

# SEPARATION OF TRAMP IRON AND FERRIC MATERIALS FROM SUGARCANE TO ACHIEVE EFFICIENT MILLING

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## Abstract

This paper deals with the separation of tramp iron and ferric materials delivered to the mill along with sugarcane and its effect on cane preparation. Although there are different designs available, most sugar factories hesitate to install a separator due to the high cost and complicated design. To solve this problem, the authors came up with the novel idea of a technique called the 'rotary type magnetic separator', which is a simple electromagnet that can be placed just before the shredder. The performance of the new magnetic separator was compared with other designs and advantages were noted. An efficiency of 95% can be achieved with this trouble-free system, the pay-back period of which is less than one-quarter of the crushing season. The authors compare the other designs available in the market with their new design.

## Introduction

The most common metal objects deposited on the cane carrier along with the sugarcane are pieces of knife blades, hooks, pieces of broken slings, bolts and nuts. Pieces of cast iron and special steel are the most dangerous. If foreign material is not removed and enters the mill, the teeth of rollers and the hammers and knives will be damaged to some extent. To avoid damage to machinery and the associated loss of revenue, early precautionary measures should be taken at the loading point, such as tightening of loose bolts and nuts, and at the offloading point proper supervision should be given to ensuring that the cane carrier is in good order.

Although there will always be foreign matter that enters the system via the cane carrier, the installation of a magnetic 'tramp iron separator' will ensure that the least amount possible will go undetected.

## Types of separators

The magnetic separator consists of an electromagnet mounted across the entire width of the cane feed, which attracts and holds the pieces of iron passing through its field. There are two peripheral types available in the market.

### *Flat electromagnetic separator*

This type of separator is normally placed behind the bottom of the feed hopper. Some are provided with four working surfaces, which automatically turn 90 degrees every 15 minutes. Thus, the face which forms part of the bottom plate is suddenly turned downwards, the electric current stops and the pieces of iron that were adhering to the magnet, drop into a box below. The next face moves into place of the bottom of the feed plate, and the magnet is immediately made active in turn.

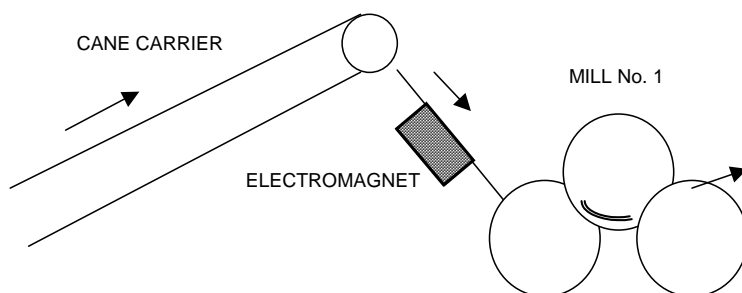
### *Cylindrical separators*

These cylindrical separators project into the feed hoppers. Each cylinder is about 1 metre in diameter, the axis of which is located in the plane of the feed chutes, viewed from the head of the carrier on to a cylinder and then to the crusher. The separator cylinder rotates slowly, picking up pieces of iron and releasing them when they have passed the feed plate. Since this type of separator occupies a large space and is so cumbersome, it is a hindrance to proper feeding. There is also the problem of cane pieces passing through the joints.

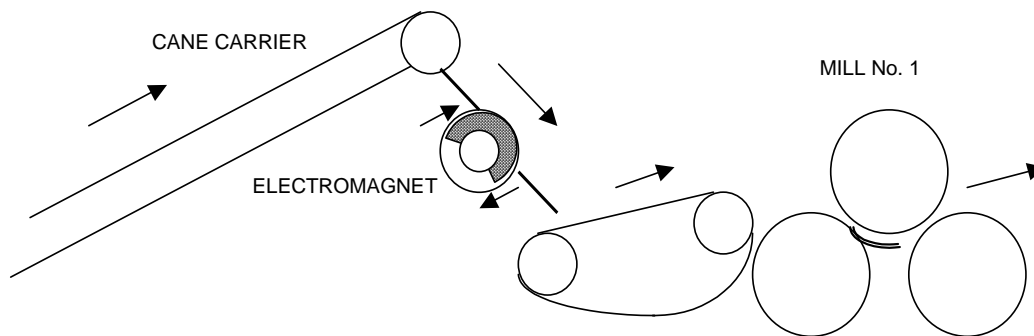
Neither of the above models can be installed on a feed plate with a slope greater than 55 degrees without risking a complete loss of efficiency. For this reasons they are not used generally. These types of magnetic separators are also very expensive.

To avoid mill stoppages due to the entrance of tramp iron, one of the designs has an additional high speed rubber belt and a box-type electromagnet has been provided. Although this system efficiently removes tramp iron material, the repair and maintenance costs are high. Many countries install such equipment to reduce downtime and ensure smooth running of the mill. India is not in favour of introducing such equipment due to the high cost.

In 1972, Hugot suggested the introduction of an electromagnet under the cane feed chute (Figure 1), but in later years many sugar mills replaced the feed chutes with Donnelly chutes, along with rake-type intercarriers. This type of installation is not possible in mills where the Donnelly chute is installed. Later, Hugot (1986) discussed a suspended box-type electromagnet installed above the high-speed conveyor belt (Figure 3). In this design the belt speed had been fixed at 2 m/s, and the layer of prepared cane above the rubber belt had to be maintained at less than 100 mm. The power of the electromagnet was kept at 7 kW, and the clearance between the magnet and the belt was 250-300 mm. In this installation the recovered iron pieces weighed about 70 kg and the author estimated an efficiency of 80 to 90%.



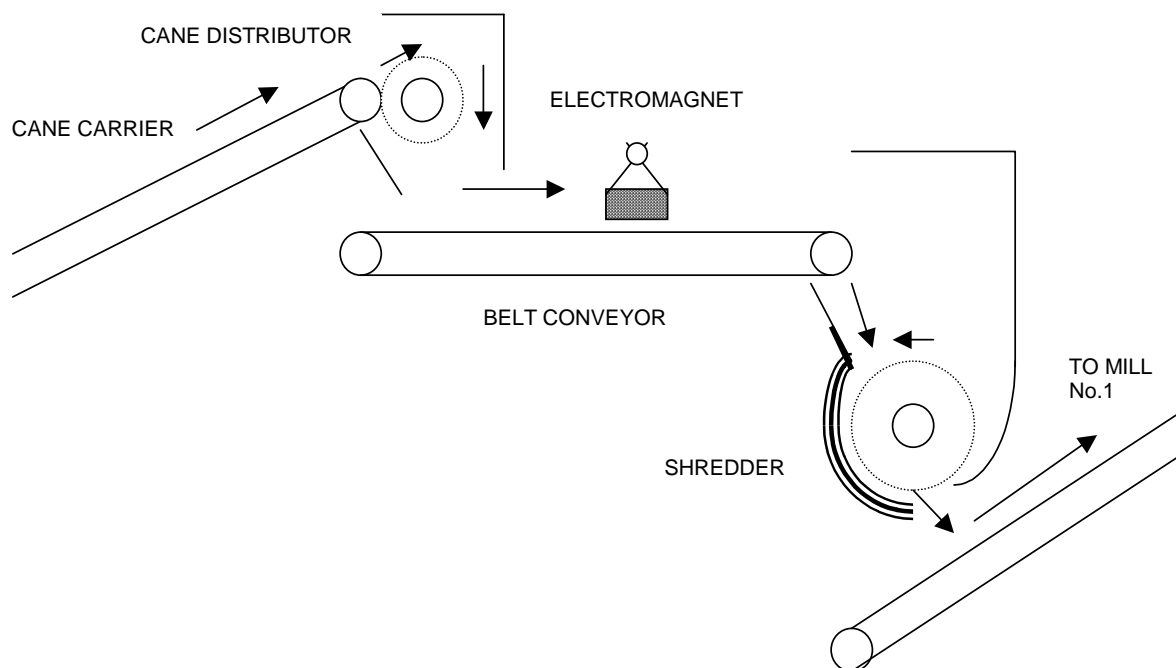
**Figure 1. Electromagnet suggested by Hugot (1972).**



**Figure 2. Electromagnet installed at Miwani Sugar Co. Ltd, Kenya.**

The installation of a high-speed rubber belt conveyor can become a headache for mill engineers because of extensive repairs and maintenance. Hence this type of magnet is not very popular. One of the authors faced similar problems at Miwani Sugar Co. Ltd. in Kenya, and at Kennana Sugar in the Sudan. At the Miwani sugar mill in Kenya the electromagnet was of the rotary type (Figure 2) and was placed under the cane feed chute of the first mill. Here, efficiency was low as the pick-up power was not sufficient. At Kennana sugar mill in the Sudan, there were two milling tandems, each 2300 mm in width, therefore two electromagnets were installed - one for each milling tandem. The following problems were faced by these mills:

- The sugarcane choked at the magnet if attention was not paid to regular cleaning.
- A batch-type operation had to be carried out because the magnet had to be taken away from the belt conveyor, demagnetised, cleared of ferric material and again moved back to the suspended position on the rubber belt conveyor.
- There was always the risk of passing some ferric material to the shredder and mills when the magnet was being cleared of the tramp iron material, or crushing had to stop until the magnet had been cleaned off.
- The cost of installation of the high-speed belt conveyor was very high and there was repeated damage to the rubber belt, which increased repair and maintenance costs.
- The rubber belt needed regular realignment, without which the drive motor would trip due to excessive deviation.

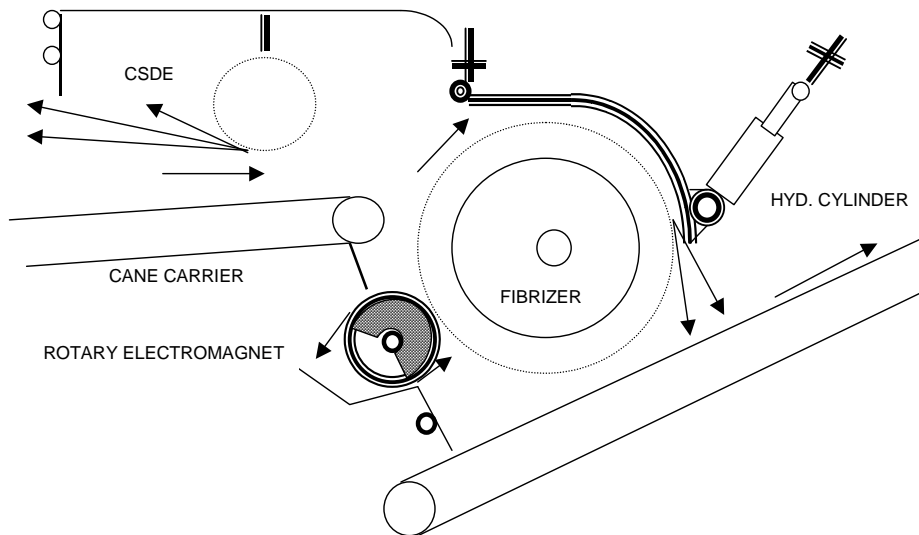


**Figure 3. Electromagnet as installed at the Kennana and Valsad sugar factories (after Hugot, 1986).**

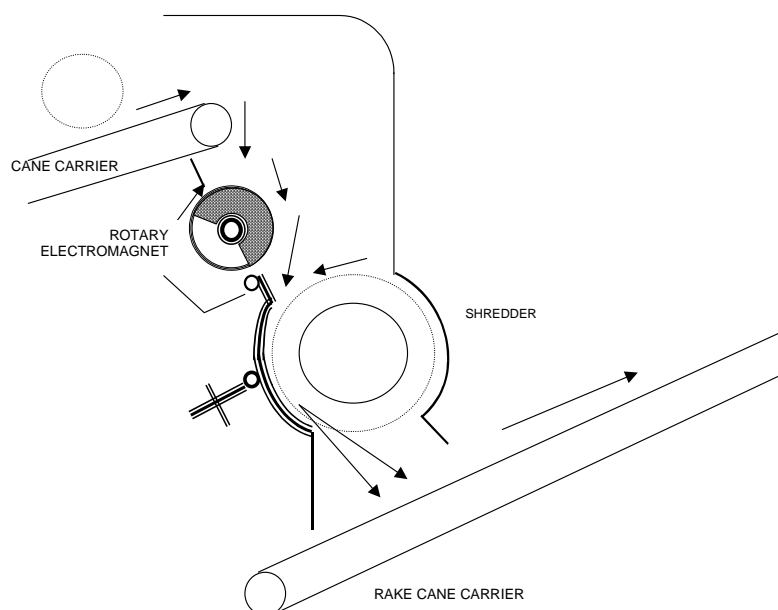
Valsad sugar mill at Gujarat (India) has installed a box-type electromagnet, suspended above the high-speed belt conveyor. The magnet is not operated at present due to problems in cleaning and tripping continuously. So, due to various problems, this system does not function well. The aim of the authors was therefore to develop a low cost and effective magnetic separator that would reduce stoppages and improve milling efficiency.

## The new continuous rotary electromagnet

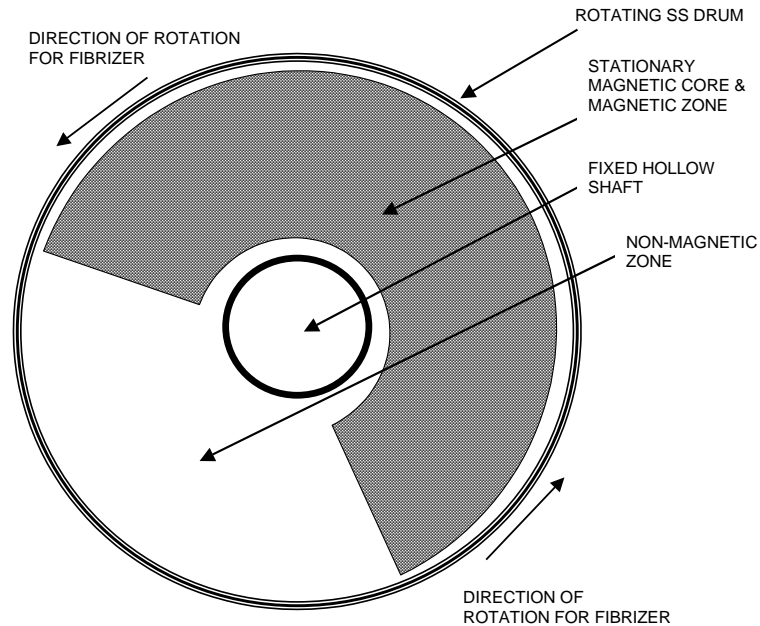
The new design is a simple rotary type electromagnet (Figures 4 and 5) that will be installed between the cane carrier and the fibrizer, to enable the removal of all ferric materials to safeguard the fibrizer and the components of the milling tandem. It is low cost and simple to install, and needs no additional high speed rubber belt. The diameter of the rotary drum is 1100 mm, and drum width and length are equal to that of the cane carrier and fibrizer. The outer rotary drum is made of non-magnetic stainless steel with a wall thickness of 10 mm. The cone of the magnet is of a fixed type, spread over an angle of 200 degrees. The air gap between the drum and the magnetic cone is maintained at less than 2 mm. The head shaft of the cane carrier will drive the stainless steel drum of the electromagnet (Figure 6), so that no extra power is required to rotate the drum. The peripheral speed of the drum is equal to that of the cane carrier, i.e. 0-0.17 m/s. The direction of rotation is the opposite to that of the cane carrier in the case of the fibrizer. A sprocket and roller chain rotate the magnetic drum, and there is an extra pair of sprocket gears to reverse the direction of rotation in the case of the fibrizer.



**Figure 4. Rotary electromagnet design to install with fibrizer.**



**Figure 5. Rotary electromagnet to be installed (as per authors' design).**



**Figure 6. Details of new rotary electromagnet.**

#### **Advantages of the new design electromagnet**

- The location of the electromagnet, chosen by the authors, is ideal for avoiding damage to the fibrizer hammers and mill rollers. The increased gap between the cane carrier and the fibrizer will also help to avoid damage to the slats of the cane carrier which is caused by loose, worn out hammers.
- The installation, repair and maintenance costs of a high speed rubber conveyor belt have been eliminated.
- The pick-up power of the new design will be more than 200 kg for a standard mill tandem 1700 mm wide. The capacity can be changed to accommodate different mills, and to suit local conditions.
- Damage to the hammer tips of the fibrizer will be avoided. This will improve and maintain the preparation index at a high level.
- The huge recurring cost of re-shelling the mill rollers will be reduced drastically, as damage will be minimised.
- Protection from tramp iron will extend the lifespan of the roller shells, increase mill extraction and decrease moisture in final bagasse. The new design can maintain efficiency at top level throughout the crushing season.
- Where necessary, more hydraulic pressure can be exerted on the mill rollers without fear of damage from iron pieces.

- Should problems occur the electromagnet can be bypassed and crushing can continue without a stoppage.
- The efficiency of the electromagnet will be 90 to 95%.
- The installation of the new design is foolproof and simple, and installation, repair and maintenance costs will be low.
- The payback period for the electromagnet will be less than a quarter of a single crushing season.

### **Conclusions**

The rotary electromagnet provides protection for the fibrizer, shredder and rollers, and is a profitable and useful piece of equipment. It is necessary in long tandem mills and where higher hydraulic pressures are applied. It is able to remove even the smallest piece of iron that enters its field.

### **Acknowledgements**

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