

# Effect of Replacing Magnetite with Limonite Ores on Reduction Behavior by H<sub>2</sub> Gas and Compressive Strength of Iron Ore Pellets

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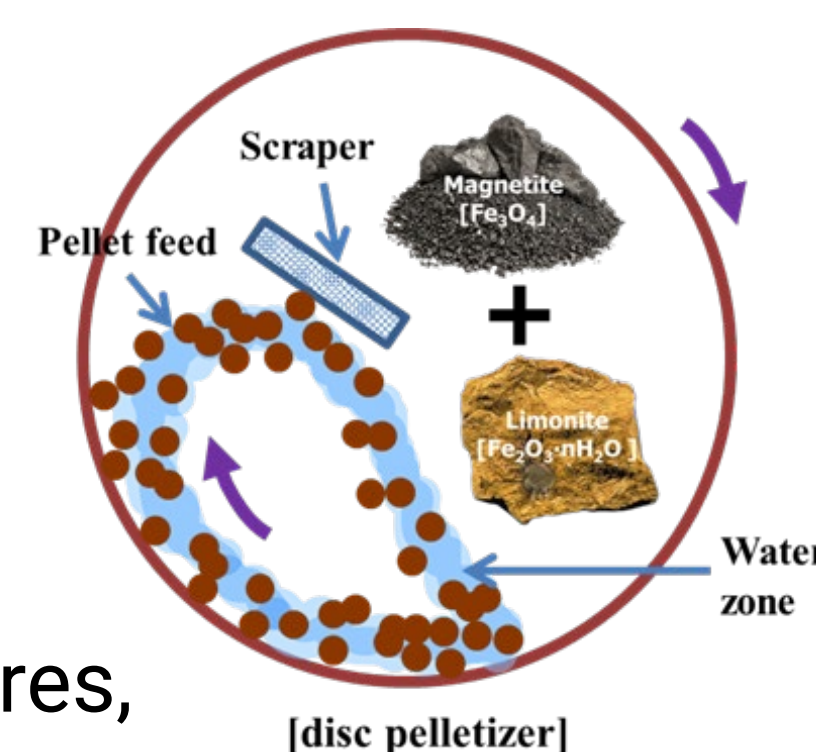
## 1 INTRODUCTION

- The necessity to reduce CO<sub>2</sub> emissions from steel plants is the driving force for the replacement of current technologies;
- The iron ore pellet market tends to increase in the next years (higher usage ratio in Blast and shaft furnaces – H<sub>2</sub> reduction);
- The production of iron ore pellets generates less CO<sub>2</sub> when compared with sinter (currently main iron burden in steel plants);
- In addition, iron ore pellets have higher reducibility (via carbon) and mechanical strength than sinters;
- As the usage of iron ore pellets tends to increase, the depletion of high-quality iron ores will become an issue shortly;

## 2 METHODS

- Pelletizing process: high-grade iron ores, especially magnetite ores (high T.Fe/ low gangue).

However, as the use of iron ore pellets tends to increase, the depletion of high-grade ores will be more evident. That is the reason for this study to investigate the effect of replacing magnetite with limonite ore as raw material to produce iron ore pellets.



Classification	Brand	Chemical composition of iron ores (wt%)											Main Phase
		T.Fe	FeO	M.Fe	Fe <sub>2</sub> O <sub>3</sub> *	Fe <sub>3</sub> O <sub>4</sub> *	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	MgO	MnO	P <sub>2</sub> O <sub>5</sub>	
Magnetite	(UKR) <b>FPF</b>	65.20	23.80	0.20	13.59	<b>76.70</b>	<b>5.35</b>	<b>0.31</b>	0.24	<b>1.12</b>	0.06	0.04	Fe <sub>3</sub> O <sub>4</sub>
Limonite	(AUS) <b>KIN</b>	56.80	0.00	0.44	<b>80.57</b>	0.01	<b>5.50</b>	<b>1.85</b>	0.03	<b>0.04</b>	0.02	0.13	FeO(OH)

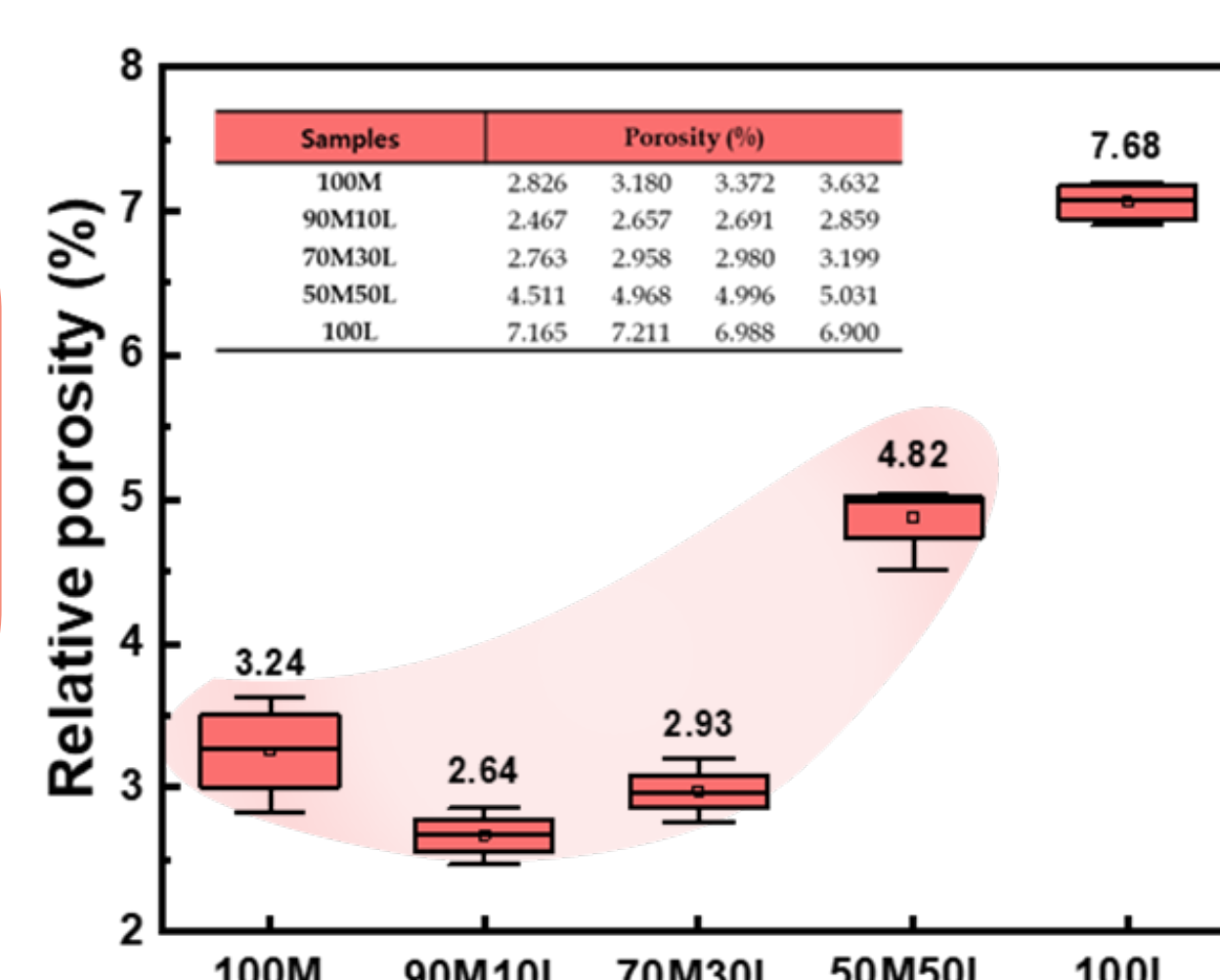
- Magnetite ore was replaced with several ratios of limonite ore and pelletized at the same conditions (moisture, basicity, heat treatment, etc). Finally, the pellets were compared in terms of compressive strength and reduction behavior by H<sub>2</sub> gas.

## 3 RESULTS

- The effect of replacing magnetite with limonite ore on important parameters for pellets to be charged into Blast/shaft furnaces was investigated;
- The use of limonite ore as raw material in the pelletizing process was avoided due to the expected deterioration of pellet strength (presence of water → formation of pores/cracks);

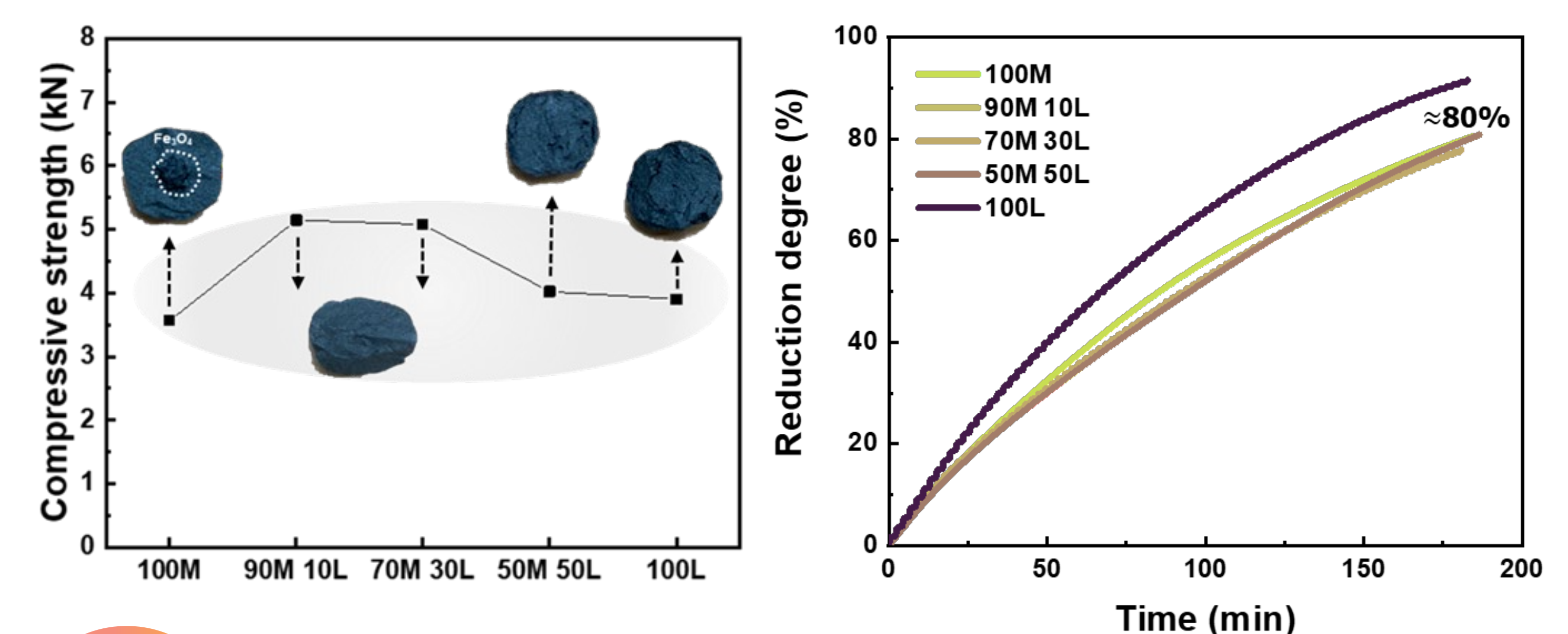
↑ Limonite ore

- Up to 30% - densification
- Over 30% - high porosity



- The compressive strength and reducibility by H<sub>2</sub> gas of limonite-based iron ore pellets were maintained at the same level or improved when compared to magnetite-based pellets;

- Porosity level is an important parameter to define the quality of pellets: higher porosity deteriorates the strength and improves reducibility;



## 4 DISCUSSION

Iron ore pellets are charged into Blast and shaft furnaces and are subjected to higher loads while they are being reduced to lower valence oxides.

Therefore, it is extremely important to measure and understand the effect of reduction degree (RD) on the strength of iron ore pellets (CCS). This study investigated the changes in the strength of pellets at three different reduction degrees.

- The strength of pellets is drastically affected by the reduction degree;

100M		90M 10L		70M 30L		50M 50L		100L	
RD (%)	CCS (kN)	RD (%)	CCS (kN)	RD (%)	CCS (kN)	RD (%)	CCS (kN)	RD (%)	CCS (kN)
14.8	6.79	13.3	7.59	13.4	10.0	15.8	8.80	12.8	5.70
38.3	2.48	39.0	2.75	32.9	4.55	45.0	1.77	35.8	4.44
51.9	2.80	51.7	4.30	51.3	4.35	56.4	2.77	45.8	3.62

## 5 CONCLUSIONS

This study investigated the viability of replacing magnetite ore, a common raw material for the pelletizing process, with limonite ore (a more abundant and cheaper source).

Through the results obtained, limonite ore can replace magnetite ore as a potential raw material for the pelletizing process.

CCS, reducibility by H<sub>2</sub> gas, and the strength after reduction are maintained at the same level or improved when using limonite-based pellets.

## REFERENCES

- Mourao, J. M.: 2<sup>nd</sup> International Symposium on Iron Ore, ABM, Brazil, 2008.
- Hossain, Sk S. et al.: ACS Applied Nano Materials, 2022, vol. 5, pp. 17828.
- Rao, V.: ISIJ International, 2002, vol. 42, pp. 800.
- Wang, G.: Minerals, 2023, vol. 13, pp. 448.
- Boechat, F. O.: ISIJ International, 2018, vol. 58, pp. 1028.