.

7. Conclusion

As a part of the new investment in the upgrade of the upstream production system, the reinforcement work of the No. 5 sinter plant was conducted. After the commissioning, while corresponding to the use of fine ore, the sinter machines maintain a production rate of 36 t/m^2 or above, and the new type sinter cooler and the exhaust gas treatment system introduced to address regional environmental conservation are also working smoothly.

References

1) Suzuki et al.: Tetsu-to-Hagané. 73, 1932 (1987)
2) Kamijo, C., Matsumura, M., Kawaguchi, T.: ISIJ Int. 45, 544 (2005)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