Reuse the Grinding Sludge as an alternative Raw Material

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Abstract

The aim is to discover another viable raw material from the powdery grinding scraps or ground chips that are generated during the grinding of Mild Steel A36 Grade. These scraps are mixed with a coolant and discharged as sludge outside the grinding machines. A specially made filtering system is used to filter the sludge so that the coolant can be reused. The leftover sludge is usually disposed of by burying it in landfills. The water-based coolant produces a grinding sludge that can be compressed and appears as a wet powder containing 86.26% Iron (Fe) and 0.23% Silicon (SI). The goal is to transform this sludge into a useful Raw Material. To eliminate the Iron (Fe) particles, the wet samples are gathered and dried. Magnets are used for the elimination of Iron Fe particles from the dried dust of grinding sludge, where silicon impurities are segregated. The samples are subsequently rinsed several times with water to enhance the quality of the Iron (Fe) particles from the Grinding sludge. The dust oxy-fuel steel cutting torch utilizes temperatures ranging from 750 to 1500 C to enhance the hardness of the material. This is achieved by melting the separated Iron (Fe) Particles. As a result of the heating process, the oxygen in Fe2O3 is oxidized, and the dust is transformed into a solid irregular shape composed of pure solid Iron (Fe) particles. The dust oxy-fuel steel cutting torch makes use of a temperature range of 750 to 1500 C to enhance the hardness of the material. This is achieved by melting the Iron (Fe) Particles which are then separated. As a result of this process, the Fe2O3 oxygen is heated and oxidized, leading to the formation of irregularly shaped solid Iron (Fe) particles.

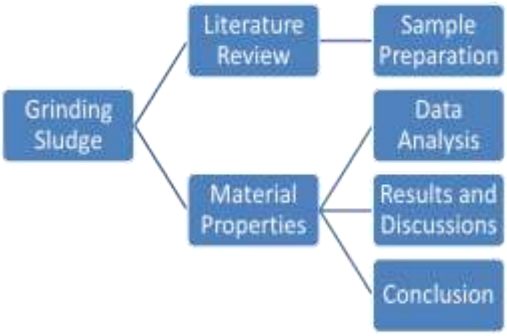
Keywords: A36 Grade Mild Steel, Grinding Sludge, Iron (Fe) Particles

1. Introduction

The waste product known as Grinding sludge is a byproduct of the Grinding process utilized in Mechanical Engineering Industries. Instead of discarding this sludge, manufacturers have discovered that it can be used as a viable substitute for low grade steel, as it possesses exceptional engineering properties and a long lifespan. The low cost of this material makes it ideal for use in developing countries, as it is more affordable than regular steel made from Iron ore. The study shows that the bearing properties of this material are closely linked to its form and it can be used as a substitute for low grade steel. It is evident that manufacturers are taking greater accountability for the environment, as evidenced by the growing number of companies producing eco-friendly iron oxide pigments. Transparency Market Research (TMR) predicts that the global market for these pigments will reach a value of 1958.1 million

USD by 2025. The objective of this project was to transform Iron (Fe) particles extracted from Grinding sludge into a viable substitute Raw Material for the steel industries. Our team employed a cost-effective approach that involved reintegrating the Fe particles into the conventional heating process, after subjecting the dried grinding dust to high temperature oxidation to eliminate both carbon and oxygen. The result was a successful conversion of the Fe particles into a useful resource for the steel industry. Nevertheless, approximately 10% of the overall production quantity is rendered as refuse. The expense associated with virgin Iron Oxide pigments is elevated in comparison to the Iron (Fe) Particles derived from the Grinding Sludge of industrial waste. The process of grinding Mild Steel plates produces a significant quantity of finely textured grinding sludge. The grinding sludge comprises of abrasive dust, Silicon particles, oil emulsions or oil utilized as a coolant. It is a significant contributor to industrial waste, generated from the process of grinding metal plates with varying grades. The grinding sludge comprises of abrasive dust, Silicon particles, oil emulsions or oil which is utilized as a coolant. The production of grinding sludge, which is a byproduct of grinding metal plates with varying grades, is a significant contributor to industrial waste. In light of the metallurgical worth of the grinding sludge, a technique has been formulated to retrieve the Iron (Fe) particle. The objective of the study was to devise a novel technique for retrieving Iron (Fe) Particles from grinding sludge, which would prove to be cost-effective and environmentally sustainable in comparison to the existing methodologies. A technique for the retrieval of Iron (Fe) particles has been devised, utilizing the grinding sludge that arises from the Rotary Grinding and surface grinding Machines employed in the processing of mild steels of diverse grades, including A36 and C45.

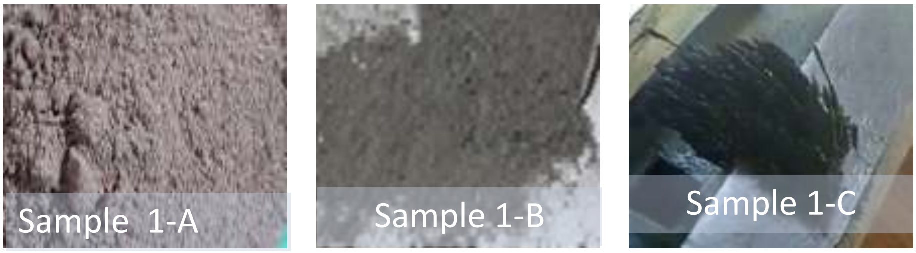
2. Methods and Material



The prescribed methodology for retrieving Iron (Fe) particles from the Grinding sludge of A36/C45 Mild steel plates entails the presence of Iron Fe particles, Silicon SI Particles, and other impurities in the form of sludge. The Coopermatic Filtering system is employed to eliminate the coolant oil, and the dry and wet residue from the grinding sludge is gathered in a bin. Please refer to the accompanying image

A. Material Collection

The sludge resulting from wet grinding is gathered and subjected to repeated washing in water to eliminate both the coolant oil and dust. The samples are then dried. During the washing process, silicon dust and other impurities are eliminated with the aid of clean distilled water that is used multiple times. Upon the third or fourth instance of washing, the water will exhibit a notable clarity devoid of any coolant oil impurities. To effectively segregate Iron Fe particles, a magnet is employed for the purpose of attracting said particles. Quality Iron (Fe) particles are drawn towards the magnet (as depicted in Figure 3-Sample 1-C), while the silicon particles remain suspended in the water. Subsequently, the Iron (Fe) particles that have been segregated are dispatched to the Laboratory for the purpose of determining the constituent elements in the specimen. The identification of the elements in the specimen will pave the way for further research discoveries. The fundamental aim is to isolate the Iron (Fe) particles.



Iron (Fe) particles that have been gathered and identified as Iron (III) oxide Fe2O3 can be transformed into Iron (Fe) particles through burning with coke or with the aid of an Induction Furnace. The process involves oxidizing the Fe2O3, as the melting point of Iron Fe particles is 1535 degrees centigrade. In order to determine the material properties of the sample, including its hardness and surface morphology, it is necessary to subject it to the heating process until it reaches its melting point. The conventional method of heating involves utilizing a domestic gas and oxygen nozzle typically employed for metal cutting (as depicted in Figure 5). The dry and wet dust particles of Iron (III) oxide, Fe2O3, were subjected to a heating process until they reached their melting point, resulting in the entire substance being in a molten state. Subsequently, the substance was cooled to normal atmospheric temperature, and after a 5-hour cooling period, it solidified (as depicted in Figure 6). The stage 2 sample has been prepared for further research

Stage 2 sample Fig 5

Figure 6

Stage 3 sample Fig 7

Figure 8

It has been determined, for research purposes, that the Stage 3 sample shall be prepared utilizing the same preparation method employed for the Stage 2 sample. The principal rationale for this decision is to enhance the hardness of the ultimate product subsequent to its melting, which is a solid metal alloy produced through the process of heating and oxidizing Fe2O3. Sample 1-C (as depicted in Figure 4) consisted of 45 grams of Iron (Fe) particles and 5 grams of Copper (Cu). The entire sample weighed 50 grams and was subjected to an oxygen pressure of 6 bar for approximately 4 minutes, resulting in the substance reaching its melting point and subsequently cooling to normal temperature. Stage 3 of the sample was observed to be solid and exceptionally rigid.

B. Material Properties

The collected Iron (Fe) particles ought to be small and possess qualities such as hardness, strength, density, durability, clarity, and purity, unlike other elements that may have been drawn in by the potent magnet. These particles exhibit the highest magnetic properties. The Scientific and Industrial Testing and Research Center (Si'Tarc) has been entrusted with the task of conducting chemical analysis on a specific set of samples. Sample 1 has been collected and will undergo analysis in three distinct stages. During the first stage, three samples will be prepared in the following manner.

Sample 1-A - Sample with impurities

Sample 1-B – Washed dry sample

Sample 1-C – Washed dry sample separated with the Magnet

With reference to Figure 2, it can be observed that Sample 1-A contains impurities, resulting in a lower percentage of Iron (Fe) particles at 66.06%. A visual inspection reveals the presence of significant amounts of silicon (Si) dust due to the grinding wheels' wear and tear, which results in the mixing of tiny silicon particles with the grinding sludge. Additionally, the sample is contaminated with oil.

By consulting Figure 3, it can be observed that Sample 1-B underwent several washes, leading to the elimination of impurities such as coolant oil and fine dust, as well as 86.26% of Iron (Fe) Particles. Upon visual inspection, the sample appears to consist of small, transparent particles that are completely dry.

With reference to Figure 4, Sample 1-C underwent several washes and was subsequently separated using a potent magnet, resulting in the separation of solely Iron (Fe) particles. The damp Iron (Fe) particles were then allowed to dry at room temperature for approximately 24 hours, on spread out a tissue paper. The laboratory analysis indicated a yield of 89.66% Iron (Fe) particles. The above method is cost effective and all the necessary steps such as magnetic separation, filtration, settling and sedimentation techniques are applied.

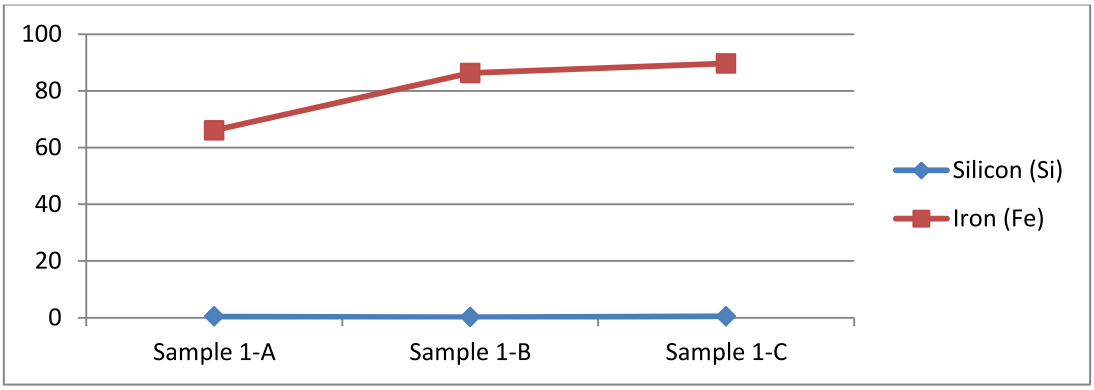
3. Results and Discussion

Sample 1-A - Sample with impurities

Sample 1-B – Washed dry sample

Sample 1-C – Washed dry sample separated with the Magnet

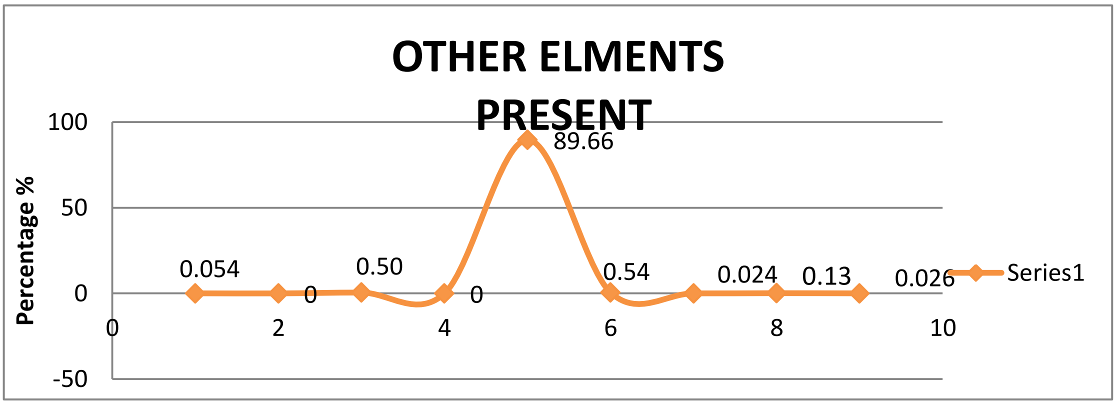
Grinding sludge	Weight	UOM	Silicon (Si)	Iron (Fe)
Sample 1-A	25	%	0.47	66.06
Sample 1-B	25	%	0.23	86.26
Sample 1-C	25	%	0.50	89.66



The aforementioned chart displays a comparison of Iron (Fe) particles, with 89.66% being obtained from Grinding sludge, a primary industrial waste. Sample 1-C has a higher percentage of Iron (Fe) particles, which is the main objective for its reuse as an alternative Raw Material. This study has been conducted for this reason. To progress to the next level of research, stage 2 and stage 3 samples have been prepared for further analysis. Figure 10 of the graph provides information on the additional components that are present in Sample 1-C. In addition to the predominant presence of Iron (Fe) particles at 89.66%, there are negligible amounts of Carbon (C), as well as traces of Sulphur (S), Silicon (Si), Phosphorous (P), Manganese (Mn), Nickel (Ni), Chromium (Cr), and Copper (Cu), as indicated in Table2

Table: 2 The chemical composition of grinding sludge

Sc Element	C	S	Si	Mn	Ni	Cr	Cu	Fe
Wt. %	0.054	-	0.50	0.54	0.024	0.13	0.026	89.66



Stage 2 samples melted iron particles have several important uses. They are used in casting and foundry, steel production, welding and fabrication, heat treatment. Melted iron is often combined with other elements to form various iron alloys with specific properties (refer figure 7 stage 3 sample) where we added copper and formed in a definite shape with improved hardness.

4. Conclusion

The chemical analysis report acquired from Si'Tarc Scientific and Industrial Testing and Research Center has revealed a greater concentration of Iron (Fe) particles in the grinding sludge that emanates from the mechanical manufacturing industries, commonly referred to as industrial waste.

The utilization of Iron (Fe) Particles for the production of lower quality steel is feasible. To progress with the research, the Stage 2 and Stage 3 samples are formulated and an investigation is to be conducted to determine the morphology of said samples, as well as the material's hardness. Iron (Fe) particles particularly in the form of powder are used in the production of magnetic materials. The Iron particles can be used in filtration systems to remove impurities and contaminants from liquids or gases and also can be used as a catalyst in certain chemical reactions. Iron oxide particles specifically used in ceramics and plastic industry. These can be incorporated into concrete and other construction materials to enhance their strength and durability.

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