AGGLOMERATION OF MANAGANESE FINES FOR EFFECTIVE UTILIZATION IN FERRO ALLOY MANUFATURING

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Keywords

Agglomeration, Briquetting, Binder, Manganese fines

Introduction

The use of briquetting technology in the recycling of industrial wastes, particularly in the production of ferroalloys, has been explored in several studies (Babanin, 2006; Diaz, 2021; Jesus, 2021; Singh, 2011). This technology has been found to be effective in agglomerating fine-grained materials, such as ferromanganese, ferrotitanium, and ferrosilicon, and in the production of manganese-rich co-products. The resulting briquettes have been shown to have better performance in the pre-reduction zone of submerged arc furnaces, with higher CO reactivity and compressive strength. Furthermore, the use of these briquettes in steel making processes has been found to lead to faster dissolution and improved manganese recovery, resulting in significant cost savings. The briquetting of manganese fines for ferro alloy production has been explored in several studies. Bizhanov (2014) and Babanin (2006) both highlight the potential of briquettes as a charge component, with Bizhanov specifically noting the economic benefits and improved technical parameters. Diaz (2021) further, demonstrating the stability and performance of briquette recycling in a pilot-scale Submerged Arc Furnace. Araujo (2006) expands on the potential of using ferro-alloy fines, including manganese, in electrolytic manganese production, emphasizing the environmental and process advantages. These studies collectively underscore the potential of briquetting manganese fines for ferro alloy production, both in terms of economic and environmental benefits. The prime goal of this study is to produce manganese fines briquettes not only to decrees the dependency of lump ores also to utilize the unused stocks. The study also aims to provide sustainable solution by promoting efficient resource utilization.

Objectives

The study aims to turn manganese fines into briquettes. Currently, manganese fines are unused by the ferro alloy manufacturers because of their fine sizes, a quality agglomerations technique with strong binder will help to solve the challenges. The study also aims to investigate the binder dosage, optimization of curing time based on the final briquette strength. The study involves the Measure of Mechanical strength of briquettes at different interval of time.

Methodology:

Materials:The samples were collected as per the scheme mentioned above from Chinna Budina Gundi (CBG) manganese mine, Swamimalai block, Kumaraswamy range of SMIORE. This is one of the best exposed sections of the area. The ore bands are either massive bodies or strata bound replacement type, separated by barren patches. The average grade is 20% Mn, 24% Fe and 2% SiO2. The Mn content varies from 20% to 22%. Fig 1 shows the manganese ore mine and collection of samples. For briquetting ground mass of lime and industry grade molasses and organic binder supplied by kimberlite chemicals have been used as a binding agents.

Figure 1: Collection of Samples from mine stocks

Methods: Roll Press Two batches were produced with the roll press briquetting machine. The test batches made in the roll press were made by using Lime +Molasses and using Polymeric Binder supplied by (kimberlite chemicals, India). These briquettes were made for drop test and compression test application, and briquettes produced by using binder is measured for its compression strength after heat treatment. The test parameters of the machine during briquetting is Feed Screw Torque 5.3 [Nm] Feed Screw Speed 38.2 [RPM] Roll Torque 125 [Nm] Roll Speed 2.8 [RPM] Agitator Torque 1.3 [Nm] Agitator speed 8.6 [RPM] Roll Gap 0.7 [mm] Roll Force 28.5 [kN].The manganese briquettes were produced following the flowsheet in Figure 2. It started with mixing of raw material manganese dust, then a binder was introduced to the mix and evenly distributed. The powder-binder mixture was then immediately transported to the briquetting equipment and green bodies were produced. Two types of briquetting methods were tested: Uniaxial pressing and Roll pressing. These green briquettes were then moved to storage and tested for given time intervals after production. The Compression Test The force needed to create a crack propagating through the surface of the briquette, in [N], was noted as the maximum compression strength of the briquettes. This test was set to stop when the force applied to a briquette dropped by 25% of the maximum measured force during a run. The compression machine held a constant speed of 2mm/min during the run. The machine used for compression testing was universal Testing machine (UTM, FIE, India).

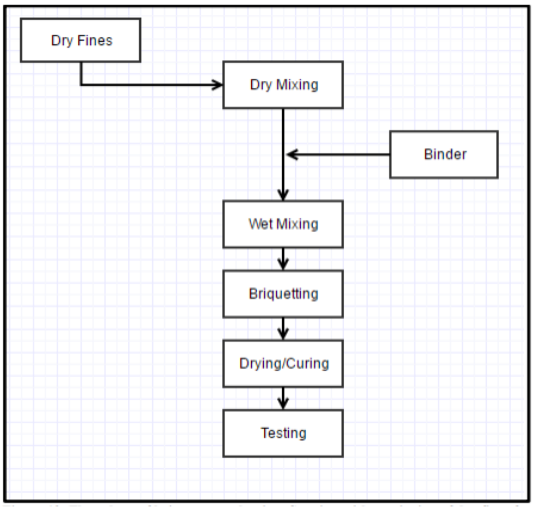

Figure 2: Test flowsheet for production of Mn Briquettes

Cold Briquettes: Initially, manganese fines with a moisture content of 3% were mixed with lime and molasses, serving as additives and binders respectively. Various proportions of lime and molasses were tested to optimize the binding efficiency. Then the mixture was fed into a cold briquetting machine, where it was compacted into briquettes under high pressure. Subsequently, the formed briquettes underwent a natural drying process for 72 hours. During this period, the strength of the briquettes was monitored and the maximum strength retained by each briquette was recorded. This allowed for the assessment of the effectiveness of different proportions of additives and binders in producing durable manganese fines briquettes through the cold briquetting process.

Hot Briquettes: In the hot briquetting process, manganese fines were prepared and formed into briquettes using a different approach. Initially, manganese fines with a slightly higher moisture content of 5% were mixed with an organic binder. Subsequently, the mixture fed to a briquetting machine, where it was compacted into briquettes under high pressure, for ensuring better binding and densification compared to the cold briquetting process the briquettes were preheated at 120 degrees Celsius for 20 minutes to facilitate better binding and compaction. Followed by heating, the strength of the hot briquettes was measured and recorded. Variations in the organic binder were tested to determine the most effective binder for producing high-quality manganese fines briquettes through the hot briquetting process.

Result and Conclusion

The cold briquettes produced by the use of Lime and molasses, have been tested for compression test. The results of compression test for 1, 48 and 72 Hrs of curing time of green briquettes with binder composition; 1 to 6 wt% limestone and 3 to 7 wt% molasses, are shown in Figure 3. It shows a slight decrease in strength is observed when increase in Molassses content in the briquettes, from the first to the third day of storage of briquettes made form 3%molasses and 6% Lime shows the optimum compression strength of 390 N and 1324N respectively. The standard deviation is approximately the same for the two storage times.

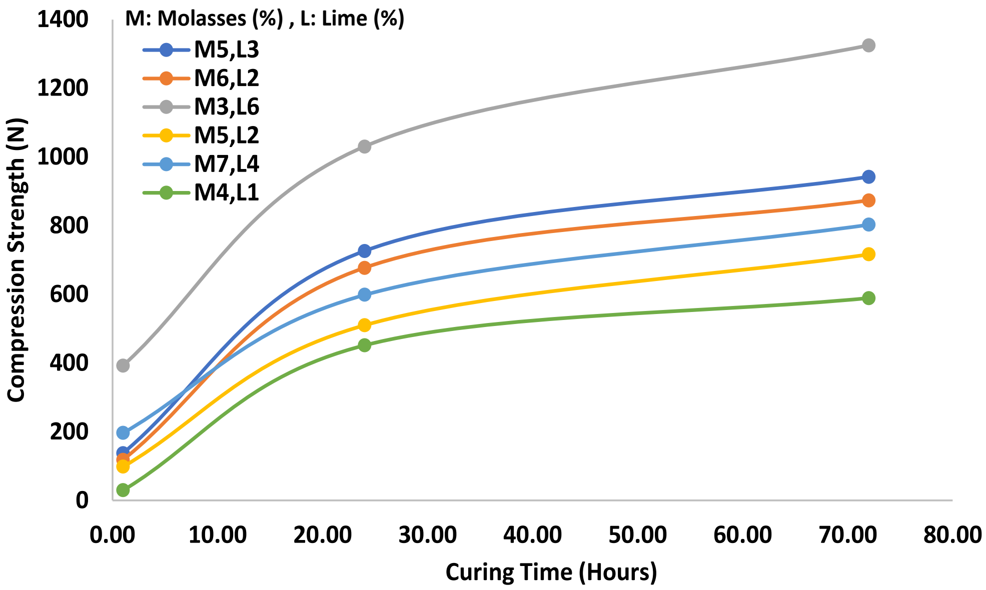

Figure 3: Results of Compression test of a cold Briquettes

The briquettes produced by the use of KIM-276, have been tested for compression test before and after preheating. The results of compression test for curing time of 120 min in a furnace of temperature 120 degrees with binder composition varied from 4, 6, 12 Wt%, are shown in table 1. It shows a slight decrease in strength is observed when increase in binder % in the briquettes, the results have shown that Molasses+ Lime combination have more strength than the binder KIM 276.

Table 1: Results of the compression test for hot briquettes

Sl N0	**Binder %**		**Curing Time**	**Avg Compression Strength (in N)**	
	KIM-276	**Curing Temp (°)**		**Before Preheating**	**After Preheating**
1	4	120	**in (N)**20 Min	667.08	765.18
2	6	120		362.97	696.51
3	12	120		598.41	725.94

Figure 4: Briquetting Machine and Briquette pictures

Innovation in the project

The project aims to optimize the use of manganese fines by converting them into valuable briquettes through a cost-effective and eco-friendly process. The investigation carried out with various materials and techniques, such as using molasses and lime as binders, to identify the most efficient method for briquette production. Notably, molasses, a central component of our process, is a byproduct of sugar production, further enhancing our resource efficiency. This approach helps industries reduce waste disposal costs while ensuring environmental sustainability. The briquettes produced not only minimize waste but also conserve resources by utilizing materials that might otherwise be discarded. Additionally, the use of eco-friendly binders is also been tested as a alternate to molasses. The project demonstrates that high strength briquettes is possible to make from manganese fines (dust) and can be effectively used in the ferro alloy manufacturing.

Scope for future work

- Further study is recommending to examine microscopic analysis to understand the binding mechanisms and internal binding of Mn and binder particles
- Further Study is also recommending to measure the yield of manganese in the electric arc furnace using these briquettes
- Economic analysis of the value-added product is recommended as future scope
- Development of alternative binder to avoid molasses is recommended as future scope.