ISSN 2176-3135

EXPERIMENT RESEARCH ON UTILIZATION OF PARTICLE BIOMASS FUEL IN SINTERING PROCESS[1]

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Abstract

Biomass energy is the most abundant resource in the nature and it can be regenerated. Its sulphur content and ash content is lower, and its hydrogen content is higher than coal. It is one of the important energies which human depend on it to survive. Particle biomass fuel is a kind of solid fuel made by biomass material, with many advantages, such as high efficiency, clean molding, easy ignition, and low carbon dioxide emission, etc. It can replace other fossil fuels and can be used in the civil fields, such as cooking, heating, and other industrial fields, such as boiler burning and power generation. In this paper, the idea that particle biomass fuel is added into sintering production is presented. At the laboratory conditions, Φ 200 mm × 600 mm pot grate tests were carried out for three particle biomass fuel ratio (0%, 0.3%, 0.5%) respectively, vertical sintering speed were measured, they are 28.57 mm/min, 17.91 mm/min and 17.65 mm/min. Sinter metallurgical property were compared, reductive degree index are 65.72%, 81% and 83%, tumbler index are 70.13%, 51.03% and 50.87%, reduction degradation index (RDI + 6.3 mm) are 37.7%, 25.42% and 24.88%. The results show that it is difficult to use native biomass fuel in sintering process, Because it is easier to absorb more water, this leads to water content in the mix material higher than raw material, bed permeability is decreased, sintering speed is lower, the strength of sinter is decreased, but reduction degree index is higher. In the future biomass fuel carbonized will be further studied in sintering process.

Key words: Particle biomass fuel; Sintering; Bed permeability; Metallurgical property.

[1] *Technical contribution to the 6th International Congress on the Science and Technology of Ironmaking – ICSTI, 42nd International Meeting on Ironmaking and 13th International Symposium on Iron Ore, October 14th to 18th, 2012, Rio de Janeiro, RJ, Brazil.*

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ISSN 2176-3135

1 INTRODUCTION

Biomass is changed from carbon dioxide and water to various organism through photosynthesis, that is organic matter which can be renewable and recycled. From a biological angle, biomass is made from lignin, cellulose and hemicellulose, and from a physical and chemical Angle, biomass is made from combustible mass, inorganic substances and water, it contains Carbon, Hydrogen, 0xygen, a small amount of Nitrogen, Sulfur .etc elements, and ash and water. Biomass is a kind of clean and renewable energy, because its sulfur content , nitrogen content and ash is lower, after burning sulphur dioxide, Nitrogen oxide and dust emissions is lower than fossil fuels. At the same time, biomass has the characteristics of zero emission for carbon dioxide on the ecological environment.
The biomass energy has been one of the important energy for humans survival ,it is the most popular kind of renewable energy on the earth, its quantity is second, just less than coal, oil, and natural gas. At present, the utilization of biomass resources is only 4% of its total quantity, it has great potential in the future. Development and utilization of biomass resources is of great significance, it can promote the development of social economy and the improvement of the ecological environment.
Since the 1970 s, the development and utilization of biomass energy is paid close attention by governments and scientists around the world, the work mainly concentrated on the biological diesel oil, fuel ethanol, solid molding fuel and biomass power generation/heating, etc. The research on biomass in metallurgical industry has just started. A new technology was applied to increase the reaction surface of metal burden in Brazil CSN company, it can control the permeability of sinter by adding microporosity nuclear forming agent (wood grain coal). In this paper an idea that adding particle biomass fuel into sintering raw materials is presented. and the preliminary experimental research is carried on, this method will be good for reducing the costs of sintering raw material and save energy, it have the important meaning for steel enterprise to realize high yield, good quality and low cost, and will benefit for environmental protection.

2 MATERIALS AND METHODS

2.1 Raw Materials

All kind of raw materials and their composition are shown in Table 1 and Table 2.

Table 1. Chemical composition (weight %) of raw material, %

type of material	TFe	FeO	H_2O	SiO_2	CaO	MgO	S	Ig
outsourcing concentrate	67.51	9.00	8.62	3.12	0.25	0.13	0.028	0.32
produced concentrate	65.14	7.55	9.50	5.82	0.31	0.22	0.087	0.72
return sinter	57.80	7.35	0.41	5.33	11.05	2.22	0.027	0.30
imported ore	64.51	0.40	15.05	4.00	0.11	0.15	0.005	1.46

Table 2. Chemical composition of fluxes, %

commodity	SiO_2	CaO	MgO	S	MnO	H_2O
quicklime	2.98	71.36	2.70	0.170	0.08	0.01
magnetite	2.21	1.29	45.88	0.016	0.19	2.12
limestone	3.00	53.28	2.12	0.069	0.15	1.7

The main component of particle biomass fuel is larch sawdust, its composition is shown in Table 3.

ISSN 2176-3135

Table 3. Particle biomass fuel composition, %

	moisture	ash	volatile	fixed carbon
larch	7.63	1.01	85.55	14.75

Figure 1. Particle biomass fuel.

2.2 Experimental Scheme

At the laboratory conditions, Φ200mm×600mm pot grate tests were carried out, raw material quantity is about 35~40 kg, layer height is 500 mm, particle biomass fuel added ratio is 0%, 0.3% and 0.5% respectively, the experimental scheme is shown in Table 4. the raw material in sintering pot is lightened up by gas, ignition time is 120 second, ignition suction is 8kPa,sintering suction is 11kPa,sintering bed charge height is 10mm.

Table 4. Blending ratio of sintering raw materials, kg

	domestic concentrate	outsourcing concentrate	imported ore	return sinter	quick lime	lime stone	magnetite concentrate	coke fine	added biomass fuel, %
1	14.52	7.00	3.50	2.8	2.1	2.17	1.4	1.4	0
2	14.52	7.00	3.50	2.8	2.1	2.17	1.4	1.4	0.3
3	14.52	7.00	3.50	2.8	2.1	2.17	1.4	1.4	0.5

2.3 Experimental Equipment

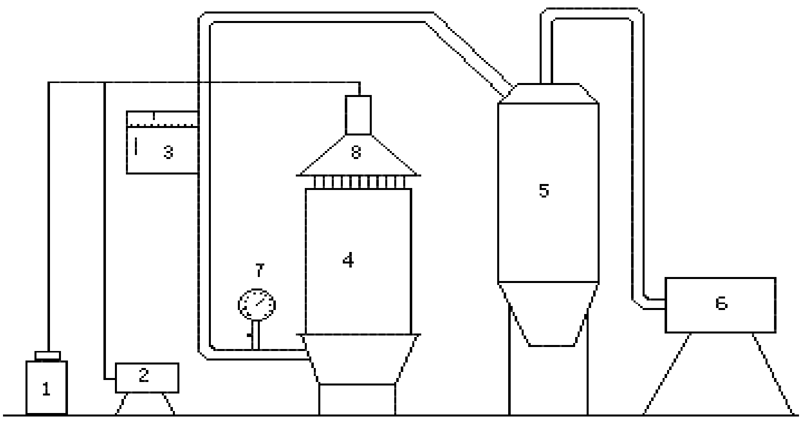

Figure 2. Sintering equipment diagram (1-ignition gas; 2-combustion fan; 3-thermotetric instrument; 4, sintering pot; 5-dust collector; 6- main exhaust fan; 7-draught gauge; 8-ignition burner).

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3 RESULTS AND DISCUSSION

3.1 Sintering Technological and Economic Indexes

Table 5. Sintering technological and economic indexes

experiment number	vertical sintering speed/mm·min^{-1}	End-point time/min	burning loss ratio, %	production yield, %	utilization coefficient, t/m^{-2}·h^{-1}	tumbler index, %	mixture water, %
1	28.57	21	14.53	44.56	0.27	70.13	5.4
2	17.91	33.5	18.52	35.42	0.23	51.03	5.6
3	17.65	34	12.42	34.6	0.13	50.87	6.0

From Table 5, it is known that with the increasing of biomass particle fuel, the water amount will increase, the water content in mixture is higher than base mixture, water content increases from 5.4% to 6.0%, because there isn't preheating measures, overmoisten phenomenon is heavier, this makes the permeability of bed poorer, the resistance in bed is increased, vertical sintering speed is reduced from 28.57 mm/min to 17.65 mm/min, sintering time increases from 21 min to 34 min. At the same time, because sintering reaction isn't sufficiently, some raw material in sintering pot doesn't react completely, this leads to sinter yield and utilization coefficient reduced.

Table 6. Sinter chemical composition, %

experiment number	TFe	SiO_2	CaO	FeO	MgO	Al_2O_3
1	58.04	5.5	9.38	10.65	2.43	0.093
2	57.81	5.39	9.54	6.45	2.96	1.0
3	58.16	5.62	8.95	5.5	2.89	0.99

3.2 Sinter Strength Test

Table 7. Sinter strength

experiment number	drop strength					tumbler index
	>40mm /%	25～40mm /%	10～25mm /%	5～10mm /%	<5mm /%	+6.3mm，%
1	1.4	1.4	5.4	5.4	16.3	70.13
2	2.4	1.9	3.9	3.6	15.1	51.03
3	1.4	2.1	4.1	2.9	18.9	50.87

After adding particle biomass fuel, the water content in mixture increases obviously, and the highest temperature in sintering layer is reduced , all kinds of physical and chemical reaction can't react sufficiently, grain growth is poorer, crystallization and recrystallization process of the minerals as binding phase are restrained, so that the tumbler strength and the drop strength of sinter fall down.

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3.3 Metallurgical Properties of Sinter

3.3.1 Reducibility of sinter

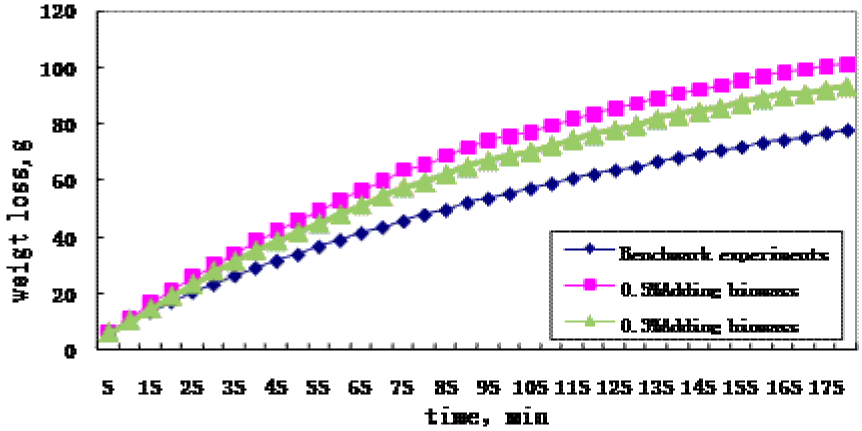

Figure 3. Weight-loss process of sinter.

Weight-loss method is adopted, and the relation between weight and time is measured continuously during reduction process of sinter, the result is shown in Fig.3. According to the formula (1), reduction degree of sinter is calculated, the result is shown in Table 8.

$$RI = \frac{O_s}{O_q} \quad (1)$$

Where, RI is reduction degree; O_s is lost oxygen amount(g) and O_q is all oxygen amount in sinter(g.).

Table 8. Sinter reduction degree, %

experiment number	reduction degree
1	65.72
2	83
3	85

From Table 8, we can know that after adding the particle biomass fuel, the reduction degree of sinter increases from 65.78% to 85%. from Table 6, we can conclude that when adding ratio of particle biomass fuel increase from 0 to 0.5%, ferrous oxide content of sinter decreases from 10.65% to 5.5%, the reducibility of sinter is improved. In General, ferrous oxide content in sinter is higher, binder phase is fayalite mainly, fayalite is difficult to reduce, so reducibility of sinter is poorer, and reduction degree is lower. The sinter chemical composition consists with its reduction degree index.

3.3.2 Low temperature reduction degradation ability of sinter

Table 9. Low temperature reduction degradation index of sinter, %

experiment number	$RDI_{+6.3}$	$RDI_{+3.15}$	$RDI_{-0.5}$
1	37.7	69.18	6.26
2	30.29	67.15	7.21
3	24.88	65.99	8.01

ISSN 2176-3135

After adding particle biomass fuel, low temperature reduction degradation index of sinter increases slightly, the reasons are following,

- When the particle biomass fuel is added in sintering mixture, the silica content in sinter will increase, this will influence liquidity of liquid; and lead to a lot of tricalcium silicate generated, these tricalcium silicate will produce phase transformation and volume expansion during cooling process, this will cause natural pulverization and reduce the sinter strength;
- When the particle biomass fuel is added in sintering mixture , aluminium oxide content in sinter will increase, and solid solution amount of aluminium oxide in monocalcium will increase too, this cause panel monocalcium produced, these panel monocalcium will began to reduce and produce stress under low temperature, the ability of crack to prevent from expanding is reduced, this can increase sinter pulverization ;
- The content of ferrous oxide has some effect on reduction degradation of sinter. From a large of production practice, it is known that lower ferrous oxide content will worsen the sinter reduction degradation ability.

4 CONCLUSIONS

- The original biomass fuel has strong ability to absorb water, this can lower the permeability mixture layer, air resistance through the layer will increase, the sintering time is extended, sintering process can't advanced sufficiently, all kinds of physical and chemical reactions in sintering cup aren’t completely, these lead to sinter yield and utilization coefficient reduced, and the sinter output reduced too.
- After adding particle biomass fuel, the silica content and aluminium oxide content in sinter will increase, the content of ferrous oxide in sinter will decrease, so reducibility of sinter can be improved, and low temperature reduction index of sinter is increased slightly.
- It is difficult to use native biomass fuel in sintering process.

Acknowledgements

The present work is supported by the science and technology funds from Liaoning Province Education Department.

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