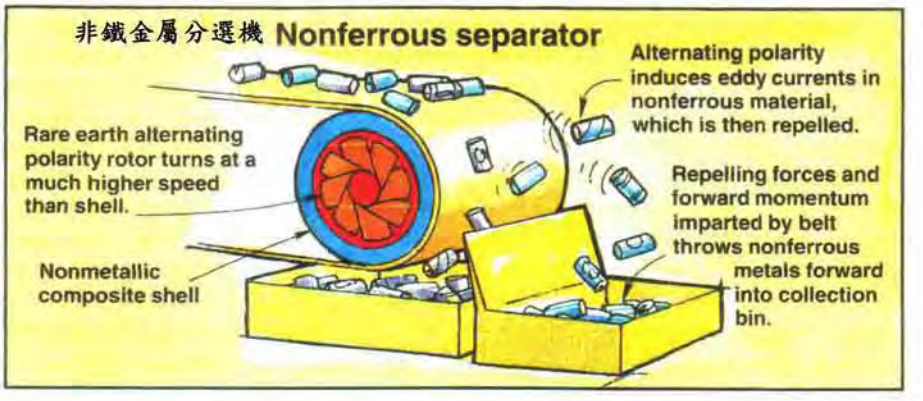
Reprinted from MACHINE DESIGN Dec 24, 1991. 渦電流分選機-幫助資源回收

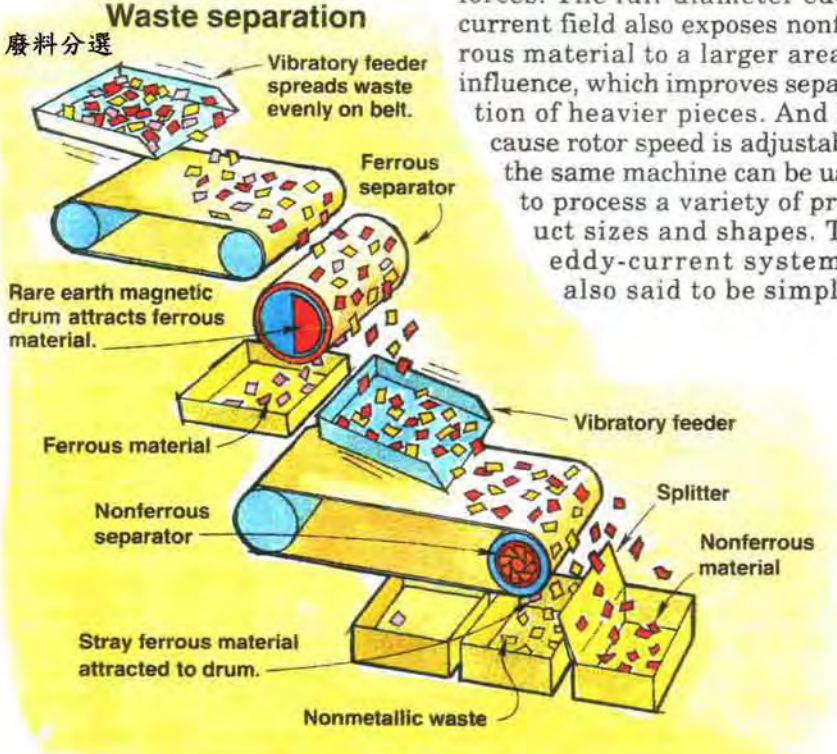
SCANNING THE FIELD FOR IDEAS

EDDY-CURRENT SEPARATOR AIDS RECYCLING

A new generation of nonferrous eddy-current separators answers the recycling industry's call for automated equipment that efficiently and economically removes aluminum from the waste stream.

The separator consists of an external nonmetallic shell, internal rotor, drive, and belt conveyor. The rotor contains permanent rare-earth magnets arranged in alternating polarity. The rotor spins at a much higher speed than the shell and the alternation of the magnetic field induces eddy currents in nonferrous metals nearby, repelling them from the conveyor. The repelling force, along with the forward momentum imparted by the belt, sends the nonferrous material into a higher trajectory than that of nonconductive material, which passes over the pulley unaffected by the alternating magnetic field.





The separator, from Eriez Magnetics, Erie, Pa., has a full-diameter rotor which gives it several advantages over competing models with smaller-diameter rotors. First, the large rotor provides room for bigger, stronger magnets, so it generates stronger eddy-current fields and repelling forces. The full-diameter eddy-current field also exposes nonferrous material to a larger area of influence, which improves separation of heavier pieces. And because rotor speed is adjustable, the same machine can be used to process a variety of product sizes and shapes. The eddy-current system is also said to be simpler, less expensive, and have better results than those systems that rely on multiple metal detectors to activate ac-powered electromagnets.

The idea of using eddy currents to separate nonferrous metals is not new. In fact, patents were issued in 1889 and the first commercial-size eddy-current separator was introduced in the late 1960s. However, according to Eriez, the technology was disregarded until a few years ago when it was used in Europe as a replacement for manual sorting. Since then, Eriez has begun using more powerful magnetic materials and has designed better magnetic circuits and field distributions.

Aluminum beverage cans are the most valuable portion of the refuse stream. Currently, many municipal solid waste (MSW) plants manually pick out the beverage cans before the waste is burned. Automatic separating will allow them to recover a higher percentage of the aluminum. The system will also benefit MSW plants that do not remove the cans, because these plants suffer downtime from grates that are plugged with melted aluminum.

渦電流分選機選別非鐵金屬+

Non-Ferrous Metal Separation Using An Eddy Current Separator

有價資源常被拋棄於垃圾掩埋場。目前很多再生回收之方法被研發出來以減少吾人對自然資源不必要之浪費。空氣分選機、人工手選、及磁選等皆是有效之分選物質方法。但直到最近從廢棄物分選出鋁金屬之經濟有效之方法才被發展出來。

渦電流技術於 1800 年代後期首先爲愛迪生所發展。他設計出可從材料中分離非鐵金屬之礦石分選器(見圖 1)。此設計雖然多年來有所改變，但基本之原理仍不變。由於高能量之稀土永久磁石被開發成功，導致再利用此原理於稀土渦電流分選機。

利用渦電流分選機在商業上可有效地分離下列物質：

—從路邊或都市固體混合廢棄物分離廢飲料罐。

—從寶特瓶(PET)碎片分離鋁片。

—從鑄造砂分離黃銅及鋁屑。

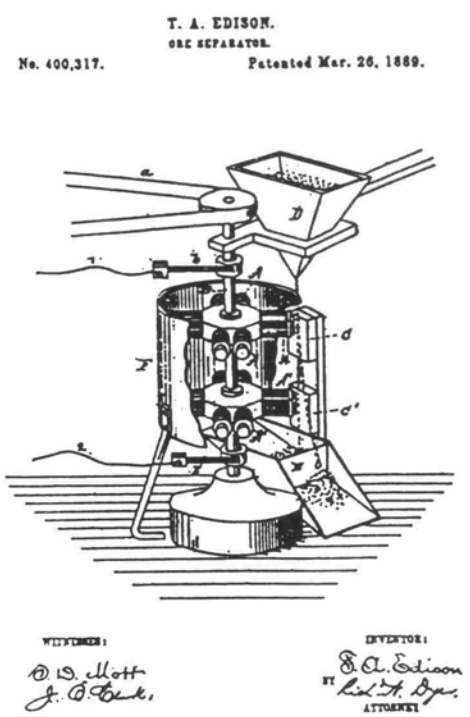


圖 1

—從玻璃碎片分離鋁蓋及鉛

—從非鐵汽車切片分離鋁及銅塊。

—從鍋爐底灰分離非鐵金屬。

—乾燥非金屬中之非鐵金屬雜質，都可能利用渦電流分選器。

當非鐵金屬通過變化之磁場會產生渦電流。當導體進入變化之磁場，則在導體內感應電流，此渦電流又產生本身之磁場。此磁場爲渦電流分選器之磁場所排斥。在渦電流分選機，其變化之磁場由轉筒內許多不同磁極排列之磁石所產生，此轉筒置於輸送帶尾滑輪內，但其轉動各自獨立(見圖 2)。當磁石轉筒高速旋轉時，產生高頻率之變化磁場，此爲發生分選作用之處。

將磁石裝置於轉筒上並非新穎之觀念，此設計如爲陶瓷磁石更具效果，磁石如果爲高能量之稀土磁石(見圖 3)則對非鐵分選更具效率，稀土磁石產生較大之排斥力，則得較好之分選效率。稀土磁石使得較小粒徑之物質亦可分選。

不同之非鐵金屬在渦電流場中，其反應各不相同。金屬之質量、導電度、及密度爲影響非鐵金屬被排斥距離之主要的因素。

+本譯文經原著者同意發表。

* Eriez Magnetics, Erie, PA, USA

圖 4 爲相同質量與形狀之金屬被排斥之相對距離。圖中是以導電度對密度爲最好比率之鋁爲尺度的標準。

顆粒之形狀對金屬被排斥亦是很重要。不同之形狀在磁場中反應不同，球形及線狀反應不佳，盤狀及圓柱狀反應良好。另一影響分選效率之因素爲非鐵金屬接近渦電流場之程度。當顆粒與磁場較遠時，非鐵金屬被排斥之力將消失。此在渦電流設計時是非常重要的因素(見圖 2)，因此磁石與輸送帶頂面之距離須最小。

另一妨礙非鐵金屬分選之因素爲分選之原料中含有鐵金屬物質，因爲渦電流分選機使用高強度之稀土磁石，鐵金屬物質會被吸附在轉筒上，不容易被除去。吸附在轉筒上之物質使得渦電流場改向及在產品中之物質發生偏移。鐵金屬物質亦會磨損渦電流分選機之輸送帶。當物質吸附於轉筒，則輸送帶在轉筒與鐵金屬物質之間移動，鐵金屬會被加熱而熔蝕輸送帶。

許多社區強制資源回收，其包括玻璃、塑膠、鍍錫鋼鐵、鋁、紙及其它物質，這些物質皆須經過分選才具經濟價值。磁石可用來去除鐵金屬物質，但手選爲較普遍之其它物質的分選方法。渦電流分選機之分選是減少人爲誤失之方法。渦電流分選機分選鋁金屬較手選有效率(見圖 5)。

寶特瓶(PET)是用於冷飲容器之材料。選別過之 PET 容器經過切碎及水洗可再生利用。再生之 PET 切片可以廣泛用於絕緣物及非食物之容器。如果 PET 含有鋁金屬雜質會阻塞擠出機之篩網而妨礙擠出程序，此會使擠出機之壓力上升，而損害機器及改變顆粒之大小。靜電分選機曾經被應用於去除 PET 切片中之鋁片；但一般言，PET 碎片含水份高及/或大氣溼度高時甚難處理。其須經過六次步驟才能得鋁金屬含量降到 100ppm。渦電流分選機可以去除鋁金屬，只須經過三次步驟就可將鋁金屬降到 50ppm，且不受 PET 之水份或高溼度之影響。

燃燒及焚化廢棄物之工廠亦可用渦電流分選機在燃焚前或燃焚後之系統。雖然有強制資源回收之法令，但許多人仍然丟棄他們之鋁罐及其它非鐵金屬物質。渦電流分選機可以在焚燒前去除有價非鐵金屬物質，此亦可有保護焚燒爐之功能，因有些物質會在爐中累積及阻塞排灰柵。未被去除之金屬經過焚燒後進入底灰中，磁性分選，然後再渦電流分選機可以去除大部份之金屬，以便在灰渣拋置前進行資源回收。此程序可以有回收資源、減少灰渣量及可將灰渣歸類於較小有毒之類別而節省費用等功效。

在廢汽車切片，可以利用渦電流分選機提升非鐵金屬之品質。汽車切片廠之非鐵金屬含有橡膠、塑膠及其它物質等雜質。渦電流分選機可將金屬含量 55%提高到 85%或以上，而回收率可達 95%。渦電流分選機可以有助於去除雜質、增加非鐵金屬之品位及其價值。

渦電流分選機也可以用減少玻璃碎片中之非鐵金屬雜質，假如玻璃原料中含有鐵及非鐵金屬顆

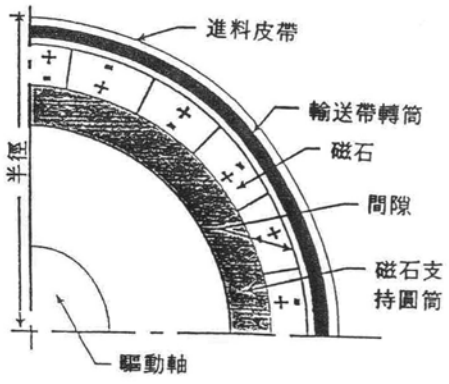


圖 2

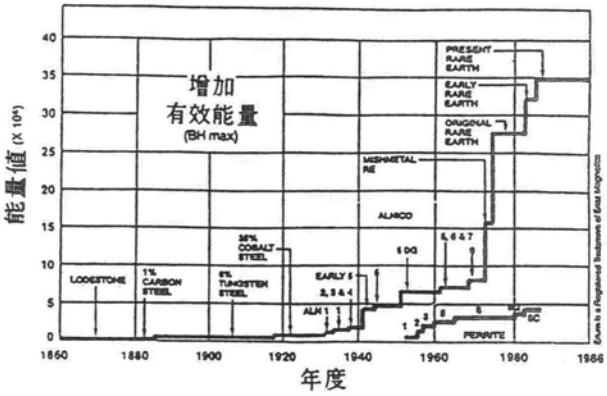


圖 3

粒，則其玻璃產品會產生瑕疵。渦電流分選機是有效減少雜質及較金屬探測器有效回收玻璃之方法。有時，將渦電流分選機安置於金屬探測器之拋棄物流程中，可以有效地減少玻璃被捨棄(見圖 6) 。

渦電流分選機是有效及經濟地從非鐵非金屬中分選非鐵金屬之分選機。使用永久稀土磁石可以產生高排斥力及不須像其它之電子脈波場渦電流分選機之額外能量消耗。渦電流分選機已經被證實是能有效地將鋁金屬飲料罐從混合之路邊物質、都市固體廢棄物。鋁片從 PET。非鐵金屬從玻璃碎片及廢汽車切片中分離。總之，渦電流分選機可以應用於非鐵金屬中含有乾燥之非鐵非金屬之雜質的地方。

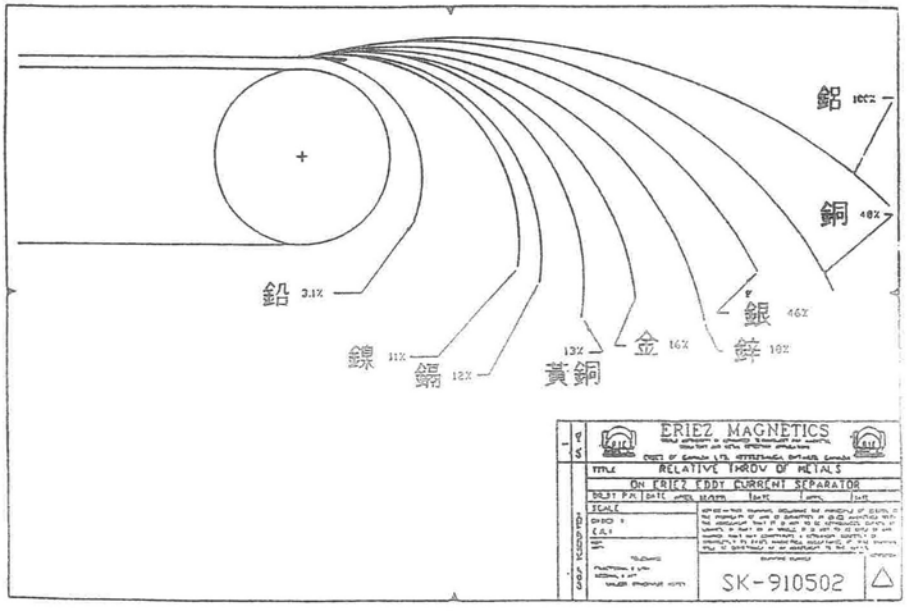


圖 4

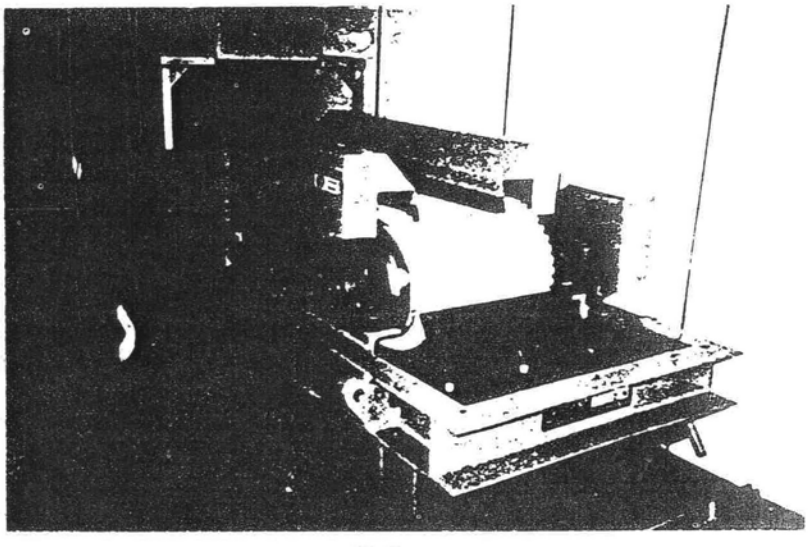


圖 5

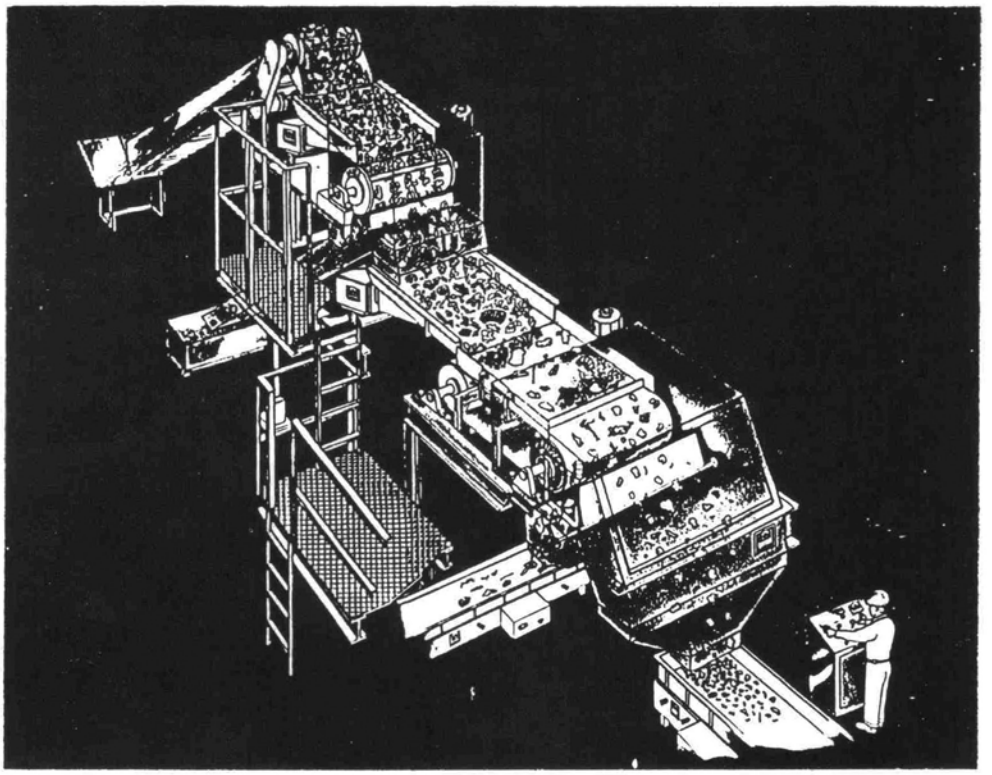


圖 6

原著參考文獻

D.A. Norrgran and J.A. Wernham, 1991, "Recycling and Secondary Recovery Applications using an Eddy Current Separator"

Mathieu, G.I. Provencher, R., and Tellier, J.G. 1990, "Mechanical Sorting of Aluminum Metal from Spent Pot Lining,"AIME 119th Annual Meeting, Anaheim, CA, February, 1990

Mathieu, G.I., Townsend, M.G., and Wronski, Z,S, 1990, "Sorting Aluminum from Spent Pot Lining"Canmet Technology Leads to Novel Separator using Fends Super Megnet's

Van Der Valk, H.J.L., Van Houwelingen, J.A., Dalmijn, W.L., and Duyvesteyn, W.P.C., 1987, "Recovery of Non-Ferrous Metals and Alloys with Eddy Current Separation Techniques," SME-AIME Annual Meeting, Denver, CO, February 1987.

Jeremy K. O'Brien, "Intergrated Collection: The Key to Economical Curbside Recycling,"
Solid Waste & Power, August 91, pg. 62-70

Stephen A. Katz, "Preparing for the New Wave of Recycling Facilities,"
Solid Waste & Power, August 91, pg. 54-60

Robert M. Chagnon, "Granulation for Post-Consumer Plastic Recycling,"
Resource Recycling, August 90, pg. 80-81

Gary L. Buley, "Resource Recovery: Turning Waste into Watts." Mechanical Engineering, December 90, pg. 37-41