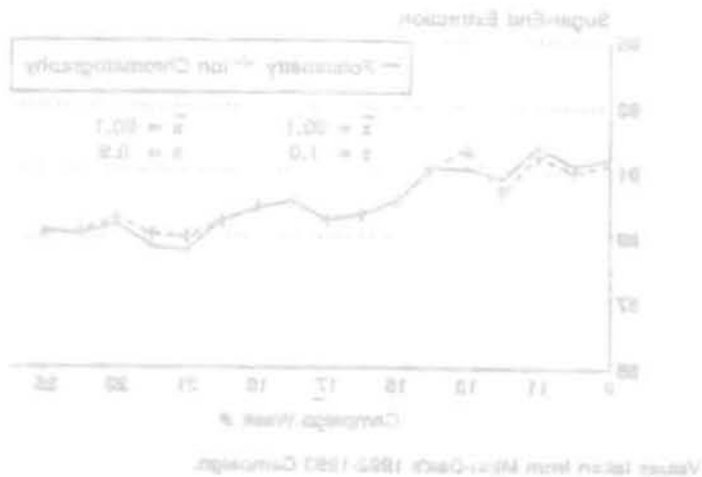# LOW RAW PAN CONTROL SYSTEM
BASED ON THE ON-LINE PURITY MONITOR

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Presented by
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LOW RAW PAN CONTROL SYSTEM
BASED ON THE ON-LINE PURITY MONITOR

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Part I

Apparent Purity Control

1.   The main objective of this project was to create an instrument that would continuously measure the apparent purity at the intermediate green level of low raw pan boiling.

2.   The concept of this instrument is as follows:

The conductivity of the intermediate green depends on the brix as shown in Figure 1.

DIFFERENT CONDUCTIVITY CURVES

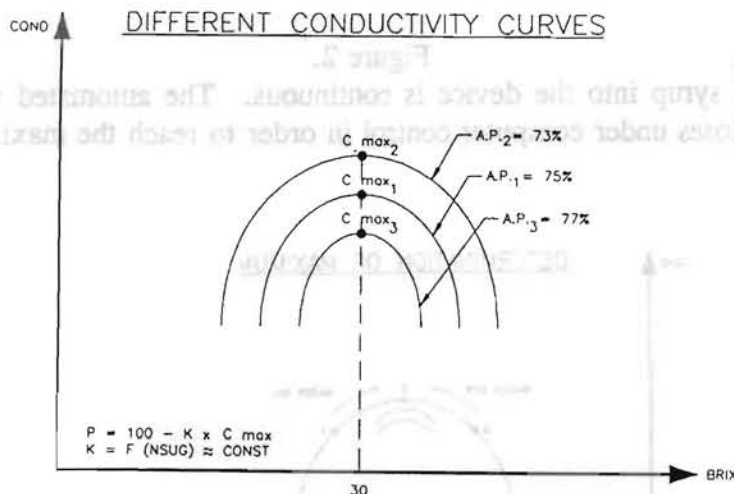$$P = 100 - K \times C\,max$$
$$K = F\,(NSUG) \approx CONST$$

Figure 1.

Conductivity reaches a maximum at about 30% brix. Intermediate greens with different purities will reach different maximums located on one line- C max 1, C max 2, C max 3.

Purity can be calculated by the following equation:

$$P = 100 - K \times C\,Max$$

K is a coefficient, dependent upon the non-sugars in the intermediate green. It is relatively constant (which can be calculated in the lab) and can be changed once every 5-7 days.

To calculate apparent purity, we need to determine the maximum conductivity as the brix is varied by diluting a continuous sample with water and subsequently turning the water off to increase the concentration.

3.   For this purpose the purity measuring device (purity meter) was developed (See Figure 2). It consists of a vessel divided into two parts. The top portion has two inlets on opposite sides- one for syrup (intermediate green) and the other for water. The conductivity probe is in the lower portion of the vessel.
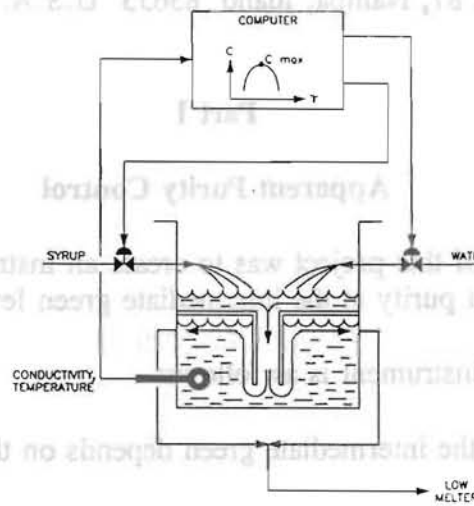

Figure 2.

The flow of syrup into the device is continuous. The automated valve for the water opens and closes under computer control in order to reach the maximum conductivity.
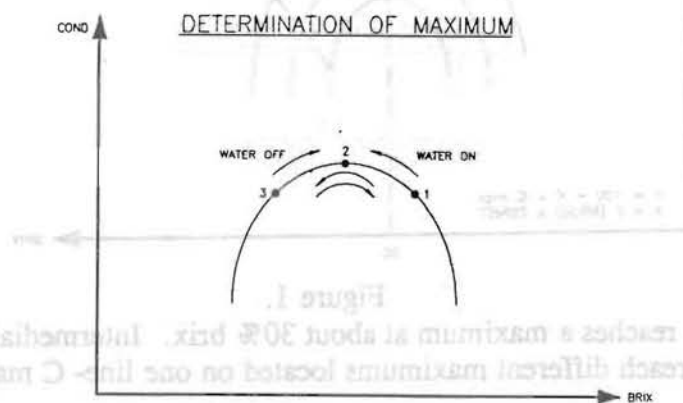

Figure 3.

If we look at Figure 3, we see that if the water valve is open, the conductivity will pass Point 1 and reach a maximum at Point 2. After this, the water valve shuts off and after the brix reaches Point 3 the conductivity starts going the opposite direction. It, again, reaches the maximum at Point 2. Subsequently, the water valve is opened. Then the conductivity changes direction at Point 1 and starts the cycle again. The conductivity signal reaches the computer where the maximum value (C maximum) is stored and the purity is calculated:

$$P = 100 - K \times C\ Max.$$

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A view of a purity meter is represented on Figure 4 and 5.
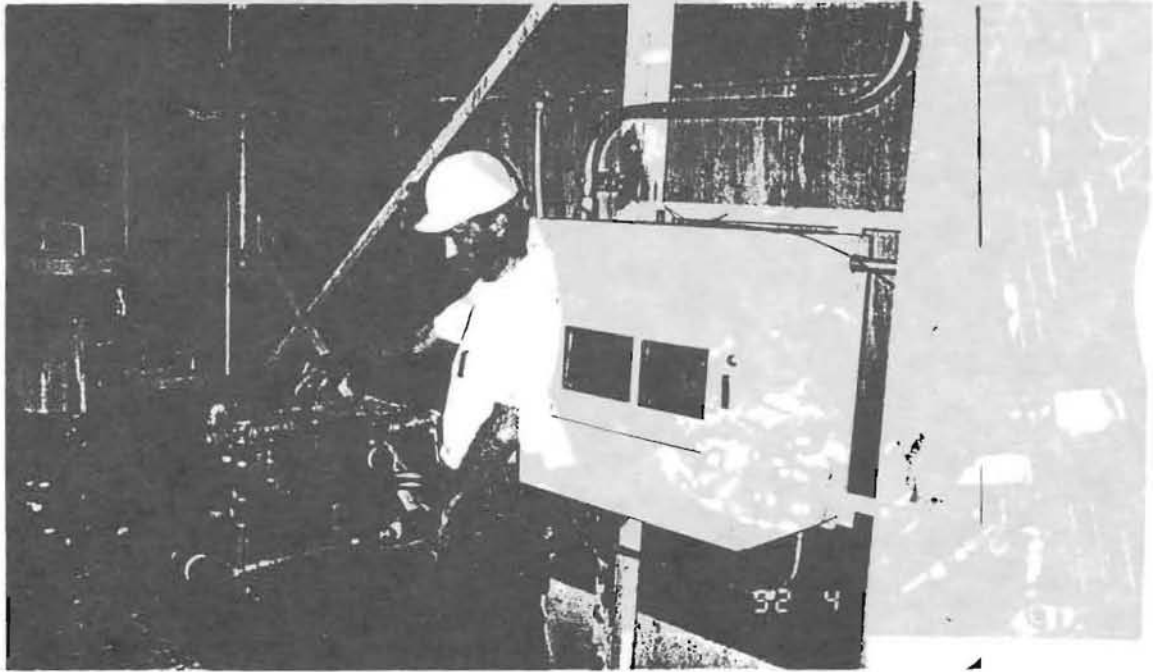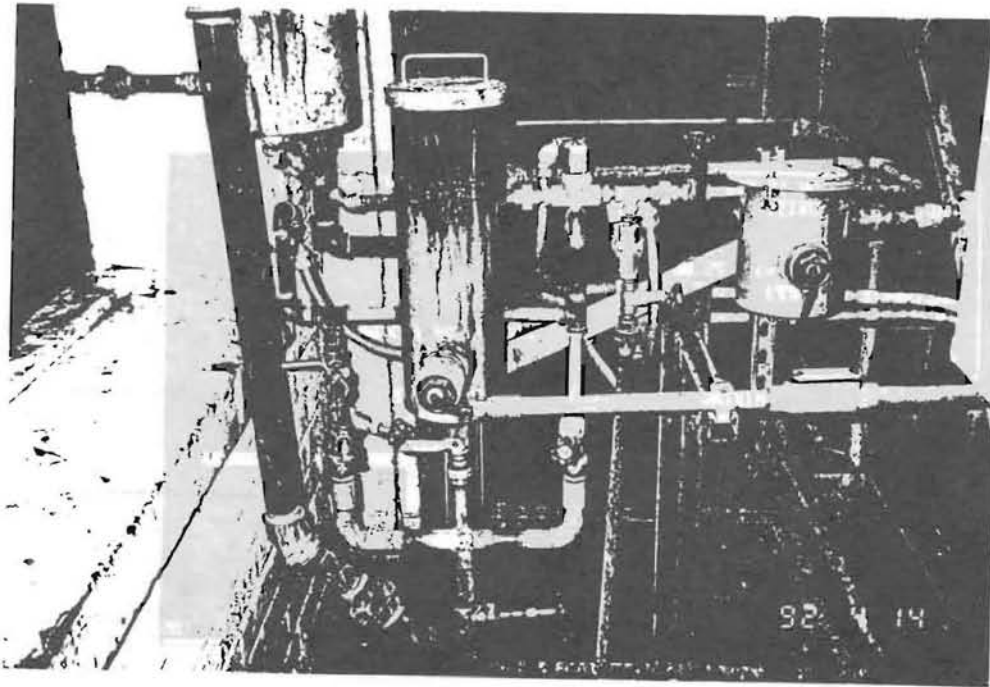

Figure 4.

Figure 5.

The mixing chamber is shown on Figure 6.

Figure 6.

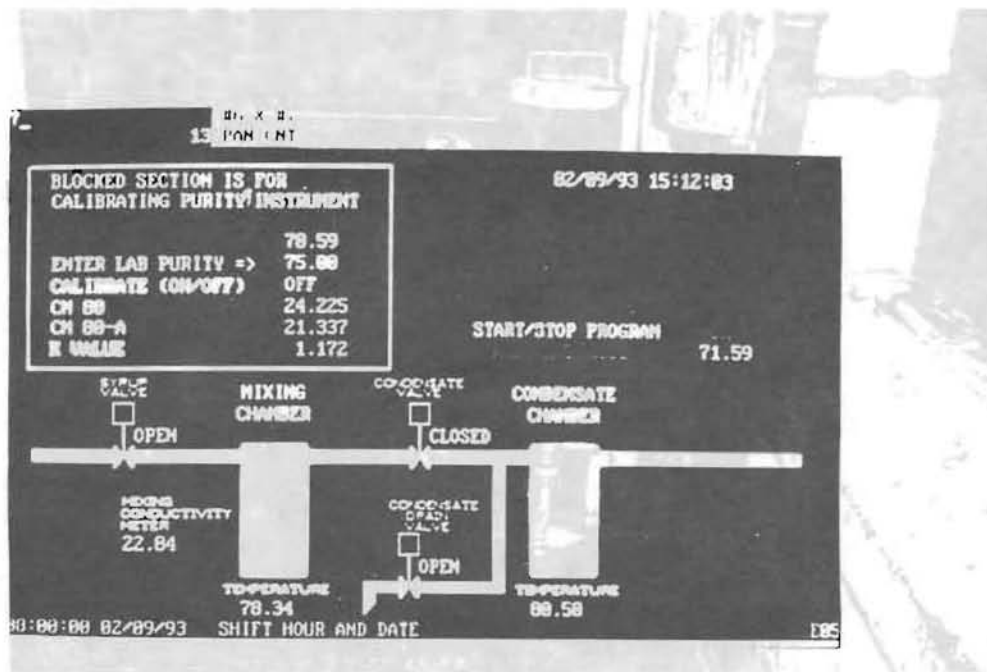Figure 7 represents a computer flow diagram.

Figure 7.

4.   Figure 8 represents a computer diagram with purity and conductivity curves.
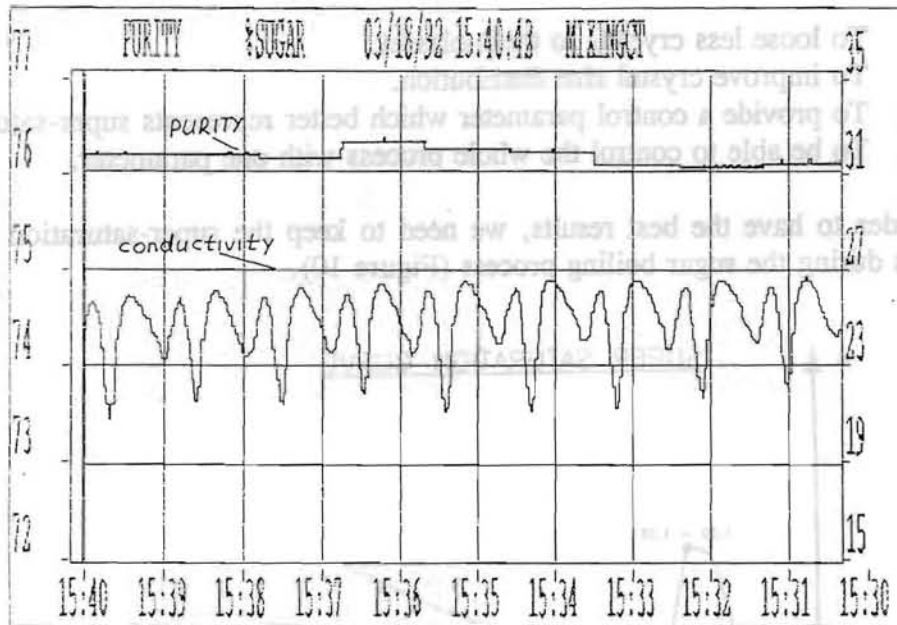

Figure 8.

5.   The purity control system has been in operation for a year. It shows stable results (especially during the syrup run) and has a good correlation with lab purities (within 0.6%), See Figure 9.
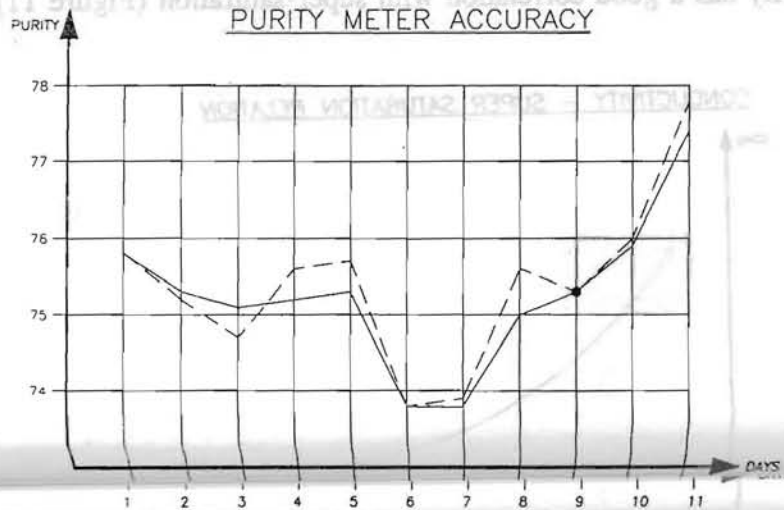

Figure 9.

Part II

Vacuum Pan Control System Based On Conductivity

1. The main objectives are:

    a. To loose less crystals to the molasses.
    b. To improve crystal size distribution.
    c. To provide a control parameter which better represents super-saturation.
    d. To be able to control the whole process with one parameter.

2. In order to have the best results, we need to keep the super-saturation within certain limits during the sugar boiling process (Figure 10).
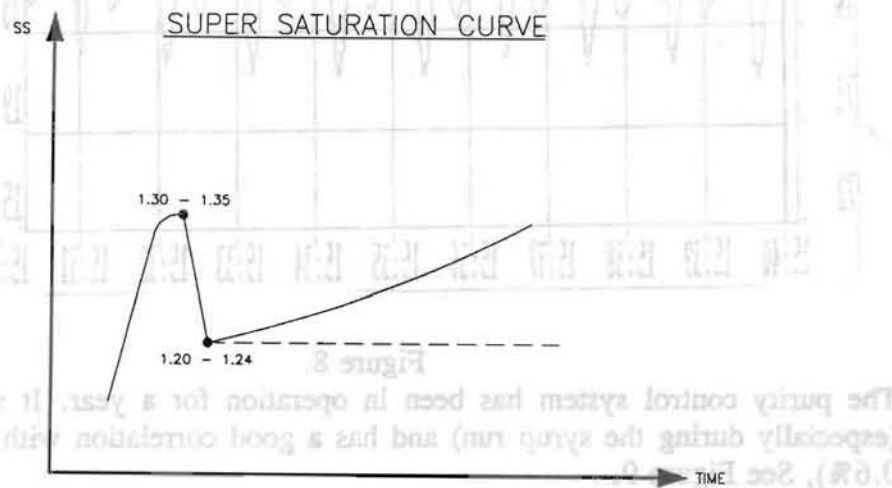

Figure 10.

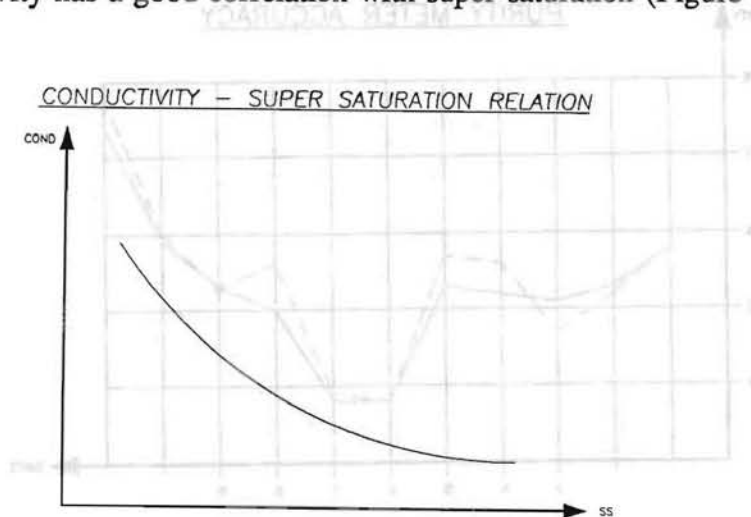3. Conductivity has a good correlation with super-saturation (Figure 11).

Figure 11.

4. During the process, conductivity should change with time as characterized in Figure 12.

COND

CONDUCTIVITY

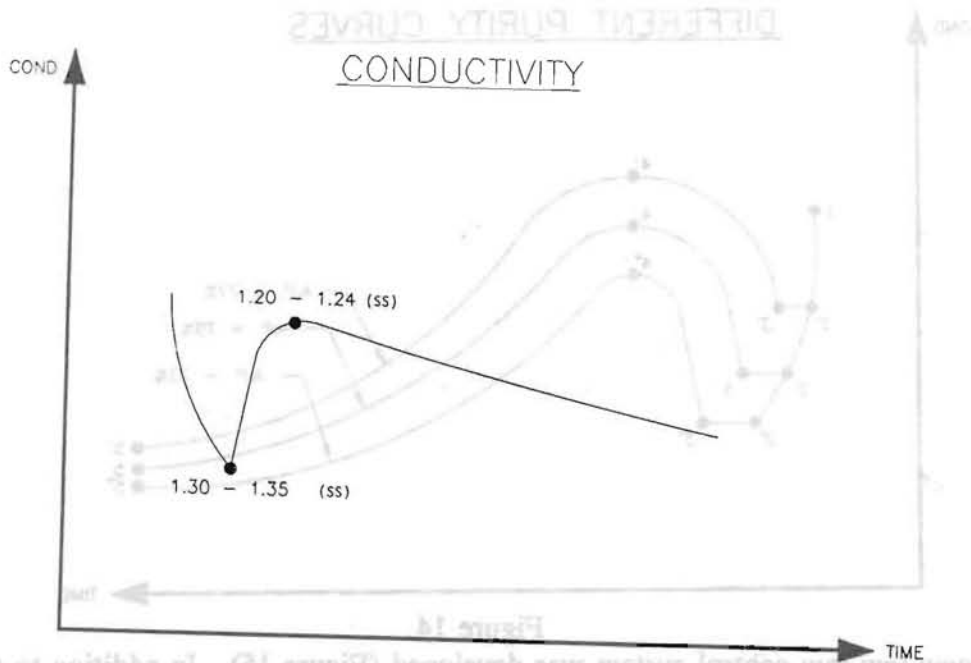1.20 — 1.24 (ss)

1.30 — 1.35 (ss)

TIME

Figure 12.

5. In order to have perfect seeding, conductivity and super-saturation will need to be kept constant during and after the seeding (Figure 13- Point 2 & 3).
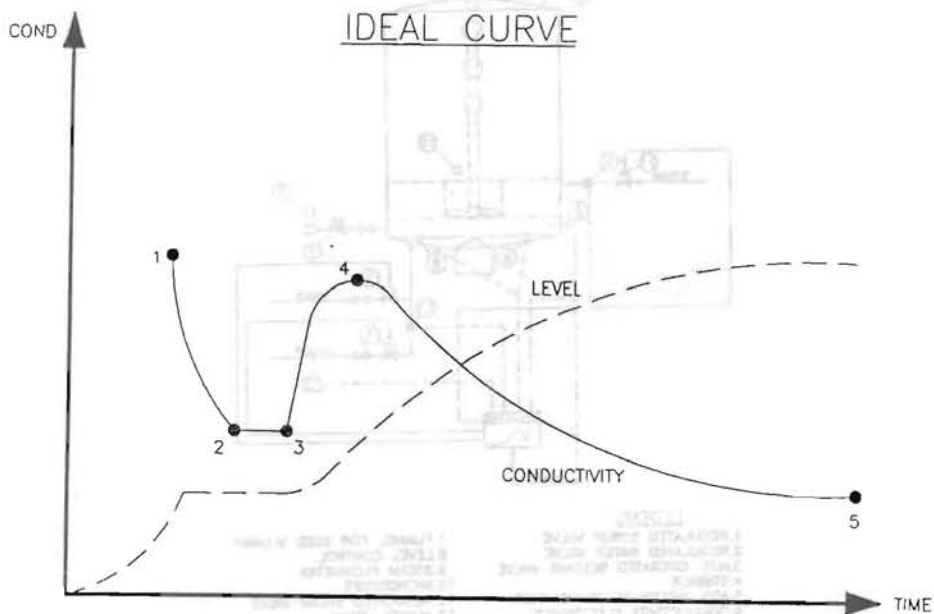

COND

IDEAL CURVE

1

4

LEVEL

2   3

CONDUCTIVITY

5

TIME

Figure. 13.

6. The conductivity curve for the pan process depends upon the purity of the intermediate green entering the pan. For different purities we have a family of curves as shown in Figure 14.
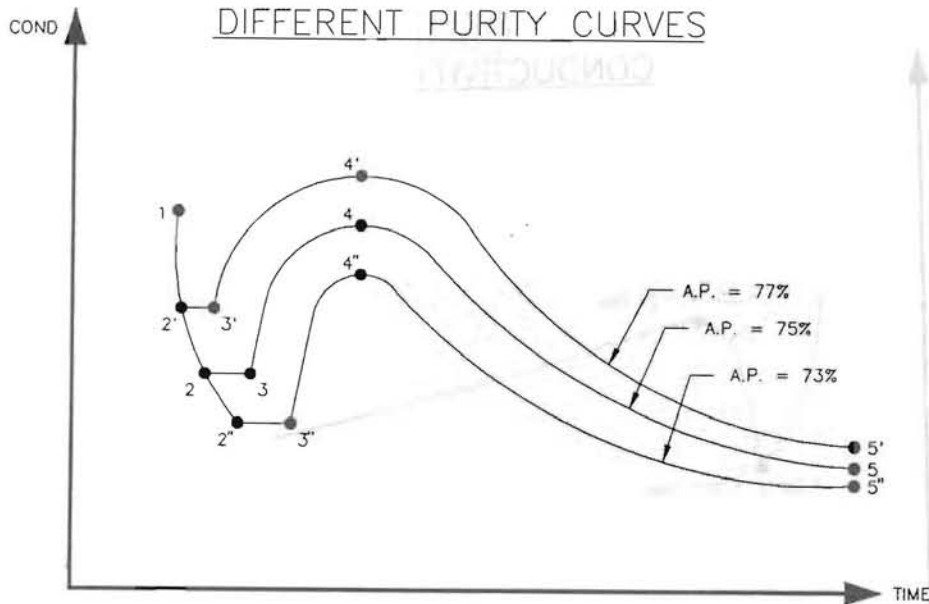

Figure 14.

7. A new low raw control system was developed (Figure 15). In addition to the previous control system, it includes two conductivity probes (Figure 16), steam and syrup flow
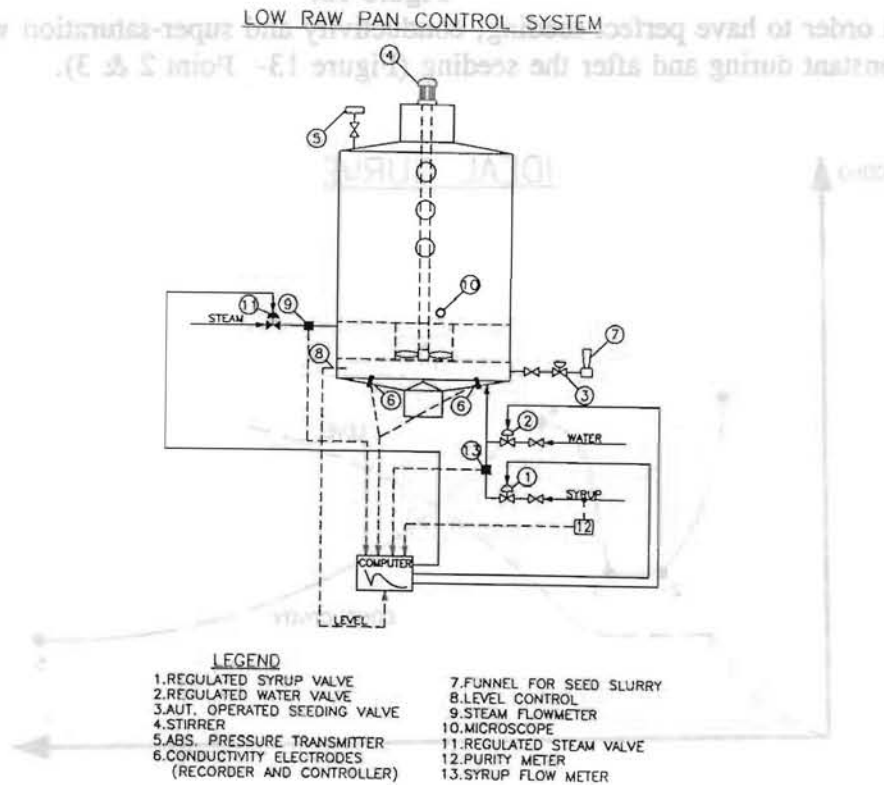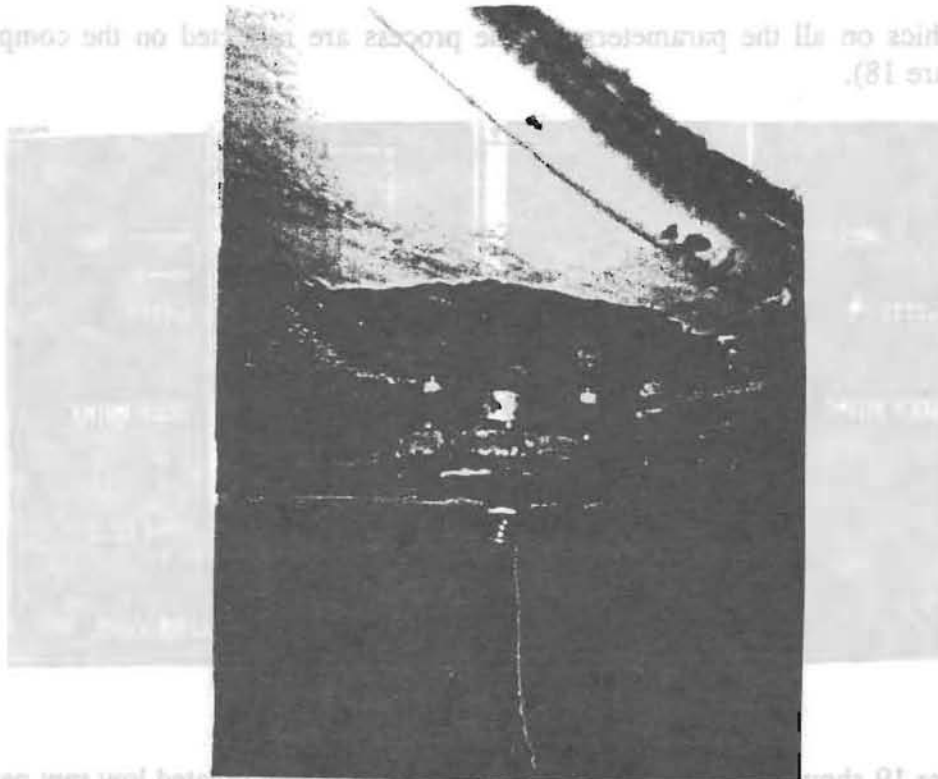

Figure 15.

Figure 16.

meters and a computer (Figure 17). The computer selects the proper conductivity curve (corresponding to the current purity) measured by the purity meter. Then the system of controls and automated valves regulate the process.

Figure 17.

8. Graphics on all the parameters for the process are reflected on the computer display (Figure 18).
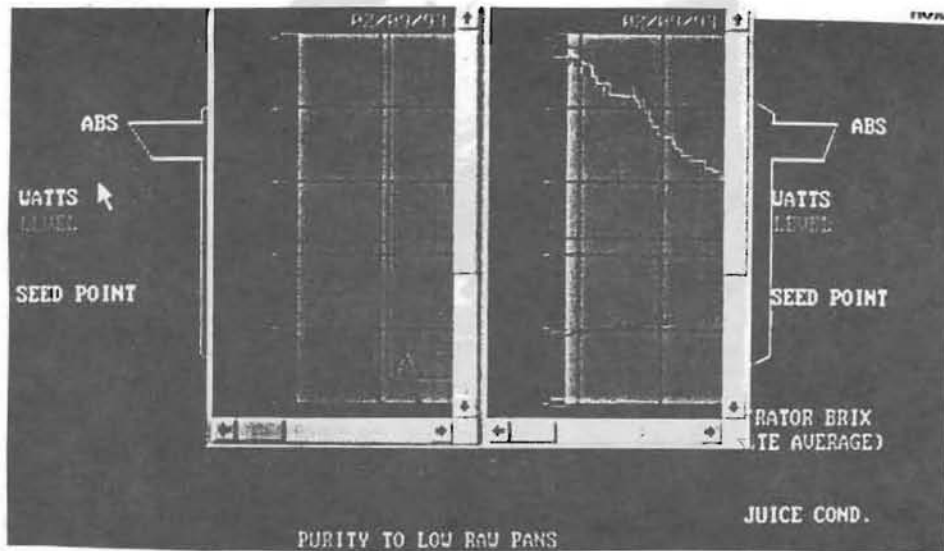

Figure 18.

9. Figure 19 shows the conductivity curve of one of the automated low raw pan boilings in April, 1992. The control system is able to boil the batch automatically to the final brixing stage.
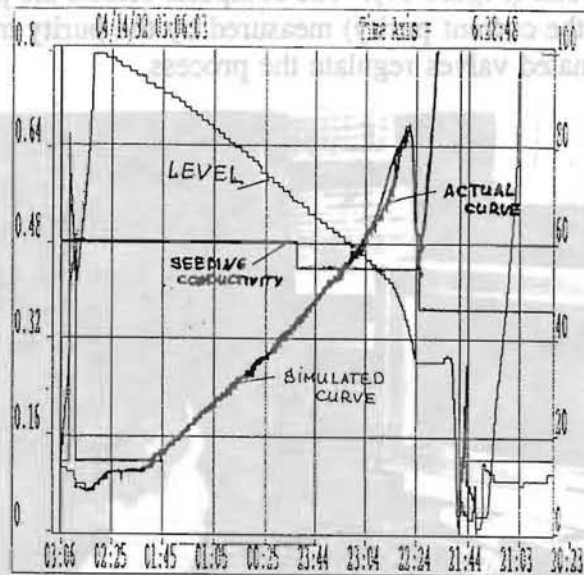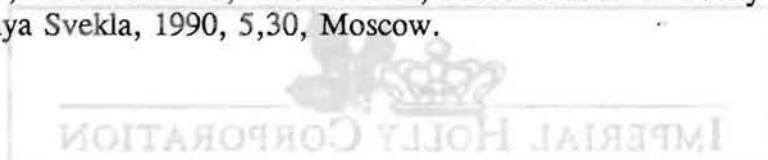

Figure 19.

10. Comparison between the automated and manually operated pans shows that the automated pans demonstrate better crystal size distribution and better molasses exhaustion. The percent of crystallization increased by an average of 2.1% for first three days of the study and by an average of 0.4 for a three week period.

ACKNOWLEDGMENTS

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