Optimizing First Carbonation - Clarification - Settling Aid Usage and Underflow Desugarization

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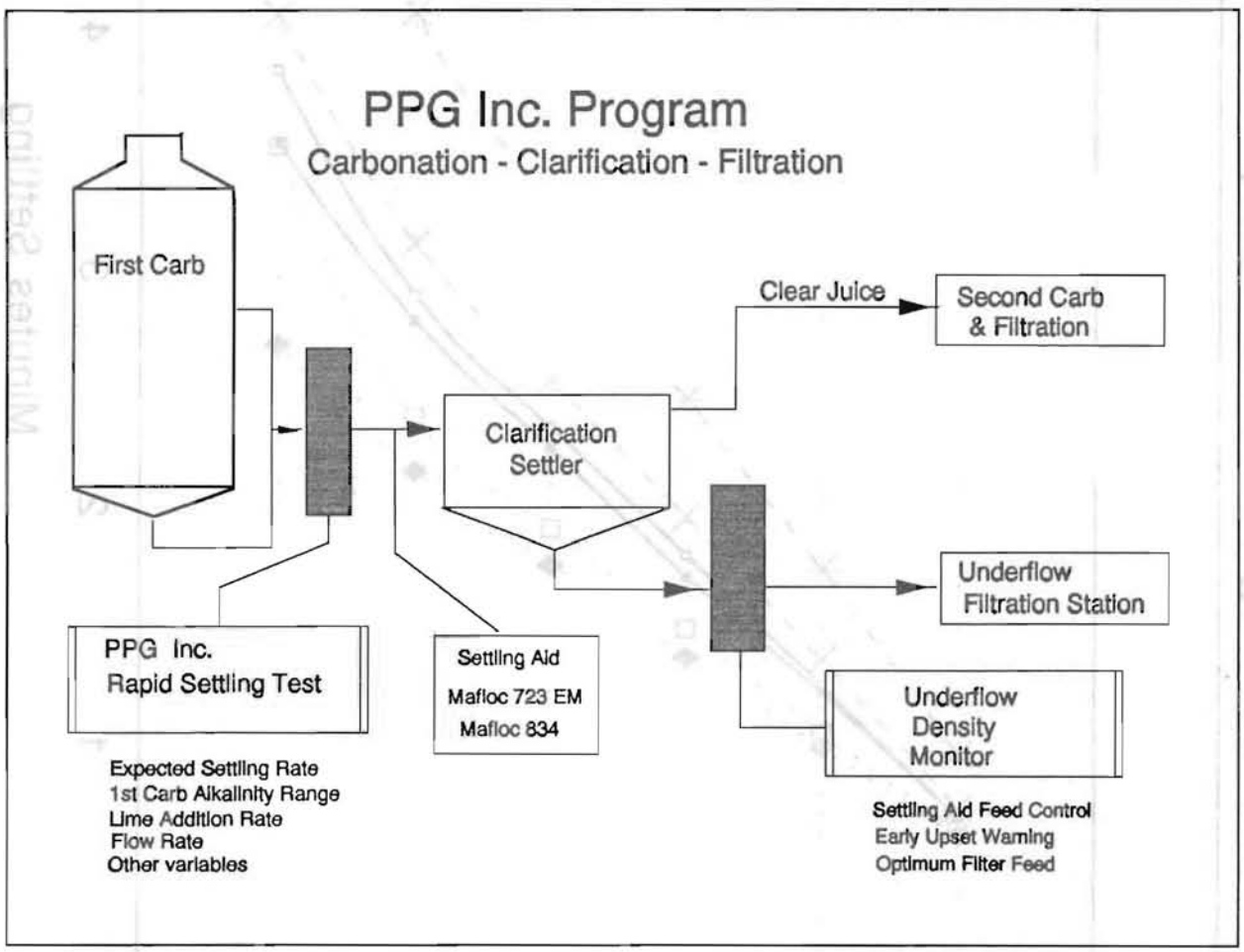

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OPTIMIZING FIRST CARBONATION - CLARIFICATION - SETTLING AID USAGE AND UNDERFLOW DESUGARIZATION

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INTRODUCTION

Juice purification, color reduction and non-sugar elimination cannot be optimized when the clarification process is a limiting factor. Also, the underflow sludge desugarization will not be economically achieved when the density is allowed to vary.

These problems can be overcome when the three steps of Carbonation, Clarification and Underflow Sludge Filtering are viewed as a unit operation. All of these operations will be improved when more uniform carbonation testing is used and continuous sludge density information is supplied to the station operators.

BACKGROUND

There are a number of carbonation systems and many studies have been done on methods to control these most important purification steps; but, that is not our subject today. This subject is well covered in Beet Sugar Technology 3rd edition, pages 155 through 290.

But we do find that no matter which lime purification system is used, we still must separate the lime from the juice, and therein, lies our task.

Under this subject of first carbonation on page 173, of McGinnis' Beet Sugar Technology, the author helps us narrow down the problem with this statement, *"It can therefore be stated, in general, that any condition which increases the surface of the calcium carbonate precipitate in first carbonation (elevated levels of alkalinity) tends to improve the chemical purification of the juice. Lime salts and color are by far the most sensitive criteria. At the same time, the speed of sedimentation and filtration are lowered.*

On the other hand, any increase in the size of the calcium carbonate grains formed, which is equivalent to a smaller total precipitate surface (lower levels of alkalinity), lowers the effect of chemical purification, but is, of course, favorable both for sedimentation and filtration".

It is very easy then, to run the carbonation and clarification stations at low levels of alkalinity and low flow for a continuous clear overflow to second carbonation. The challenge is to push the first carbonation system to its highest levels of juice purification and flow while learning to control and contain the clarification and desugarization processes.

INCREASING JUICE PURIFICATION AND INCREASED THROUGHPUT SHOULD BE THE HIGHEST PRIORITY OF THE BEET END OPERATION!

To help do this, PPG has developed a control scheme that begins with an on-line settling test that will quantify the expected settling rate of currently produced carbonated juice. Management can then integrate this information into their controls and set realistic goals and levels of first carbonation alkalinities.

The second part of this control scheme is a continuous readout and recording of the clarifier underflow sludge density.

This information is needed to optimize the clarifiers performance. It will yield the highest quality clear juice, while controlling and optimizing the Settling Aid addition rates. It also prepares the desugarization station for low sugar loss with possible reductions in water usage and corresponding energy cost.

THE RAPID SETTLING TEST

The major items that affect the settling rates of finished carbonated juices are:

- Lime addition rates and recycled limes
- Lime quality and quantity
- Juice temperature and density
- Excess colloidal or foreign material
- System circulation and controls
- Juice flow rates
- Final alkalinity

Most of these conditions are preset or do not change much other than flow rates and final alkalinity.

In order for us to do our job correctly in the clarifier and get the best results, we need to know the accurate settling condition that has been created by the prior items, especially the flow and alkalinity.

A direct and efficient method to determine this is to sample the first carbonation stream at the same place and time as the normal final alkalinity sample, then set the sample aside in a 250 ml beaker. This "break" or settled sludge level is then observed in one minute, and recorded, along with the corresponding alkalinity reading.

Figure #1 shows a direct correlation of settling rates as they are affected by different levels of alkalinity and are easy to establish. Then when the other settling conditions are constant, a trend line of settling rates for any carbonation system can be made.

Most important for operators and managers is that a "Safe Zone", an "Operating Zone" and a "Danger or Out of Settling Range Zone", can also be made. This is shown in Figure #2.

With this information and control, you are now able to achieve the highest possible levels of alkalinity (with its increased purification) with no fear of clarifier upsets.

This rapid settling test can also be used to evaluate changes in other settling conditions, or to alert the operator that one of the other settling items is off standard.

As an example, if the break level is approaching the danger zone, but the alkalinity is still in a normal or safe zone, you would then check on flow, lime, etc.

CLARIFIER OPERATION

After learning how the Rapid Settling Test works and using this in your control system, you will always know that the feed material to the clarifier has a "good break" or settling rate and continuous clear overflow is no longer a problem.

The focus now should be on the development and condition of the sludge bed, and the advantages of maintaining the proper density.

The control of the clarifier is made easy when the density of the sludge bed or the density of the underflow sludge is known and recorded.

Settling Aid (polymer) should be used to maintain this density and this usage can also be controlled with the density reading.

The rapid style clarifiers will give best performance when the sludge bed (interface) is held constant, and when the bed density is held constant.

Both of these operating parameters have an optimum level and when found and set, should not vary as seen in Figure #3.

Operators quite often, in trying to achieve clear juice overflow but not having the necessary information on the juice settling rate or the sludge bed density, may make moves in the wrong direction.

A) Changing or lowering the bed level to try for a larger clear juice "Safety Zone."

B) Reduce the sludge bed density, trying to pump out or "get ahead of the mud."

Both of these moves go against the principle of this type clarifier's method of separation.

When the feed is introduced into the sludge bed (via top or bottom feed), it is typically near the center of this sludge bed. The area above this that this feed juice will percolate upwards through for all practical purposes, should be considered as a "filter zone".

To give maximum separation, as a "filter zone", it should be as large (deep) and as dense as practical.

Use of high quality Settling Aid is a very cost effective way to develop and maintain sludge bed density.

The control systems or operators that look at overflow juice clarity only, and/or try to control the juice clarity with Settling Aid feed, are doing the wrong thing. This is a reactive mode that controls after the fact and does not consider the condition of feed material or the causes of settling problems.

This type of control does not consider the sludge bed condition or its important relationship to optimum clarification/separation.

The settler or clarifiers function is just that: to clarify first carbonated juice. A clear juice (not polished) overflow is all that is necessary at this step in the process. As a matter of fact, milk of lime and other chemicals that cloud this overflow stream are often added prior to the second carbonation step.

Further juice clarity improvements or lime salt reduction are both best carried out in the second carbonation process and with the following steps of thin juice filtration.

Knowing that the first carbonation juice has a good settling rate and with the clarifier under control, effective use of Settling Aid to develop and improve the sludge bed will now allow you to increase and maintain higher levels of first carbonation alkalinity and juice flow rates.

So it can be truly stated, **"Controlled usage of high quality Settling Aid will help increase juice purification and flow rates."**

Concerning the larger multi-try clarifiers, knowing the discharge sludge density is also very important.

Generally, overflow clarity is not a big problem if outlet flows and underflow pumps are properly balanced. Settling Aid usage is also usually much less of a problem. The main concern is to continuously remove the sludge solids at the same rate as they were introduced and not get behind on the pumping of the trays.

By using the information of the discharge sludge density, you can control the Settling Aid feed rate and also the underflow discharge rates. A program can be set that will not overpump or underpump the clarifier.

Knowing the density set point you want, (say 40 brix), when the density readout is higher, the control will reduce the Settling Aid feed rate and increase the underflow pumping. If the density is lower than this set point, it will increase the Settling Aid feed rate and reduce the underflow pumping.

DESUGARIZATION

Vacuum filter operations rely on various steps for desugarization and de-watering of underflow sludge. These include changes in vacuum, drum speed, levels, temperature and, of course, washwater.

If the underflow sludge (feed stock) is of varying densities, then most of these prior variables must also be changed, to give the best efficiencies.

A much better way is to set and maintain the proper underflow sludge density (feedstock) and then tune in the other variables to match this.

This type underflow density readout and control system was installed in a factory in the Fall Campaign of 1988. With this improved control of filter feed, the average of the lime sugar loss for the next four years was 41% lower than the prior four years. It was 46% lower than the average of the prior ten years.

CONCLUSIONS

The "Rapid Settling Test", when integrated with other first carbonation controls, will help the station operator better understand the present condition of the station and give them a preview of what will happen in the clarifier, for better control and a continuous clear juice overflow.

Underflow density information should be used to optimize clarifier operation and maintain a steady state of operation.

Settling Aid can and should be used effectively to improve suspended solids coagulation, thereby allowing higher levels of alkalinity (for juice purification) and flow rates.

Settling Aid feed rates are better controlled by sludge bed density information than overflow clarity information.

Steady underflow density feed rates to the desugarization station will allow reduction in wash water usage and a subsequent reduction in energy cost.

PPG Process Chemical Service Representatives will be glad to review your particular carbonation clarification and desugarization system and help you install these needed controls. They will also be glad to work with you on an evaluation of the best settling aid and Settling Aid delivery system for your particular needs.

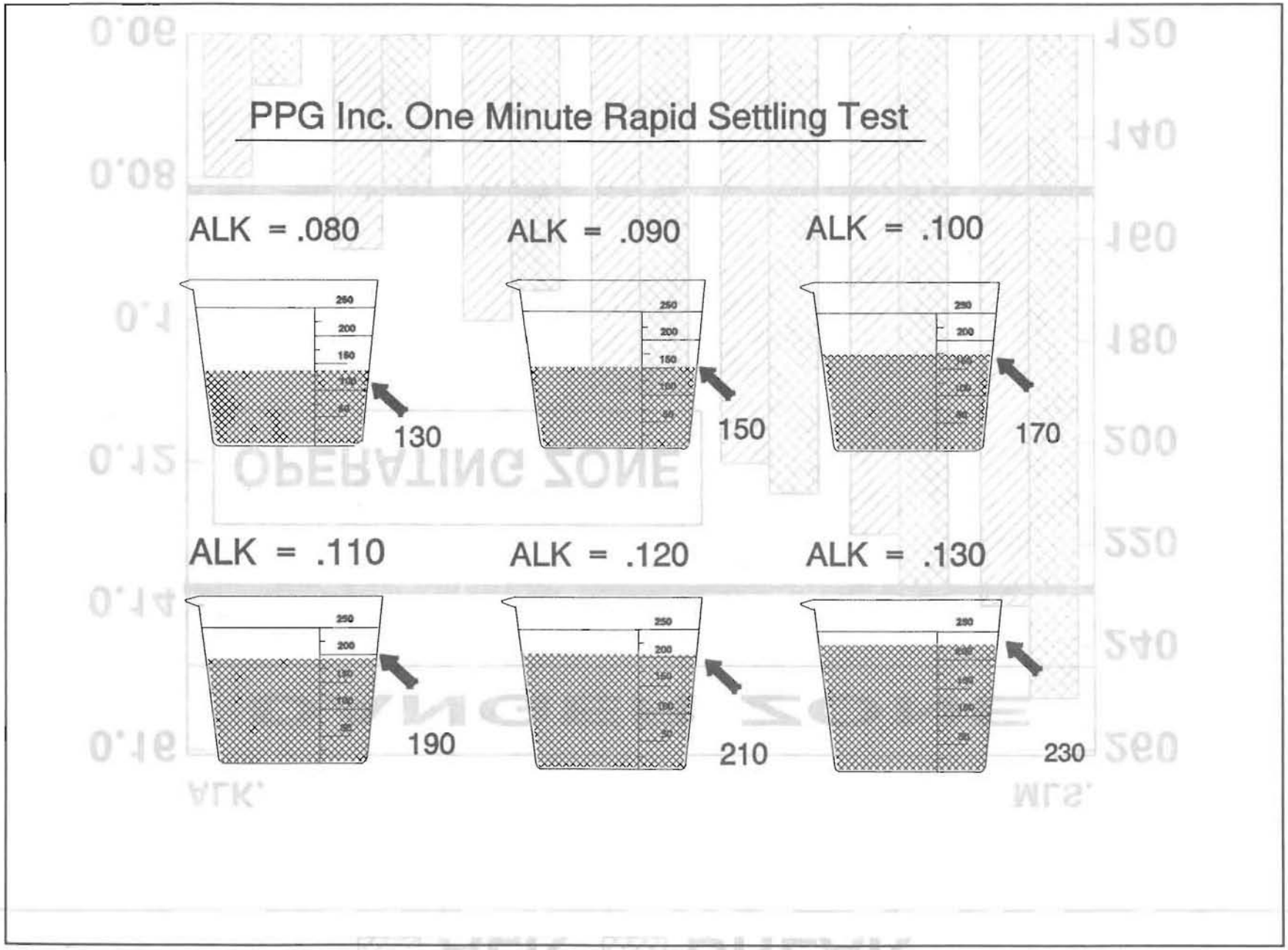
PPG Inc. One Minute Rapid Settling Test
ALK = .080
ALK = .090
ALK = .100
130
150
170
ALK = .110
ALK = .120
ALK = .130
190
210
230

Figure 1

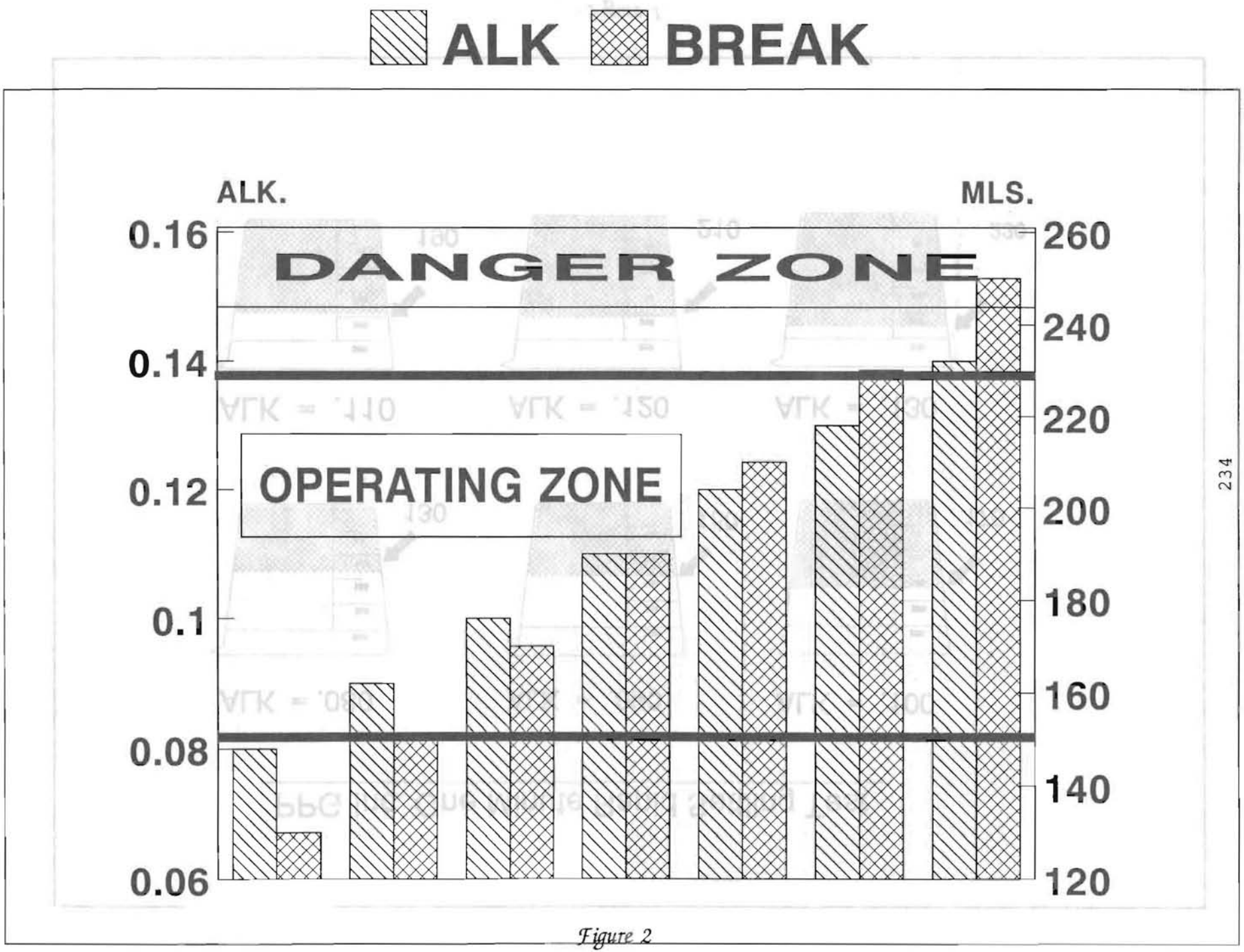
ALK
BREAK
ALK.
MLS.
0.16
0.14
0.12
0.1
0.08
0.06
260
240
220
200
180
160
140
120
DANGER ZONE
OPERATING ZONE

Figure 2

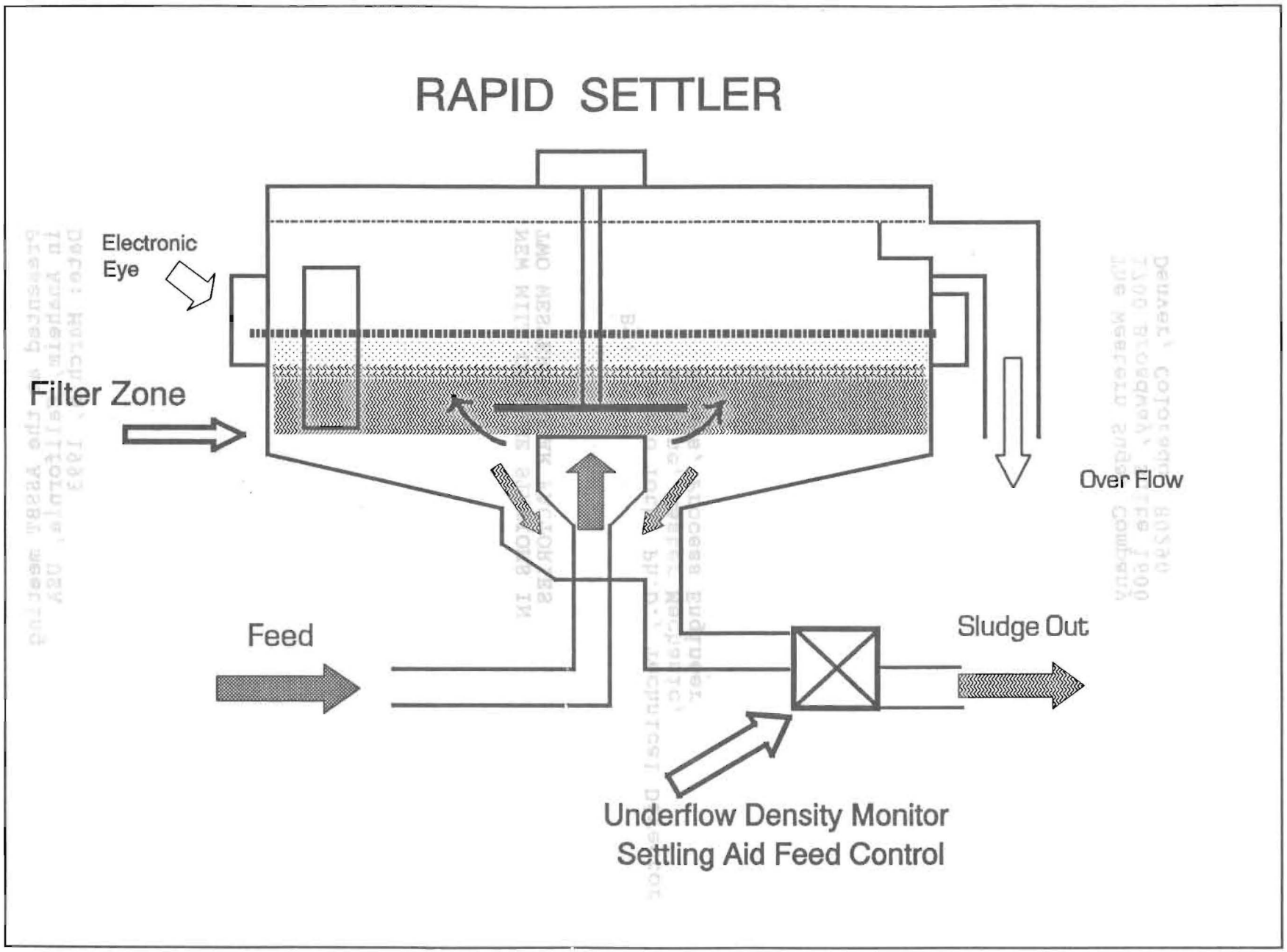
RAPID SETTLER
Electronic Eye
Filter Zone
Over Flow
Feed
Sludge Out
Underflow Density Monitor
Settling Aid Feed Control

Figure 3