Tetraphospho Glucosate as a Scale Inhibitor

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Glucosides and their derivative glucosates and similar preparations have been widely recommended by their manufacturers as scale inhibitors for sugar factory evaporators. Favorable results have been reported for the use of tetraphospho glucosate in a raw cane sugar mill[2] and a refinery.[3]

It was our purpose to test the efficiency of these compounds in our high pressure, long tube vertical evaporators.

Scaling conditions at Woodland are very severe. During the 1946 campaign of 113 days, we had 35 evaporator boil-outs. Yearly average thin juice lime salts were 0.191 percent on R.D.S. During the 134 days of 1947 campaign with 0.203 lime salts we boiled-out 44 bodies. It is evident that the Woodland evaporators provide a severe test for a scale inhibitor and that an appreciable abatement of scaling would justify a considerable treatment cost.

Experimental Procedure

In another paper on this program, Coons has described the design and operation of these evaporators. It is necessary here to point out only that the parallel bodies in first and second effect afford an unusually direct method of testing a scale inhibitor, since one side can be treated, and the other used as a control, and variation in the inherent scaling tendency of the feed can be disregarded. One need only compare the efficiency, expressed as an overall heat transfer coefficient, of the treated with the untreated side.

The heat transfer coefficients for the first bodies were calculated from the steam flow to the individual bodies, obtained from recording flow meters, the steam temperature and pressure, and the constant area of the heating surface. Juice flow to the individual first bodies was measured by installing an orifice in each feed line and measuring the pressure drop with a mercury manometer. From the above data and the R.D.S. of the feed to and discharge from each body, second body coefficients were calculated.

A run through four separate boil-out cycles was made with tetraphospho glucosate, two at 15 parts per million addition to the juice entering 1B and two at 7 parts per million. One test at 7 parts per million was made by treating 1B and one test by treating 1A to check the possibility that one body might have some inherent advantage.

Later a further test was conducted with a straight glucosidal preparation, free from phosphate.

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[2]Hewlett Wulfekuhler and Lui: "Hawaiian Experience with Tetraphospho Glucosate for Preventing Scale in Evaporators". Sugar, 42, 4 April, 1947, pp. 30-31.

[3]Fitzwilliam and Yearwood "Use of Tetraphospho Glucosate as an Evaporator Scale Preventer". Sugar 42, 1 January, 1947, pp. 24-26.

Experimental Results

Figure 1 shows the results of the first three runs with tetraphospho glucosate. The first set of curves shows the heat transfer coefficients for the period September 20 to September 30. Tetraphospho glucosate was added to 1B at the rate of 15 parts per million on juice. Inspection of the curves shows that near the end of the run the treated body was about 2½ days behind the untreated in loss of heat transfer efficiency. For the 10-day run this corresponds to a lengthening of the boil-out cycle of about 25 percent.

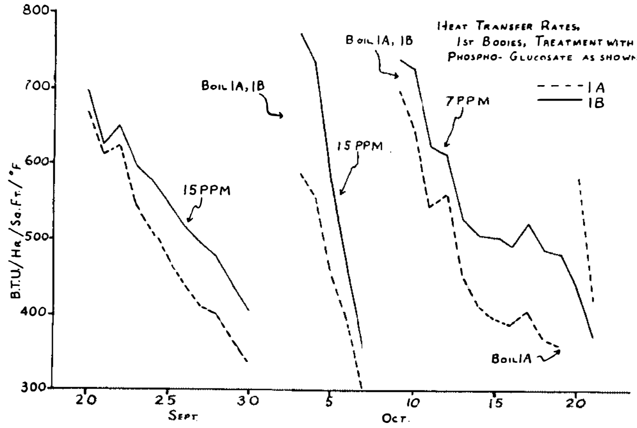

Figure 1.—Three tests with tetraphospho glucosate.

The second test, at the same addition rate, shows a lengthening of the boil-out cycle of the treated body of about 0.8 day in 5 or about 16 percent.

For the third and fourth runs the addition was reduced to 7 parts per million. The third test shows a lag in the treated body of almost 3 days in 10 or about 30 percent. Here we actually gained one boil-out as 1A was boiled on October 20. However, scaling conditions were so bad that both bodies had to be boiled 2 days later.

In figure 2, the fourth test with tetraphospho glucosate is shown. Addition was to the other first body, 1A, at a rate of 7 parts per million. Again the treated body shows an advantage of about 2 days in 10 or 20 percent.

No tests were made at higher addition rates, since we were approaching the economic limit, where the cost of treatment exceeded the cost of boiling-out. On the basis of these tests at 7 and 15 parts per million, we found a gain in the length of the boil-out cycle (or a reduction in boil-outs) of first effect evaporators, attributable to the treatment, of about 25 percent. No benefit in second effect was discernible.

At this point we dropped the testing of tetraphospho glucosate and began a test with a plain glucoside. We hoped to make a series of runs with this chemical; however, as shown in figure 3, the evaporators scaled very slowly during this period, and we were unable to complete our planned tests before the end of campaign. Day to day variations at this slow scaling rate make this curve extremely irregular, but a slow scaling tendency, which increases toward the end, can be observed. The trend is better shown in figure 4, by plotting the 3-day moving averages of the heat transfer coefficients.

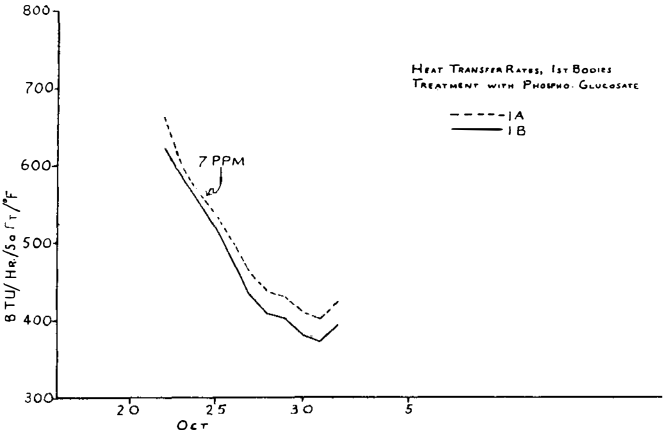

Figure 2.—Fourth test with tetraphospho glucosate.

Although there is undoubtedly some benefit to be attributed to the treatment, it is difficult to evaluate due to the slow and erratic progress of the scaling curves. An estimate can be made by treating the curves as linear and extrapolating to the minimum allowable heat transfer coefficient, which we consider to be about 300 B.T.U. per hour per square foot per degree Fahrenheit. By this method (for which no accuracy can be claimed), an apparent benefit of about 30 percent is found.

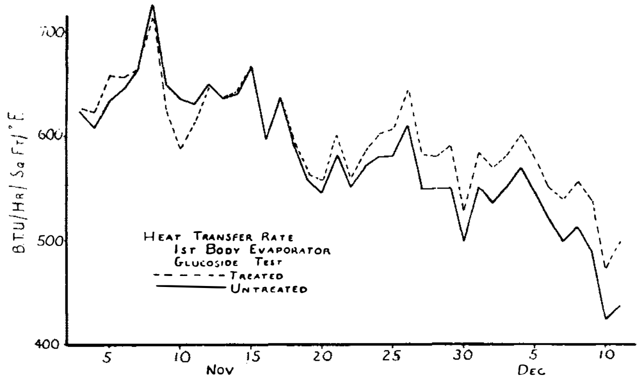

Figure 3.—Test with a plain glucoside.

Effect of Sulfitation

The question arises: why did we run only 8 days between first body boil-outs at one period (October 2 to October 10) and later make an incomplete boil-out cycle of 38 days (November 2 to end of campaign)? A possible explanation lies in the effect of varying the sulfur dioxide addition.

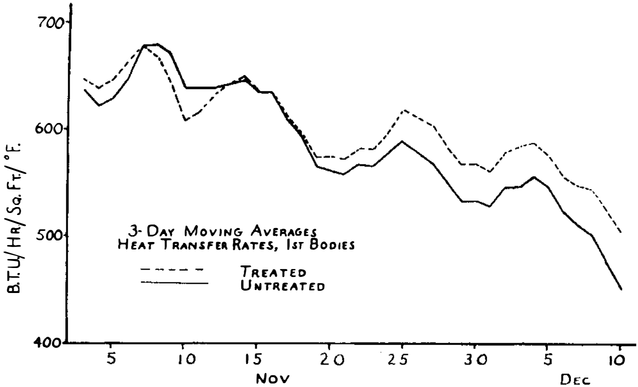

Figure 4.—Test with a plain glucoside. Three-day moving average to smooth curve.

Calcium sulfite is a compound of low solubility with an inverted solubility curve, typical of scale-forming compounds. If the sulfite concentration were kept low enough that the solution was under-saturated with respect to calcium sulfite, scaling from this cause would be eliminated.

By a coincidence, at the start of the last test, November 2, the sulfur addition was reduced to ½ the previous addition (0.18 pound per ton of beets to 0.08 pound per ton). This change was not thought of at the time in connection with evaporator scaling, but later as the evaporators continued to stay clean, the reduced sulfitation was advanced as an explanation.

To test this possibility, the sulfur dioxide addition was again raised on December 5, and the increased scaling after this date seems to provide some verification. We plan to continue this investigation.

Summary

Controlled tests with the two inhibitors, tetraphospho glucosate and a glucoside, indicate partial (about 25 percent) benefits in first effect, and no discernible benefit in later effects. Since only 12 of our 44 boil-outs were of first bodies, this would save us only 3 boil-outs out of 44. The tests were made in the Woodland long tube vertical high-temperature evaporators, and the results probably are not directly applicable to beet sugar evaporators of conventional design.