

# SOME ASPECTS OF AUTOMATION IN THE BRITISH AND SWEDISH SUGAR INDUSTRIES

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## Introduction

In a short paper it would be impossible to cover but very briefly all the forms of automation the author was privileged to see in England and Sweden during a recent tour. The more common type of automation which can be seen in Natal shall be ignored and only the more unique types will be described.

However, before ignoring the so-called common types the author feels that he must comment on the present trend in the recorder/controller type of automatic control. For economic reasons and as a means of space saving, instrument manufacturers have developed miniature recorder/controllers of about six inches square facing on the instrument panel. These instruments are all of the strip chart type using charts from 4 inches to 5 inches wide. Thus the use of these instruments has virtually been the end of the daily circular charts that are so popular in Natal. Contrary to first thoughts that this is a retrograde step, the strip charts, particularly miniature charts, are a real advance in the process of accepting automation. It is very difficult to compare events recorded on one circular chart with events on another chart. If a series of recorder controllers form the basis of an automatic process control, it is essential that recorded events on each recorder can be compared with recorded events on all the other units of the control console. This is a simple matter with strip charts about 4 to 5 inches wide, each having the same travel distance of chart per unit time. All that is necessary is to place the charts on a table with the same time marks corresponding and the comparison of events is then simple and irregularities are usually glaringly obvious.

As an obvious development, instruments are becoming more and more of the electronic or transistorised type and in fact it is due to this that miniature strip charts can be used. Although the chart is small it is possible by suitably biasing of the electronic circuit to use the full width of the chart for only the range required, thereby achieving pen movements over the required range almost as large as those used on the older type of "mechanical" instrument.

Operators of automation utilising the strip chart type of controller in general only tear off the charts at the end of a week, that is if the charts are removed at all. Here again is a new conception. We are used to changing our circular charts daily and keeping a pile of charts as a record of what is "history". Does this serve any real useful purpose? If nothing went wrong it is an uninteresting picture; if a fault occurred, someone has taken remedial action long before the chart arrives at its point of scrutiny. The purpose of the chart is to record operating features and is a policeman or watchman and will record errors, but

if the automation has been correctly installed the corrective action is taken or initiated often before the error has time to make itself evident on the chart.

## Automatic Sucrose Determination

The beet sugar industry relies on the efforts of many hundreds of small and large beet farmers, probably more farmers per factory than we have here in Natal. This presented a problem in determining the sucrose delivered by each farmer, and great advances have been made in this direction. Firstly the polariscope has been abandoned in favour of an electronic polarimeter which uses a Faraday effect of the sucrose solution to measure the sucrose content. Instruments of this type were seen both in England and in Sweden. They are amazingly accurate and cannot be cheated. Not only do they do away with inaccuracies due to a person's eyesight but they also overcome personal fatigue which must occur when many hundreds of samples must be read per shift. The electronic polarimeter has been arranged to indicate the sucrose content on a dial (to two decimal places) or to print a ticket, or in the most advanced installations, to punch a card to be used in a "punched card" analyses. This latter card, when being processed through the machines, is connected to the automatically punched card initiated at the weighbridge. Further processing in the punched card machines produced a typed payment cheque for the farmer who sent the consignment.

## Automatic Weighbridges

In an endeavour to reduce labour and to improve accuracy, many weighbridges used for the gross and tare weight of vehicles delivering sugar beet have been made automatic to such an extent that, instead of printing a card, a punched card is produced. This card carries a serial number which is produced by placing a perforated metal plate on the punching machine. This same plate is carried by the driver to the sampling point and is used to serialise the analysis punched card recording dirty weight, clean weight and sucrose. The dirty weight is the initial weight of the sample weighed on an automatic scale and recorded on the punched card; the sample then passes through the automatic washer to remove all attached earth. The washed sample is then topped manually and the cleaned topped beets are automatically reweighed and recorded on the same card. The sample then passes through the multiple saw to produce the sucrose reading mentioned before above.

In the meanwhile the lorry has been off-loaded and proceeded to the tare weighbridge. At this point the first punched card is combined with a name and address card and also punched with the tare weight. At the same time the automatic typewriter coupled to the punched card system produces a docket for the driver as a record of the date, gross and tare weight of the vehicle and the serial number of the

sample. Further processing in the administration office connects the analysis card with the weighbridge card, calculates nett clean weight, total sucrose delivered and corresponding payment, eventually to producing the actual payment cheque.

#### Automatic Diffusion Rate Control

The rate of consumption of beet slices into the continuous diffuser is, in general, influenced by the speed and sharpness of the knives or blades in the beet-slicing machines. The faster the cutting speed and the sharper the blades, the more the beet will be sliced. The slices are fed into the diffuser by means of a conveyor belt. To achieve automatic control, a belt weigher is installed on the conveyor belt. In general the weigher integrates the weight being conveyed and gives a large integrated reading so that readings taken hourly will give the quantity of beet slices consumed during each hour. Added to this information is an automatic control by setting the desired rate on the scale. Each individual weight per unit length of belt should equal the desired setting. Any increase or decrease of weight generates a signal which is fed back to the beet slicing machines causing a decrease or increase in the weight of beet slices. Usually three slicing machines feed a diffuser, two run at a constant speed and the third is variable and is controlled in speed by the belt weigher. As the knives become blunt, the quantity of slices drops, the belt weigher detects this and speeds up the one slicer. As this is the normal trend the speed increases until the slicer is near a maximum speed. At this point an alarm rings and a fourth, spare cutting machine is started and one other machine is stopped for a change of blades. As the beet industry operates non-stop from the start to end of a campaign, cutting blades are changed "on the run" daily. This belt weigher automatic control can be amazingly accurate and variations of no more than  $\pm \frac{1}{2}$  per cent are not uncommon.

While this has no direct connection with cane sugar milling, it has been mentioned because the author considers that so accurate a control on crushing rate would be the answer to many a problem in cane sugar manufacture.

#### Automatic Factory Control from Beet Slicing to Thick Liquor

Automation of one function can lead to automation of another and this can be sometimes carried on until complete automation is achieved. The author was privileged to visit one factory where automation had progressed from beet reception right through to the syrup (or thick liquor) tanks on the pan floor.

The control of the consumption of beet slices has been described. Step two is to control the brix of the raw juice from the diffuser, this being effected by controlling the quantity of water used by the diffuser (called draught). We are all conversant with density (or brix) controllers but when this is applied to a diffuser consuming beet slices at a constant rate, the work of the density controller is simplified as it has now only to cope with different sucrose contents of the slices and not with any variation in rate of

consumption. This raw juice is pumped to a tank, the carbonation supply tank which is also a surge tank.

This constant density raw juice is then heated under automatic control. Here again as the brix is constant and the quantity only varies, due to difference in sucrose or dissolved solids from the beet slices, the control of the temperature is reasonably simple.

The control of the carbonation process is firstly roughly performed by conductivity control and finally by pH control. This juice then flows directly to the clarifier which has no automatic control because it is not considered necessary. It should be stated that carbonated beet sugar juice settles at a fantastic rate compared with defecated cane sugar juice and the small variations in quantity as controlled by beet slices rate and constant brix, present no problem. The clarified juice is pumped to the evaporator supply tank which is now the second surge tank in the system.

The evaporator presented a problem because it was a sextuple effect with two vessels per effect. Exhaust steam, all of it, from the power station is fed to the double first effect at 30 p.s.i.g. Extensive bleeding for the pans, heaters and diffuser water heater is utilised from the various effects of the evaporator and live steam is used to boost the exhaust steam when the first effect draws too much. For the optimum fuel economy, no vapour from the fifth effect should go to the sixth effect, the boiling in this effect is achieved by dropping the vacuum or absolute pressure to a point where the temperature of the liquor entering this effect is higher than the boiling point for that pressure. Here is a really complex section of the factory to control. The various levels are easy to control and this is done conventionally.

However controlling levels does not achieve much as far as automatic control is concerned, particularly when the evaporator station is the key to fuel economy. At this factory the problem was solved by feeding an electronic brain or digital computer with all the variables concerned and allowing the computer to re-transmit the necessary control signals to the required steam and vapour bleeding valves. Here is a bold step forward in automation but a very logical one. This instrumentation hardly saves labour but certainly pays its way in fuel economy.

The thick liquor or syrup is pumped to the pan supply tanks which form the third surge tanks in the system.

So far the author has described stages in the complete automation process. The significance of the three different surge tanks has not yet been stressed. For ease of factory control all the control instruments are miniature recorder/controller type. Apart from the conductivity and pH carbonation controls and the digital computer, all the instruments are arranged in a flow pattern on one panel about 25 feet long by 7 feet high. The beet slicing machine speeds are indicated at one end, these being controlled by the belt weigher. The slice rate is set to a desired rate by the Factory Manager. Alarms are coupled to the

belt weigher to either indicate blunt blades on the slicers or a stoppage of beet to the slicers. The automatically controlled diffuser brix and the raw juice surge tank level is also recorded. High and low alarms are fitted to this tank. Increase in level above a preset level causes the beet intake rate to decrease because the level recorder is coupled to the belt weigher signals to the beet slicers. The raw juice temperatures are recorded and alarms set for undesirable temperatures. The evaporator supply tank (surge tank number two) level is recorded. High and low alarms are incorporated and are coupled to the pumps drawing from the raw juice tanks to the carbonation process. The brix of the thick liquor from the evaporator is recorded. As this is controlled by the digital computer it is not necessary to couple this to anything. Finally the level in the thick liquor tank (third surge tanks) is recorded and also equipped with high and low alarms. Here high levels react on the digital computer and cause a slow down of the evaporator which causes the evaporator supply tank to fill until the high level here reduces the quantity drawn off the raw juice tank which in turn fills up and reacts on the beet slicing machines and the whole factory is automatically slowed down. This occurs when the pan floor cannot deal with all the thick liquor. When the condition clears the reverse action takes place.

#### The Use of Closed Circuit T.V.

In one factory visited in the United Kingdom and in one factory in Sweden, the author inspected installations of closed circuit television apparatus. While this is hardly an automatic control in the true sense of the word, it is nevertheless a labour saving device and therefore worthy of mention. In the British installation, one camera pick up point actually energised two T.V. screens. The camera was located on top of the beet receiving bin of the diffuser system and one viewing screen was located on the control panel adjacent to the operator who supervised the washing and intake of beet and the other was on the main diffuser control panel so that a visual check could be made on the beet directly available for diffusion. The "diffusion" beet receiving bin was far removed from both these points but was under constant supervision.

In Sweden the camera was installed on a rotating platform in the top of a refined sugar silo and the viewing screen was placed on the pan floor. Refined sugar massecuite from the pan strike receivers flowed to batteries of fully automatic Swedish made centrifugals, from the centrifugals to rotary driers and from the driers to a conveyor belt system to the silo. With only one operator on duty at the centrifugal machines and no operator for the drier or conveyor belt system, a minimum of labour is used from the pans to the silo and yet the loading of the silo is under observation.

#### Conclusion

The author has described but few of the many automatic controls seen during his recent tour. Whilst all the systems are labour saving devices this is not the main theme of automation and this factor

should not be allowed to influence one's decisions on whether or not automation should be employed. The main function of automatic controls is the better process control that it achieves. Flow rates can be controlled to desired quantities, operations in one phase of manufacture can be related to other phases so that optimum conditions can be maintained, and equally important, if a fault occurs corrective action is taken immediately and equally immediately conditions are returned to normal. Under manual operation, operators are slow in returning a system to normal after correcting a fault for fear of the fault re-occurring.

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**Mr. J. McD. Dick** asked why it was stated that the control of levels in evaporators did not accomplish much. In view of the fact that some factories desired automatic control between vessels he asked the author what he thought of the need for such control.

**Mr. Gunn** replied to the Chairman that the only topping of beet was that done in the laboratory. The mechanical harvesters did not top the beet effectively. These tops went into the factory.

In reply to Mr. McD. Dick he said that the electric brain, in the factory referred to, indicated that it was necessary to control the evaporator levels automatically.

**Mr. Perk** enquired what staff was required to keep the automation equipment in efficient running order.

**Mr. Gunn** referred to the Chairman's statement that there was a big benefit in being in a country where there was an adequate number of capable technicians. The factory at Wissington had no instrument technicians on its staff but if anything went wrong the management got in touch with the instrument manufacturer who immediately had the fault corrected.

In reply to Mr. Robertson (?) he said that in Britain the beet factories were controlled by the British Sugar Corporation whose policy it was to install automation from the front of the factory towards the back end. They did however consider that automatic centrifugals were not necessary. In Sweden the tendency was to use automatic centrifugals only. He had seen a factory which had automatic pan-boiling but this was not used because this did not prove entirely successful. In reply to another question he stated that in Britain automation terminated usually at the syrup tanks, but he had seen in a large refinery there, automatic centrifugals, and from the time the pans were dropped until the sugar came from the drier the whole process was automatic.

He had not mentioned the control of limekilns. They, when they were automatically controlled, were subject to the use of a radio-active beam. This was focussed on a Geiger Counter on the other side of the kiln and when this beam was cut off by the height of the material in the kiln, the feed was cut off, thus controlling the feed.