PRACTICAL TECHNIQUES TO OPTIMIZE MOLASSES EXHAUSTION

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Sugar lost to molasses is by far the largest sugar loss in a beet sugar factory. The simplified extraction statement shown in Figure one indicates the magnitude of extraction lost to molasses. Typically 10 to 16 points of extraction are lost to molasses.

As we endeavor to minimize sugar lost to molasses it is helpful to review the process steps where molasses is produced. Figure two shows the low raw process. The low raw pans, crystallizers, and low raw centrifugals are the three major process steps. The low raw mixer which often has a heating coil is a minor step. The low raw sugar produced by the low raw centrifugals is either directly melted or undergoes affination. The affination step is not covered in this paper.

Our goal is to extract as much sugar as possible to the silos and minimize the amount of sugar going to the molasses tank. This goal is accomplished by maximizing the purity difference between the low raw pan and molasses. Each of the above mentioned process steps contributes positively or negatively to this purity drop as shown in Figure 3.

We have a two steps forward, two steps backward situation. We therefore must maximize the purity drop across the pans and crystallizers and minimize the purity rise across the mixer and centrifugals.

In the remainder of this paper I would like to cover some practical techniques that have been useful in optimizing and measuring the four process steps mentioned above.

Boiling good clean crystals in the low raw pan is absolutely essential to producing the lowest possible molasses purity. Compared to boiling white and hi-raw, low raw is relatively easy. But, it is important to control the feed syrup purity, and keep this purity at a minimum practical level (Figure 4).

The overall purity drop from pan purity to molasses can be optimized and held at a fairly steady value. But, if pan purity increases, molasses purity will tend to increase also.

Determining the crystal population by regulating the amount of seed is critical. Adequate surface area must be provided by the crystals to allow the sugar to crystallize out and reduce the purity of the mother liquor. This mother liquor purity must be low enough at brixing to not allow grain to form spontaneously. Grain formed during brixing in the pan rarely grows large enough in the crystallizer to escape passing through the centrifugal screen and becoming sugar lost to molasses. Seed with plenty of grain. Use a pan microscope to visually detect if grain are formed during brixing. Having plenty of grain will allow boiling tighter, i.e. at a higher super saturation, without fear of breaking in grain during the boiling phase. Boiling at higher super saturation increases crystal growth rates. Try using a higher magnification pan scope with a measuring reticle.

With a little practice you can estimate crystal growth rates and determine the amount of undersized crystals which will probably pass through the centrifugal screen. A scope with a twenty power eyepiece, four power objective and measuring reticle works well.

Crystallizer purity drop is chiefly a function of fillmass supersaturation and retention time of the fillmass in the crystallizers. Supersaturation is controlled by cooling the fillmass. Retention time is largely dictated by crystallizer capacity and fillmass rate but is significantly influenced by sugar and non-sugar recycle.

Experimenting with cooling rates and temperature profiles across the crystallizers can help maximize the crystallizer purity drop. Our factory often has less than eight hours of crystallizer retention time. Every hour needs to be well utilized. We significantly increased the crystallizer purity drop by using the information learned from the following tests done with help from our research department.

We sampled the fillmass entering the crystallizers and then after two hours, four hours, and six hours retention time. The batch type crystallizers were dropped after approximately six hours. The mother liquor, called true green, was pressed out using a small air powered press (Figure 5). Apparent purities were 2determined on the true green and fillmass temperatures were noted at sample times. In Figures 6A & 6B, curve #1 represents our old operating procedure and curve #2 indicates an improved cooling procedure. Note the significant reduction in true green purity. We found that valuable time was being wasted by cooling too slow. Our new procedure calls for rapid cooling down to 55°C and holding at 55°C until dropping. Fillmass cooler than 55°C will not purge adequately at our centrifugals, therefore we do not cool below 55°C.

It is valuable for operations managers to know the effect of increased crystallizer retention time on molasses purity. The factory lab sheet data plotted in Figure 7 was during a period of high molasses purity. Notice that increased retention time can have a significant effect on lowering molasses purity. This information helps motivate us to limit non-sugar recycle by working to improve low raw sugar purity. Raising low raw sugar purity will reduce non-sugar recycle and therefore reduce the volume of low raw fillmass and increase retention time in both the pan and crystallizers.

It is good to know how much purity rise occurs across the low raw mixer when reheating fillmass. Fillmass can be sampled before and after the mixer and true green pressed out and analyzed. We find that reheating 5 to 10° raises the true green purity very little; often the rise is not measurable.

With very viscous fillmass it is sometimes necessary to reheat for the last hour or so in the crystallizers. Tests have indicated only a 0.5 to 1.0 purity rise occured even when we reheated from 50 to 75°C over 1 1/2 hours. Water leaks in heating coils pose a bigger threat to increased molasses purity. It is of value, therefore, to monitor the brix into and out of the low raw mixer.

In the pans and crystallizers we attempt to grow uniformly large crystals that will separate easily at the centrifugals. We often heat the fillmass in the mixer so as to reduce the viscosity of the molasses and aid in the separation of crystals and molasses at the centrifugals. We strive for a clean separation of crystals and molasses. Doing so produces high purity low raw sugar which contributes to a low non-sugar recycle and maximizes pan boiling time and crystallizer retention time. Obviously, keeping sugar crystals out of the molasses helps minimize molasses purity. Usually the molasses is sticky enough to require the addition of steam and water to help effect the separation. Sugar is dissolved by this steam and water, and thus, the addition must be minimized.

This is the challenge of the low raw centrifuge; to bring about the separation of crystals and molasses with the minimum rise of molasses purity.

It is important to measure and monitor the purity rise across the centrifugals. When factory production molasses purity tends upward it is good to check first for the obvious. Check to see if molasses brix is lower due to overwashing or underloading machines without reducing steam and water. Next, check all centrifugal screens with a stroboscope. If a problem is not spotted, sample molasses from each centrifuge and check for brix and purity. This information will tell us if all machines are producing higher purity molasses or just one is. If one machine stands out, usually a badly worn screen or similar centrifugal problem is found.

If the cause for the higher purity is still unknown and a quick review of the pan, crystallizer, and mixer data is not revealing, it is good to determine the true green at the centrifugal gooseneck. This can be done with the compressed air press or by getting a sample of molasses from a factory centrifugal running without steam or water. You need to wait six to eight minutes for the molasses chamber to fully reflect the high brix unwashed molasses. Unwashed molasses is typically close to 90.0 brix. See Figure 8.

If you periodically determine the washed and unwashed molasses, it will help determine whether a high purity problem can be sourced at the centrifugals or direct you to look upstream. Even though molasses purity varies up and down due to purity profile drift, the difference between washed and unwashed molasses tends to stay constant at a given wash level. Figure 9 shows data collected at our factory.

I like to use one centrifugal to help minimize sources of variation; in this case it was #2 low raw centrifugal.

If the washed - unwashed purity differential is less than typical, the elevated purity problem is more than likely upstream from the centrifugals.

If pressed true green molasses is determined at the gooseneck, it will run 1.0 to 2.0 purity points lower than the unwashed factory centrifugal molasses. If the difference is greater than 2.0, it often indicates the presence of alot of sugar crystals smaller than the centrifugal screen openings. Fewer undersized crystals will be pressed out with depth filtration as compared to the very thin layer screening with the factory centrifugals. The probability of undersized crystals finding their way to molasses is much greater with the thin layer factory centrifugal. Also, centrifugals likely cause some crystal breakage.

Running a centrifugal without steam and water can provide other insightful information. By inspecting the unwashed low raw sugar, you can judge the purgability of the low raw fillmass. Easy to purge fillmasses will yield lighter colored granular appearing sugar bands on the centrifugal wall. Difficult to purge fillmasses produce darker sugar without any granular appearance. In fact, with the most difficult to purge fillmasses, the low raw sugar purity will be very near to the feed fillmass purity.

A quick check of a trial centrifugal screen can be run by observing its unwashed operation versus that of your currently used screen. If the open area is inadequate or the slots too narrow, the screen will not pass the molasses. Run the trial screen several hours to break it in before running the comparison.

Working to reduce molasses purity can be painstaking and at times frustrating but it is profitable. Remember that a 1.0 reduction in molasses purity will reduce sugar lost to molasses by 4%.

FIGURE 1

TYPICAL BEET SUGAR FACTORY EXTRACTION STATEMENT

Per Cent on Sugar Entering	
White Sugar Produced	82.0%
Pulp Loss	2.0
Lime Flume Loss	0.2
Sewer Loss	0.2
Molasses Loss	13.0
Unknown Loss	2.6

FIGURE 2

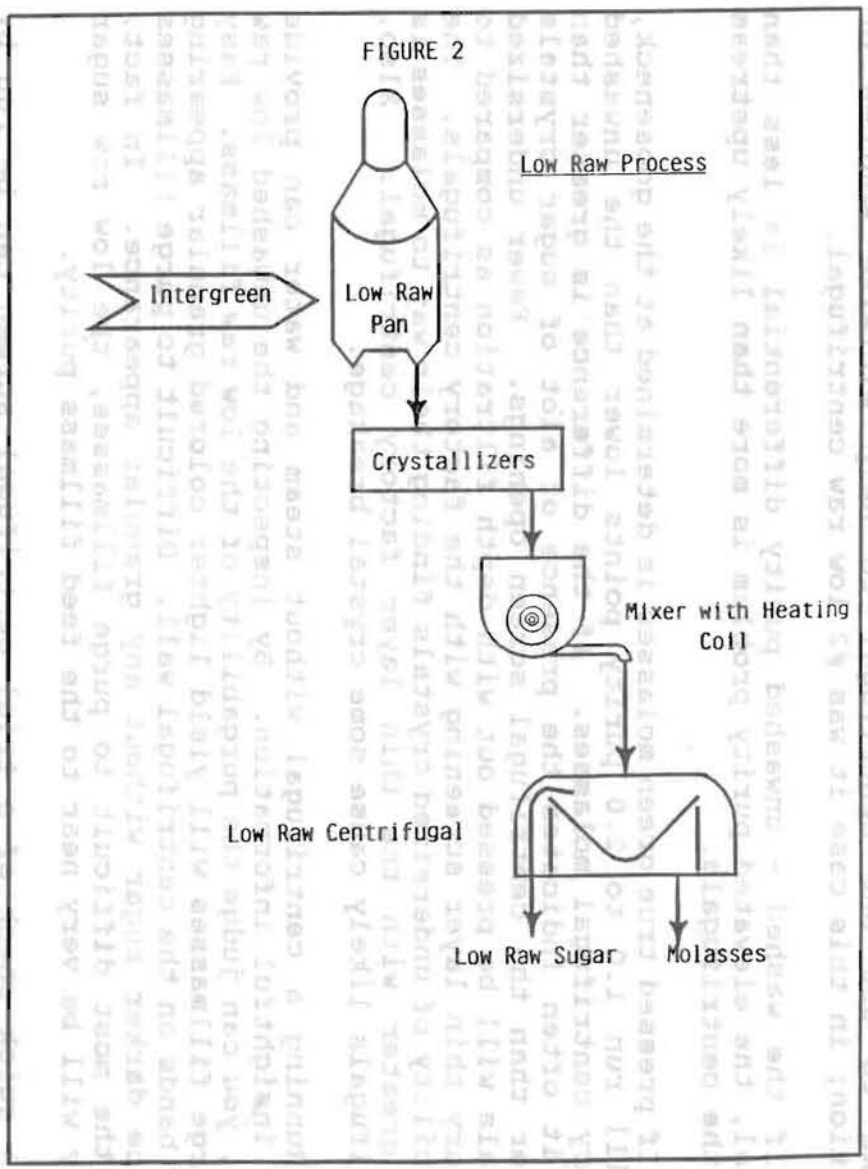


FIGURE 3

PURITY DROP COMPONENTS

OVERALL PURITY DROP	=	Purity Drop Across LR Pan	+	Purity Drop Across Crystallizer	-	Purity Rise Across Mixer	-	Purity Rise Across Centrifugal

FIGURE 4

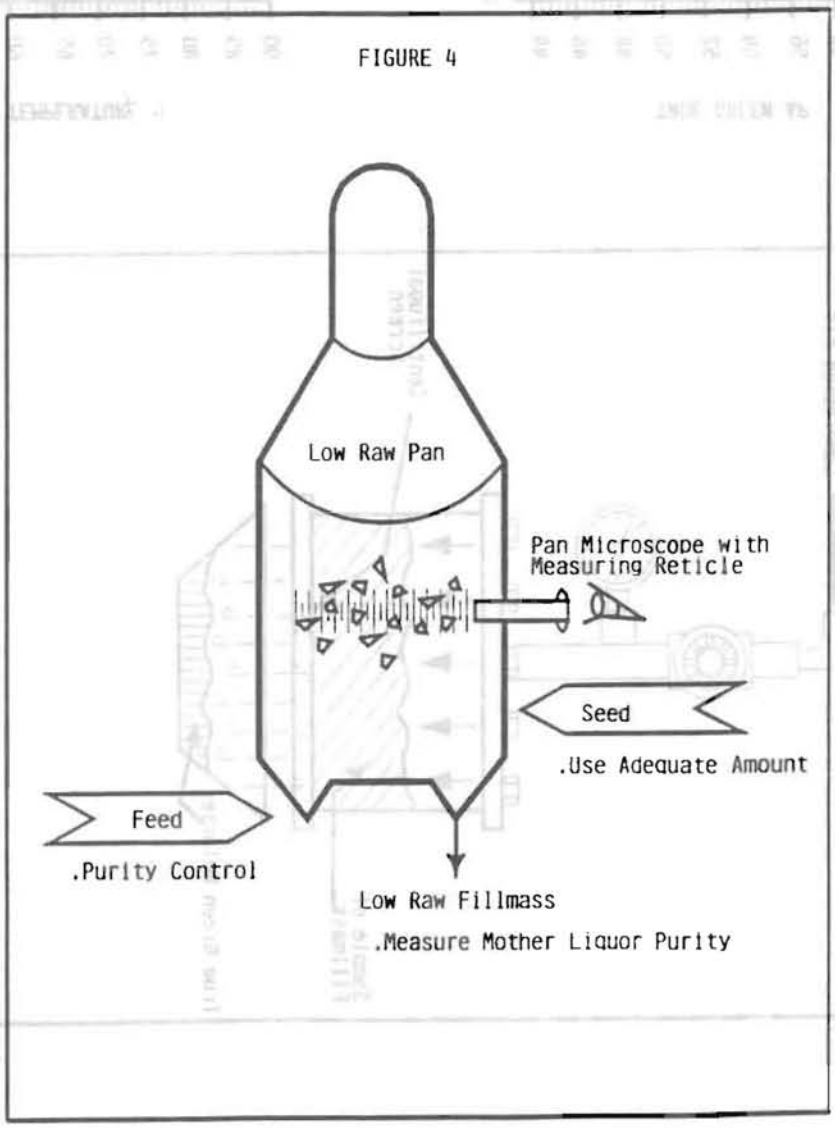


FIGURE 5

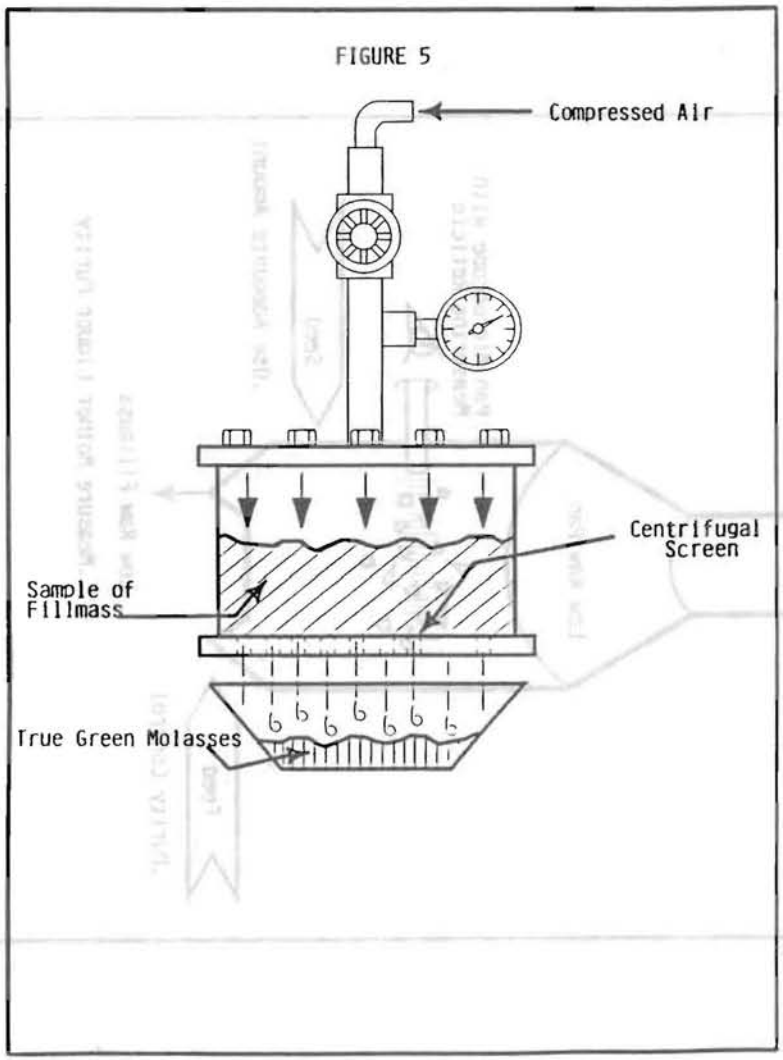


FIGURE 6A

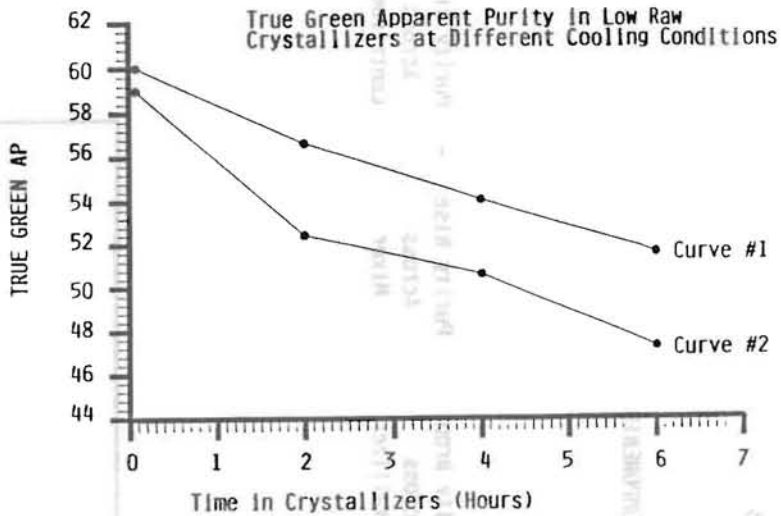


FIGURE 6B

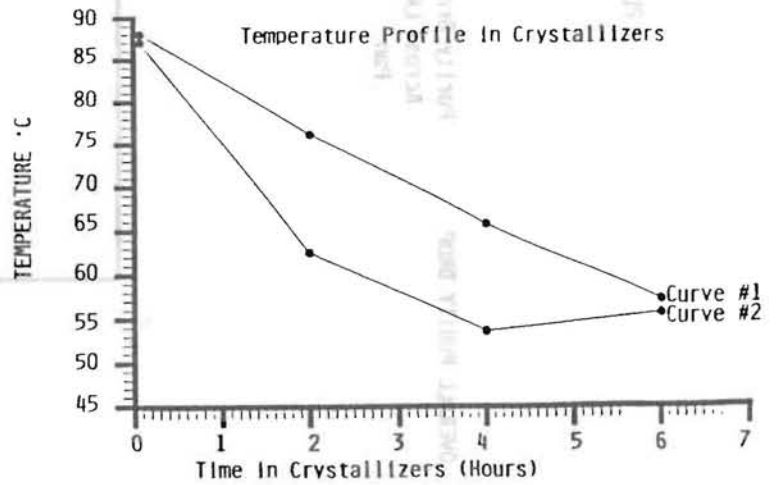


FIGURE 7

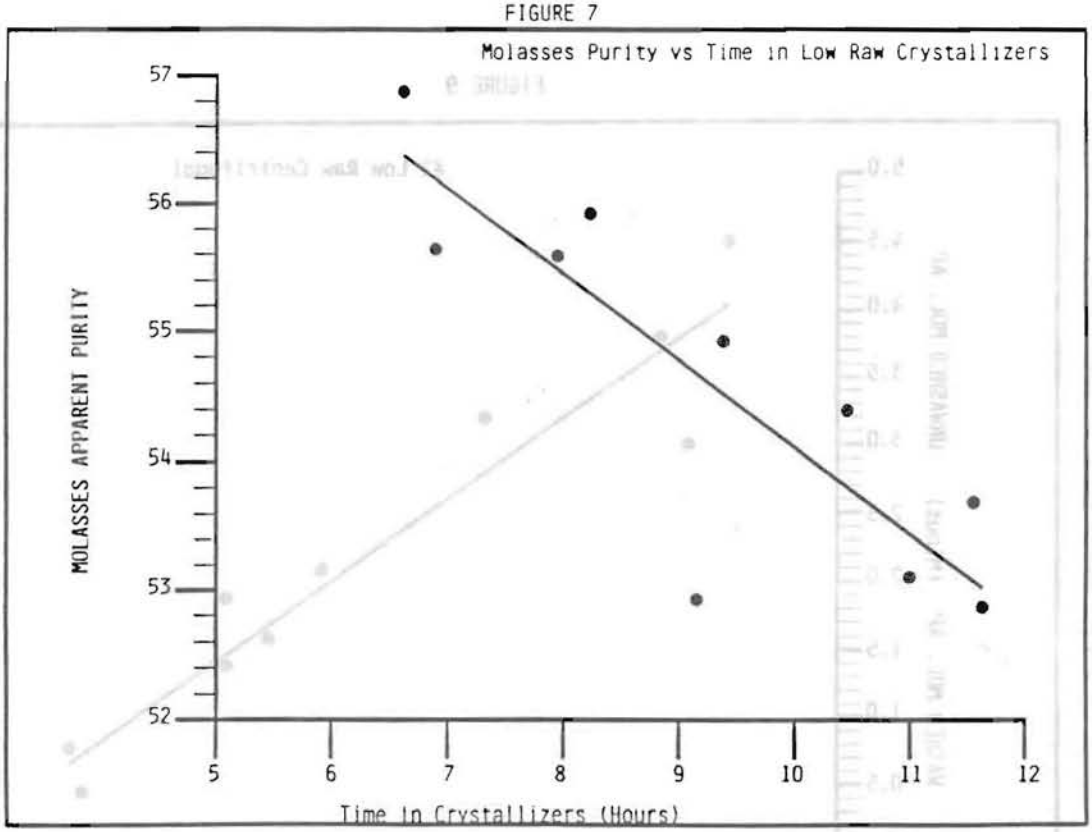


FIGURE 8

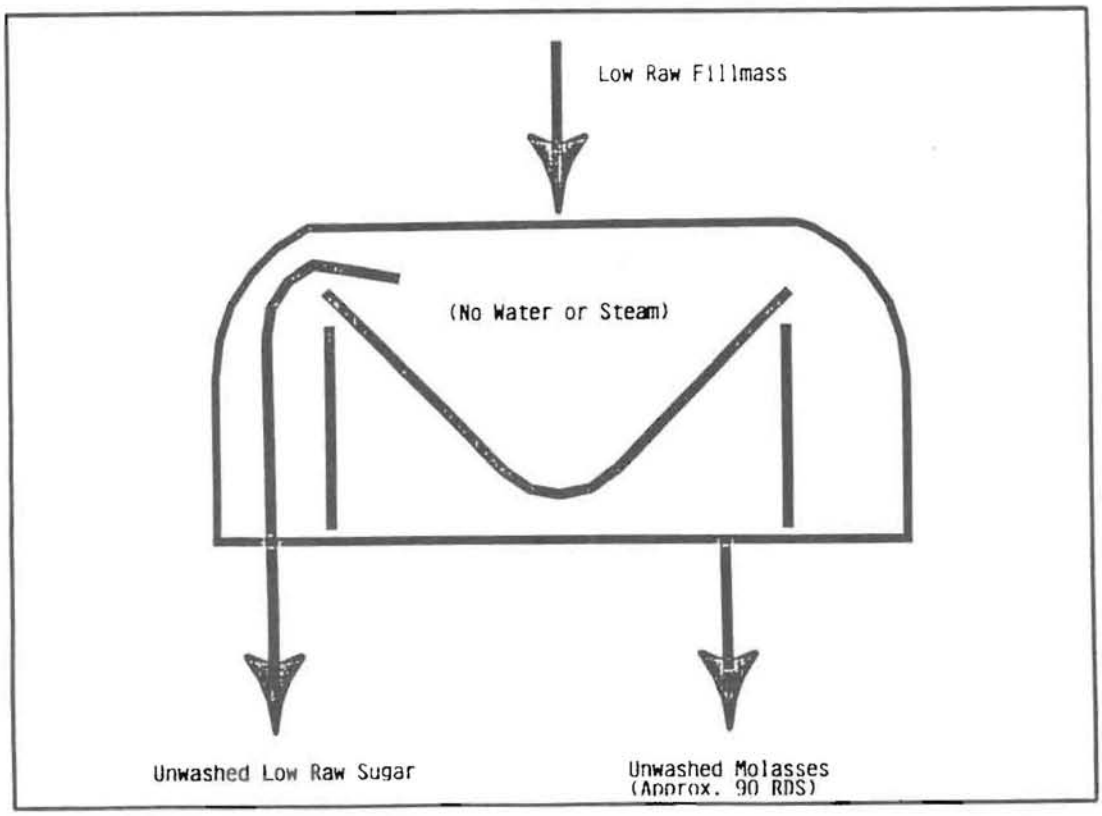
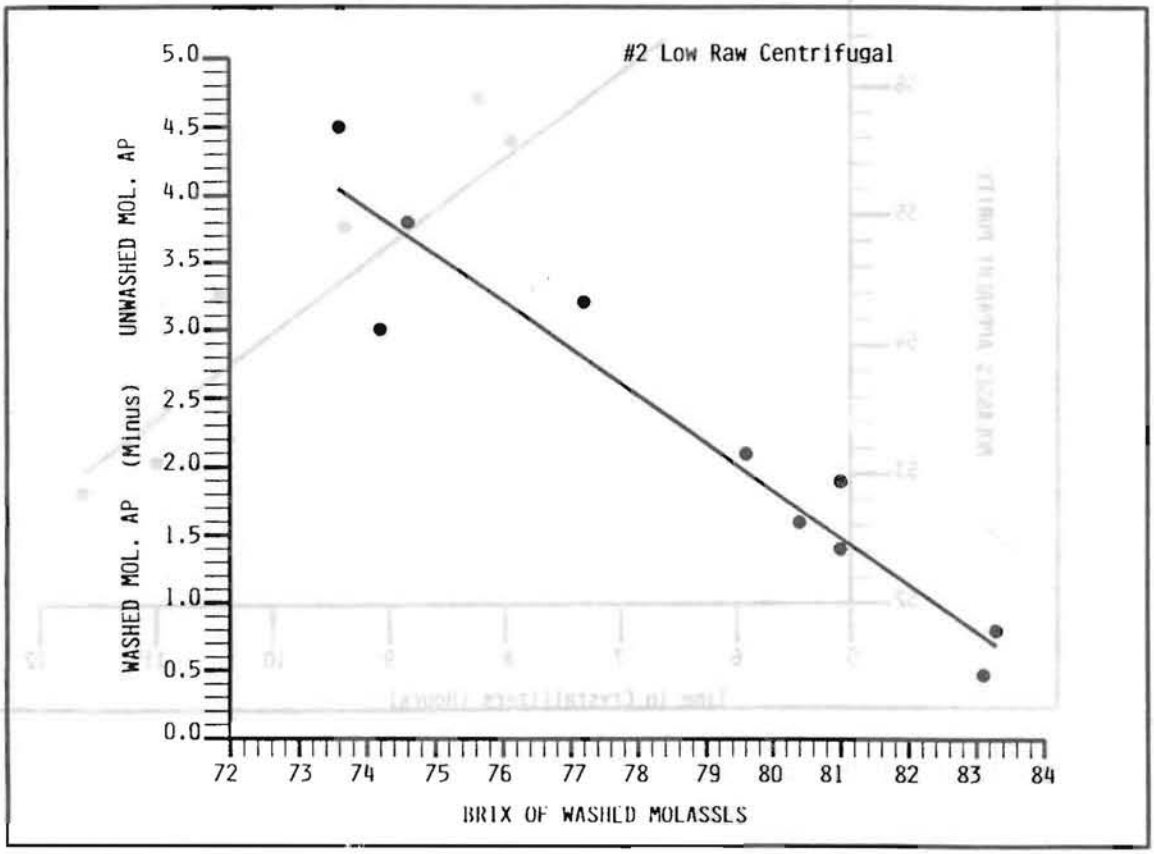


FIGURE 9


#2 Low Raw Centrifugal
WASHED MOL. AP (Minus) UNWASHED MOL. AP
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
72
73
74
75
76
77
78
79
80
81
82
83
84
BRIX OF WASHED MOLASSES