MMPB-738G

# Ferrous Wheel™

*…Only from Eriez.*

# *High Gradient Magnetic Separator*

*Wet High Gradient Magnetic Separators utilizing high strength permanent magnets and flux-converging matrix. Continuous operation for the concentration of magnetic ores or the cleaning of non-magnetic ores.*


## Features

- High strength permanent magnetic field
- High capacity
- Continuous operation
- Low operating and maintenance costs
- Inversion of matrix prevents plugging due to oversize particles

Patented in U.S. & Mexico
Others pending and applied for.

In the design of a magnetic separator, the magnetic field intensity and the magnetic field gradient are the only two first order variables that affect separation response. The intensity of the magnetic field refers to the number of lines of flux passing through a unit area. Lines of flux are measured in gauss (1 line/$cm^2$).

The magnetic field gradient refers to the rate of change or the convergence of the magnetic field strength. Figure 1 illustrates two different magnetic field configurations. Case A has a very uniform pattern of flux lines without gradation. The magnetic field intensity is essentially equal at any point in the field. A magnetic particle entering this field will be attracted to the lines of flux and remain stationary without attraction to either pole piece. Case B illustrates a converging pattern of flux lines displaying a high gradient.

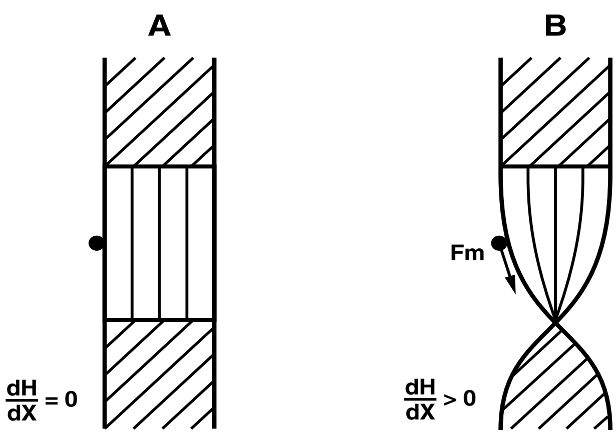



*Figure 1. Magnetic Flux and Gradient Patterns.*

As these lines pass through a smaller area, there is a significant increase in the magnetic field intensity. A magnetic particle entering this field configuration will not only be attracted to the lines of flux but will also migrate to the region of highest flux density, which occurs at the tip of the bottom pole piece. In simplified terms, the magnetic field intensity holds the particle while the magnetic field gradient moves the particle. This illustrates the methodology for magnetic separation.

The magnetic attractive force acting on a particle is proportional to the product of the magnetic field intensity and the magnetic field gradient. To maximize the magnetic force acting on a particle, the product of the magnetic field intensity and magnetic field gradient must be optimized.

It has been demonstrated in magnetic separation technology that the most effective method of maximizing the magnetic field gradient is with the use of a matrix. The matrix typically resembles a metal mesh and such materials as screen cloth, expanded metal, steel balls, and steel wool have been used. When placed in a magnetic field, the function of the matrix is threefold. The matrix 1) amplifies the magnetic field, 2) converges the lines of flux to produce localized regions of extremely high magnetic field gradient, and 3) provides collection sites for the magnetic particles.

## Separator Design and Operation

A conceptual illustration of the Ferrous Wheel™ Separator is shown in Figure 2. The separating ring is vertical and rotates clockwise. The separating ring consists of two discs with the matrix situated in pockets between them. The depth of the matrix is typically 5-inches (125 mm). The separating ring is open in the middle to allow the removal of the separated products. Magnets are mounted on each side of the separating ring and generate a magnetic field through the matrix.

Two magnetic stations, each with approximate 60 degree magnetic arcs, are used on the separating ring. When concentrating a magnetic ore, the feed enters the matrix in the magnetic field located near the top of the separating ring. In this "rougher" stage, the feed enters from the outside of the separating ring and flows inward toward the center. The non-magnetic particles pass through the matrix and are collected in the center of the separating ring and channeled out of the system. The magnetic particles are collected and held in the magnetized matrix.

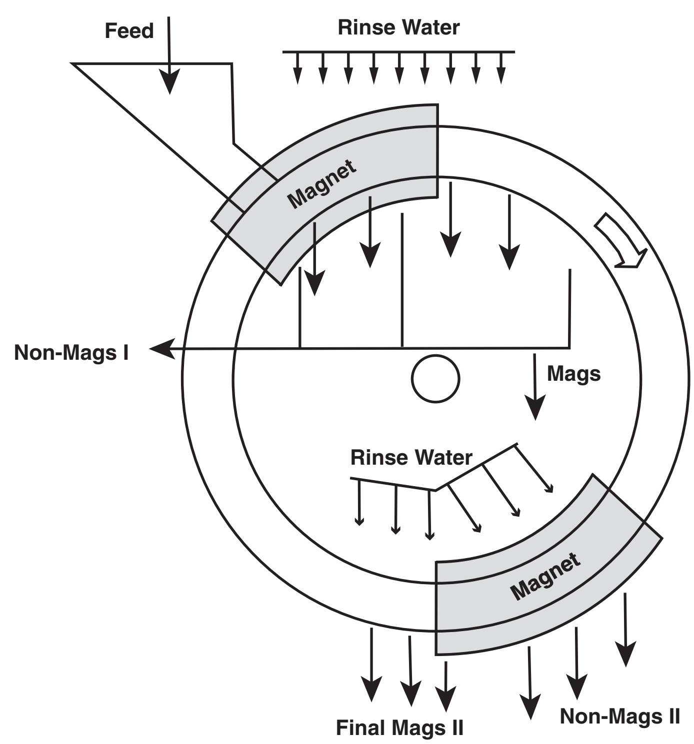



*Figure 2. Ferrous Wheel Magnetic Separator. Magnetic Upgrading in a Rougher/Cleaner Configuration.*

As the matrix rotates out of the magnetic field, these particles are rinsed out of the matrix and collected in the center of the separating ring. The magnetic fraction is then channeled to a "cleaner" separation stage located at the bottom of the separation ring. In the cleaner stage, the feed enters from the inside of the separating ring and flows outward. Again the non-magnetic particles pass through the matrix and are channeled out of the system. The magnetic particles are magnetically collected and rinsed out of the matrix representing the final magnetic product.

When cleaning a non-magnetic ore, the initial rougher magnetic separation stage is used to remove most of the magnetic contaminants. The non-magnetic product is then repassed through a secondary "cleaner" separation stage to further remove any residual magnetic contaminants.

There are several unique features about the Ferrous Wheel Separator. The magnetic field is generated with permanent magnets. Conventional barium ferrite magnets are used to produce magnetic fields up to 1500 gauss, while high energy rare earth magnets are used to produce magnetic fields up to 4000 gauss in the open matrix gap.

The evolution of permanent magnets has provided a cost effective alternative to electromagnets for the generation of high intensity magnetic fields. Specifically, in recent years, the strength of permanent magnets has increased several-fold with neodymium-boron-iron rare earth magnets now providing an energy product of 45 million gauss-oersted. Figure 3 shows the evolution the strength of permanent magnets. The development of these earth magnets has led to the design of magnetic circuits possessing a magnetic attractive force an order of magnitude greater than that of conventional permanent magnetic circuits.

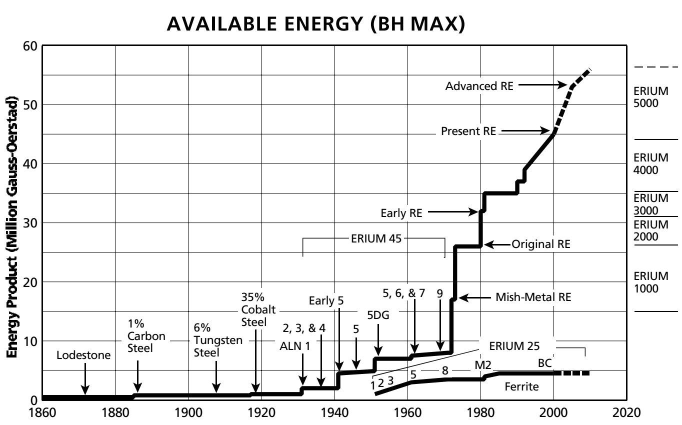



*Figure 3. Evolution of Permanent Magnets*

*Each of these 15 ring model Ferrous Wheel Separators can process up to 22 tons per hour of iron ore, using only five kilowatts for operation.*

*Multiple 15 ring Ferrous Wheel units recovering iron minerals from tailings.*

As a point of reference, upgrading magnetite ore requires magnetic fields of less than 300 gauss. The collection of para-magnetic hematite, ilmenite, or chromite typically requires magnetic fields of 1500 - 2500 gauss.

There are several types of continuous feed wet high-intensity magnetic separators. Essentially all other separators use electromagnets to generate the magnetic field and have the separating ring in a horizontal "carousel" configuration. Although the magnetic field strengths available from permanent magnets may not be as high as those produced by electromagnets, there are several major advantages with using permanent magnets to generate the magnetic field. Initially, the capital cost is significantly reduced compared to separators using electromagnets.

Permanent magnets eliminate the need for a magnetic coil, an extremely heavy steel circuit to carry the flux, a direct current rectifier and heat exchangers and pumps for cooling the magnetic coil. Operating costs are greatly reduced when using permanent magnets. The only utility required is the power to drive the separating rings. Approximately .5 HP per ring is required. The separating rings are typically driven at 2-3 rpm. Further, with a lighter and more compact separator, installation costs and maintenance costs are greatly reduced. Pumping costs are minimized; feed flows through the Ferrous Wheel Separator by gravity flow, and the separated products are also channeled out of the system by gravity flow.

Several rinse stations can be employed to control both grade and recovery. Although a rinse is usually not used in the magnetic field while magnetic collection takes place, one may however be employed for grade control. In such a configuration, the rinse further expels entrapped non-magnetic particles or even locked particles.

## Typical Applications

### Magnetic Concentration

- Magnetite
- Ilmenite
- Hematite
- Chromite

### Magnetic Cleaning

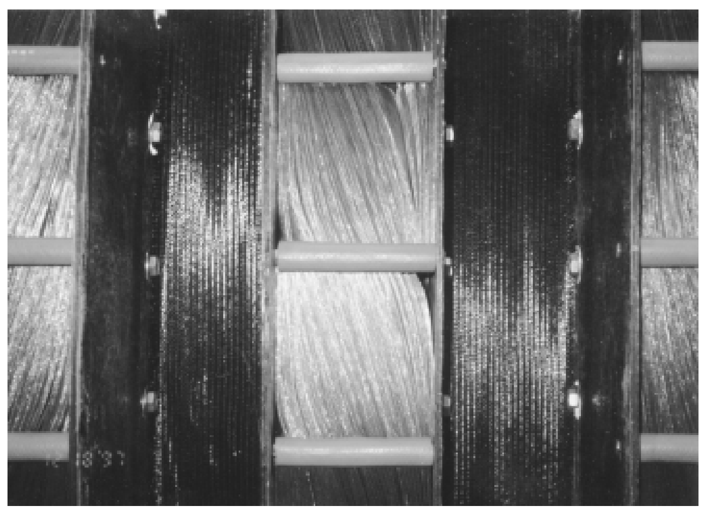
- Mica Group
- Talc
- Alumina
- Kaolin
- Zircon
- Rutile
- Calcium Carbonate
- Silica Sand / Quartzite
- Feldspar Group

The magnetic particles are rinsed from the matrix from the outside of the separating ring in the rougher stage, and from the inside of the separating ring in the cleaner stage. This prevents buildup of oversize particles and physically entrapped particles that is common on all carousel separators.

## Capacity

The feed capacity is related to the diameter and width of the separating ring. The ring diameter is an engineered option with 96-inches (2440 mm) as standard. A magnetic field of 1000 gauss can be generated in a 5-inch (125 mm) wide separating ring capable of treating up to 10 tph feed. A magnetic field of 3000 gauss can be generated in a 2 1/2-inch (65 mm) wide separating ring capable of treating up to 5 tph feed.

Several separating rings are combined to provide the necessary production capacity feed rates. The permanent magnets are placed between each ring to generate the magnetic field. The feed distributor consists of a box that runs the length of the separator. Each separating ring has a single feed nozzle attached to the distributor box to accept new feed.



*96-inch diameter, 5-inch wide separating rings containing flux-converging matrix. In this machine, each ring can treat up to 10 tph feed.*

*Dimensions and specifications are subject to change without notice.*



World Authority in Advanced Technology for Magnetic, Vibratory and Metal Detection Applications
HEADQUARTERS: 2200 ASBURY ROAD, P.O. BOX 10608, ERIE, PA 16514-0608 U.S.A.
Telephone 814/835-6000 • 800/345-4946 • Fax 814/838-4960 • International Fax 814/833-3348
Web Site: http://www.eriez.com e-mail: eriez@eriez.com
MANUFACTURING FACILITIES IN: AUSTRALIA • BRAZIL • CANADA • INDIA • JAPAN • MEXICO • SOUTH AFRICA • UNITED KINGDOM • UNITED STATES

201-5.5M-SP-SP ERIEZ MANUFACTURING CO. PRINTED IN USA