ERIEZ World Authority in Magnetic Separation Equipment

RARE EARTH ROLL MAGNETIC SEPARATORS

SETTING INDUSTRY STANDARDS WITH

HIGH-INTENSITY RARE EARTH PERMANENT MAGNETS

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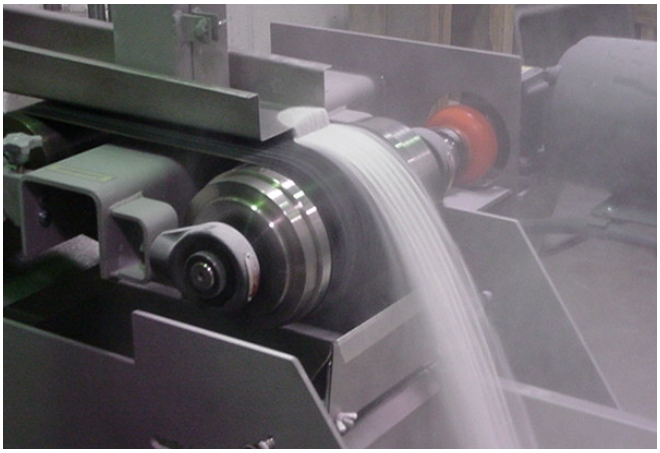
High-Intensity Rare Earth Roll Magnetic Separators Engineered

- **High-intensity magnetic roll assembled from rare earth permanent magnets**
- **Magnetic roll diameters of 100mm and 150mm**
- **Magnetic roll widths up to 1.5 metres**
- **Continuous duty applications treating up to 12 TPH feed/separator**
- **All stainless steel construction**
- **Variable speed drive on each magnetic roll.**
- **Mounted spread box/hopper and vibratory feeder or rolls feeder**

Wide Range of Applications Extending to:

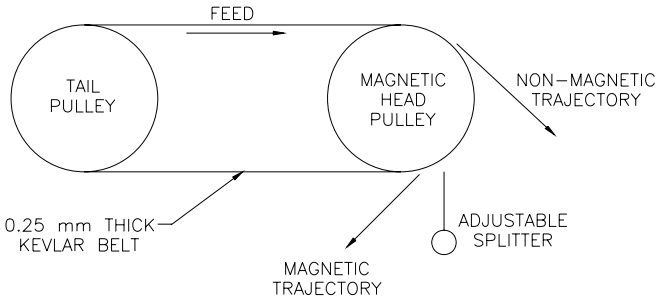
- **Industrial Mineral**
  - **Silica Sand**
  - **Quartzite**
  - **Feldspar**
  - **Nepheline Syenite**
- **Abrasives and Refractories**
  - **Alumina**
  - **Garnet**
  - **Chromite**
  - **Corundum**
- **Heavy Mineral Sands**
  - **Ilmenite**
  - **Leucoxene**
- **Chemicals and Pharmaceuticals**
- **Recycling**



Rare Earth Roll Magnetic Separator

Recent developments in magnetic separation technology have provided an effective, efficient means for magnetic separation. New magnet materials and magnetic circuit design have allowed for the manufacture of separators that operate energy free at high field strengths. As a result, new opportunities for magnetic separation have evolved in the cleaning and purifying of high purity feedstocks. These separators are essential in response to new advances in materials and specifications. Increasingly, there is a demand for higher purity feedstock materials used in the manufacturing. Magnetic cleaning has been applied to the most basic industry foundations such as industrial minerals, metals recycling, glass batch and cullet, abrasives and refractories, chemicals pharmaceuticals, and plastics.

Figure 1. Schematic of the Rare Earth Roll Magnetic Separator



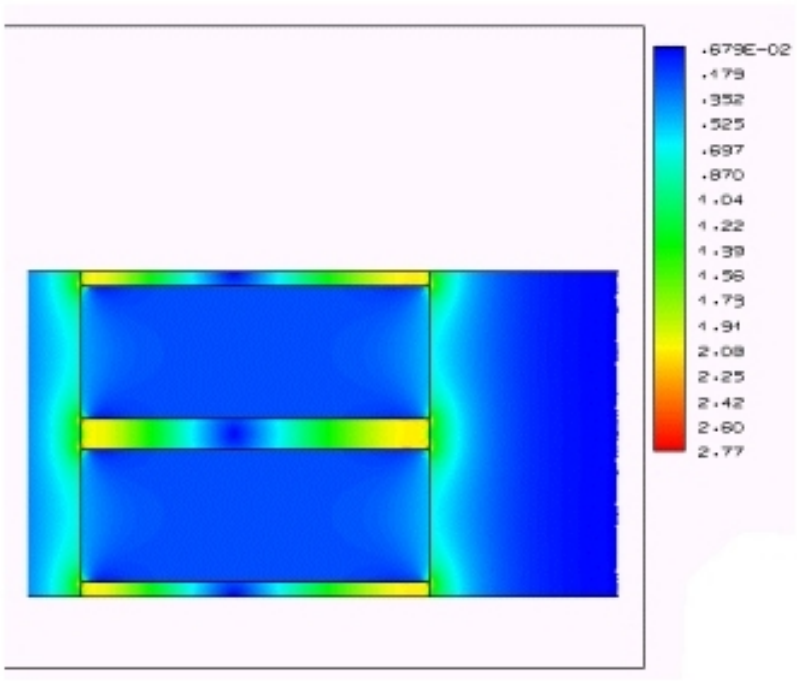
The Rare Earth Roll, generating peak magnetic field strengths approaching 24,000 gauss is very effective for concentrating or removing weakly magnetic minerals from a dry process stream. The Rare Earth Roll magnetic separator is designed to provide peak separation efficiency and is typically used when a high-purity product is required. The roll is constructed of discs of neodymium-boron-iron permanent magnets sandwiched with steel pole pieces. The steel poles are magnetically induced to the saturation point of approximately 24,000 gauss. Magnetic roll diameters are typically 100mm or 150mm, although separators as large as 300mm diameter are available.

Figure 2. RE5 Lab Roll Magnetic Separator

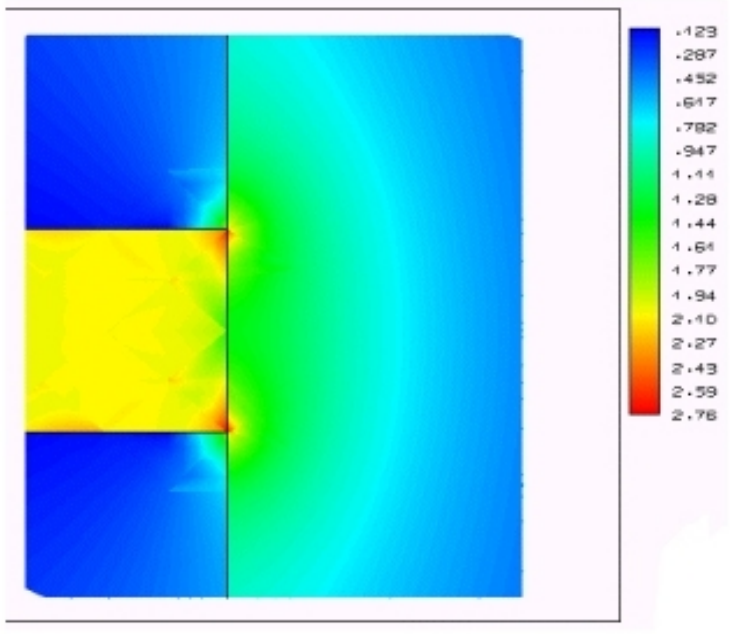
The separator is configured as a head pulley in the separator. A schematic of the rare earth roll magnetic separator is illustrated in Figure 1. A thin belt, usually from 5 to 20 mils thick is used to convey the Feed material through the magnetic field.

Figure 3. Modeling the Magnetic Roll

Contour plot of the magnetic field configuration of magnetic roll. The magnetic circuit consists of alternating magnetic discs and thin steel pole pieces.



Contour plot of magnetic field configuration. Close-up on magnetic discs and steel pole. Note that the highest magnetic field strength occurs at the interface of the magnet and steel pole.



When feed material enters the magnetic field, the non-magnetic particles are discharged from the roll in their natural trajectory. The paramagnetic, or weakly magnetic, particles are attracted to the roll and are deflected out of the non-magnetic particle stream. A splitter arrangement is used to segregate the two particle streams. A schematic of a production scale separator is illustrated in Figure 2.

Magnetic Circuit

The magnetic element is comprised of alternating discs of rare earth (neodymium-boron-iron) permanent magnets and steel poles. The magnet discs induce the steel poles and generate a high-intensity high-gradient magnetic field. A contour plot of the magnetic field configuration of this magnetic circuit is illustrated in Figure 3. The highest magnetic field strength occurs at the interface between the magnetic disc and the steel pole piece. A close-up of the magnetic field configuration at this interface is also shown if Figure 3.

Separation Variables

The magnetic attractive force generated by the magnetic roll is opposed by centrifugal force. The primary variables affecting separation efficiency are the magnetic field strength, feed rate, linear speed of the separator surface, and particle size. An effective separation requires an equilibrium among these variables.

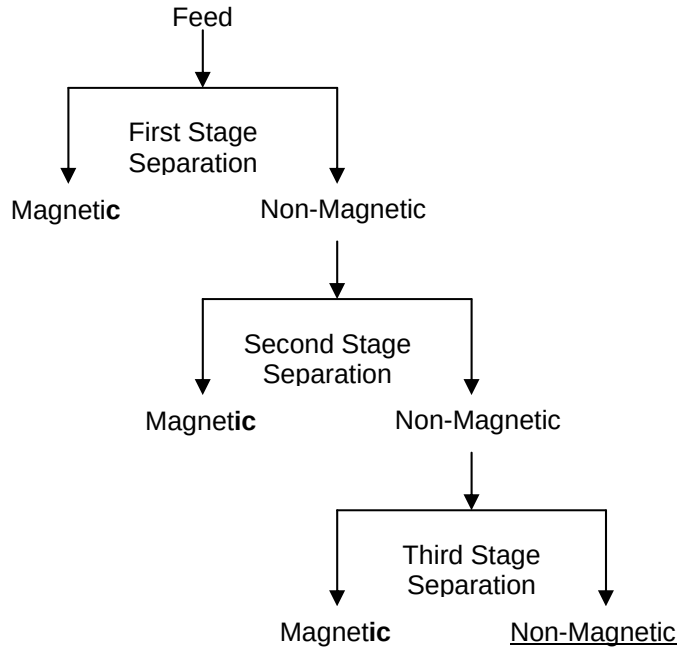
The centrifugal force exerted by the roll surface is the critical factor in providing separation. Beyond the critical speed, the centrifugal force overcomes the magnetic attractive force and the separation efficiency deteriorates.

Particle size will also effect separation efficiency independent of all other variables. Coarse particles provide a relatively high burden depth on the separator surface and respond with a relatively high magnetic attractive force. Coarse particles typically provide high unit capacities with high separation efficiencies. Fine particles with a relatively low mass respond detrimentally to electrostatic forces. As a consequence, precise magnetic separations balancing magnetic forces against centrifugal forces deteriorates.

In assessing the feedrate, a balance must be struck between an economic feedrate, product specifications, and collection of the magnetics. As the feedrate increases, the layered particle bed on the feed belt increases in height and the collection of magnetics decreases.

The linear speed of the roll is also a primary variable related to the feedrate. As the linear speed is increased, the layered particle bed decreases in height responding with an improved collection of the magnetic particles.

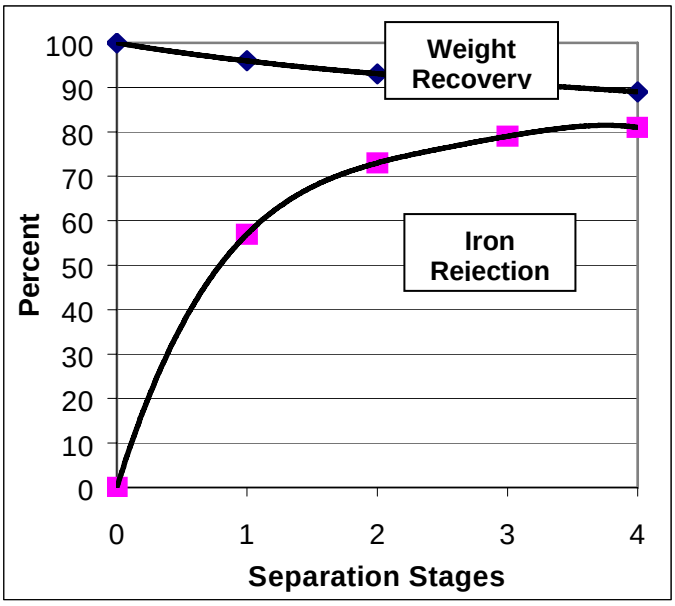
Figure 4. Schematic of Three Stage Separation on the Rare Earth Roll Magnetic Separator



Another primary variable is the number of separation stages. This is very common when treating industrial minerals such as silica sand, quartzite, feldspar, or nepheline syenite. The Rare Earth Roll magnetic separator is utilized to remove weakly magnetic iron-bearing minerals producing a high quality non-magnetic product. Multiple separation stages may be required to achieve product quality. A multiple separation is commonly performed as is illustrated in Figure 4. The initial separation produces a magnetic and a non-magnetic product. The non-magnetic product is subsequently treated on the second separation stage producing an additional non-magnetic and magnetic product. This process is repeated on a third separation stage.

This test work provides a classic example of diminishing efficiency at each separation stage. Both the iron and weight rejection as a magnetic product diminishes with each separation stage.

Figure 5. Effect of Multiple Separation Stages on the Magnetic Cleaning of Silica Sand



A general separation efficiency curve is illustrated in Figure 5. The highest level of iron rejection to the magnetic product is achieved in the first stage of separation. Subsequent separation stages provide a diminishing return. As expected, the weight rejected to the magnetic fraction follows the same trend.

Separator Specifications

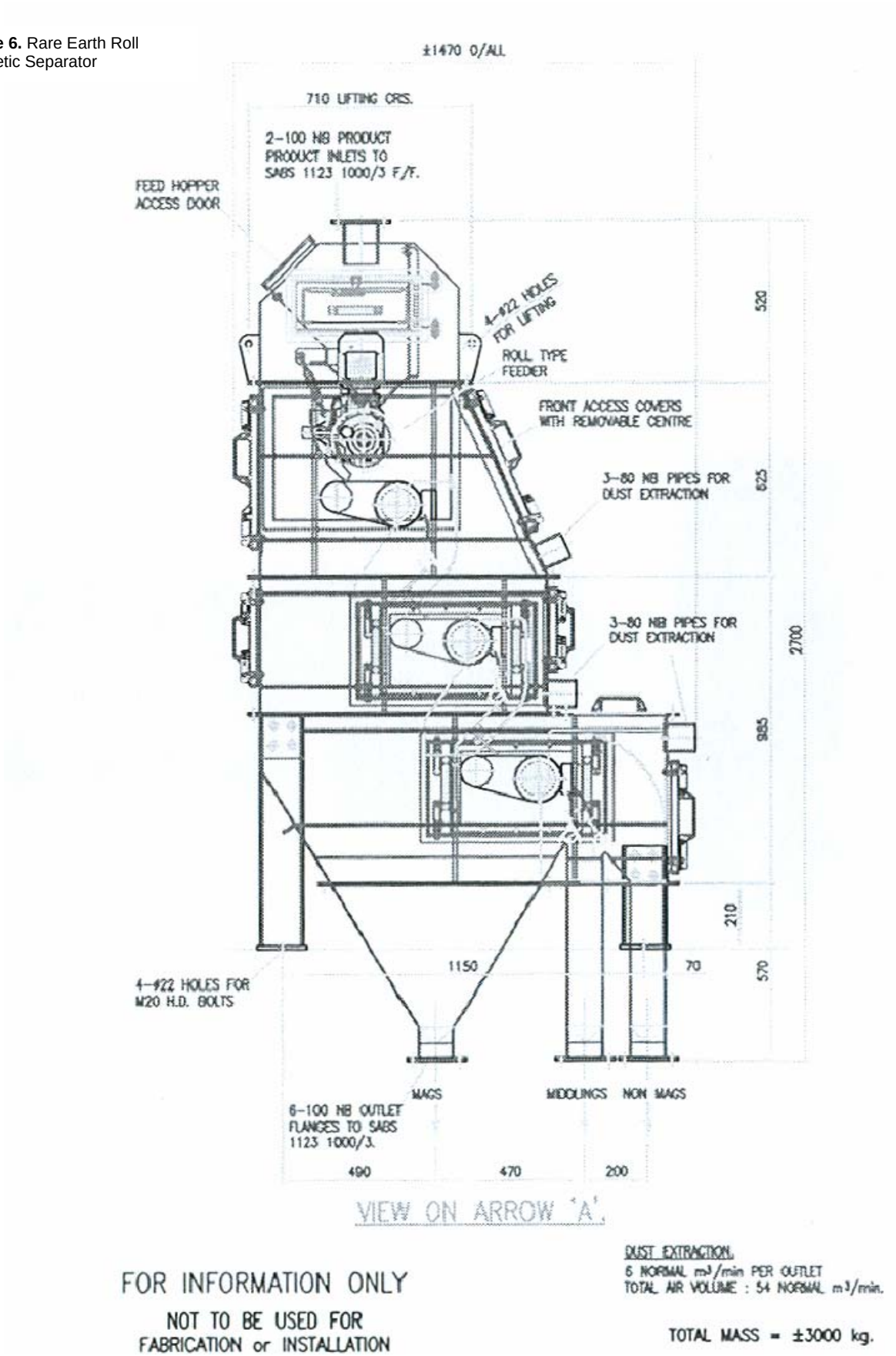
The Eriez Rare Earth Roll magnetic separator incorporates the latest available design and technology. The highest strength and highest quality magnet material is utilized. This separator combines the best engineering and operational features and provides excellent performance with ease of operation, inspection, and maintenance.

Various features and options are available for any specific application. Some of the features are tabulated below.

- High strength neodymium-boron-iron permanent magnets
- Several magnetic roll diameters available to match the specific application.
- Several magnetic roll widths available to match the production capacity.
- Multiple separation stages available on one separator. Up to three magnetic rolls placed in series.
- Kevlar feed belt. Positive belt tracking features.
- Cantilever rolls for ease of operation and maintenance.
- Mounted hopper with slide gate control.
- Mounted vibratory feeder or alternatively a rolls feeder with control to provide consistent feed rate to the magnetic roll.
- Independent drive on each magnetic roll.
- Variable speed drive. Feed belt speeds up to 180m/min using a variable frequency control.
- All stainless steel construction.
- Wide range splitter to segregate magnetics and non-magnetics.
- Flanged magnetic and non-magnetic product discharge chutes.
- Dust tight housing available.
- High temperature magnets available for wet feed products

A schematic of a Rare Earth Roll magnetic separator is illustrated in Figure 6. This separator has 100mm diameter by 1.5 metre wide magnetic rolls. This separator is configured with a two stage separation.

Figure 6. Rare Earth Roll Magnetic Separator



THREE ROLL RARE EARTH MAGNETIC SEPARATOR IN NON-MAGNETIC RE-PASS CONFIGURATION WITH ROLL FEEDER

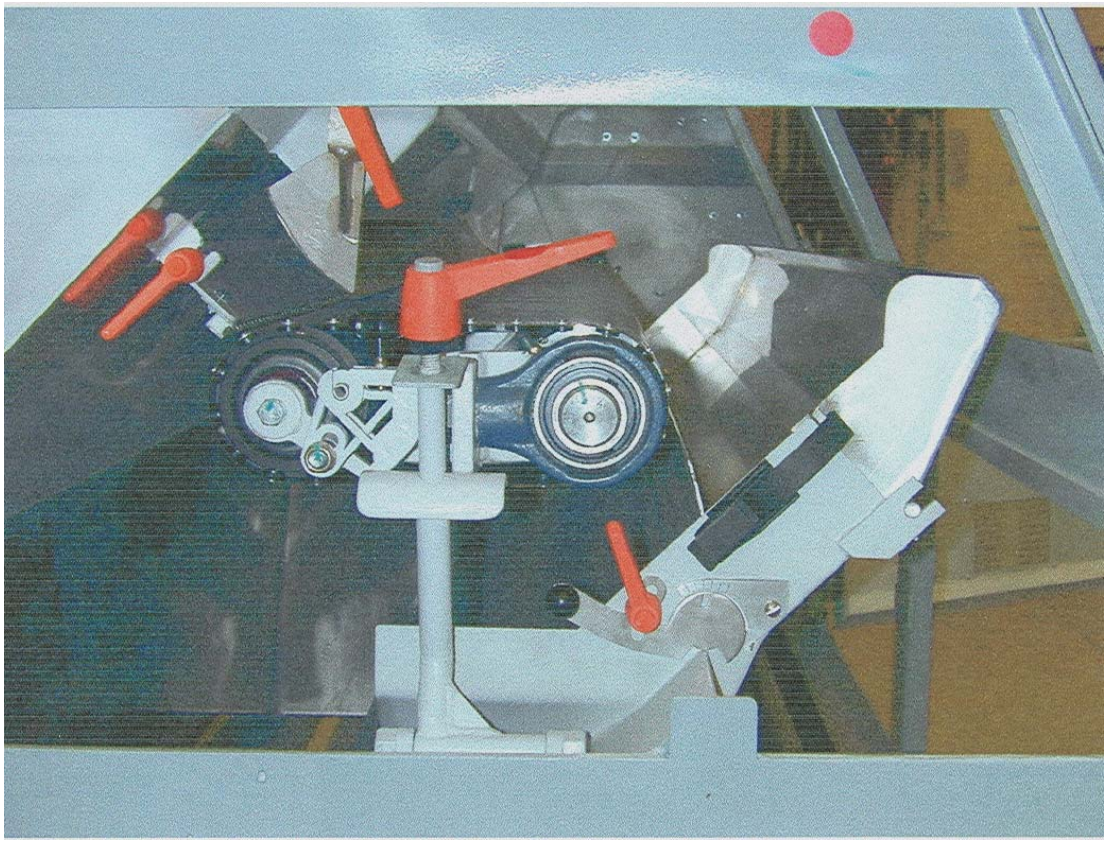
The magnetic roll or head pulley is constructed of alternating discs of Neodymium-Iron-Boron magnets and thin mild steel pole pieces. The roll is 100mm diameter and has an effective width of up to 1524mm.

PURGE AIR SHROUD:
ERIEZ air purging system to help prevent build up of magnetic dust on the Rare Earth Roll is the most effective available. The purge air carrier is also a close fitting back shroud to the Rare Earth Roll minimising the available exposed area for magnetic dust to contact the Rare Earth Roll which creates a relatively high velocity purge air stream to expel dust away from the restricted entry points.

ROLLS FEEDER

This feed system allows an accurate, consistent and uniform delivery of the fed material across the width of the belt. The feed roll delivers feed to the adjustable stainless steel curved feed chute, which in turn delivers the feed to the belt surface. The curbed feed chute can be used to increase or decrease the feed velocity to match the belt speed. The chute also has the feature of orientating the feed angle to the belt so that product bouncing and resulting in spillage is minimised. Feed material is delivered to the feed roll by means of a spread-box hopper and features an adjustable feed gate.

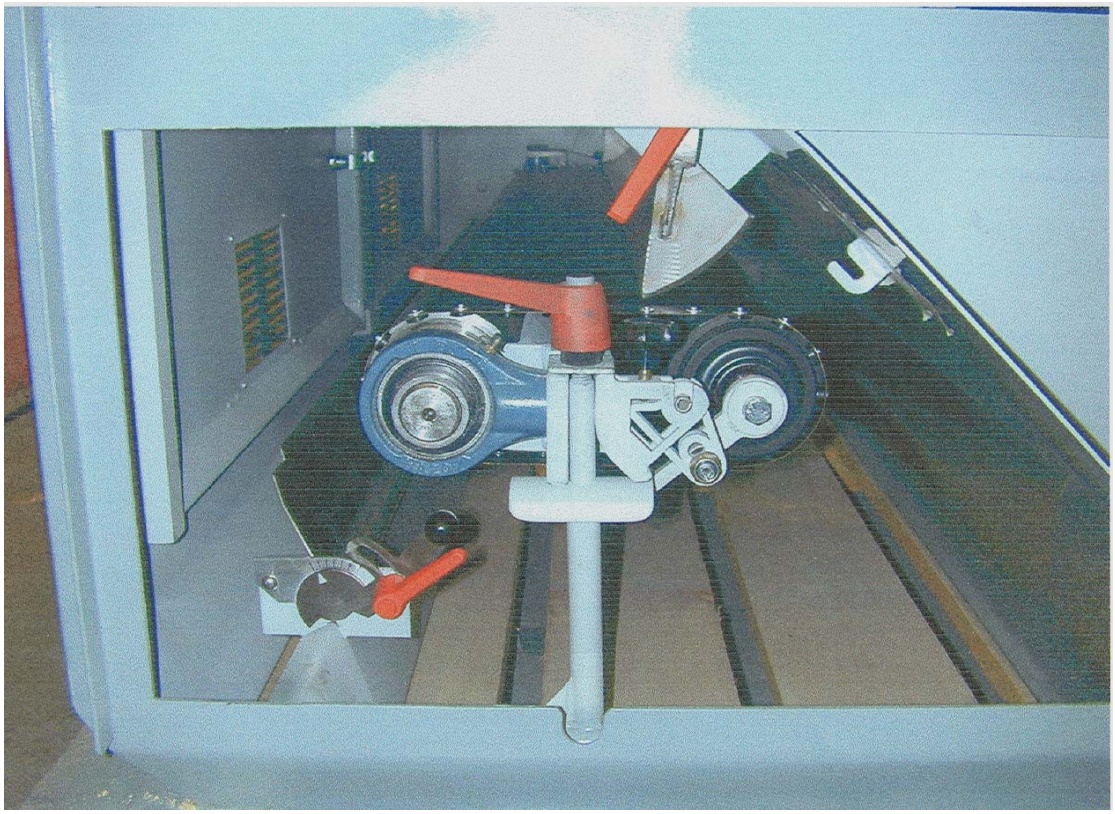
BELTS



For the mineral sands industry these units are normally supplied with Kevlar belts. For other applications such as in the Diamond industry, belts are or the Habasit type. Each belt is fitted over the 100mm diameter tail pulley and the 100mm diameter Rare Earth magnetic head pulley. Automatic belt tension is affected by the counterweight action of the pivoting tail pulley. Belt tracking adjustments are made by a hand screw on one end only, which adjusts a cam that increases or decreases the pivot angle of the tail pulley, to compliment the button tracking feature.

Pulley speeds are available to 600 R.P.M.

PRODUCT SPLITTERS



The splitters are fabricated from Grade 304 stainless steel to avoid magnetic inducement, should they be positioned close to the magnetic element.

The wide range splitters are adjustable radially about the given nominal locations.

The radial adjustments can be accurately set by means of the locking lever that is fitted to the end of the splitter shaft. Dial labels allow for splitter position repeatability.

The leading edge of the splitter blade comprises of a straight edge for positive division of product streams.

Separator Sizing

Eriez Rare Earth Roll magnetic separators are available in several sizes to meet any specific application. The magnetic roll sizes are listed in Table 1.

Table 1. Rare Earth Roll Sizes

Roll Diameter	Roll Width
100mm	Up to 1.5 metres
150mm	Up to 1.5 metres
300mm	Up to 1.5 metres

There are several variables effecting the feed rate on the Rare Earth Roll magnetic separator. The bulk density and the size of the material are fundamental in determining the appropriate unit capacity. Some general guidelines for unit capacity on a production scale are presented in Table 2.

Table 2. General Unit Capacity Guidelines for the Rare Earth Roll Magnetic Separator

Application	Unit Capacity *
Fine/Light Material – Plastic Pellets for Compounding, Fine (-75 Micron) Industrial Minerals such as Silica or Alumina, Pharmaceutical Powders, Resins, or Grains	20 to 45
Industrial Minerals – Glass/Ceramic Feedstocks sized at –850 Micron +106 Micron – Silica Sand, Quartzite, Feldspar, Nepheline Syenite, Alumina, or Tabular Alumina	45 to 120
Heavy Mineral Sands – Sized at –1400 Micron – Ilmenite, Leucoxene, Rutile, Zircon, Staurolite, or Monazite	70 to 140
Fine Heavy Material – Hematite and Limonites Sized at –1400 Micron or Metallic Powders	90 to 180
Coarse Heavy Material – Iron Ore and Slags Sized at 1 – 10mm	140 to 230

* Unit Capacity is kilograms / hour for each 2.5cm of magnetic roll width.

Eriez Engineering Services

Eriez provides Engineering Services to cover a wide range of functions, assistance, and support. Specific engineering features related to the Rare Earth Drum magnetic separators and specific processes are as follows:

- Design and equipment modifications incorporating specific features and options. The separator may incorporate various options and features applicable to the process.
- Equipment layout and dimensional drawings. Modifications are common to fit an existing plant or provide specific operating characteristics.
- Equipment selection, sizing, material flows and balances. Eriez has a database for accurate separator sizing and separation performance.
- In-plant audit to determine iron contamination levels, production flow rates, material handling aspects, equipment selection and sizing, and predict performance.

Eriez Test Facility

76mm Diameter and 100mm diameter Rare Earth Roll separators are available at our Wynberg facility for product testing.

High intensity magnetic separation tests are typically carried out to assess separation performance. In this case, magnetic separation test work is conducted on a representative sample to characterize the separation parameters. A series of separation tests are conducted investigating the effect of the different separation variables specific to the material. The test work may extend from the basic bench scale feasibility stage through to an extensive pilot plant program dependent on the assessment required. All test work culminates in a report detailing the test work and equipment recommendations.

Figure 9. Testing high purity quartz on the 150mm diameter Rare Earth Roll magnetic separator.