

REPORT ON AN AUTOMATIC CONTROL SYSTEM FOR SUGARCANE CARRIERS EMPLOYING THYRISTOR-FED DC DRIVE MOTORS

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Abstract

A system employing a Hall generator for mill chute level sensing and automatic speed control is described. The speed controlled sugar cane conveyors, from the feed tables to the first mill chute are driven by DC motors and are fed by thyristors. This system has proven itself in three sugar campaigns at Açucareira de Moçambique where a constant crushing rate was maintained throughout the entire crushing periods.

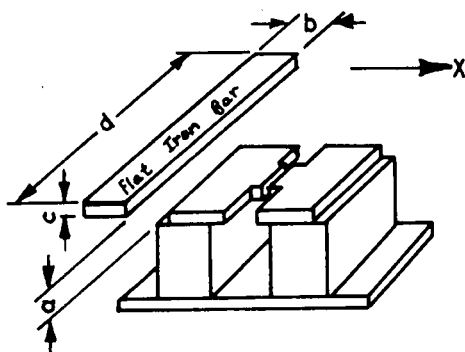
When the new sugar factory was built by Açucareira de Moçambique at Mafambisse near Beira in 1968/70, a reliable stepless controlled variable speed drive system was sought for the cane carriers to the crushing mills. After giving thorough consideration to cane carrier drive and control methods employed at existing factories, an optimum solution appeared to be the application of thyristor-fed DC shunt wound motors. The speed of these motors should be governed by simple and robust electrical signal transmitters, able to operate continuously under stringent ambient conditions which prevail in the milling section of a sugar factory.

For determination of the sugarcane intake rate to the mills, the initial governing factor is the level of the first mill chute and the lift of the first mill top Roller. Overriding factors are the electrical currents drawn by the primary and secondary cane knife motors and the shredder motor.

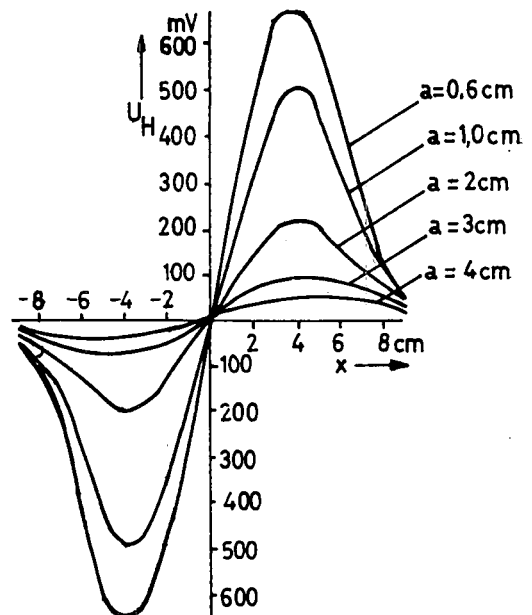
Existing chute level control methods, as employed at various sugar factories have not proved entirely satisfactory. The various methods are as follows:

- limit switches installed at different heights of the chute;
- probes set at different heights of the chute to measure electrical values such as resistance and capacitance;
- chute deflection plates operating potentiometers;
- flaps operating limit switches in different positions of the cane carrier to the first mill.

The major difficulty experienced in the above methods is that control components are continuously subjected to external influences such as foreign matter, residue sugar, moisture, wear and tear etc., which lead to distorted results. The answer was found in



b 50mm
c 6mm
a 75mm



HALL VOLTAGE BEHAVIOUR

FIGURE I Hall Generator

employing the chute deflection plate method (as under C) and utilising an electrical sensing transmitter called "Hall Generator". This is a totally enclosed semi-conductor element which can be magnetically controlled and works contactless. Figure 1 schematically shows the Hall generator and its "Hall voltage" behaviour as a function of the proximity of a permanent magnet flat iron bar.

When the intercarrier to the first mill is stopped or slowed down below a preset value, the five conveyors are automatically stopped in the following sequence:
 Main carrier — horizontal
 Main carrier — inclined
 slat conveyor
 belt conveyor — yard to mill
 intercarrier to first mill

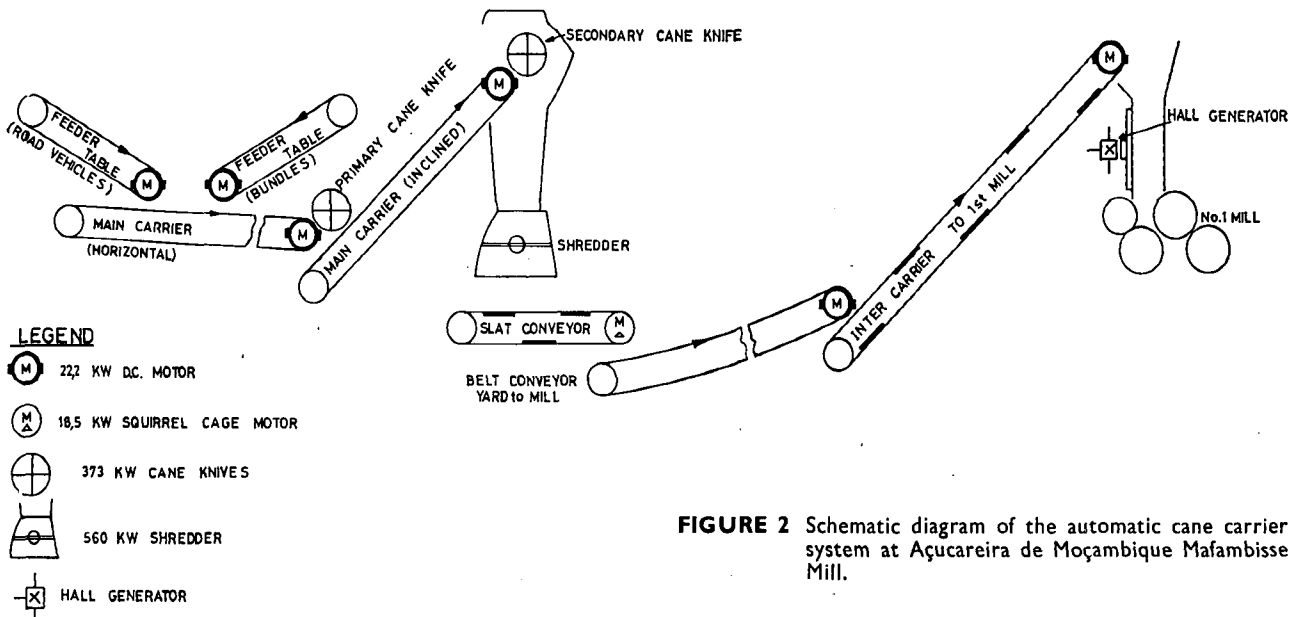


FIGURE 2 Schematic diagram of the automatic cane carrier system at Açucareira de Moçambique Mafambisse Mill.

The flat iron bar is fixed to the chute deflection plate while the Hall generator is rigidly mounted adjacent to it. The deflection plate bulges proportionately to the chute contents and, therefore, gives a true reflection of the chute level. A total deflection of approximately 10 mm suffices for the Hall generator to produce a useable signal voltage.

The basic control of the function of the system is made up as follows:

- (1) The Hall generator installed on the first mill chute controls the speed of all four thyristor fed DC drives proportionately depending on

Figure 2 serves to illustrate schematically the automatically controlled cane carrier system as installed at Açucareira de Moçambique.

There are six thyristor-controlled DC Motors each 22,2 kW with a speed range of 200 - 1 600 r.p.m.

These are:

- Feeder Table 1
- Feeder Table 2
- Main Carrier — horizontal
- Main Carrier — inclined
- Belt conveyor — yard to mill
- Intercarrier to first mill

The two feeder table drives are manually controlled and hence are not part of the automatic control system at present.

The speed against load characteristics of the DC Motors employed in this scheme, may be seen from figure 3.

A slat conveyor which transports the cane from the shredder to the belt conveyor is driven by a 18,5 kW 1 450 r.p.m. motor and electrically interlocked with the automatic control system to prevent choking.

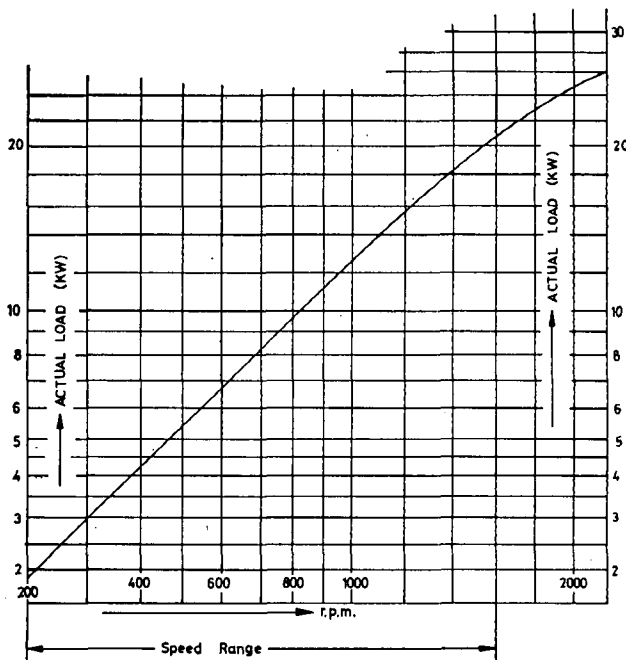


FIGURE 3 Speed against load of a DC 22,2 kW motor as installed at Açucareira de Moçambique

the level of the cane in the chute. The level of this chute can be predetermined by a manually operated potentiometer installed in the remote mill control desk. If the amount of cane exceeds the predetermined level the speed of the DC drives is reduced, if it is lower, the speed of these drives is increased to a predetermined value.

- (2) In the event of the load of the primary cane knives exceeding a preset value the speed of the horizontal main carrier is reduced proportionately. Here again the load conditions are sensed by measuring the electric current drawn by the drive motor.

The preset value of current of the primary cane knives serves as an initial signal to determine the crushing rate of the mill.

- (3) In the event of the load of the secondary cane knives or the shredder exceeding a preset value the speeds of the horizontal main carrier and the inclined main carrier are slowed down proportionally, with a slight time lag. The sensing of load conditions of these carriers is done by measuring the electric current drawn by the drive motors.
- (4) The speeds of the horizontal and inclined main carriers automatically return to their preset values, once the load of the knives and the shredder have returned to their preset values.
- (5) A hydraulic pressure cylinder, fitted to the first mill, senses the lift of the top mill roller and transmits a signal to a recording instrument. An adjustable limit switch, set to a maximum allowable lift position, is provided. If the roller reaches this position, all four DC drives are slowed down simultaneously to a preset value which can be adjusted by a potentiometer.
- (6) In order to facilitate slow feed to the mill or in the unforeseen event of an excess feed into

the intercarrier to the first mill where quick action is required, a potentiometer is provided in the mill control desk. This enables the operator to reduce the speed of all four DC drives simultaneously and proportionally.

- (7) The horizontal main carrier is fed by two DC motor-driven feed tables. These motors which are of the same size and have the same speed range as the four cane carrier drives are thyristor fed. Speed control is done manually and the operator's desk is situated in a separate high-perched control cabin in the cane yard.

The cane carrier drive and control system as described in this paper has been working completely satisfactorily since it was commissioned. Teething troubles were only experienced with the deflection plate which rapidly wore down. After replacement by a plate of stainless steel, however, the problem was solved.

When switched from "manual" to "automatic" the sugar mill can be kept at a constant crushing rate and the process house settles down to smoother running as a constant input is ensured.

The Hall generator has proved to be continuously reliable and requires no maintenance, apart from normal external cleaning.

The totally enclosed fan-cooled DC motors with constant torque characteristics are ideally suited for the application and allow for continuous speed control within a wide speed range.

The thyristor control units are of the transistorised type and comprise printed circuits mounted on replaceable plug-in trays. These units are housed in dust-proof metal cubicles located in the mill control room. Here the mill control desk is also positioned. As the system is fully automated, the mill operator is merely on stand-by duty, should a mechanical breakdown occur.