Chemical Aids to Carbonation Mud Settling and Filtration

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In recent years, many factories have greatly increased beet slicing capacity by the introduction of continuous diffusers, and have consequently shifted the rate-limiting process to a later stage. Even though the sugar content of the cossettes may have dropped, so that little, if any, more sugar is being produced, a much greater tonnage of juice must be handled in carbonation and evaporation.

This situation developed in one of our plants until a muddy Dorr overflow with excessive mud to the second carbonation filters became the limiting factor in house capacity. At the same time, constant efforts were

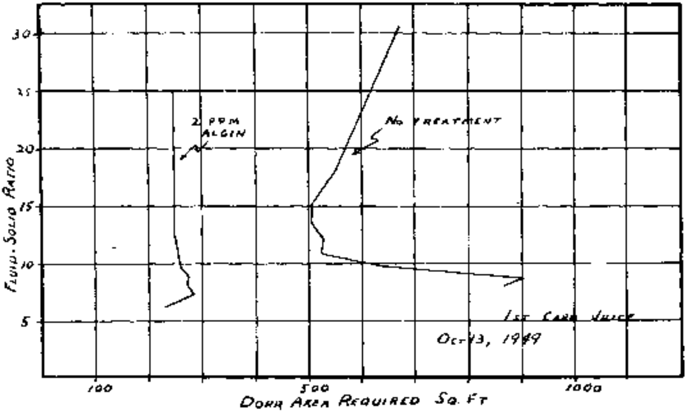

Figure 1. Typical settling test data for a Steffen house.

being made to improve sugar quality. According to the work of Skaar and McGinnis (1)[2] we consider it axiomatic that color reduction is favored by high alkalinities in first carbonation, but that alkalinities approaching the optimum inhibit mud settling in the Dorr thickener.

It had been noted by Losee (2) that agar was useful in accelerating the filtration of $CaSO_4$ slimes. No noticeable effect by agar on first carbonation juice could be noted. However, in the fall of 1949 and after, **a** number of other gummy materials were discovered which often effect **a**

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[2] Numbers in parentheses refer to literature cited.

radical improvement *in* first carbonation settling rates. The following materials have all proved more or less useful:

Algin (sodium alginate)
Gum arabic
Carboxymethyl cellulose
Irish moss gum
Gum Karaya
Kelcoloid HV[3] (the propylene glycol ester of alginic acid)

An investigation of the usefulness of these compounds was made by the settling test of Coe and Clenenger (3) as modified and described for carbonation work by McGinnis (4). I am indebted to Dr. McGinnis for the settling test data which follows. In most of our tests we used algin, Kelgum.[4]. Alginic acid is a polymannuronic acid derived from seaweed.

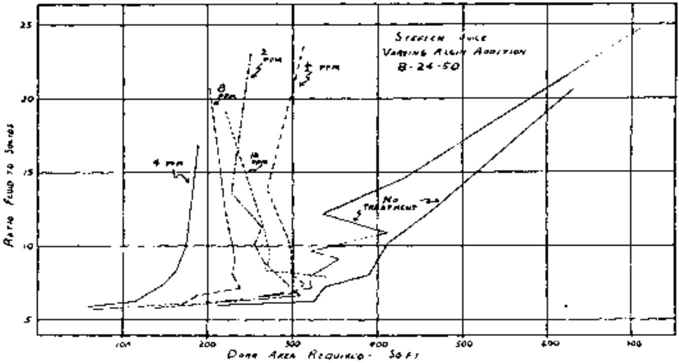

Figure 2. The effect of Algin addition.

Figure 1 shows typical settling test data for Steffen house juice. The ordinate is the fluid-solid ratio at various stages of thickening, the upper portion representing the thin Dorr feed, the bottom the thickened sludge discharge. The abscissa is the settling rate expressed as the area required to settle the juice from a nominal factory. The algin reduced the area required from 900 to 200 square feet. Figure 2 shows the effect of varying algin addition. This shows a rather clear optimum at 4 ppm., but many tests have shown the optimum to be variable and not too sharp, so we ordinarily compromise at 2 ppm. algin on juice.

The concentration of algin in the solution fed to the Dorr is critical. It was found that a solution even as concentrated as 1 percent does not work at all, while 0.1 percent is convenient and most effective. We use a 0.1 percent solution of algin in water. Algin dissolves rather slowly, so in

[3] Trade name of the Kelco Company, Los Angeles, Calif.
[4] Trade name of the Kelco Company, Los Angeles, Calif., for their brand of sodium alginate.

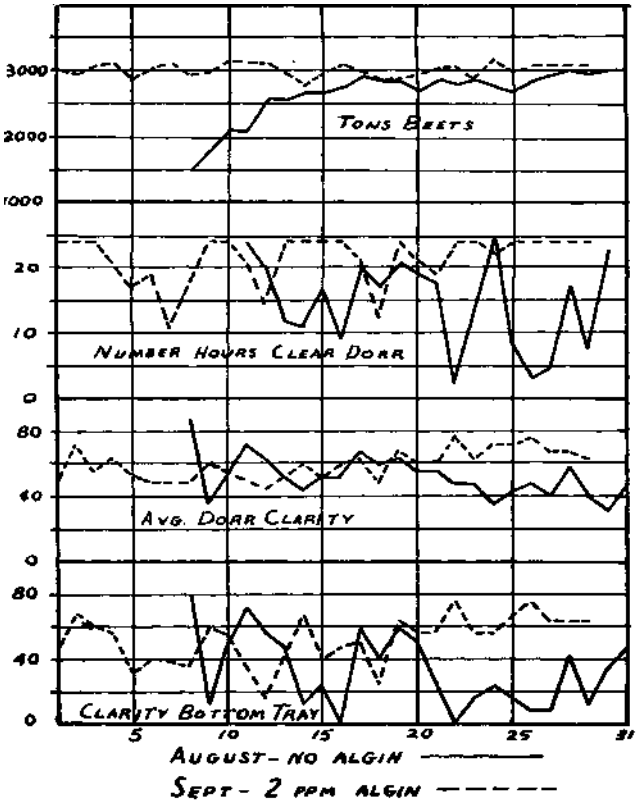

Figure 3. The effect of 2 ppm. algin addition in a Steffen house.

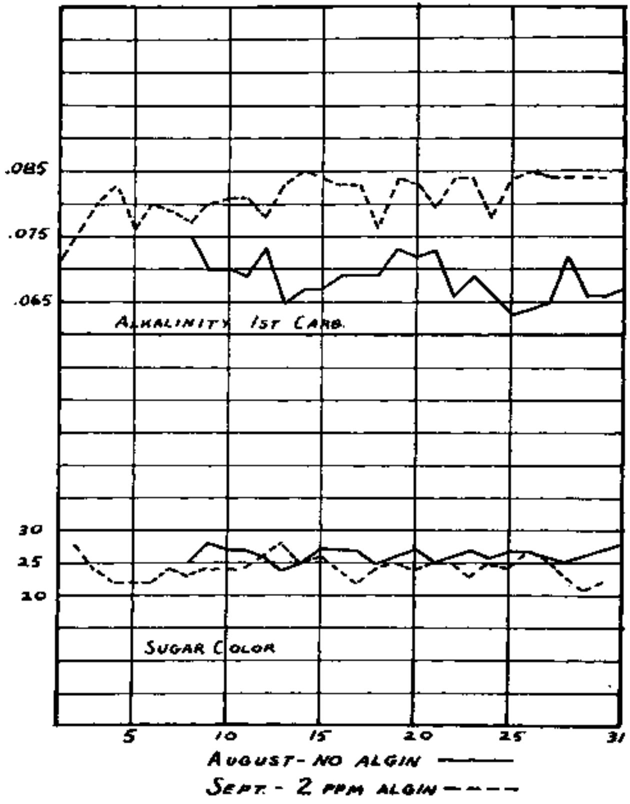

Figure 4. Continuation of Figure 3.

the factory we use two tanks each of 4 hours capacity, one stirring and dissolving while the other is in use. In very hard water an insoluble calcium alginate inhibits solution, and a polyphosphate sequestrant may be desirable.

Figures 3 and 4 show actual operating results for a Steffen factory for the first two months of the 1950 campaign. 2 ppm. algin on juice was added in 0.1 percent solution to the pipe line from first carbonation to the Dorr thickener. The comparison is not very useful until the slice in August reached a fairly high level, but it is clear that in September with algin addi-

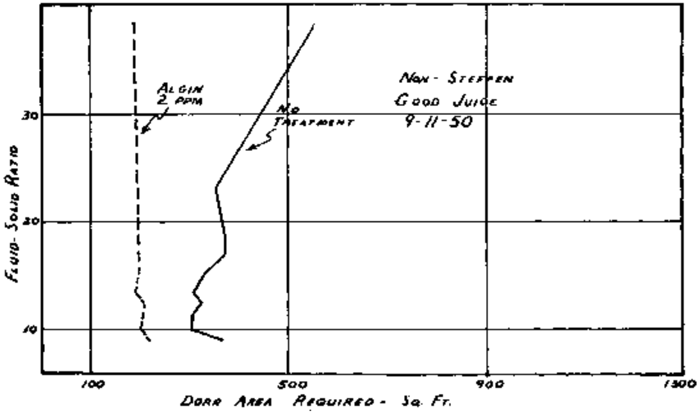

Figure 5. Settling tests at a non-Steffen factory.

tion we sliced more beets at a higher alkalinity, with a much clearer Dorr. Subsequent comparative tests in this factory were difficult to arrange because the factory operating staff was convinced of the efficiency of the algin addition, and because, whenever the algin was discontinued, the Dorr ran muddy in a few hours. Good results were readily obtained at our non-Steffen factory (Figure 5) and routine use of algin at these two factories has continued.

There is a property of juice which we may call algin susceptibility. The juices in the settling curves shown previously have all responded very well at all fluid-solid ratios. Figures 6-9 show a series of tests in which the effect of algin is successively less and is finally harmful at all ratios. Figure 6 shows a juice with a top-rate determining curve which was helped by algin, but shows a toe developing at a ratio of about 7. This juice was at .066 alkalinity. In Figure 7 we have about the same effect at .064 alkalinity. However, in Figure 8 we have a very poor juice at the same factory at .086

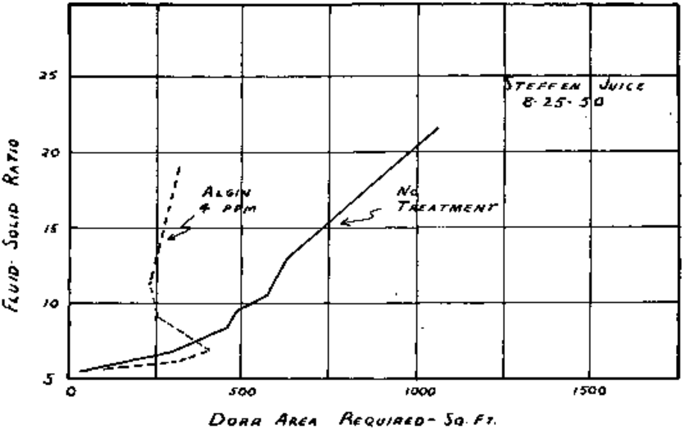

Figure 6. Although the algin is still effective, a "toe" is developing in the settling rate curve, at the level of the thicker slurry.

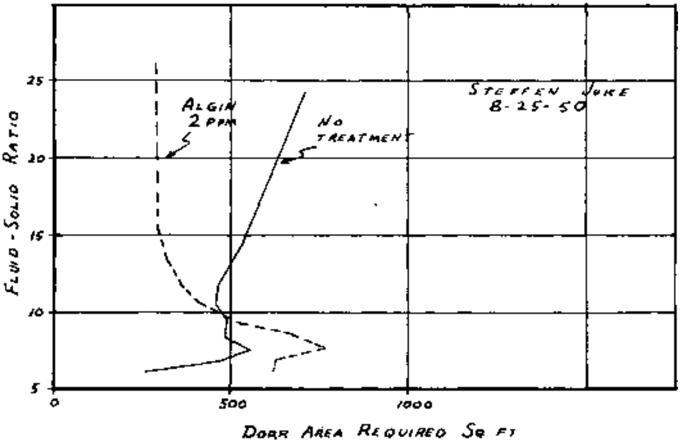

Figure 7- The "toe" is now controlling.

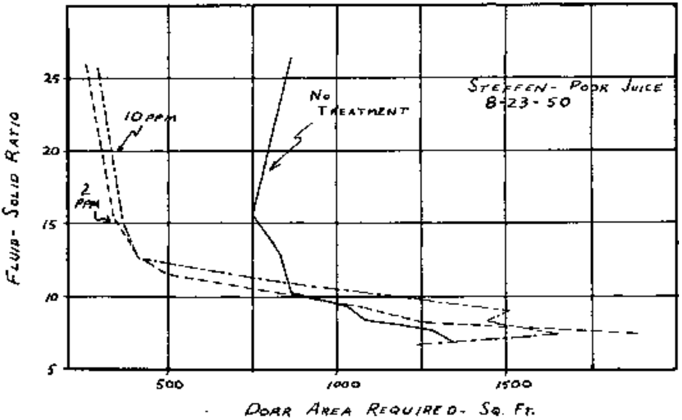

Figure 8. On this refractory juice, algin is definitely harmful to the settling rate of the thick slurry.

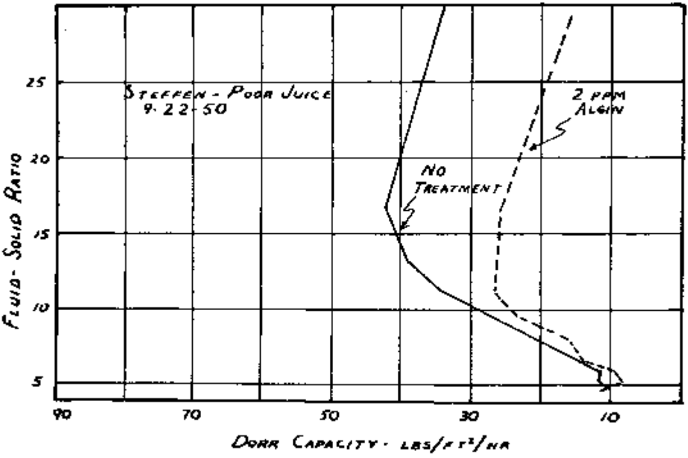

Figure 9. In this case, algin was harmful in all proportions.

alkalinity in which the algin was actually harmful on the thicker juice. We can make two generalizations about algin susceptibility:

1. Algin almost always helps the settling of the thin slurry, but as the susceptibility of the juice decreases, trouble develops with the thicker slurry, the bottom of the settling rate curves.
2. Juices which are naturally the best settling are most susceptible to the action of algin.

Figure 9 shows an extremely refractory juice in which algin was harmful in all proportions. At this Steffen house, the use of algin has never been successful in the factory, and only very rarely on laboratory samples. Settling and filtration difficulties are characteristic of this house, and it is here where effective algin treatment would be most desirable that the algin susceptibility is lowest.

Algin treatment, then, is indicated when carbonation is normal and the trouble is a physically overloaded Dorr. Algin will not be useful and may be harmful if the trouble is poor carbonation. Generally, predefecated juices are slow settling juices and algin will not be useful. However, algin will work well with batch carbonated juices if they are carbonated to a good break.

The settling rates in the curve are based on the "break" line. There is usually some residual haze of fines in the supernatant liquid. Algin treatment will reduce the suspended solids in the overflow to 1/2 to 1/3 the original value. Also algin frequently improves mud filtration rates very markedly, due to the agglomerated character of the floc.

Sodium alginate in solution dissociates into sodium ions and a multivalent colloidal negative ion. Since the carbonation floc particles are positive, it is believed that weak electrostatic bonding is responsible for coagulation.

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