# DRY MAGNETIC PARTICLES SEPARATION PROCESS BY USING BELT CONVEYOR


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DEPARTMENT OF MECHANICAL ENGINEERING

SONARGAON UNIVERSITY (SU)


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# DRY MAGNETIC PARTICLES SEPARATION PROCESS BY USING BELT CONVEYOR

A thesis report submitted to the department of Mechanical Engineering for the partial fulfilment of the award of degree of "Bachelor of Science in Mechanical Engineering "


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Letter of Transmittal

20 September, 2023

To

Hasan Tareq Mahin

Lecturer

Department of Mechanical Engineering.

Sonargaon University of Bangladesh

Subject: Submission of Project Report.

Dear Sir,

We are pleased to submit the project report on “Dry Magnetic Particles Separation Process By Using Belt Conveyor ". It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the Sonargaon University. We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours,

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# Declaration

This is hereby declared that this thesis or any parts of this thesis has not been submitted elsewhere for the award of any degree or diploma.

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# Abstract

Magnetic separation is an indispensable part of magnetic separation, and the dry magnetic separator can be selected under the condition of water shortage in China to ensure that our country can also be selected under the conditions of lack of some resources. The magnetic separator plays a role in improving the grade of ore, purifying solid and liquid materials, and recycling waste. With the application and development of magnetic separation technology, magnetic separation equipment is constantly updating and replacing, and dry magnetic separation has experienced remarkable technological progress over the past twenty years.

There are many new ideas and techniques applied in magnetic separators. So far, dry magnetic separators have developed many different applications for mineral and coal processing, for induction roller magnetic separators for chromite. Cross-belt magnetic separator for removing harmful magnetic particles and paramagnetic particles. The lifting roller magnetic separator is used in the heavy mineral industry to separate garnet from monazite and rutile. Rare earth drum magnetic separator for fine feed dry magnetic separation sorting process and rare earth roller magnetic separator for zircon and rutile in heavy mineral sand industry. These magnetic separators have different applications, and the dry magnetic separator is also moving toward large-scale and easy-to-manufacture.

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# Chapter 01
# Introduction

## 1.1 General

Selecting the proper magnetic separator requires an understanding of magnetic properties, the process application and environment elements that exist in each specific installation. This guide provides a basic understanding of how to choose the proper magnetic separator for different process requirements. Head roll magnets are available in various magnetic strength. A head roll magnet is mounted as a drive roller in a conveyor belt. Next, it will attract iron particles present in the product and deflect these to the bottom of the belt. There, the iron particles will be released from the magnetic field and collected in a funnel or a slide plate. Over belt magnets can be mounted both in line with and across the conveyor belt. All magnets have a short weakening pole at the end of the main pole, in order to promote releasing of iron particles. The magnetic field will become steadily weaker, as a result of which iron particles will be released easier and are less likely to return to the magnetic pole.[1]

There are different methods for classifying magnetic separators, but grouping of these units based on magnetic field strength can be divided into:

(1) Dry electromagnetic magnetic separator, e.g., Induction roller magnetic separator, Lift roller magnetic separator, and Cross belt magnetic separator;
(2) Dry permanent magnet magnetic separator. e.g., rare earth roller magnetic separator and rare earth drum magnetic separator

## 1.2 Objectives

- To remove ferrous contaminants that's, occur occasionally in product lines, particularly large pieces of metal such as nuts, bolts or staples from dry products
- To be an excellent machine to separate magnetic materials from concretes.

- To removes natural magnetic minerals such as magnetite as well as steel filing from metal processing material and iron particles.
- To remove magnetic like gold concentrates, because it allows gold to recover much more easy.
- To remove high level of ferrous contaminants from liquid, helping with recycle and reuse goal.

## 1.3 Motivation

Our body has small amount of metals in it already like iron, copper and zinc. These metals are important to keep our organs functioning. If we have too much metal accumulated within our body it can damage our vital organs like brain and liver. Once inside of our body, the metals reside in our blood or tissues, which spreads from our head to our toes.

Heavy metals fight with components in our Cells like enzymes and protein. If our organs aren't able to do his job because they're bullied by heavy metals, we experience symptoms of heavy metal poisoning that can be life threatening without treatment.

The innovation of magnetic separator, we are able to eat safe food and use products that are free of dangerous materials. In industries, magnetic separator also protects equipment from serious damage by keeping the line clear of hazardous metal scraps. Food, Dairy, Grain and Milling Chemical, Plastic, Oil, Textile, Recycling, Powder and Bulk, Mining or the Non-woven industries, magnetic separation applications are crucial to the success if business. [2]

By reviewing the above information, we consider how to separate iron from goods very easily and quickly.  We decided to make a magnetic separator which is also a product conveyor.

## 1.4 History of Magnet Separation

Michael Faraday discovered that when a substance is put in a magnetic environment, the intensity of the environment is modified by it. With this information, he discovered that different materials can be separated with their magnetic properties.
In the 1860s, magnetic separation started to become commercialized. It was used to separate iron from brass. After the 1880s, ferromagnetic materials started to be magnetically separated. In the 1900s, high intensity magnetic separation was inaugurated which allowed the separation of pragmatic materials. After the Second World War, systems that were the most common were electromagnets. The technique was used in scrap yards. Magnetic separation was developed again in the late 1970s with new technologies being inaugurated. The new forms of magnetic separation included magnetic pulleys, overhead magnets and magnetic drums.[5]

In mines where wolframite was mixed with cassiterite, such as South Crafty and East Pool mine in Cornwall or with bismuth such as at the Shepherd and Murphy mine in Moina, Tasmania, magnetic separation is used to separate the ores. At these mines, a device called a Wetherill's Magnetic Separator (invented by John Price Wetherill, 1844–1906) was used. In this machine, the raw ore, after calcination was fed onto a conveyor belt which passed underneath two pairs of electromagnets under which further belts ran at right angles to the feed belt. The first pair of balls was weakly magnetized and served to draw off any iron ore present. The second pair were strongly magnetized and attracted the wolframite, which is weakly magnetic. These machines were capable of treating 10 tons of ore a day.

# Chapter 2
# Literature Review

## 2.1 Development of Magnet Separation

When a magnetisable particle is placed in a non- homogeneous magnetic field, it is acted upon by the magnetic force ($F_m$) given by the above equation. Magnetic force is thus proportional to the product of the external magnetic field and the field gradient and has the direction of the gradient. In a homogeneous magnetic field, the force on a particle is zero.

In a magnetic separator several competing forces are acting on the- particles. These are, among others, the force of gravity, the inertial force, the hydrodynamic drag, and surface and inter-particle forces. This situation is shown schematically
in Fig. 2.1. The force of gravity can be written as

$$Fg = p\,V\,g \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where, p is the density of the particle. The hydrodynamic drag force is written as

$$Fd = 6\pi\Pi dp\ vp \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where, Π is the fluid viscosity, $d_p$ is the particle size and $v_p$ is the particle velocity relative to the fluid.

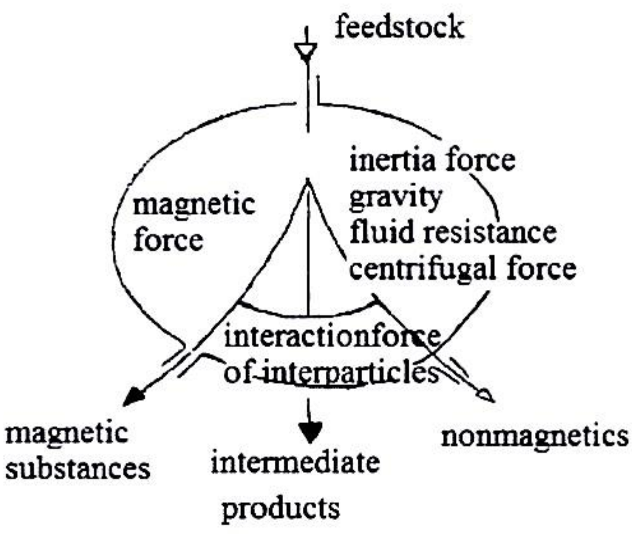


Fig. 2.1. Schematic diagram of magnetic separation.

Magnetic particles will be separated from nonmagnetic (or more magnetic particles from less magnetic particles), if the following conditions are met:

$$F_m^{mag.} >E\ F_c^{mag.} \text{ and } F_m^{nomag.} >E\ F_c^{nonmag.}$$

where $F_c$ is a competing force while $F^{mag.}$ and $F^{nonmag.}$ and non-magnetic particles, respectively.

In order to achieve high recovery of magnetic particles, the magnetic separating force must thus be greater than the sum of the competing forces, as shown in the above equation. If, however, magnetic force is much greater than the competing force, selectivity of separation will be poor, as no distinction will be made between various magnetisable particles. The selectivity of the process will be critically deter- mined by the relative values of the magnetic and competing forces. And these are affected by a correct choice of a separator itself and its operating conditions.

Although the conditions of efficient separation are clearly defined, a complication arises because the relative significance of the forces is determined mainly by the particle size. It can be seen from the above Equations that while $F_m \infty d_p^3$ or $d_p^2$, the competing forces have the following dependence on particles size: $F_d \infty d_p^1$ and $F_g \infty d_p^3$. In dry magnetic separation where $F_d$ is usually negligible, the particle size, as a rule, does not affect the efficiency of separation significantly because of the same particle size dependence of the magnetic force and of the force of gravity. On the other hand, in wet separation where the hydrodynamic drag can be important, selectivity of the separation wilt be influenced by particle size distribution. With decreasing particle size the relative importance of the hydrodynamic drag increases in comparison to the magnetic force. [4]

The non-selective nature of the magnetic force is illustrated in Table 2.1. It can be seen that the same magnetic force is exerted on a coarse, weakly magnetic particle as on a small, considerably more strongly magnetic particle. Both particles will appear in the same product of separation unless the competing forces affect particles of different sizes in a different manner.

Table 2.1: The effect of particle size on sepability (with arbitrary units)

| Particle size | Magnetic Susceptibility | Magnetic Force |
|---|---|---|
| 10 | 10 | 1000 |
| 01 | 1000 | 1000 |

# 2.2 Types of Magnet Separation

## 2.2.1 Drum Type Magnet Separation

Magnetic Drum Separators are used to separate metal particles from slurries, granules or powders. These industrial magnets work on a high-volume basis for applications where there is a great deal of continuous turnover of product. These continuous self-cleaning drum magnets are ideal for applications where there is a high level of ferrous and para-magnetic contamination.
As material is introduced to the drum surface, a magnetic field attracts ferrous material to the rotating outer drum. This action continually conveys the captured ferrous material out of the product flow to the ferrous discharge area creating a self-cleaning action.

Common uses for magnetic drum separators include magnetite recovery in heavy media mining circuits, tramp metal extraction, and product purification.

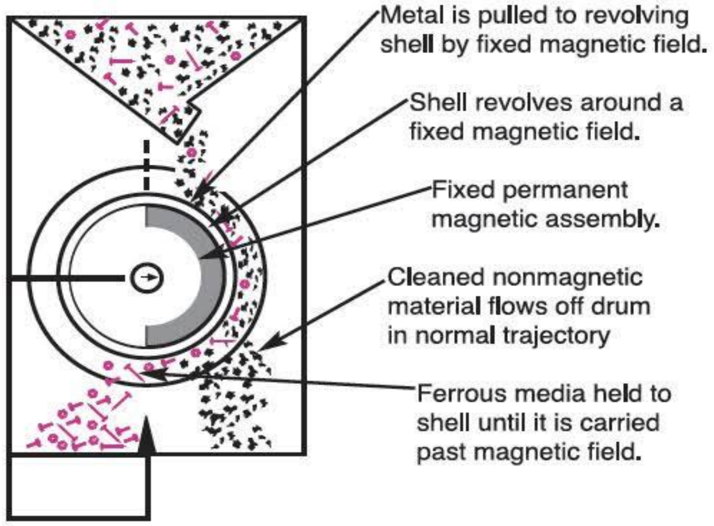


Fig. 2.2.1 Drum type magnet Separation

## 2.2.2 Cross Belt Magnet Separation

Cross Belt Magnetic Separators are used to remove tramp iron from conveyed materials by pulling the tramp upwards through the material against the force of gravity. They are very powerful magnets and are generally suspended above conveyor belts. Magnetic separation with belt pulley.

Incorporated is a motor-driven magnetic conveyor belt running across the face of the magnet, continuously moving the collected material away from the magnetic field. The removed material falls away from the belt once it leaves the magnetic field, making it a self-cleaning suspended magnetic conveyor belt separator.

It must be stressed that overhead magnets are not metal detectors, and they will only operate on magnetic materials. They will not react to authenticate steels or non-ferrous items.[6]
Medium Intensity Permanent Magnetic Cross Belt Separators are used where the material to be separated is large enough to get acted upon by medium magnetic fields from large distances. These separators find ease in picking up large ferrous material from around 200mm depth. However, if the material size is smaller and the burden depth is larger, these separators become inefficient.

High Intensity Permanent Magnetic Cross Belt Separators are employed at locations where separation of ferrous material is required from a distance for around 300 mm. This type of separator is useful in picking p bolts and nuts, channels, angles, and metal pieces from distances.

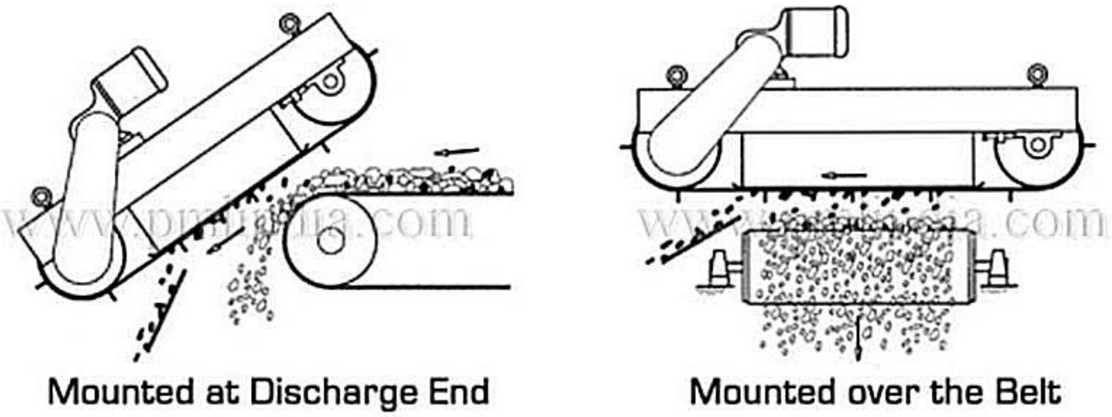


Fig. 2.2.2 Cross Belt type magnet separation

## 2.2.3 Roll Type Magnet Separation

Bunting's Induced Roll Separator offers continuous extraction of magnetic particles for optimal mineral purification. The induced roll separator continuously extracts small magnetic particles from minerals being processed, resulting in a final mineral product of exceptional purity. This separator is an excellent choice for implementation in a wide range of mineral and ceramic processing industries. Most commonly, the induced roll separator is used to separate weakly magnetic or paramagnetic minerals from non-magnetic minerals when material is in a dry state. These non-metallic minerals are widely used in the production of plastics, ceramics, paper, glass, and many other common materials. Feldspar and silica sand are examples of minerals that are typically processed.

While in operation, magnetic material attaches itself onto the roll face, or is deflected towards the roll. Any material that is non-magnetic is thrown from the face of the roll at a normal trajectory. When magnetic material reaches a point of lower magnetic intensity, it is discharged off the roll face (aided by a brush). Between the two product streams, a splitter plate is interposed

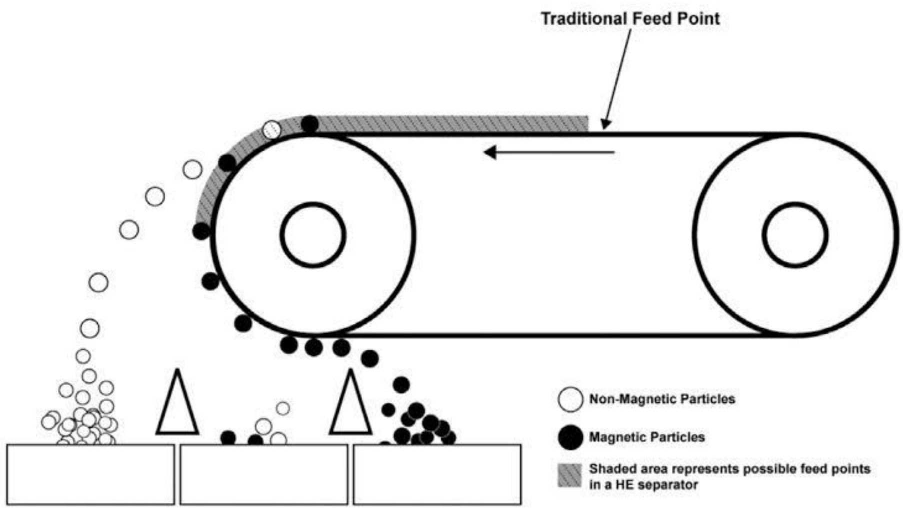


Fig. 2.2.3 Roll type Magnet Separation

## 2.2.4 High-Gradient Magnet Separation

HGMS is effective in separating or filtering fine and weakly magnetic particles and widely applied in mineral processing, water treatment, cell and protein purification. The magnetic matrix is a crucial device used in magnetic separator to generate high magnetic field gradient and provide surface sites for capturing magnetic particles. The material, geometry, size and arrangement of the matrix elements can significantly affect the gradient and distribution of the magnetic field, and the separating or filtrating performance. [6]

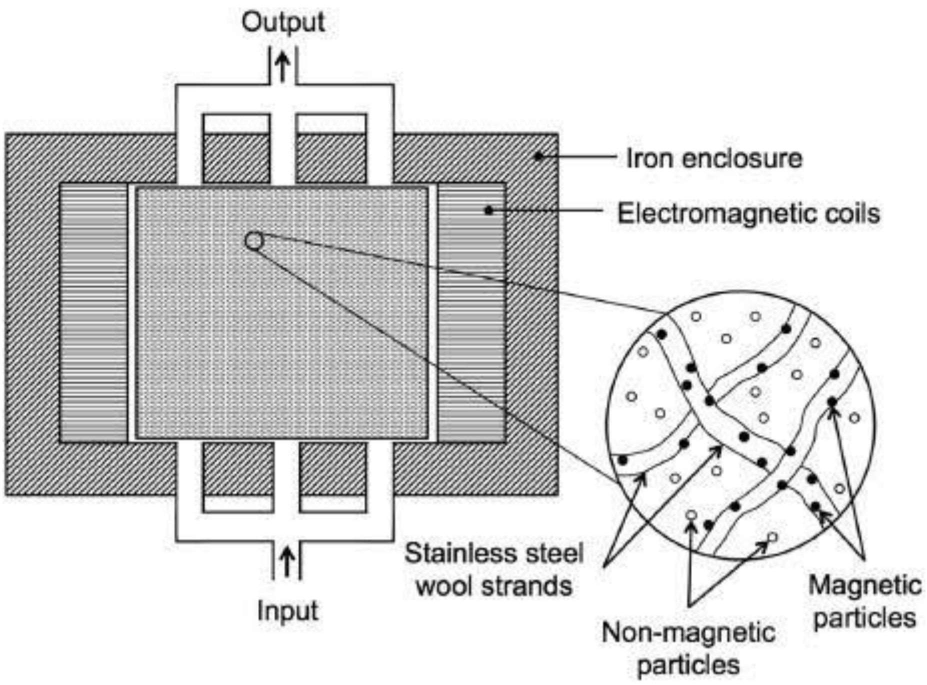


Fig. 2.2.4 High Gradient Magnet Separation

## 2.2.5 High-intensity Magnet Separation

In the recent past the problem of removing the deleterious iron particles from a process stream had a few alternatives. Magnetic separation was typically limited and moderately effective. Magnetic separators that used permanent magnets could generate fields of low intensity only.

These worked well in removing ferrous tramp but not fine paramagnetic particles. Thus high-intensity magnetic separators that were effective in collecting paramagnetic particles came into existence. These focus on the separation of very fine particles that are paramagnetic.

The current is passed through the coil, which creates a magnetic field, which magnetizes the expanded steel matrix ring. The paramagnetic matrix material behaves like a magnet in the magnetic field and thereby attracts the fines. The ring is rinsed when it is in the magnetic field and all the non-magnetic particles are carried with the rinse water. Next as the ring leaves the magnetic zone the ring is flushed and a vacuum of about – 0.3 bars is applied to remove the magnetic particles attached to the matrix ring.[7]

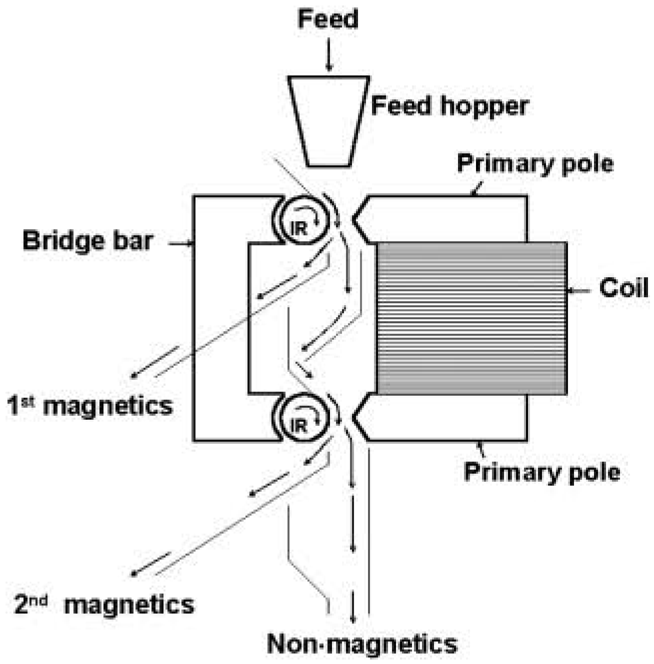


Fig. 2.2.5 High-intensity Magnet Separation

## 2.2.6 Low-intensity Magnet Separator

LIMS are designed around the revolving magnetic drum with an internally stationary magnetic array. They are available in several types for vast number of duties and could be seen as split into two categories, dry separation and wet separation.

The dry models are intended predominantly for material 2 to 200 millimetres in dry or nearly dry state like crushed iron ore.

The wet versions are designed for material of a few micrometres size to less than around 6 - 8 millimetres suspended in water. For both separator types two magnetic systems are available for highest possible efficiency of each application. [8]

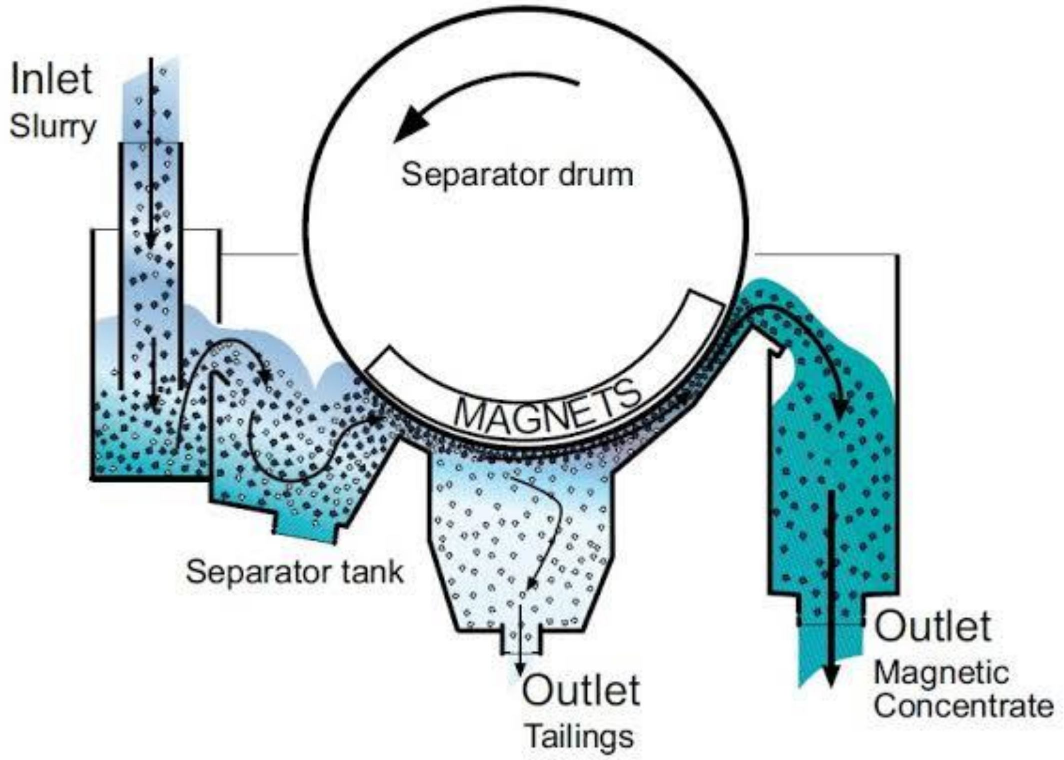


Fig. 2.2.6 Low-intensity Magnet Separation

# Chapter 3
# Methodology

## 3.1 Working Process of Rare Earth Roller Magnetic Separator

RERMS is a permanent high intensity magnetic separator, mainly paramagnetic mineral dry sorting machine having the higher operating costs. With the advent of the rare earth permanent magnet material roll magnetic separator, we have been successfully configured to use larger magnetic roll separator electromagnetic alternating laminations of magnetic and non-magnetic . The RERMS feed material is introduced onto a magnetic roller with a ribbon, and the magnetic particles are attracted by the magnetic roller. The non-magnetic particles are rejected by centrifugal force, gravity and other forces due to lack of magnetism. A schematic of particle separation in RERMS is shown in Figure 3.1. Rare earth permanent magnet improved availability and affordability further extends the applicability of the sorter drum moderate or even weakly magnetic material. Moreover, when the material enters the magnetic zone, no material rebounds or scatters under the action of the magnetic force, and all materials enter the magnetic region at the same horizontal velocity. All of this helps to separate the magnetic material from the non-magnetic material. Moreover, the use of rare earth permanent magnets can greatly reduce the quality and size of the induction roller magnetic separator. [9]

Because of the excellent separation efficiency of RERMS, they replace the traditional electromagnetic high-strength magnetic separator. Roller Magnetic capacity depends on the diameter of the roller. Diameter of the roller magnetic separator is determined according to the particle size to be treated. Therefore, the roller magnetic separator is more efficient and can be adjusted more easily according to needs. It is not only effective and efficient means of conventional particle size, but also particularly effective for finer particles (<75μm) work material. In addition, samples from Turkey feldspar are processed to sorting coloured impurities in the RERMS. Non-magnetic parts composed of feldspar and quartz and minimal titanium and iron oxide were found to be suitable for the ceramic industry.

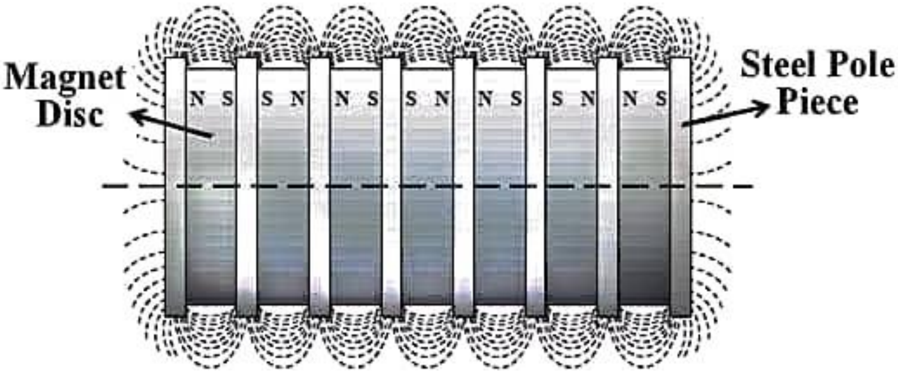


Fig 3.1 : Magnetic field generated on a roller magnetic separator.

## 3.2 Effect of Variables on Particles Separation

The parameters affecting the RERMS sorting process can be divided into three categories: design variables, process variables, and feed characteristics. The results show that the diameter of the roller, the magnetic field strength of the roller, the design type and magnetic steel ratio, the type and thickness of the belt, and the sorting grade are all key design parameters in RERMS. In addition, it was found to control the separation process variables is critical to achieving optimal performance on grade and recovery. Therefore, the feed rate, magnetic separator position, feed rate, and feed depth on the RERMS belt are key parameters for controlling separation efficiency. In addition, particle size, density, shape, and distribution feed susceptibility characteristics in the design and optimization process is critical. [10]

### 3.2.1 Effect of roll speed, feed rate and split position

Roller speed and feed rate are important parameters that are often adjusted based on changes in industrial feed characteristics. Separation of impurities in iron-containing perlite was studied by a permanent magnet roller magnetic separator. It was found that Fe2O3 content and particle size varied at different separation stages of different roll speeds. By changing important variables such as roll speed and feed rate, it is possible to optimize the production of high-quality glass products. In some literature has appeared similar test, the powder was observed in the separation of a fluid catalytic cracking (FCC) in the belt to affect the type and thickness of the belt. There is another study based on the separation of hematite from silicate-containing gangue minerals. The influence of the interaction between the roll speed, the feed rate and the split position of RERMS on the low-grade ore hematite fine powder was studied from the slope of the three-dimensional surface map. As a result, it was found that the roll speed and the position of the magnetic separator have a more significant influence than the feed rate. The analysis was performed from the slope of the three-dimensional surface map. It was found that the grade of the magnetic product increased as the roll speed increased, and the intermediate level was also reflected as a higher value of the separation efficiency.[12] However, the roll speed is further increased beyond the peak, resulting in decreased quality. This change in mass may be due to the fact that the increase in roll speed makes the net resultant force on the hematite particles not optimal. It is clear that the RERMS roll speed determines the separation of particles on a given magnetic roll. Similarly, the interaction can be observed along with other variables and recovery results.

## 3.2.2 Particle size effect

Particle size is an important parameter for magnetic selection, which determines the other design of the magnetic separator and the corresponding adjustment of the process parameters during the separation process. Ibrahim et al. studied the effect of magnetic separator position and roll speed on particle separation of different particle size components. It has been concluded that the closed particle size range has better efficiency in this type of magnetic separator compared to a wider particle size range feed. Many authors have analysed the effect of particle size on RERMS separation. The effect of particle size on a given magnetic field is well analysed for particle trajectories and product mismatch (Tropics et al., 2017). Figure 3.2 analysis the effect of feed size on the efficiency of a particle size-based RER magnetic separator in an interesting manner. The particle trajectories of these non-magnetic particles are determined only by the centrifugal force. When the non-magnetic particles and allowed to drop unhindered movement in the roll, substantially according to their particle size, the particle size decreases as shown in FIG. 3.2. The large particles will move further from the smaller centreline of the roll.[13] Thus, usually lower than the surface velocity of small particles to large particles treated. When a magnetic roller is used, magnetic particles having a stronger magnetic field are usually pinned on the surface of the roller until they are released from the magnetic field, and magnetic particles having a weak magnetic field can only be deflected by the magnetic field, causing them to deviate from the normal path. When this happens, overlap occurs in the larger-sized weak magnetic particles and the small non-magnetic particles. If a product separator is provided to eliminate the large size weak magnetic particles, many small non-magnetic particles will be incorporated into the magnetic product. This is due to the entrainment of the magnetic portion by the non-magnetic fine particle fraction. On the other hand, when the product magnetic separator is set to recover non-magnetic particles of a relatively small size, the non-magnetic product after sorting will contain many large-sized weak magnetic particles. This problem can generally be divided into closed magnetic separation after sorting by particle size and components to overcome the feedstock. In addition, these components can be separated in multiple stages to track, to enhance the recovery.

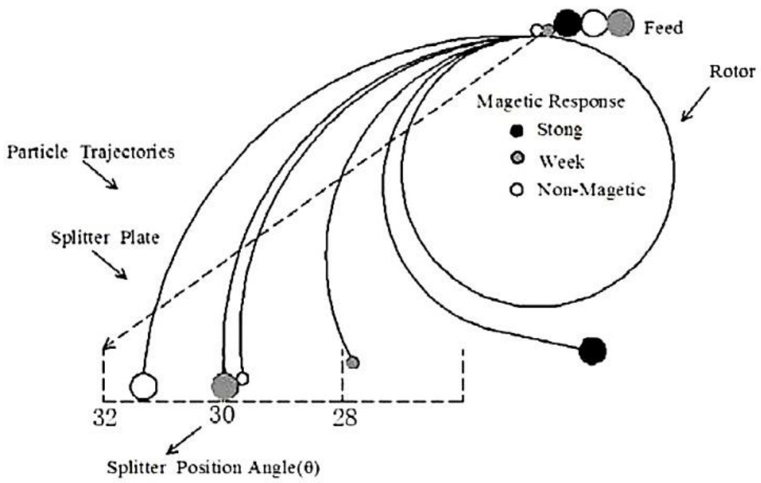


Fig 3.2 : Particle trajectories for different particle size and magnetic susceptibility.

## 3.3 Project Overview

Magnetic separation method: The main parts of this machine are two types of iron rollers and the conveyor belt continuously moving around them. One of the rollers is nonmagnetic while the other is electromagnetic the conveyor belt moving around the rollers is made up of leather or brass (nonmagnetic). The powdered ore is poured at that end of the conveyor belt which is on the side of the nonmagnetic roller. Two collector vessels are placed below the magnetic roller. The particles of the nonmagnetic part in the ore are not attracted towards the magnetic roller. Therefore, they are carried out further along the belt and fall in the collector vessel which is away from the magnetic roller.[14] Simultaneously the particles of the magnetic ingredients of the ore stick to the magnetic roller and therefore fall in the collector vessel near the belt.

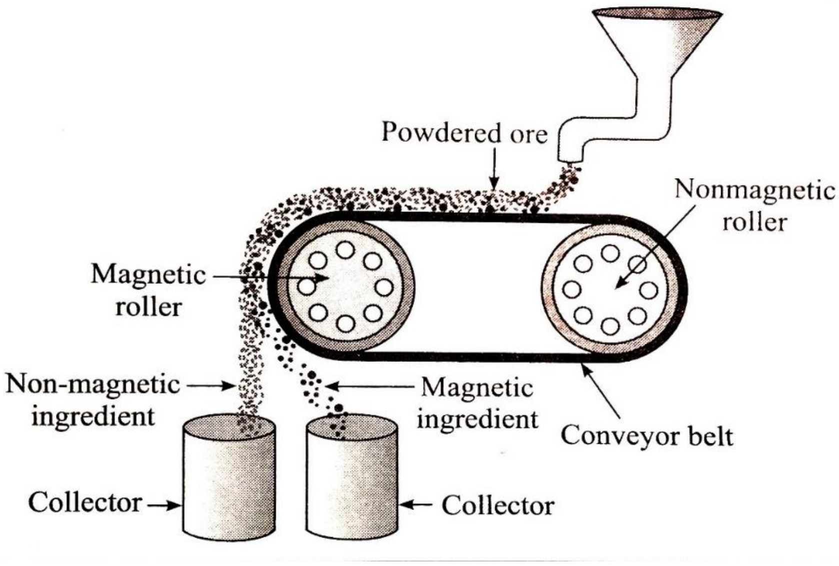


Fig 3.3 : Magnetic Separation Method

In this way the magnetic and nonmagnetic particles in the ore are separated because of their magnetic nature. For example. cassiterite is a tin ore. It contains mainly the nonmagnetic ingredient stannic oxide ($SnO_2$) and the magnetic ingredient ferrous tungstate ( $FeWO_4$). These are separated by the electromagnetic method.[20]

## 3.4 Block Diagram

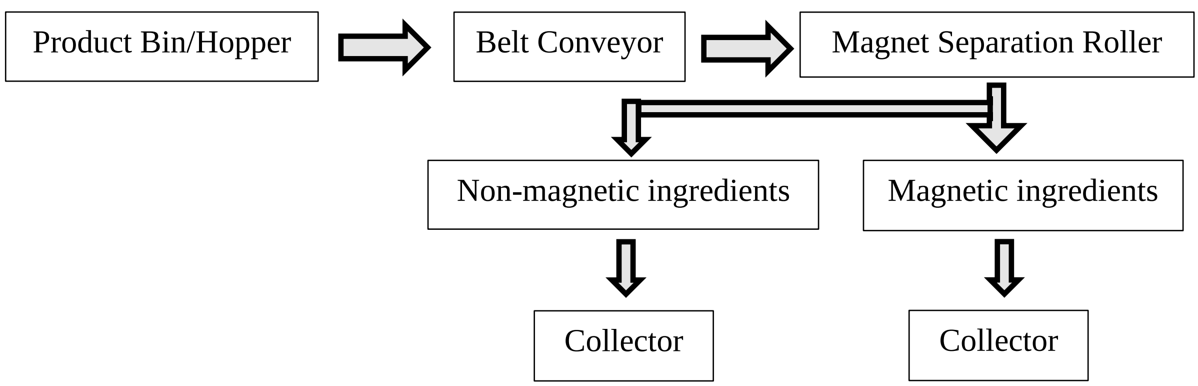


Fig. 3.4: Process Block Diagram

# 3.5 Experiment Setup

## 3.5.1 Fabrication Process

- We cut angle bar as per drawing for Base.
- Both roller stand are cutting as per drawing dimension.
- Using MS Pipe as a non-magnetic roller.
- Using a magnetic roller which is drive head.
- Cutting sheet for hopper and fitting as per design.
- When all equipment are ready (Base, Stand) we start welding.
- Bearing Point is cutting in lath machine.
- Belt making as per design and setup.
- We use a tension for preventing loss the conveyor belt.
- Finally complete, we run and trail the machine and it works properly.

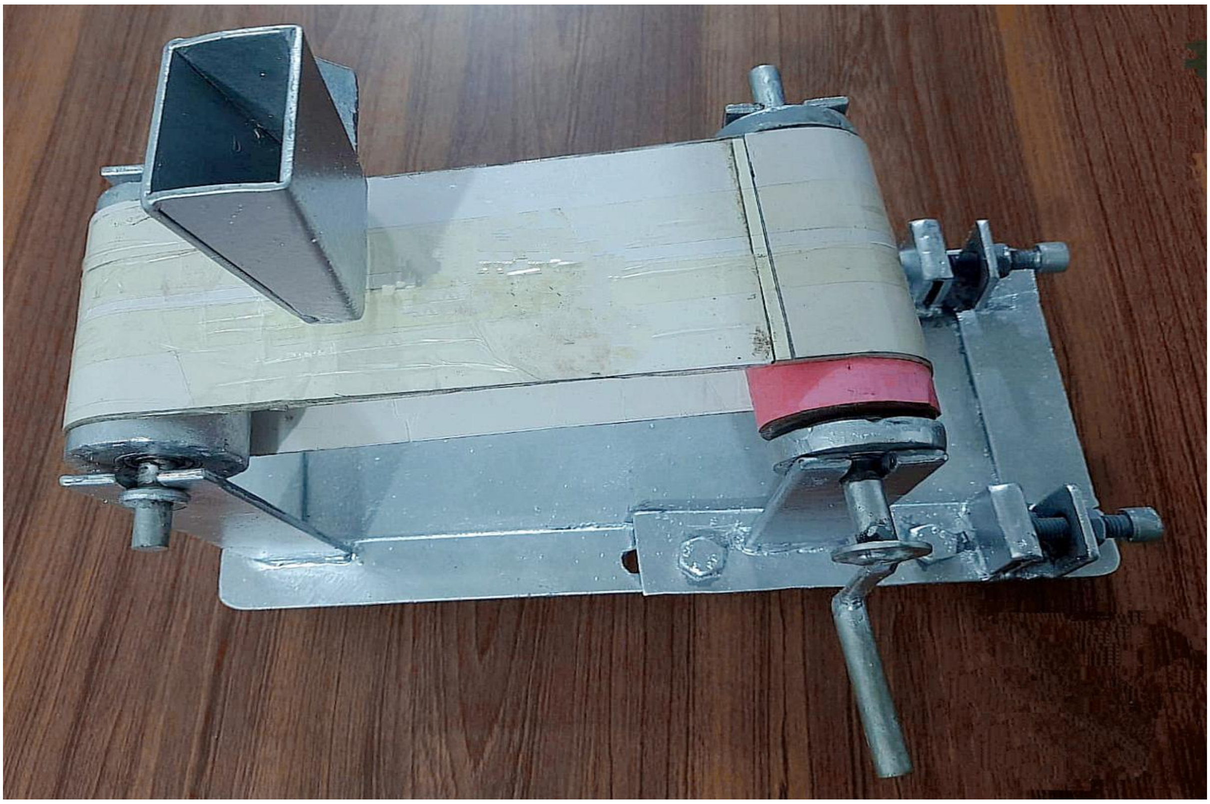

Fig. 3.5.1 Schematic of Project View

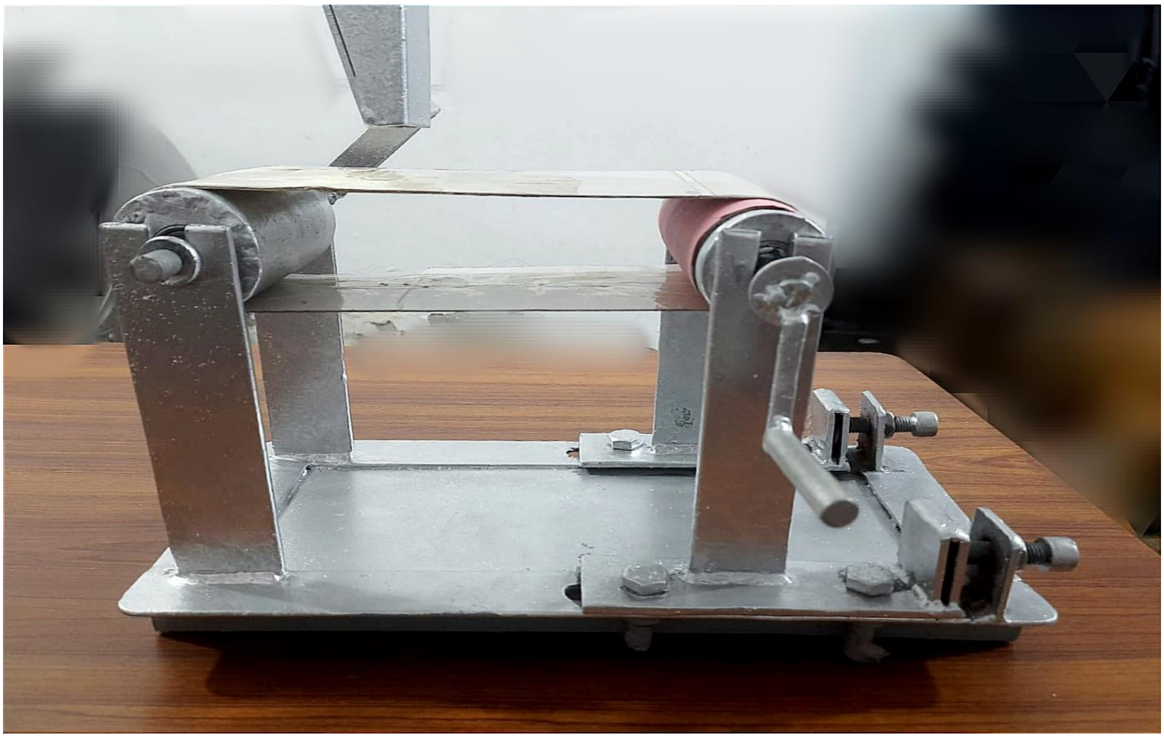

Fig. 3.5.2 Schematic of Project View

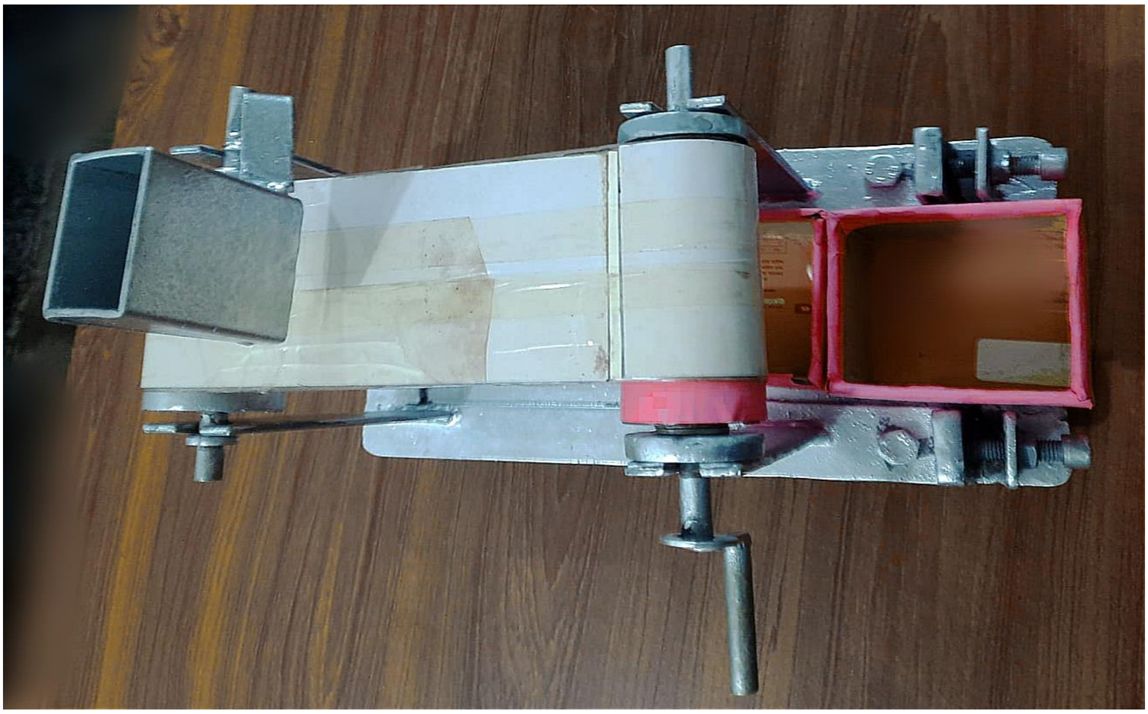

Fig. 3.5.3 Schematic of Project View

## 3.6 Require Equipment & Costing

### Items Details with Figure

01. Item Name: M.S Angle Bar
Dimension: 50*50*5 mm
Quantity: 4 Feet
Materials: Mild Steel
Purpose: Use for base.

Fig. 3.6.1 M.S Angle Bar

02. Item Name : M.S Plate
Dimension : 600*350*8 mm
500*300*4 mm
300*200*12 mm
Quantity : 1+1+1 pcs
Materials : Mild Steel
Purpose : Use for support and magnet extension.

Fig. 3.6.2 : M.S Plate

03. Item Name: M.S Shaft
Dimension : 350*8 mm
Quantity : 1 Pc
Materials : Mild Steel
Purpose : Use for roller shaft.

Fig. 3.6.3: M.S Shaft

04. Item Name: M.S Sheet
Dimension : 400*300*2.5 mm
Quantity : 1 Pc
Materials : Mild Steel
Purpose : Use for Bins.

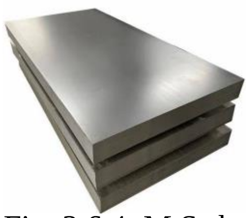

Fig. 3.6.4: M.S sheet

05. Item Name: Ball Bearing

Model No. : 6001-2Z/C3

Quantity : 04 Pcs

Materials : Chrome Steel

Purpose : Use for holding roller shaft.

Fig. 3.6.5: Ball Bearing

06. Item Name: Magnets

Dimension : OD- 52 mm, Thickness -12 mm

Quantity : 05 Pcs

Materials : Neodymium (NdFeB)

Purpose : Use as magnetic roller for extract metal.

Fig. 3.6.6: Magnet

07. Item Name: M.S Pipe

Dimension : OD-55 mm, Length -110 mm

Quantity : 01 Pc

Materials : Mild Steel

Purpose : Secondary Non-magnetic Roller.

Fig. 3.6.7: M.S Pipe

08. Item Name: Conveyor Belt

Dimension : 800*95 mm

Quantity : 1 Pc

Materials : Rubber

Purpose : For carry products from the bin.

Fig. 3.6.8: Conveyor Belt

09. Item Name: Paint

Colour : Grey Oxide

Quantity : 2 Gallons

Materials: Liquid

Purpose : For painting


Fig. 3.6.9: Paint

10. Item Name: Electrode

Dimension : 3.2*229 mm

Quantity : 30 Pcs

Purpose: Welding the project.

Fig. 3.6.10: Electrode

**Table 3.1 : REQUIRE EQUIPMENT AND COSTING.**

| SL | Items Name | Specifications | Quantity | Price | Use for/Purpose |
|---|---|---|---|---|---|
| **01** | M.S Angle Bar | 50*50*5 mm | 4 feet | 1200.00 | Base. |
| **02** | M.S Plate | 600*350*8 mm | 1 Pc | 1550.00 | Support Stand. |
| **03** | M.S Plate | 500*300*4 mm | 1 Pc | 1200.00 | Support Roller. |
| **04** | M.S Plate | 300*200*12 mm | 1 Pc | 860.00 | Magnetic roller extension. |
| **05** | M.S Shaft | 350*8 mm | 1 Pc | 350.00 | Roller inside shaft. |
| **06** | M.S Sheet | 400*300*2.5 mm | 1 Pc | 750.00 | For product bin. |
| **07** | Ball Bearing | 6001-2Z/C3 | 4 Pcs | 880.00 | Holding roller shaft. |
| **08** | Magnets | OD-52mm; Thickness 12mm | 5 Pcs | 1050.00 | Extract metal. |
| **09** | M.S Pipe | OD-55mm; L-110 mm | 1 Pc | 280.00 | Non-magnetic roller. |
| **10** | Conveyor Belt | 800*95 | 1 Pc | 100.00 | Carrying products. |
| **11** | Paint | Gray Oxide | 2 Gallon | 200.00 | Painting. |
| **12** | Electrode | 3.2 mm | 30 Pcs | 350.00 | Welding. |
| **13** | Others | -- | -- | 1500.00 | |
| | | | Total Cost - | **10270.00** | /= |

# Chapter 4

# Results & Discussion

## 4.1 Procedure of Testing & Experiment

4 Put some corn which is mixed with ferrous metal in hopper/Product bin.

5 Start rolling the moving belt with the help of two rollers.

6 Corn is non-magnetic so it pulls down at the end of belt conveyor but ferrous metals are close contact with magnets.

7 Ferrous metal is disconnected later and they pulldown a small distance from corn.

8 This is the way of separation and more than 97% metal we removed successfully.

## 4.2 Results

- We try to magnet is more efficiency and less maintenance of drives and bearing.
- We use more lubricant to reduce friction.
- We try to improve performance if rare earth magnetic separators and separators due not suffer from similar drawback.
- Magnetic separator greatly reduces nails, scrap iron particles and staples.
- The permanent magnetic drum separator is removed ferrous metal and dry bulk product.
- Magnetic separator is one of the ways of separating heterogeneous solid by mixture.
- We experiment in different types of ingredients as like Wheat, Paddy. Rape Seeds, Soya Seeds, Corn, Coal, Sand, Plastic etc.
- In the ceramic industry, magnetic separator can remove the iron mixed in the patents and improve the quality of the ceramic product.
- Magnetic separator can also be used in coal firing sand making, refractory and other industries that need delroning.
- It works properly and separate iron from Wheat, Paddy. Rape Seeds, Soya Seeds, Corn more than 98%.
- In coal medium it can separate more than 97% iron.

- In sand medium, it can separate more than 96% iron.
- In our experiment, we have better result from grains.
- Overall magnetic separator efficiency more than 97% and it’s working smoothly.
- There are five main types of permanent magnet material; these are, in order of strength from strongest to weakest, neodymium, samarium cobalt, alnico, ferrite, and flexible rubber.
- Magnetic Separation is a method of Waste management where magnets are used to separate metal from Refuse.

## 4.3 Discussion

Magnetic separators and Metal separators play a vital role in protecting key manufacturing process from potentially harmful and costly metal particle contamination. A product recall could potentially cost the manufacture huge sums of money, not to mention damage to brand confidence. Magnetic Separations take advantages of natural magnetic properties between minerals in feed. In the magnetic separation process, Magnets are collecting magnetic force, also known as the force of magnetic trap. [16]

A magnetic separator applies basic magnetic principles to remove ferrous based and paramagnetic metals from a range of substances including powders, granules, liquids, pellets or pastes. The raw material or finished product is feed either by gravity, air, pumped or conveyor belt where it passes through or over a magnetic rod, grid, grate or plate. The magnetic field captures the ferrous contamination by attracting it to the magnetic tube or plate. The non-magnetic clean product continues through the process.

Magnetic separators are effective in any sector which has risk of ferrous particle ingress. Safety critical processes such as food, pharmaceuticals and chemicals use both primary and secondary separator to protect powders, chocolate, tea and cereal. In other industries such as recycling and construction materials primary separation may be adequate, typical examples include cement, aggregates wood chips, plastic or glass recycling.
There are various types of magnetic separator, the choice is dependent on the feed method and the substance being fed. They are typically split into 2 (two) groups (1) primary magnetic

separators and (2) secondary magnetic separators. Primary separators are used to prevent machinery damage such as nails, screws, bolts and Secondary separators guarantee product purity and removing ultra-fine particle ferrous contamination such as natural process machinery wear. [17]

Different magnet materials have different properties, so the choice is very important. The latest high intensity magnetic separator use Neodymium Magnets. This is the strongest magnet material and is effective in extracting the finest ferrous and paramagnetic particles.

# Chapter 5

# Applications and Scope

## 5.1 Applications

A magnetic separator is often used for industrial purpose such as:

- Waste plant
- Chemical production plant
- Food industries
- Handling equipment Conveyor belts.
- Liquid treatment plant
- Recycling
- Agriculture machines.

## 5.2 Advantage of Magnet Separator

Magnetic separators are powerful, portable and can be adjusted to remove various types of magnetic materials from a liquid or solid. They are most effective when used in a liquid, although it is also possible to remove solid impurities. Magnetic separators are very versatile and incredibly simple in design. In fact, a basic magnetic separator can be built at any time, using only a powerful magnet such as neodymium magnets and a clamp to hold the material down. It's low cost and easy to maintenance. Another advantage is it's self-cleaning system.

## 5.3 Disadvantages of Magnet Separator

The main disadvantage of a magnetic separator is that it must be constantly maintained. The magnetic separator should be washed or cleaned to remove accumulated magnetic materials, while oil should be added to moving parts. In the case of an electromagnetic separator, the electromagnets must be able to be switched off at any time in case of emergency.[19]

For industry, the magnetic separator comes in a different range of products such as magnetic drums, which are ideal for the continuous removal of ferrous particle contamination from any bulk material in the dry state, as well as magnetic drums with housings, which provide good separation in applications where there is a high concentration of metal contamination.

## 5.4 Limitation

This model is suitable for dry magnetic particles separation.  It cannot work properly in wet or liquid medium. In wet or liquid medium, it will lose efficiency.

# Chapter 6
# Conclusion & References

## 6.1 Conclusion

The magnetic particles and non – magnetic particles can be finely separated with the help of magnetic property i.e. magnetic attraction. The non-magnetic particles of the corn are not attracted by the magnet and flats to do a separate heap at a distance but the magnetic particles of the corn cling to the belt for a longer distance and forms another heap near the corn heap. The core advantage of magnetic separation is the fast kinetics, similar to expanded bed adsorption, but in a continuous process combined with an easier process control and a high flow rate. The recovery rate of the adsorbent achieves, depending on the particle magnetization, is more than 99.9 %.

Head roll magnets are available in various magnetic strengths. A head roll magnet is mounted as a drive roller in a conveyor belt. Next, it will attract iron particles present in the products and deflect these to the bottom of the belt. There, the iron particles will be released from the magnetic field and collected in a funnel or a slide plate. Magnetic separator is widely used for resource recovery, the timber industry, Mining industry, ceramics, chemical, food and other workshop.

Magnetic separation is a process in which magnetically susceptible is extracted from a mixture using a magnetic force. This separation technique can be useful in mining iron as it is attracted to a magnet.

Developments is magnetic separators have produced user friendly wet and dry separator which are suitable for the economic processing of silica sands at high capacity to produce superior grade materials or open up new reserves which were previously unusable.

## 6.2 Future Recommendations

The model can be improved by attached some mechanical and electrical devices and components. Some suggestions are given below-

- We can add a motor for automatic Control.
- We can add a weighbridge for count/measure weight and flow rate.
- We can use more non-magnetic roller to increase conveyor efficiency.
- Lower cost procurement: leveraging off economies of scale.

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