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EFFECT OF OLIVINE AS MgO-BEARING FLUX ON LOW- AND HIGH-ALUMINA IRON ORE PELLETS

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Abstract

In the present study, the effect of MgO in the form of olivine flux on low- and high-alumina iron ore pellet mineralogy and pellet quality was studied. Green pellets were prepared by varying the MgO content from 0 to 1.5% with a basicity (CaO/SiO_2) of 0.30. The pellets were tested for green pellet properties, cold crushing strength (CCS), and reduction degradation index (RDI) and fired at temperatures between 1300 and 1320 °C. An optical microscope with an image analyzer, SEM-EDS, was used to assess the mineralogical phases present in the pellets and the chemical analysis of the mineralogical phases, respectively. The laboratory tests showed that with increasing MgO addition in both low and high alumina pellets, magnesio-ferrite & silicate melt phases increased and the porosity and hematite phases decreased. The decrease in porosity was due to increase in silicate melt formation from the silica in the olivine. With increasing MgO addition, the CCS value of the pellets increased up to an MgO content of 0.9 to 1.1%. Thereafter, the CCS value of the pellets decreased with increasing MgO addition for both low and high alumina pellets. At an MgO content of 0.9 to 1.1%, the CCS value was higher due to the formation of a low melting point magnesio-ferrite phase, which imparted strength to the pellets. For pellets with an MgO level of >1.1, the RDI was within the control limit for both low- and high-alumina pellets. This may be due to a reduction in the porosity of the pellet and a better distribution of the silicate melt phase. Low-alumina pellets showed better physical and metallurgical properties compared to high-alumina iron ore pellets.

Keywords: *Iron ore pelletization; Olivine as MgO flux; Low and high alumina iron ore pellets; Firing; Green pellet properties; Mineralogy and physical and metallurgical properties*

1. Introduction

MgO is present in nature in the form of magnesio-silicates (olivine) or dolomite. Indian iron ores are generally rich in alumina, which has a negative effect on the RDI of the pellet. MgO is proven to be a good flux material in pellets to reduce RDI and swelling index and improve softening and melting properties. Olivine consists of LOI <1.5%, whereas the LOI content in dolomite varies from 40 to 45%. The use of olivine in the production of pellets reduces the LOI content in the green mix, and reduces the specific consumption of flux and concentrate. Olivine requires no calcination of carbonate and no additional heat; moreover, olivine is rich in magnesium. At present, various available minerals containing MgO and CaO, namely,olivine, pyroxenite, dunite, dolomite, etc., are widely used in different plants to improve pellet properties. However, the properties of the above fluxes are physically and chemically different, and they contain different types and amounts of gangue materials, such as silica and alumina. Although MgO and CaO have some specific roles, other gangue materials carried by MgO and CaO-bearing fluxes also have a significant effect on phase formation or slag bonding in pellets and pellet properties. Besides acid and CaO fluxed pellets, MgO fluxed pellets were found to be more advantageous in blast furnace iron-making units, as follows: 1. MgO fluxed pellets can respectively improve the softening and melting properties, reduction swelling index (RSI), and reduction disintegration index (RDI); (2) MgO fluxed pellets can meet the MgO needs in the slagging process of a BF, which makes it possible to fulfil the reasonable cohesive zone configuration, the favourable gas distribution in BF, as well as the better metallurgical properties of BF slag [1, 2, 3]. The pelletization process parameters are specific to the given ore or concentrate and are based on the association of the mineralogical phases. The present study is undertaken for soft low- and high-alumina iron ore fines in the Bellary-Hospet region. These iron ores consist of hematite, goethite, limonite, quartz, kaolinite, and a small amount of magnetite. The alumina and silica in pellet feed are in the range of 5.5 to 8.5%. There is no extensive literature or research

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on the preparation of pellets with such a high content of gangue minerals using MgO bearing flux such as olivine,. In some of the literature, it was found that MgO can weaken the strength of the pellets depending on the size of the olivine particles. It was found in the literature that the firing temperature required for the pellets decreases with increasing olivine addition [4]. The fineness of the olivine also influences iron ore pellet properties. According to the literature, the finer the olivine particles, the higher the dissociation rate, the better the oxidation and sintering, and the better the final pellet microstructure [5]. To study the effect of olivine (MgO bearing flux) on low and high alumina iron ore pellet properties, detailed laboratory studies were carried out by varying the MgO percentage and the firing temperature (1300 and 1320 ^{o}C).

2. Experimental

2.1. Material and methods

The raw materials used for pelletization studies were iron ore fines, limestone, olivine, coke breeze and bentonite . All raw materials were prepared in the laboratory using a ball mill to achieve the required fineness. The chemical composition of the raw material and the size analysis are shown in Table 1 and Table 2, respectively.

2.2. Mineralogical studies

Mineralogical studies were carried out on high- and low-LOI iron ore fines. With the coning and quartering sampling methods, a representative sample was collected for mineralogical studies. The coarse ore with a size of +2mm was crushed to 2 mm size using a jaw crusher. The iron ore fine of -2 mm was mounted using epoxy resin. The mounted sections were polished according to the procedure described below, which is also applied to pellets.

Mineralogical studies were carried out on produced iron ore pellets of low- and high-alumina iron ore fines with various MgOcontents. The pellets of -12.5+10mm size were chopped on a cutting machine to obtain a flat surface for mounting in moulds. The flat pellets were mounted with epoxy resin. These sections were polished with silicon carbide paper up to 1000 grit with water as a lubricant. The final polishing was done with diamond paste. For the characterization studies an optical microscope was used in which a high-resolution camera was mounted. Leica Q-Win Image Analyzer software was used to provide an objective measurement of the different phases of the microstructure (hematite, magnetite, silicate, and pores). The polished sample was placed under a microscope for examination. A camera is mounted behind the lens to capture the image. The eyepiece of a 20X objective lens was selected for the present study. The images of each sample were stored on the computer after being taken on different locations on the sample. For each sample, 24 images were taken for phase analysis, and the percentage error in phase quantification is less than 1%. Different image analysis tools were used to measure the area fraction of the different phases in the pellet.

The elemental analysis of pellet phases was carried out using scanning electron microscope (SEM).

Table 2. *Size analysis of raw materials*

Size, µm	Iron ore fines	Limestone	Olivine	Coke breeze
	%			
+150	1.0	1.0	-45 µm : 80%	1.0
-150+75	99.0	99.0		97.0
-75+45	90.2	95.0		93.0
-45+25	70.9	74.0		70.0
-25+10	52.1	62.0		59.0
-10	34.4	40.0		38.0

Table 1. *Chemical analysis of raw materials*

	Iron ore (Low alumina)	Iron ore (High alumina)	Limestone	Olivine	Coke breeze	Bentonite
Fe,%	63.00	61.69	0.29	6.10		11.25
SiO2,%	3.40	4.85	0.60	39.80		46.94
Al2O3,%	2.20	3.16	0.19	0.60		17.0
MnO	0.05	0.08		0.60		0.13
CaO	0.21	0.26	52.62	1.50		1.65
MgO	0.04	0.07	2.04	48.20		2.32
C,%					80.10	
LOI,%	2.40	3.10	43.59	1.40		9.86

2.3. Pelletization process

The production of iron oxide pellets from iron ore fines involves different steps from drying to induration. The beneficiation plant concentrate is ground to achieve required fineness (Table 2). The ground ore is now mixed with other additives such as bentonite, limestone, olivine, and coke breeze and then sent to palletising/balling disks to prepare green pellets/balls of size -16+6 mm. The pelletization disk parameters are as follows:

Diameter – 450mm

Disk inclination – 45°

Disk rpm – 27

The green mix proportion is shown Table 3 (A-B). The production of good quality green pellets is an essential prerequisite for the production of high quality fired pellets. Classic tests such as the drop number and green compression strength (GCS) are used to predict whether the green pellets will remain intact during the further heat hardening process. Apart from these classic quality parameters, green pellets need to withstand to thermal spalling during the drying and firing process.

These green pellets were fired in a rising hearth furnace to get the required physical and metallurgical properties, making them a suitable feed material for iron-making units. The schematic diagram of the pelletization process is shown in Figure 1. The heating rate was maintained at 26 to 28 °C/min. For each experiment, 20 kg of green pellets were loaded into an nconel basket. One basket was kept in the rising hearth furnace chamber. The pellets were heat-hardened with the help of heating elements. The firing cycle was set according to Table 4 (temperature and time for the different zones).

For systematic evaluation the study was carried out on iron ore pellets with low and high alumina content according to the following plan:

MgO: 0.5 to 1.5% (interval of 0.2%)

Firing temperature: 1300 & 1320 °C (Interval of 20 °C)

The olivine fineness: -45µm –80%

The Cold Crushing Strength of the pellets was

Table 3A. *Green pellet mix proportion for low alumina iron ore fines*

MgO,%	0.00	0.50	0.70	0.90	1.10	1.30	1.50
Pellet	A	B	C	D	E	F	G
Iron ore fines,%	96.50	95.62	95.17	94.73	94.25	93.76	93.33
Limestone,%	1.70	1.80	1.85	1.90	2.00	2.10	2.15
Olivine,%	0.00	0.78	1.18	1.57	1.95	2.34	2.72
Bentonite,%	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Coke breeze,%	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Moisture, %	9.0%						

Table 3B. *Green pellet mix proportion for high alumina iron ore fines*

MgO,%	0.00	0.50	0.70	0.90	1.10	1.30	1.50
Pellet	A	B	C	D	E	F	G
Iron ore fines,%	95.80	95.08	94.68	94.10	93.60	93.15	92.72
Limestone,%	2.40	2.40	2.42	2.60	2.70	2.75	2.80
Olivine,%	0.00	0.72	1.10	1.50	1.90	2.30	2.68
Bentonite,%	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Coke breeze,%	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Moisture,%	9.0%						

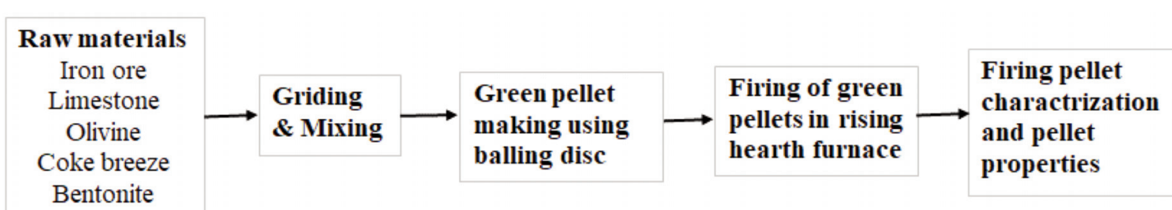

Figure 1. *Schematic diagram of pelletization process*

measured as per ISO 4700. Reduction Degradation Index (RDI) of pellets measured in the present study is a combination of ISO 4696 (LTBT Test) and ISO 7992 (Reduction under load).

For mineralogical studies 3 pellets from each size fraction were collected representatively. Mineralogical studies and phase analysis were carried out using an optical microscope and image analyser.

3. Results and discussion

3.1. Mineralogical studies on iron ore fines

Low- and high-alumina iron ore samples consist of hematite as the main iron-bearing mineral and goethite and limonite as the minor iron-bearing minerals. In high-alumina iron ore fines, the goethite content was slightly higher. Quartz and kaolinite are the most important gangue-bearing minerals. In low- and high-alumina iron ore fines, kaolinite is associated with goethite and limonite minerals. The microstructure depicts that hematite is weathered and altered to goethite. The phase analysis of the iron ore fines is shown in Table 5, and micrographs of the iron ore fines are shown in Figure 2.

3.2. Green pellet properties

With increase in MgO%, the green crushing strength (GCS) and drop number increased for both low- and high-alumina iron ore pellets. High-alumina iron ore fines show a higher GCS and drop number compared to low-alumina iron ore fines with increase in MgO%. The GCS and drop numbers are in the range of 0.9 to 1.50 and 15 to 33, respectively. Olivine is naturally present in the form of magnesium-silicate; the strength properties of bentonite in pellets are not affected by the addition of these materials. Thus, MgO-bearing fluxes with gangue materials such as SiO_2 and Al_2O_3 in the green mix can improve the properties of the green pellets.

3.3. Chemical analysis of fired pellets

The chemical analysis of the olivine fluxed pellets with low and high alumina iron ore fines are shown in Table 6 and Table 7, respectively. In both cases the silica content in the fired pellets increased with increasing olivine addition. The silica content in low and high alumina iron ore pellets varied from 3.89 to 5.09 and

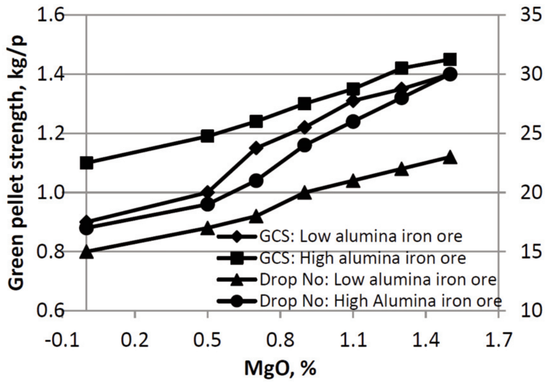

Figure 3. *Green pellet properties*

Table 4. *Firing cycle*

	Time, mins	Temp, °C
Updraft drying	8.50	200-250
Down draft drying	6.80	250-350
Preheating	2.50	350-800
Firing	16.10	800-/1300 &1320
After firing		1260-1320/ - 900
Cooling and after cooling	15.20	900-300/300-80

Table 5. *Phase analysis of iron ore fines*

Phases	%	
Hematite	75.3	68.00
Martite	1.0	0.70
Goethite	12.0	14.50
Limonite	3.0	5.00
Quartz	3.6	4.95
Alumina	3.2	4.62
Others	1.9	2.20

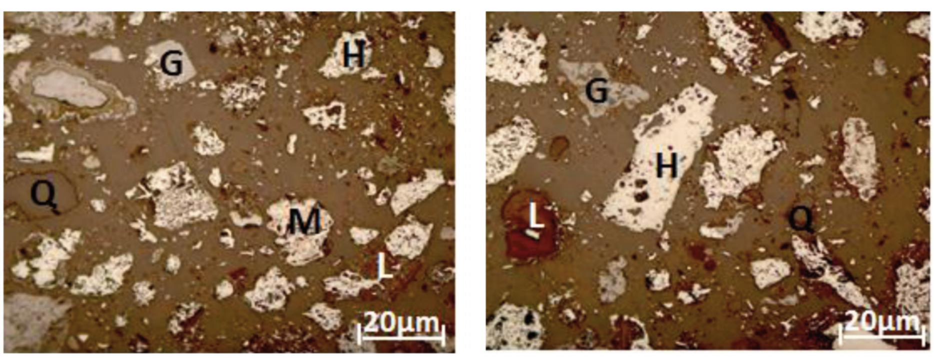

Figure 2. *Micrographs of iron ore fines*

5.33 to 6.44, respectively. In both the low and high alumina olivine fluxed pellets the constant basicity (0.30) and green pellet carbon (1.20 to 1.25) was maintained.

3.4. Mineralogical studies on fired pellets

Figure 4 (A-G) and Figure 5 (A-G) show the micrographs of low and high alumina iron ore pellets with varying MgO content from 0 to 1.5%, respectively. Figures 6 and 7 show the phase analysis of low- and high-alumina iron ore pellets with varying MgOcontent. The image analysis shows that hematite, magnetite, silicate melt, magnesioferrite, and magnesio-silicate phases are present in the pellets. With increasing MgO addition, the magnesioferrite and silicate melt phases increased in both low- and high-alumina iron ore pellets. In high-alumina pellets, the amount of magnesium silicate was found to increase beyond 1.1% MgO content in the pellets. For both low- and high-alumina pellets, the porosity of the pellets decreased with increasing MgO addition. The porosity of high-alumina pellets was lower than that of low-alumina iron ore pellets. The decrease in porosity was due to increase in silicate melt formation from the silica in the olivine.

3.5. SEM analysis on different phases of fired pellets

Table 8 shows the EDS analysis of low- and high-alumina iron ore pellets with 0.9 and 1.1% MgO levels. The EDS images of low- and high-alumina iron ore pellets with 0.9% MgO are shown in Figure 8. The phase analysis shows that the chemistry of the slag phase changes with the addition of olivine as the MgO-bearing flux in both low- and high-alumina iron ore pellets. With increasing MgO addition, the FeO content in the slag phase decreased the FeO content in the slag phase of low-alumina iron ore pellets is higher compared to high-alumina iron ore pellets. The maximum MgO was distributed in the magnesioferrite phase. The FeO-MgO phase diagram [5] is shown in Figure 9. With increasing MgO addition, the decrease in FeO content in the slag phase was due to the formation of magnesiowustite and the conversion of magnesiowustite to magnesioferrite during cooling.

Table 6. *Chemical analysis of olivine fluxed pellets with low alumina iron ore fines*

Elements	%						
	A	B	C	D	E	F	G
Fe (t)	64.03	63.5	63.23	62.97	62.69	62.41	62.15
SiO_2	3.89	4.19	4.35	4.50	4.64	4.79	4.93
Al_2O_3	2.39	2.38	2.37	2.36	2.35	2.35	2.34
CaO	1.17	1.24	1.27	1.31	1.37	1.43	1.46
MgO	0.10	0.50	0.70	0.90	1.10	1.30	1.50
FeO	0.92	0.85	0.68	0.52	0.49	0.44	0.39
MnO	0.06	0.06	0.06	0.06	0.06	0.07	0.07
B_2	0.29 to 0.30						
Green pellet Carbon	1.20 to 1.25						

Table 7. *Chemical analysis of olivine fluxed pellets with high alumina iron ore fines*

Elements	%						
	A	B	C	D	E	F	G
Fe (t)	62.03	61.6	61.36	61.05	60.77	60.53	60.3
SiO_2	5.33	5.59	5.73	5.87	6.02	6.16	6.30
Al_2O_3	3.34	3.32	3.31	3.29	3.28	3.27	3.26
CaO	1.61	1.62	1.63	1.74	1.80	1.80	1.81
MgO	0.14	0.50	0.70	0.90	1.11	1.30	1.50
FeO	0.88	0.80	0.62	0.48	0.44	0.40	0.35
MnO	0.06	0.07	0.07	0.07	0.07	0.08	0.08
B_2	0.29 to 0.30						
Green pellet carbon	1.20 to 1.25						

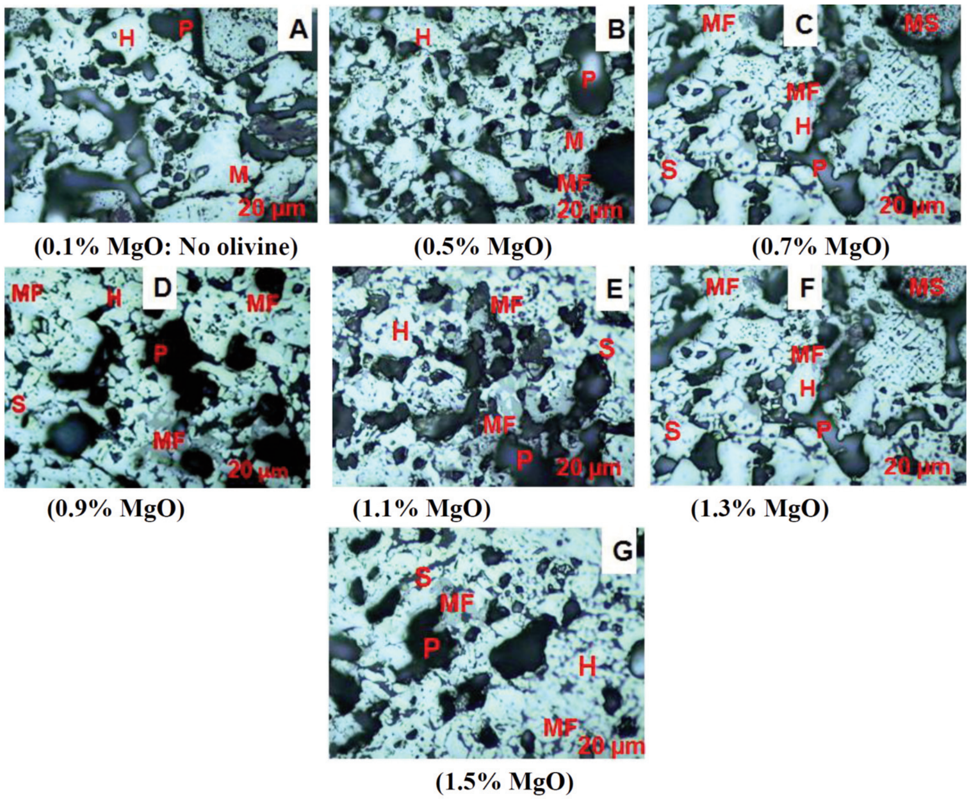

Figure 4. *(A-G) Micrographs olivine pellets with low alumina iron ore*

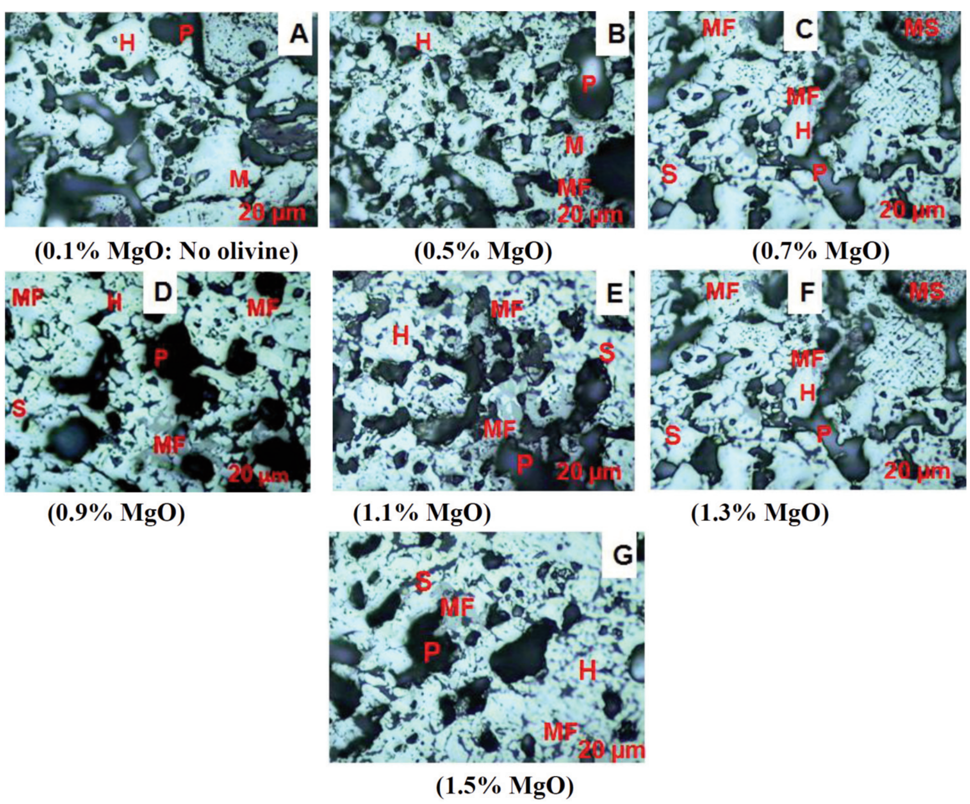

Figure 5. *(A-G) Micrographs olivine pellets with high alumina iron ore*

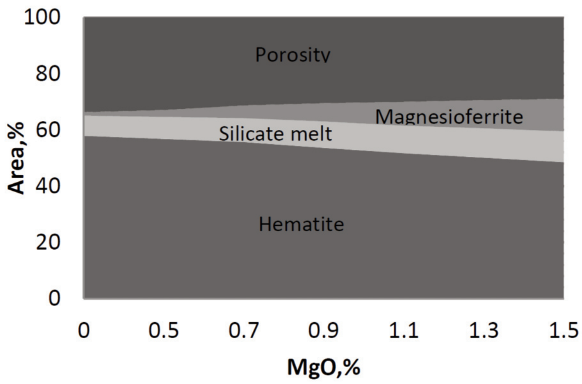

Figure 6. *Phase analysis of pellets with low alumina iron ore*

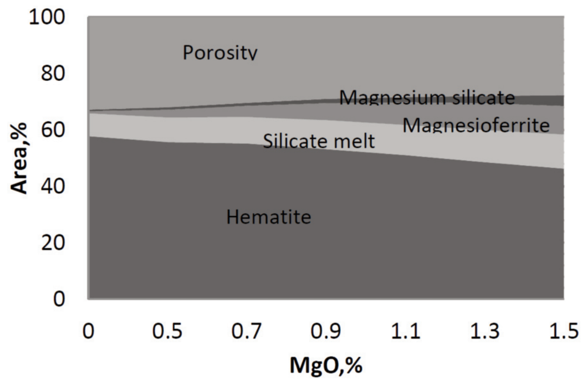

Figure 7. *Phase analysis of pellets with high alumina iron ore*

Table 8. *EDS analysis of different phases of low and high alumina iron ore pellets*

		Low alumina iron ore pellets		High alumina iron ore pellets	
MgO, %	0	0.9	1.1	0.9	1.1
Iron oxide					
MgO,%	0.05	0.04	0.05	0.04	0.05
Al_2O_3, %	0.19	0.2	0.18	0.24	0.26
SiO_2,%	0.25	0.27	0.26	0.3	0.33
Fe_2O_3,%	98.2	98	97.7	97.2	96.5
Slag					
MgO,%	0.01	0.2	0.5	0.4	0.7
Al_2O_3, %	4.8	4.89	4.52	4.9	4.2
SiO_2,%	64	79	81	77	79
CaO,%	0.8	0.8	1.1	1.4	1.7
FeO,%	28	8.4	6.5	7.5	6.5
Mg Ferrite					
MgO,%	0	18.5	18	17.5	18.2
Al_2O_3, %	0	5.2	4.8	4.5	5.2
SiO_2,%	0	1.5	1	2.5	2.7
CaO,%	0	0.9	1.1	1.2	0.8
Fe_2O_3,%	0	72	74	73.5	76.5

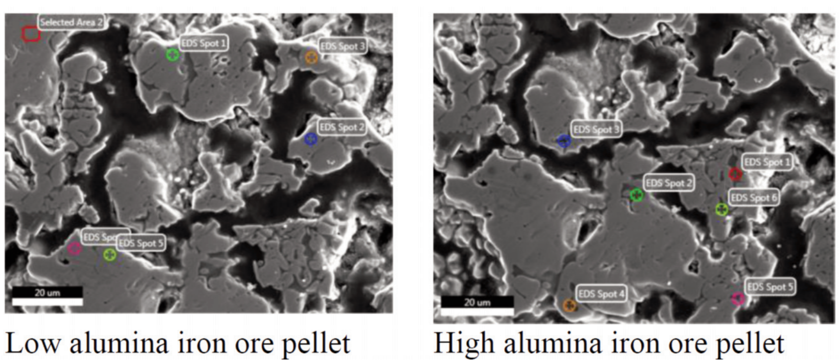

Figure 8. *EDS images of fired pellets with 0.9% MgO*

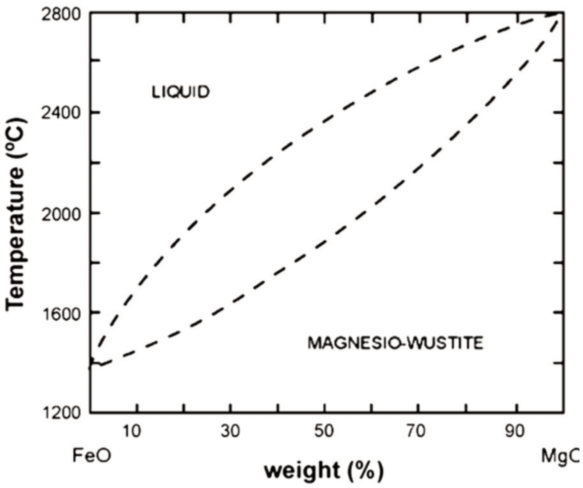

Figure 9. *FeO - MgO Phase diagram*

3.6. Physical and metallurgical properties of the pellets

3.6.1. Effect of olivine addition on CCS of the pellets

The effect of MgO addition through olivine on the strength of low and high alumina iron ore pellets at firing temperatures of 1300 and 1320 °C are shown in Figure 10. The test results show that for both low and high alumina pellets, with increase in MgO%, the strength, i.e., CCS, of the pellets increased up to a MgO level of 0.9 to 1.1%, and afterwards, pellet strength decreased with increasing MgO addition. At lower MgOcontent, i.e., <0.9%, the CCS of the pellet was lower for both low and high alumina pellets due to the presence of higher porosity and no proper slag bonding with oxide phases, as well as the presence of a lesser magnesioferrite phase. Pellets with an MgO content of 0.9 to 1.1% have a higher CCS value for both low- and high-alumina iron ore pellets due to the presence of optimised mineralogical phases with proper slag bonding. At this MgOcontent, the low-melting point magnesioferrite phase gives strength to the pellets. At a higher MgO content> 1.1%, the strength of the pellet decreases for both low and high MgO pellets due to the presence of a low-strength silicate melt phase and improper slag bonding with other oxide phases. For high-alumina iron ore pellets, a high temperature is required to achieve a pellet CCS value similar to that of low-alumina iron ore pellets. This may be due to the refractory nature of alumina and the presence of high alumina in iron ore pellets. When the Al_2O_3 content gradually increased, the high melting point of Al_2O_3 particles hindered the oxidation of Fe_3O_4 and the recrystallization of Fe_2O_3, which increased the internal porosity of the pellets, resulting in a decrease in the compressive strength of the pellets [7].

3.6.2. Effect of olivine on reduction degradation index (RDI) of the pellets

The effect of MgO addition through olivine on the reduction degradation index (RDI) of low and high alumina iron ore pellets at firing temperatures of 1300 and 1320 °C are shown in Figure 11. It was evidenced from the experimental results that for both low and high alumina pellets, with increase in MgO%, the RDI of the pellets decreased to MgO levels of 0.9 to 1.1%, and afterwards, pellet RDI was in control. At lower MgO levels, the RDI of the pellet was higher for both low and high alumina pellets, even though the higher FeO content was due to the presence of higher porosity. At an MgO content of >1.1 the RDI was within the control limit for both low and high alumina pellets. This may be due to a decrease in the porosity of the pellet and a better distribution of the silicate melt phase. The decrease in porosity was due to an increase in silicate melt formed from the silica in the olivine. The distribution of the silicate melt phase is a good indicator of bonding, as is the lower RDI. The RDI of high-alumina pellets is higher compared to low-alumina iron ore pellets. The FeO content in the pellet is directly proportional to the RDI of the pellet. The higher the FeO content in the pellet, the lower the

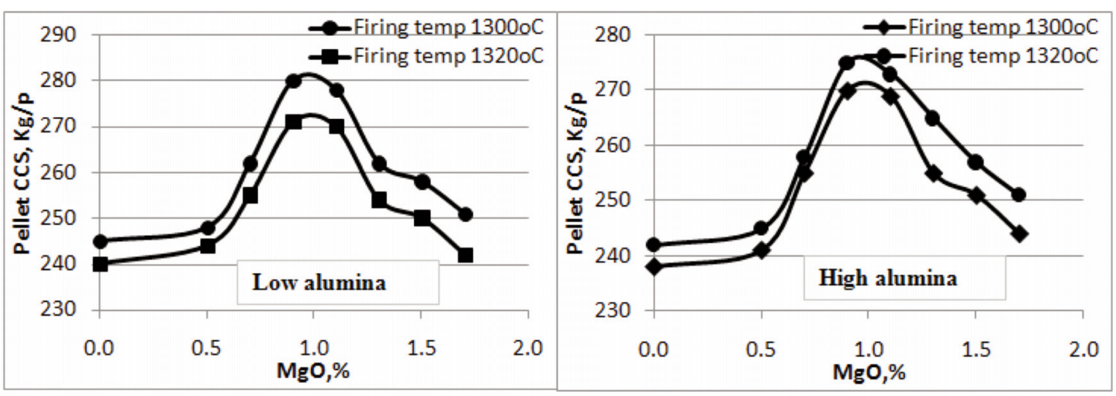

Figure 10. *Effect of MgO% on pellet strength at various temperatures for low (A) and high (B) alumina pellets*

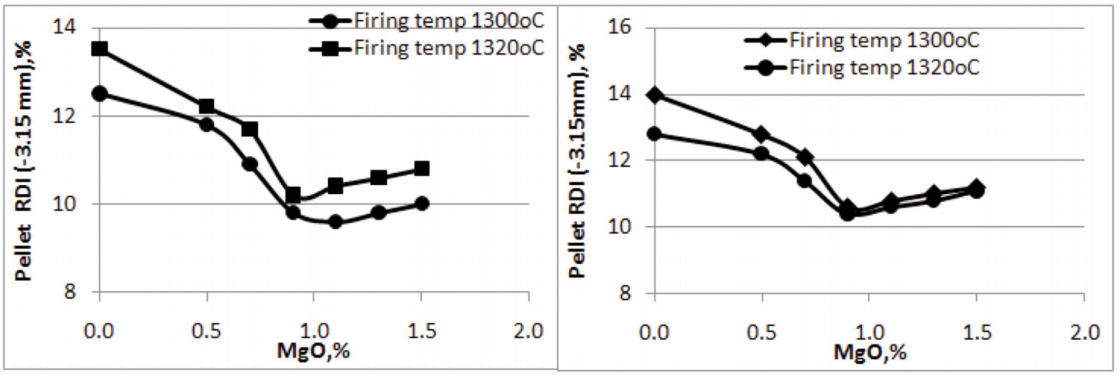

Figure 11. *Effect of MgO% on pellet reduction degradation index on low and high alumina iron ore pellet*

pellet RDI. The FeO content in low-alumina pellets is higher compared to high-alumina pellets (Tables 6 and 7). The silicate melt between the particles exerts pressure to pull them together due to interfacial forces, leading to lower porosity and hence lower pellet RDI. To ensure proper silicate melt formation, the firing temperature should be properly maintained during the pellet induration to control the RDI [8].

Pellets with MgO contentbetween 0.9 and 1.1% showed better physical and metallurgical properties of the pellets for both low and high alumina pellets due to the presence of optimised mineralogical phases with proper slag bonding.

4. Conclusions

The following conclusions can be drawn from the present work, which is mainly focused on the influence of MgO addition through olivine on low- and high-alumina iron ore pellets:

Low- and high-alumina iron ore samples consist of hematite as the major iron-bearing mineral and goethite and limonite as the minor iron-bearing minerals.

With increase in MgO%, the green crushing strength (GCS) and drop number increased. High-alumina iron ore fines show a higher GCS and drop number compared to low-alumina iron ore fines with increase in MgO%.

With increasing MgO addition, the magnesioferrite and silicate melt phases increased, and porosity and hematite phases decreased with increase in MgO% in both low and high alumina pellets. The decrease in porosity was due to increase in silicate melt formation from the silica in olivine.

With increasing MgO addition, FeO content in the slag phase decreased. The decrease in FeO content in the slag phase was due to the formation of magnesiowustite and the conversion of magnesiowustite to magnesioferrite during cooling.

Pellets with an MgO contentof 0.9 to 1.1% have a higher CCS value for both low- and high-alumina iron ore pellets because, at this MgO level, the low melting point of the magnesio-ferrite phase gives strength to the pellets.

Pellets with an MgO content of >1.1 and the RDI were within the control limit for both low and high alumina pellets. This may be due to a reductionin the porosity of the pellet and a better distribution of the silicate melt phase.

Pellets with an MgO content between 0.9 and 1.1% showed better physical and metallurgical properties of the pellets, which can be attributed to the presence of optimised mineralogical phases with proper slag bonding.

Author’s contributions

T. Umadevi: Experiment, test, and validation; conceptualization; writing-original draft;
R Sah: Technical discussion and checking the technical content in the paper.

Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

[1] M. Iljana, A. Kemppainen, T. Paananen, O. Mattila, E.P. Heikkinen, T. Fabritius, T, Evaluating the reduction-softening behaviour of blast furnace burden with an advanced Test. ISIJ International 56 (10) (2016) 1705–1714. https://doi.org/10.2355/isijinternational.ISIJINT-2016-117.

[2] A. Kemppainen, O. Mattila, E. Heikkinen, T. Paananen, T. Fabritius, Effect of H_2-H_2O on the reduction of olivine pellets in CO-CO_2 Gas. ISIJ International 52(11) (2012) 1973–1978. https://doi.org/10.2355/isijinternational.52.1973.

[3] M. Matsumura, M. Hoshi, T. Kawaguchi, Improve of sinter softening property and reducibility by controlling chemical compositions, ISIJ International 45(4) (2005) 598–607. https://doi.org/10.2355/isijinternational.45.594.

[4] M.D. Meraj, P. Susanta, P. Jagannath, Role of MgO and

its different minerals on properties of iron ore pellets, Transactions of the Indian Institute of Metals, 69(6) (2015) 1141–1153. https://doi.org/10.1007/s12666-015-0676-8.

[5] H.M. Ahmed, P. Semberg, C. Andersson, B. Bjorkman, Effect of added olivine on iron ore agglomerate during induration, ISIJ International 58(3) 2018 446-452. https://doi.org/10.2355/isijinternational.ISIJINT-2017-327.

[6] E. Prestes, A.S.A. Chinelatto, W.S. Resende, Post mortem analysis of burned magnesia-chromite brick used in short rotary furnace of secondary lead smelting, Ceramica 55(33) (2009) 61–66. https://doi.org/10.1590/S0366-69132009000100008.

[7] J.-L. Zhang., Z.-Y. Wang, X.-D. Xing, Z.-J. Liu, Effect of alumina oxide on the compressive strength of pellets, International Journal of Minerals, Metallurgy, and Materials 21(4) (2014) 339–344. https://doi.org/10.1007/s12613-014-0914-9.

[8] D. Srinivas, M. Ranjan, Influence of oxide and melt phases on the RDI of iron ore pellets suitable for shaft furnace of direct reduction, ISIJ International, 50(11) (2010) 1581-1589. https://doi.org/10.2355/isijinternational.50.1581

UTICAJ OLIVINA KAO TOPITELJA NA BAZI MgO NA PELETE GVOZDENE RUDE SA NISKIM I VISOKIM SADRŽAJEM GLINICE

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Apstrakt

U ovoj studiji proučavan je uticaj MgO u obliku fluksa olivina na mineralogiju peleta sa niskim i visokim sadržajem glinice kao i na kvalitet peleta. Sirovi pelet je pripremljen variranjem sadržaja MgO od 0 do 1,5% sa baznošću (CaO/SiO_2) od 0,30. Pelet je testiran na svojstva sirovih peleta, čvrstoću na hladno drobljenje (CCS) i indeks redukcione degradacije (RDI), i pečen je na temperaturama između 1300 i 1320 °C. Optički mikroskop sa analizatorom slike, SEM-EDS, korišćen je za procenu mineraloških faza prisutnih u peletu i hemijsku analizu mineraloških faza, pojedinačno. Laboratorijski testovi su pokazali da se povećanjem dodatka MgO u peletu sa niskim i visokim sadržajem glinice povećavaju faze rasta magnezijum-ferita i silikata i smanjuju poroznost i hematitne faze. Do smanjenja poroznosti došlo je zbog povećanja formiranja silikatnog rastopa iz silicijum dioksida u olivinu. Sa povećanjem dodatka MgO, CCS vrednost peleta je porasla do sadržaja MgO od 0,9 do 1,1%. Nakon toga, CCS vrednost peleta se smanjila sa povećanjem dodatka MgO kako za pelete sa niskim tako i za one visokim sadržajem glinice. Pri sadržaju MgO od 0,9 do 1,1%, vrednost CCS je bila viša zbog formiranja magnezijum-feritne faze niske tačke topljenja, što je peletu dalo čvrstoću. Za pelet sa nivoom MgO >1,1, RDI je bio unutar kontrolne granice za pelete i sa niskim i sa visokim sadržajem glinice. Do ovoga možda dolazi zbog smanjenja poroznosti peleta i bolje distribucije faze rastapanja silikata. Peleti sa niskim sadržajem glinice su pokazali bolje fizičke i metalurške osobine u poređenju sa peletima sa visokim sadržajem glinice.

***Ključne reči**: Peletizacija rude gvožđa; Olivin kao MgO topitelj; Peleti gvozdene rude sa niskim i visokim sadržajem glinice; Pečenje; Svojstva sirovih peleta; Mineralogija i fizička i metalurška svojstva*