OPERATION OF TWO RAW-SUGAR SCALES IN SERIES AT HULETT REFINERIES

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Abstract

Prior to 1977 agreement between the two raw sugar Servo's and the road and rail weighbridges at Hulett Refineries was poor. The Servo's were replaced with new ones during that year. Whilst the difference between the new scales and the weighbridges reduced, it was nevertheless still unacceptable. In 1985 the two new Servo's were positioned to weight raw sugar in series. In addition, the scales were modified to control the rate of sugar being fed into the process. Results of the comparison between the two Servo's weighing in series for a period of eleven months after commissioning, and the success of the control system, are discussed.

Introduction

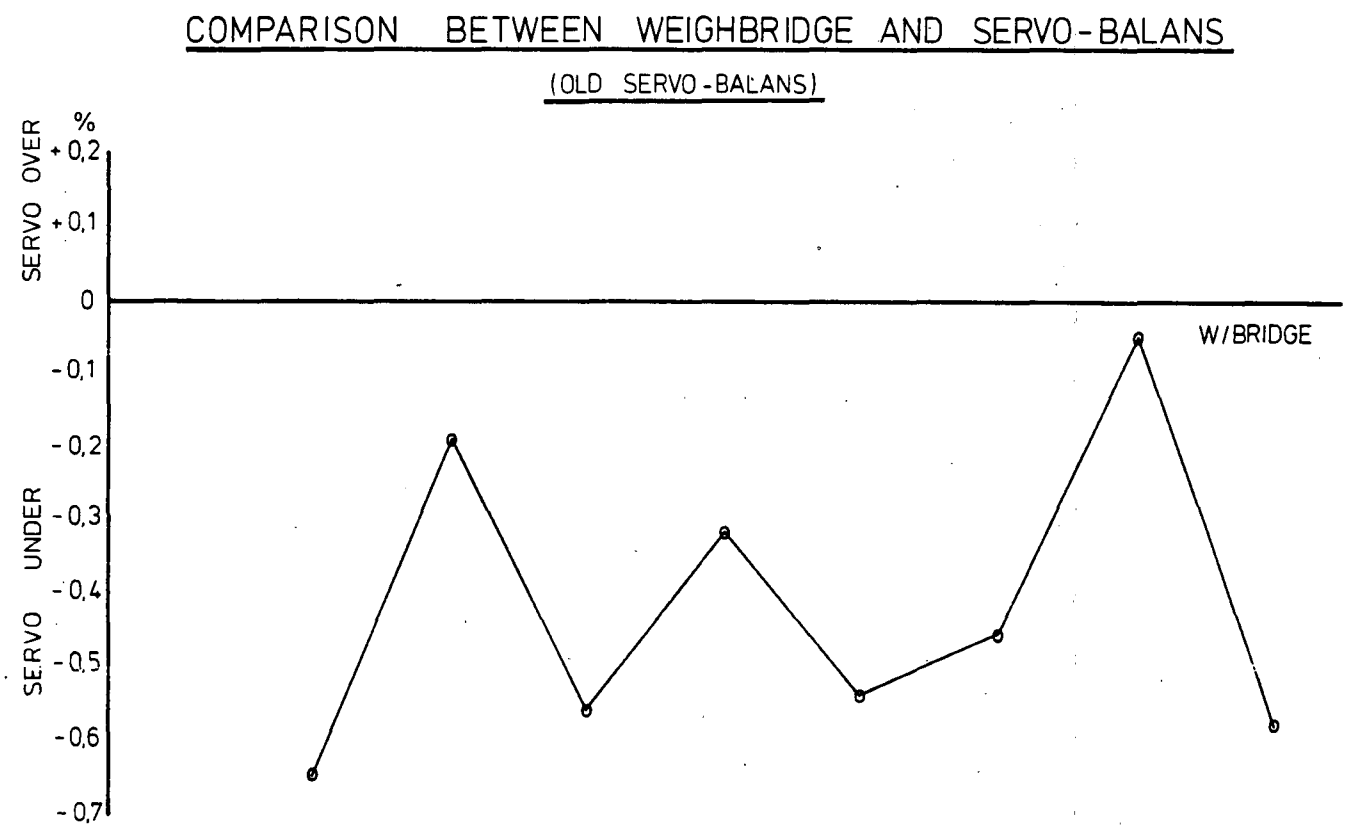
Raw sugar is received at the Refinery by road and rail. The vehicles are weighed on two separate weighbridges. The sugar is conveyed either to store or directly into process via a 700-ton surge bin. When sugar is drawn from store into process it goes via the same bin.

Before entering process the sugar is weighed again by a Servo-Balans. At least once per season a tonnage of sugar recorded by the weighbridges is compared with the mass of the same sugar recorded by the Servo-Balanses. This exercise is called a Melt-Out.

The monthly performance figures are based on the Servo readings. Because the weighbridges and the Servo's invariably differ from each other a 'provisional scale error' is applied to the Servo readings in an attempt to make the monthly figures meaningful. The provisional scale error is based on the results of previous melt-outs.

Historical Information

The following graph shows the results of some melt-outs done on the old Servo's.



PERIOD from	28/3/76		10/4/76		28/4/76		15/6/76		8/7/76		28/4/77		24/6/77		1/7/77	
to	10/4/76		28/4/76		15/6/76		8/7/76		28/4/77		24/6/77		1/7/77		29/7/77	
TOTAL TONNAGE	23068		25058		76481		34721		36268		87432		11476		43405	
% THRU' No1&2 SCALES	100	-	65	35	57	43	40	60	56	44	49	51	26	74	-	100

FIGURE 1 Melt-outs done on the old Servo-Balanses

Points to observe are:

- the Servo's almost always record lower masses than the weighbridges
- the differences are not consistent in magnitude
- the differences are significantly larger than the expected accuracy of a Servo-Balans, assuming of course that the weighbridges are correct.

An error of 0.5 % may not seem excessive, but at current prices of raw sugar and the throughput of the Refinery, this has a value of almost R2 million.

In 1977 two new Servo-Balanses were installed to replace the inaccurate ones. It was then decided to do melt-outs on individual scales, thereby obtaining the accuracy of each.

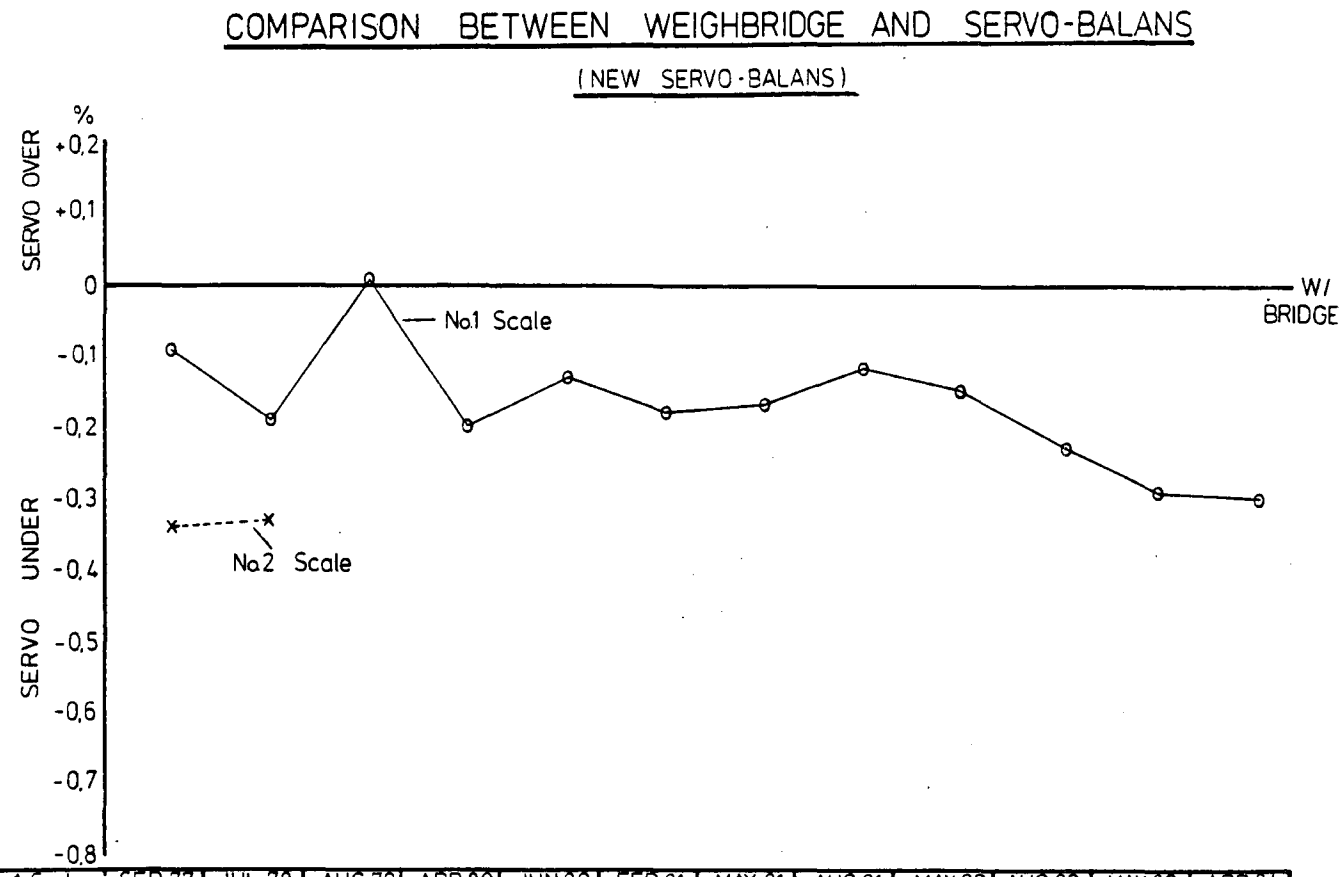
The following graph shows results of melt-outs done on the new Servo's.

The New Arrangement

A new raw sugar melter was installed at the Refinery during the 1985 annual shutdown. The system of transferring raw-sugar from the 700-ton bin to the new melter was due to be altered, and the opportunity was taken to position the two Servo's to weigh the sugar in series. The weighing bins were positioned one above the other, with the uppermost being supplied with sugar via a feed bin. All three bins are equipped with clam-shell type discharge valves. The old and new arrangements are shown below.

Comparison Between Servo Readings

Everyday, at about the same time, the Servo readings are taken, and the daily variance plotted on a graph.



No.1 Scale on	SEP 77	JUL 78	AUG 79	APR 80	JUN 80	FEB 81	MAY 81	AUG 81	MAY 82	AUG 82	MAY 83	APR 84
" " off	MAY 78	APR 79	APR 80	JUN 80	FEB 81	MAY 81	AUG 81	MAY 82	AUG 82	MAY 83	APR 84	NOV 84
Total tons	313757	356512	292564	108274	379489	101124	154276	390327	135190	390030	565506	397142
No.2 Scale on	MAY 78	APR 79										NOV 84
" " off	JUL 78	AUG 79										APR 85
Total tons	107438	143099										263401

FIGURE 2 Melt-outs done on the new Servo-Balanses

Points to notice are:

- No. 1 Servo appeared to be more accurate than No. 2, which is the reason why No. 1 was used as a routine, and No. 2 only as a standby
- once again the Servo's almost always recorded lower masses than the weighbridges
- the magnitude of the difference between No. 1 Servo and the weighbridges was increasing.

The set of graphs shown in Figure 4 are some sections of the daily variance plot highlighting some observations:

- Graph A. September 1985. No. 2 scale reading was higher than No. 1 by varying amounts, between 5 and 16 tons per day. The Servo's were operating under very dusty conditions, and the reason for the discrepancy was attributed to sugar build-up on linkages etc. The scales were cleaned, and from then on were cleaned regularly. The daily difference reduced, and was more consistent at about 4 tons per day, which is approximately 0.2 %.

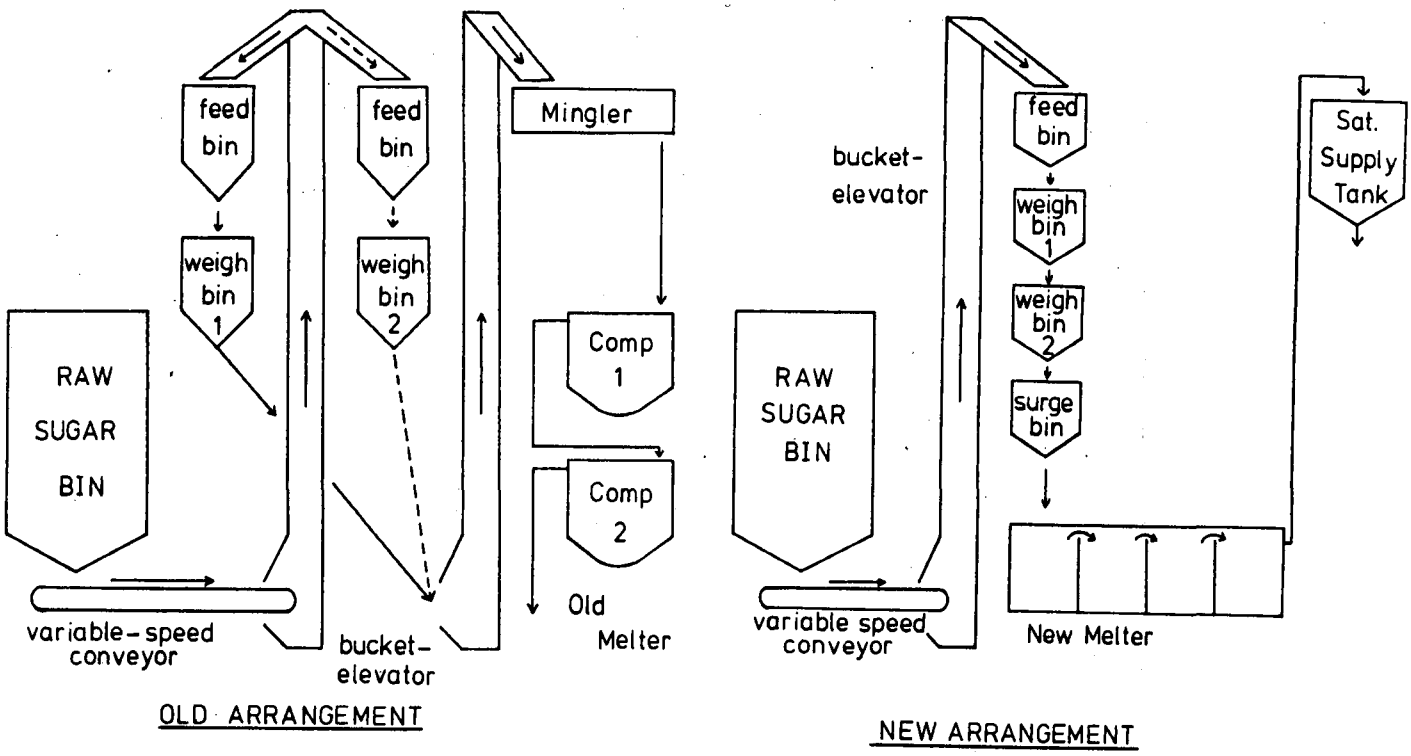


FIGURE 3 The old and new arrangements of the Servo-Balanses

- Graph B. October 1985. The month started with a difference of 2 to 3 tons per day, No. 2 higher. Then No. 2 started to weigh about 11 tons lower per day, or 0.55%. Several days later the problem was traced to a broken flexture-band on No. 2 scale. Once repaired the discrepancy returned to 2 to 3 tons per day, No. 2 still being higher.

- Graph C. December 1985. A very steady daily discrepancy of about 6 tons per day, or 0.3%.

- Graph D. January 1986. At the month-end shutdown both scales were cleaned as normal. In addition the totaliser counter on No. 1 scale was replaced. The daily difference reduced to a more acceptable 1 to 2 tons per day. Then, for three consecutive days, No. 2 scale readings were about 30 tons per day higher than No. 1. This difference mysteriously disappeared, and from that point on, agreement between the two Servo's was almost perfect. Good agreement continued until mid-March 1986.

Operating Details

Interlocking

As the weighing cycle time of each unit cannot be kept constant, the discharge valves of all three bins are interlocked so that a full cycle must be completed before a new one can commence.

To cater for either one of the Servo's being out of commission, the facility to have the discharge valve of that unit locked in the open position and the interlocking arrangement switched from the top supply bin to the operating Servo, has been provided.

The interlocking arrangement is illustrated in Figure 5.

Control of Throughput-Rate

It is well established that any continuous process benefits from steady conditions. In the past the refinery had reasonable success at achieving a steady raw sugar input rate by using a variable speed belt to feed the sugar into process. The belt speed was controlled to a setpoint by a controller. This system relied on a consistent load onto the variable speed belt to achieve a steady input. However, belt loading varied considerably as sugar quality changed, which meant that a knowledge of the throughput-rate could only be obtained at the end of each hour when a Servo-Balans reading was taken.

With the rearrangement of the Servo's and the installation of a new melter station, it was decided that a more reliable and accurate control of throughput was required, and that the control system should make use of the Servo-Balans as a means of continuous feedback of raw sugar input rate.

A programmable controller is used for this purpose. The two inputs to the controller are taken from the Servo-Balans and the level signal from a surge tank downstream in the process. The output of the controller is to the drive on the variable speed belt. The controller can be linked to either of the Servo's. Feedback of throughput rate to the controller is achieved by measuring the time taken to complete each weighing cycle of the Servo being monitored. Using the cycle and time and an average net weight per cycle, an hourly rate is computed and used by the controller to update its output against setpoint.

The measurement of the weighing cycle is achieved by positioning two proximity sensors and switches in the Servo headwork to detect the movement of the mechanism which operates the opening and closing of the discharge valve on the Servo.

The level input from the surge tank biases the remote setpoint of the controller downwards should the tank level exceed 60% of its capacity.

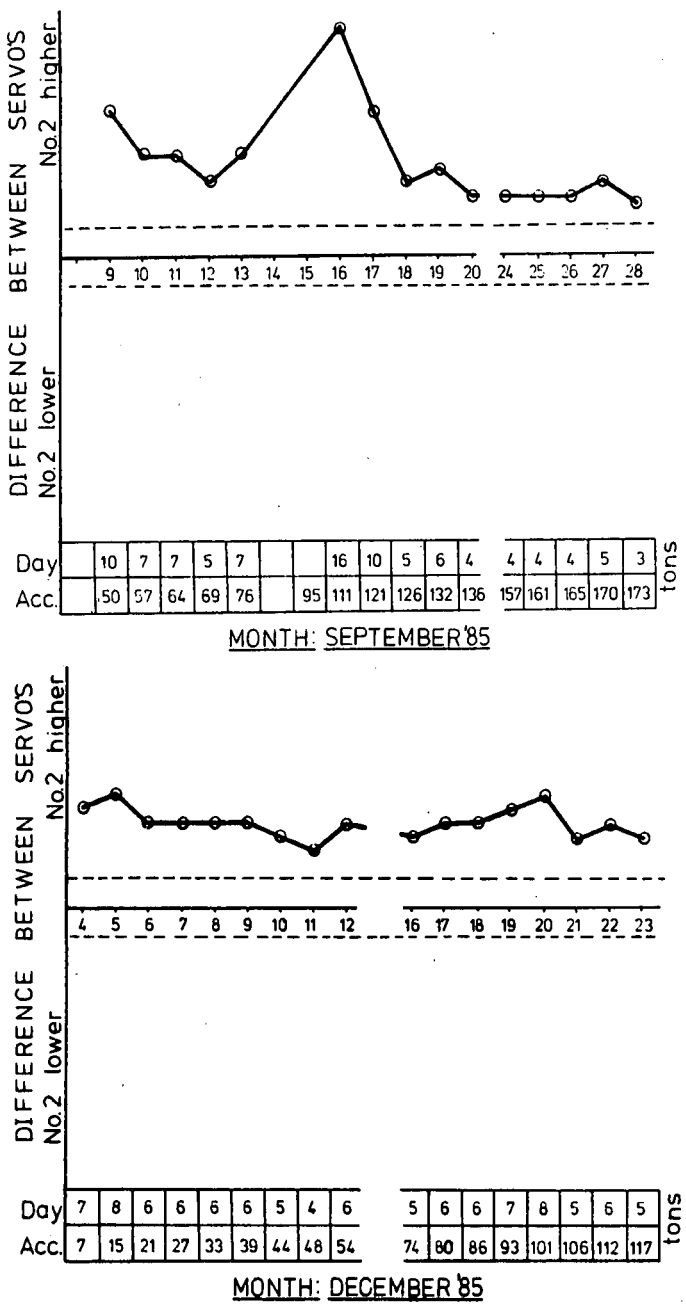


FIGURE 4 Sections of the daily variance graph

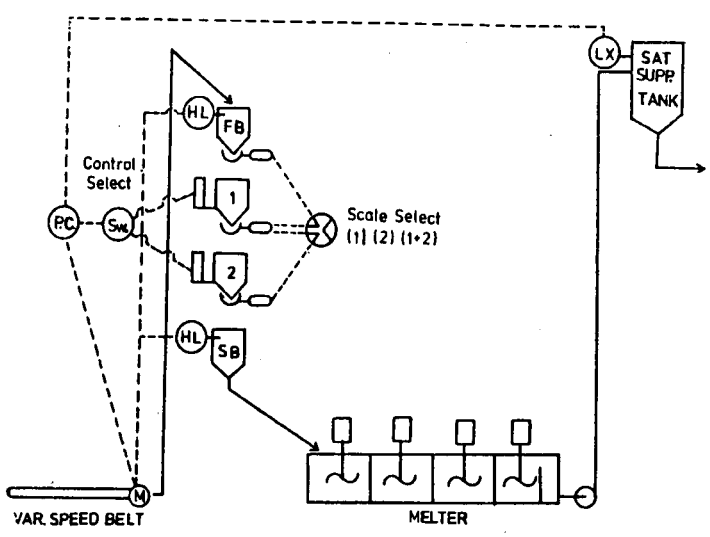


FIGURE 5 Interlocking the Servo-Balanses

Conclusions

The benefits of having two raw sugar scales weighing in series are seen to include the following:

- Problems with the scales can be detected timeously
- a better knowledge of the accuracy of Servo-Balanses, operating under conditions at Hulett-Refineries, will be obtained
- when differences between scales exceed their expected accuracy, the suppliers of the equipment can be approached for involvement in the problem. In the past the only accuracy check which could be conducted was a static test with the built in check-weights of the Servo, which invariably showed the scales to be accurate.

Concerning the control of throughput-rate, very satisfactory results have been achieved, and the steadier input into process has been of great benefit to the refinery.

The cost of this control system relative to other types of belt-weigher system was some 70% cheaper.