Hard Rock Mining: High-Intensity Dry Vibrating Magnetic Filter (DVMF) Removes Fine Iron-Bearing Contaminants Found in Lithium and Other Hard-To-Flow Powders

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This white paper covers Eriez® high-intensity Dry Vibrating Magnetic Filters (DVMF), which are specifically designed to remove very fine iron-bearing contaminants from hard-to-flow fine powders such as lithium. Typical applications include fine sand, glass power, talc, clays and various other finely divided industrial minerals and chemical products.

After reading this paper, you will understand how the DVMF operates. You will learn about the standard design, what is bore of the separation zone, how a filter element concentrates the magnetic flux of the magnetic field and how scores of high-gradient collection zones capture magnetic contaminants as material filters through the element to produce a higher quality end product.

Source of Lithium: Hard Rock Mining

The main sources of lithium are spodomene, petalite and lepidolite from hard rock, which accounts for 13 percent of the global reserve. Salt Flats, a brine solution, account for 87 percent of the global reserve. (Thomas G. Goonan, 2012)

The DVMF is perfect for both lithium producers and users. Producers pulverize lithium before it goes to the user as a very fine powder. DVMF units are placed prior to and after mill processing. As an additional check, many users position the DVMF at the point they receive lithium purchased from their producer.

When it comes to hard rock mining, a best practice among operators is to install equipment to protect crushers and belts. They accomplish this by combining suspended electromagnets (SEs) and metal detectors. The belt magnet removes ferrous material as it passes under a magnet on a belt or vibratory conveyor, while a metal detector detects ferrous metals missed by the SE and all nonferrous metals. This an important preparation procedure as the fine powders move to the DVMF.

The DVMF is perfect for glassmaking, feedstocks, talc, industrial ceramics and abrasives.

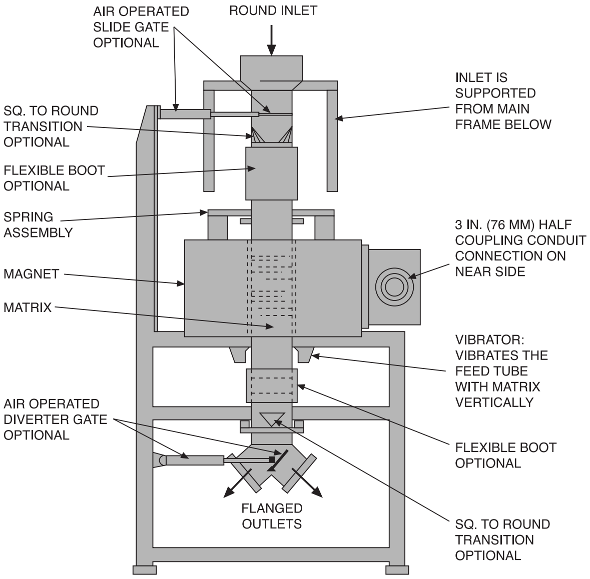
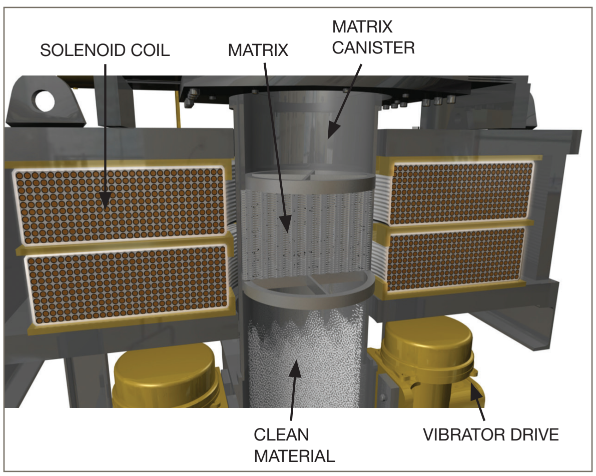
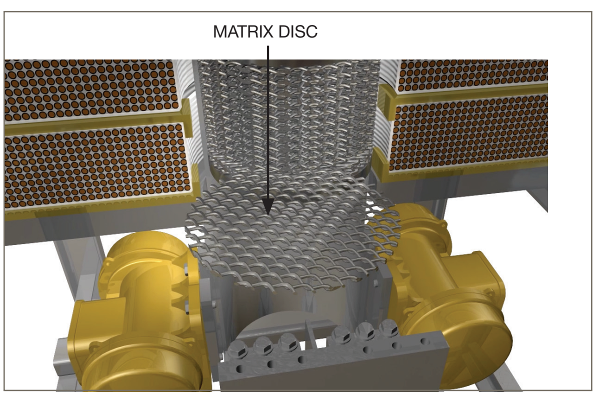


Figure 1: Dry Vibrating Magnetic Filters are designed specifically for dry applications - the treatment of powders. Its purpose is to remove fine ferrous contaminants from dry powder.





Figures 2 and 3: The DVMF consists of a thick steel box with a canister in the bore. Aluminum or copper coils are positioned around the canister. Direct current power energizes the coil and allows the matrix to collect magnetic particles.

DVMFs reduce contamination in lithium dramatically by utilizing a high-intensity electromagnet and revolutionary flux converging matrix. The DVMF is fed vertically via gravity flow. As the feed material filters through the matrix and exits out the bottom, the matrix captures and holds the magnetic material as the non-magnetic material passes through (See Figure 1).

The magnetic collection of fine particles requires a high-intensity, high-gradient magnetic field. This type of separator utilizes a high-intensity electromagnet and flux converging matrix. The matrix amplifies the magnetic field and provides high-gradient collection sites for the magnetic material as the feed materials filter through. The canister is attached to dual high-frequency, low-amplitude vibratory drives. These drives deliver a strong vibratory action to the canister assembly which enhances the fluidity of very fine powders, resulting in a smooth and even flow of product through the matrix grid. This has proven to be the most effective separation process for hard rock mining lithium applications.

Eriez 5,000 gauss strength DVMFs reduce contamination to parts per billion, rather than parts per million.

Eriez state-of-the-art DVMFs are fully automated and feature a simplified cooling system. Other highlights include programmable controllers and the ability to handle four to 12-inch diameter sizes. The standard filters' background magnetic field capacities are based on fine powder flow range up to 100 pounds per square inch of cross sectional area of matrix. A 6-inch diameter is capable of treating up to 2,800 pounds per hour of material weighing 400 lbs. cu/ft.

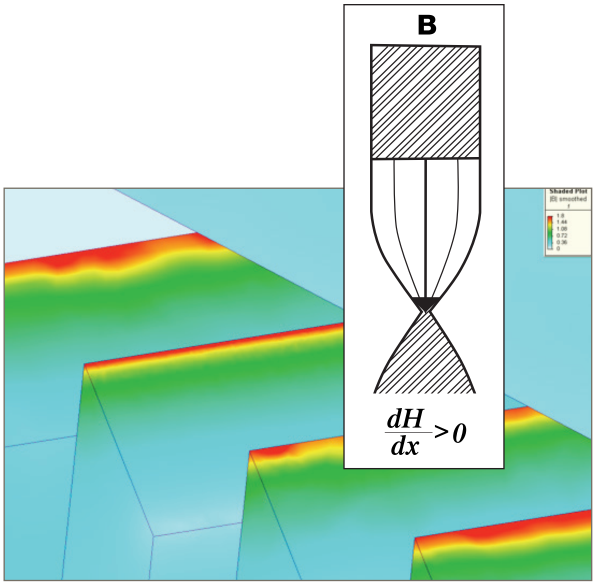
Design Characteristics

The magnetic filters consist of a solenoid electromagnetic coil enclosed in a steel housing. Figures 2 and 3 illustrate the 5,000 gauss Eriez DVMFs. The coil generates a uniform magnetic field throughout the bore of the coil, which represent background magnetic field. A stack of expanded metal discs are packed in the bore and induced by the magnetic field. These expanded metal discs, termed the matrix, provide the vehicle for separation. The matrix amplifies the background magnetic field, produces local regions of extremely high gradient and provides the collection sites for magnetic particle capture.

The magnetic force acting to capture a magnetic particle is proportional to the product of the magnetic field intensity and the magnetic field gradient. In equation form:

$$Fm \propto H \frac{dH}{dx}$$

Where Fm is the magnetic force acting on a particle, H is the background magnetic field, and dH/dx is the magnetic field gradient (convergence of flux) generated on the matrix. Utilizing a relatively high background magnetic field coupled with an extremely high magnetic field gradient results in a high-intensity high-gradient separator (See Schematic 1).



Schematic 1: The DVMF's matrix converges the lines of magnetic flux for improved collection of magnetic contaminants.

A matrix type separator substantially improves the capture of fine particles. In a matrix, the material must filter through several layers of highly induced magnetic grids, increasing the probability of capturing more contamination over conventional plate, grate, trap or drum type separators. Even with relatively large matrix spacing, the material is subject to this filtering effect, resulting in the capture of magnetic material.

The dry filters are rated by the magnetic field strength generated in the bore of the solenoid coil with the matrix removed. The background magnetic field, often termed the open bore field, represents the driving force that produces the amplified high magnetic gradient throughout the matrix. Depending on the matrix configuration, it is typically the case that a 5,000 gauss background field will result in an excess of 10,000 gauss in localized regions of the matrix.

The electromagnet is a solenoid coil completely sealed in a steel housing. Standard model filters generate background magnetic field strengths of 5,000 gauss. The solenoid coils are wound from copper to dissipate heat and operate at relatively cool temperatures. They are oiled-cooled and utilize a heat exchanger where it is cooled with a 10 GPM water flow.

Operating Characteristics

The background magnetic field is typically determined through an identification of the magnetic material or by quantitative testing. Eriez' experience has established some general guidelines for selection of the proper magnetic field selection.

The 5,000 gauss unit is perfect for very fine (minus 50 micron to sub-micron) ferromagnetic iron of abrasion, scale or paramagnetic contaminants such as ilmenite or chromite. It is specified when a high-purity product is required and where product specifications call for parts per million (ppm) contaminants levels. Again, the DVMF achieves a parts per billion removed performance level.

Duty cycles, the operating time of the magnet between cleaning cycles, are typically determined by identifying the amount of magnetic material contained in the feed product. Materials containing up to two percent contaminant may require very frequent cleaning. In these applications, the duty cycle may approximate 10 to 20 minutes. In this scenario, an automated feeding valve and reject gate are recommended. Treating relatively pure materials, which may have only average ppm levels of contamination, allow relatively long duty cycles which can sometimes exceed an hour.

About Eriez®
Eriez is recognized as world authority in separation technologies. The company's magnetic lift and separation, metal detection, fluid recycling, flotation, materials feeding, screening, conveying and controlling equipment have application in the process, metalworking, packaging, plastics, rubber, recycling, food, mining, aggregate and textile industries. Eriez manufactures and markets these products through 12 international subsidiaries located on six continents.

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