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Reduction behavior of newly designed low-carbon sinter by H_2

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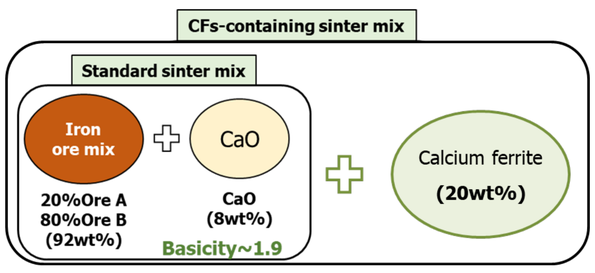
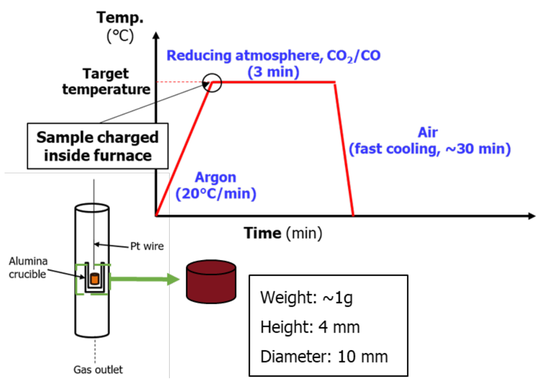
1 INTRODUCTION

- In the sintering process, the CO_2 is generated from the combustion of fine coke and anthracite coal present in the sinter mixture (iron ores, fluxes, and return fines);
- Fine coke and anthracite coal are used as heat sources - sintering temperature reaches around 1350˚C, bonding the particles;
- To reduce the CO_2 generated in the sintering process, the only way is to decrease the amount of heat source. However, such a decrease will deteriorate the sinter quality (lower temperature, less bonding);
- Therefore, in this study, the authors investigated the reduction of CO_2 emission in the sintering process through the addition of low-melting temperature material – calcium ferrite to compensate for the bonding loss from the heat source;

2 METHODS

- Iron ore-based calcium ferrite was added to the sinter mix at 20 wt.%;
- Sinter mix was manufactured into tablet form with a weight of 1 gram;
- The tablet was sintered in a vertical furnace at 1280˚C, with the atmosphere maintained as reducing atmosphere of CO/CO_2 mixture;
- The porosity and reduction behavior were measured for the newly designed sinter;

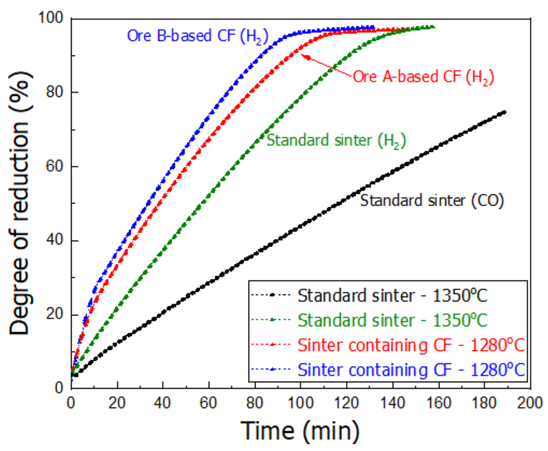




3 RESULTS

- Standard sinter mix, without the presence of calcium ferrite, was defined as the reference sample. The preparation conditions of this standard sample were like the calcium ferrite-containing one;
- The only exception: sintering temperature. 1350˚C for the standard sinter while 1280˚C for the calcium ferrite-containing sample;
- Major changes provoked by the presence of calcium ferrite:

✓ ↓ sintering temperature → ↓ fuel ratio → ↓ CO_2 emissions
✓ The porosity was maintained in the same range
✓ Major pore size was changed from macro to medium pores
(macro: 100 μm / medium: <100 μm and >10 μm)
✓ The amount of SFCA and SFCA-I was significantly increased



- The newly designed sinter showed a faster reduction rate compared to the standard sinter.
- Increased amount of SFCA and micropores within the sinter, attributed to the presence of calcium ferrite, have resulted in superior reduction behavior.

4 DISCUSSION

- To validate the suggested technology, additional low-temperature sintering tests were conducted using 1 kg Sintering Test Equipment (STE);
- Calcium ferrite was prepared from several iron-bearing by-products;
- Even though the coke ratio was reduced, both Tumbler Index (TI) and Reducibility Index (RI) were maintained at the same level or improved;

Samples	Method	Batch	Coke ratio (wt%)	T. Fe* (wt%)	Basicity (C/S)	Maximum sintering temperature (°C)	TI (%)	RI – CO (%)	RI – H_2 (%)
Standard sinter	-	0	3.0	57.6	1.79	1342	77.9	82.5	94.5
2CF-containing sinter (10wt%)	Addition of 2CF	1	2.0	57.1	2.18	1237	79.5	93.4	97.6
		2	2.0	57.7	2.32	1245	82.0	82.3	94.7
		3	2.0	58.0	2.16	1273	78.3	83.4	98.6
		4	2.0	58.4	2.20	1289	80.9	79.5	95.3
	Keep basicity at 1.8	1*	2.0	59.5	1.80	1298	79.3	80.5	96.3
		2*	2.0	60.9	1.80	1310	80.0	89.9	97.2

5 CONCLUSIONS

- Sinter properties (TI and RI) were improved even with lower sintering temperatures. This mechanism is attributed to the presence of the calcium ferrite phase, which increased SFCA and smaller pores.
- This new approach not only reduces CO_2 emissions during the sintering process (reduction in coke ratio) but also decreases coke consumption in blast furnaces due to improved reducibility and strength and in coke plants due to lower coke demand.

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