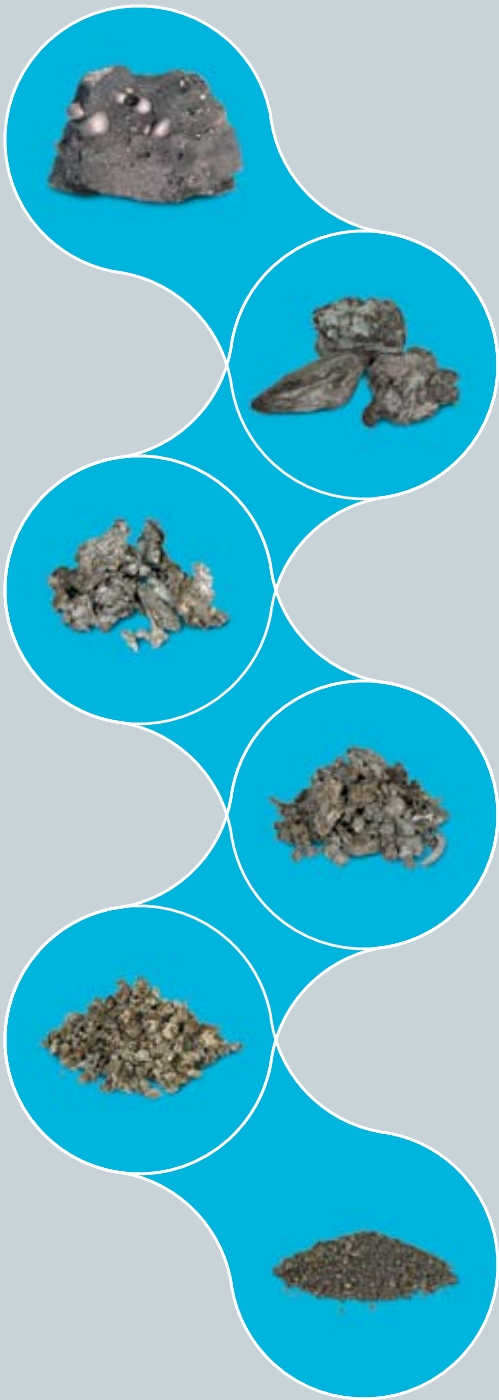


Introducing the RecCo-Marilyn  
**dry** recovery process of  
stainless steel from slag



S3R



Stainless Steel Scrap Recovery

The RecCo-Marilyn sensor technique is also suitable to recover other Ferro-Alloys

# Introduction of s3R

**s3R**, Stainless Steel Scrap Recovery, is a partnership of 3 companies for the recovery of non-ferrous metals from various waste flows. The following companies have formed a strategic alliance to provide the stainless steel industry with turnkey proposals for the **dry** recovery of stainless steel scrap from residual slag in accordance with the RecCo-Marilyn concept.



**RECCO**

**RecCo BV** (Recycling Consultancy), based in Aerdenhout and Akersloot, the Netherlands, has specialised know-how in engineering and management of the recovery of non-ferrous and ferrous metals from slag. Recco BV has now established a strategic alliance with Mous BV, a well established metal construction company, for building their designs. This includes products for s3R and Recco Contracts.



**Hofung Technology**, based in Beijing, China is an expert in bringing together the needs of Chinese clients with specialised technology and equipment suppliers outside China.



**Evergoed NV**, investment company based in The Hague.

**s3R** has developed the RecCo-Marilyn **dry** recovery process, described in this brochure, in order to provide the stainless steel industry and its contractors with a complete proposal for the recovery of all valuable stainless steel scrap from residual slag as from 1mm upwards. The rest product is a marketable residual slag fraction of 0-10mm slag, which, after it has been treated with  $\text{FeSO}_4$ , safely converts  $3\text{Cr}6+$  particles into  $\text{Cr}3+$  particles, thus creating an environmentally safe end product.

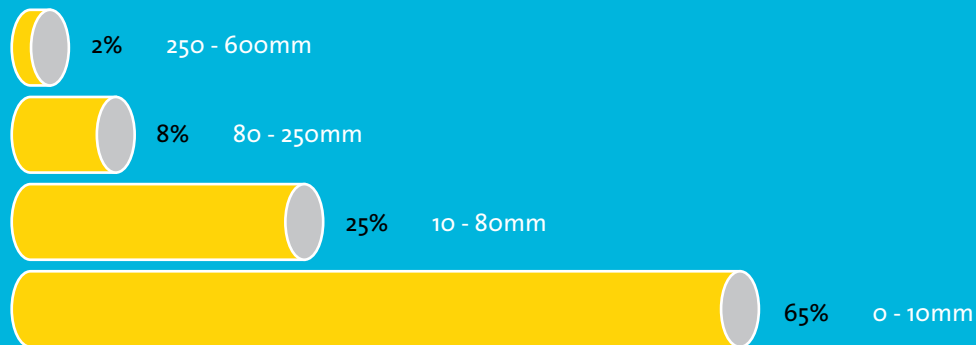
After an initial site visit and some laboratory testing, we will present customers with a basic engineering concept including flow sheet, layout, cross-sections and a CAPEX budget. The payback of the RecCo-Marilyn concept is 1-2 years.

The first concept for a 75 t/hr, single shift/day recovery plant was sold in 2005 to a Taiwanese customer. This plant will be fully operational in may 2006.

A second order was placed in February 2006 by the largest stainless steel producer in the world, the Chinese company Tisco for a 150 t/hr plant, 2 shifts/day, 760.000 t/year plant.

# RecCo-Marilyn dry recovery process of stainless steel scrap from steel mill slag

**Introduction** The stainless steel slag approximate particle size distribution consists of:



Ratio slag to steelmaking: 30-40% slag from 1 ton stainless steel production.

## **Traditional recovery of stainless steel scrap**

Today's most common recovery process of stainless steel scrap derived from residual slag at stainless steel producers is based on a **wet** grinding/ screening process. This process starts with scalping the slag oversize at 250mm, which is followed by primary crushing and hand sorting of metal pieces from 80-250mm.

The residual slag is then ground in 2 stages to liberate the enclosed metal from the slag. The primary mill is a peripheral discharge wet grinding rod mill, in which the discharge is screened out at a double deck screen where 10-50mm and 4-10mm fractions are extracted as metal concentrates.

Minus 4mm fractions are pumped to a screw classifier for dewatering prior to the material being routed to a secondary grinding mill for the final decomposition of the slag. This secondary mill is a wet overflow ball mill.

The discharged material is treated on a screw classifier, whereby the oversize is taken out as metal concentrate. The overflow from the classifier is deslimed in a hydrocyclone before being treated on a spiral concentrator for recovery of fine metal particles.

Fine slag (slurry) treatment is a system of special sealed settling basins from which the overflow water is re-circulated for the grinding and screening process. Fine slag will remain behind in the settling ponds. This process has a high degree of recovery and produces good quality wet recovered scrap. However, this process is very capital intensive, consumes a lot of energy and the residual slag (>90%) product is mostly **non-reusable** and can therefore only remain at a deposit landfill area. Various modifications have been made to this basic wet principle but the final recovery and grinding stage is still largely a **wet** process.

# The RecCo-Marilyn dry recovery process

The RecCo-Marilyn process is a new, completely **dry** recovery process, which uses standard crushing techniques (impactor) to liberate the metal pieces, and a unique combination of metal sensor/magnet recovery techniques to recover metal pieces from 15mm to 80/150mm. The fraction smaller than 15mm is processed in a **dry** milling process, after which clean metal 0,5-15mm is recovered.

The RecCo-Marilyn process is a 5-step approach consisting of separate modules, where clients can choose the degree of metal fraction recovery.

**Step 1** In principle slag is screened at 250mm, 80mm and 10mm to remove +250mm and 0-10mm. After removing >250mm metal, + 250mm slag is later separately crushed and added to the flow. The 80-250mm is either handpicked or metal sensor-treated to recover metal pieces prior to routing all slag through an impactor and hammer mill.

- Metal products : +250mm



80-250mm (Handpicked or handpicked/sensor-picked (combination))



s3R plant  
in Taiwan



**Step 2 & 3** After crushing (impactor) and screening, material is sensor-treated in various fractions to retrieve clean metal, residual slag is rerouted through the crushing circuit to liberate more metal. To increase the efficiency of the sensor recovery machines, **s3R** removes ferritic stainless steel particles first.

- Metal products: 35 – 80mm (Magnet and sensor-separated)



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15 – 35mm (Sensor-separated)



**Step 4** The minus 0,5-15mm metal parts are retrieved through a dry milling process in combination with the use of barium-ferrite magnets and neodymium magnets. After the dry milling process, the material is screened at 1mm, whereby all material smaller than 1mm is dry slag to be added to the 0-10mm slag fraction after a special treatment, while the + 1–15mm fraction is pure metal.

- Metal products: 1 – 15mm (Screened after dry milling)



The 0-1 mm fraction is treated with special magnets to retrieve the 0,5-1mm metal fraction from the slag.

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**Step 5** **new concept!** From the initial screened out (wet) 0-10mm fraction, the metal is concentrated by a series of special magnets. This concentrate is then sent to a special crusher which is modified for this material. The crushed material is then added to the proces of step 4.

By processing this 0-10mm fraction which is  $\pm$  65% of the total slag, another 4% of metals can be retrieved.

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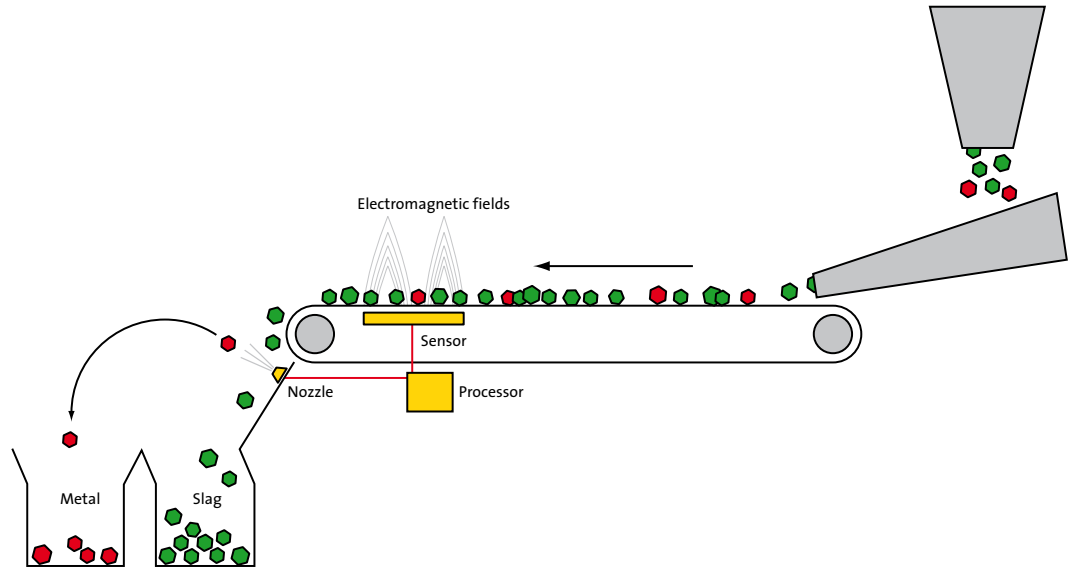
The recovery rate and quality of retrieved scrap are equal to those obtained with the wet milling process; stainless steel metal content >80-90%.

The total recovery rate of metal products varies from 8 – 12% of the total input. In this case, large pieces of scrap >250mm are already excluded as they will normally have been recovered by the steel mill.

# Basic principle of the sensor technique

Metal containing slag of a defined size distribution is screened and then routed onto a fast-moving conveyor belt (3-5m/s). Nearly at the end of this conveyor, the material is measured by a sensor to define the damping of the induction value of the material passing over. Material to be recovered is detected by the sensor. A signal is sent to the processing unit, which in sequence activates air valves located below the material flow of the sorting unit. Finally, the activated air valve will blow out the programmed material (metal pieces).

Principle drawing



These sensor technique recovery machines have been substantially improved lately, and s3R has modified the system to suit our particular application.

By varying certain critical parameters, we can either retrieve both free clean metal and metal bearing slag (high-sensitivity mode) or retrieve only pure metal pieces, whereby metal bearing slag is then recirculated to liberate more metal. Capacities up to 20t/hr can be reached.

With the sensor technique, s3R has managed to retrieve metal pieces from 150mm down to 15mm at a high degree of purity of >80-90% metal.

Marilyn Sensor separator in Taiwanese plant



# Advantages of this dry process

- CAPEX (Capital expenditure) is substantially less than the CAPEX required for the wet milling route.
- There is no slag disposal problem as the process produces 0-10mm dry slag which can be re-used in civil construction applications.  
Treatment with  $\text{FeSO}_4$  will convert  $\text{Cr}^{6+}$  into  $\text{Cr}^{3+}$ , eliminating the undesired  $\text{Cr}^{6+}$ .
- Far less energy consumption.
- More efficient, as it does not grind slag further if no significant metal pieces are enclosed.
- The plant can be built on permanent or semi-mobile configurations in accordance to our 5-step module approach, where clients can choose the degree of metal fraction recovery.
- No large concrete foundations are required. Simple concrete platforms will support the various plant items built in modules on subframes.
- Delivery of all components is within 16-18 weeks of approved design.
- No water treatment installation. No risk of contaminated water entering the environment.
- Dust-free sorting plant with special dust treatment technology.

# S3R

- **Stainless Steel Scrap Recovery**



# s3R

● Stainless Steel Scrap Recovery

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