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THE CONTROL OF SCALE AND CORROSION IN WATER SYSTEMS USING MAGNETIC FIELDS

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TREATMENT IN A SUGAR MILL

A series of sequential steps are followed in processing sugar cane into raw sugar. The sugar cane is pressed to remove the juices. The solid material (bagasse) is discarded or used as a byproduct. The juices are treated with lime and heated to precipitate impurities. Flocculants are added and the juice is filtered. This clarified juice is fed into a series of vacuum evaporators (called bodies) where the water is removed. The incoming juice is concentrated from about 15% solids to about 65% solids. During the evaporation residual inorganic solids from the soil and from the lime treatment precipitate on the tubes of the evaporators.

Evaporators must be shut down every few days to clean the tubes. The scale is removed by treatment with boiling caustic and acid. In this plant the boil-outs took 10 to 12 hours. It is very costly in terms of chemicals used, time wasted, lost production, and damage to the system by the harsh chemicals.

Any reduction in the scale formation would be extremely beneficial. Hugot (12) reported the use of a magnetic unit and an electric unit in sugar mills to reduce the scale formation. Meade and Chen (13) reported on the use of an ultrasonic descaler. They compared two identical evaporators running in parallel; one with the treatment and one without it as a control. After 14 days operations, the treated evaporator had about 1/3 as much scale as the untreated evaporator (85g vs 189g scale per tube, and .26 mm vs .65 mm scale thickness respectively).

In view of this, magnetic units were installed in a sugar mill in Louisiana. It was installed to treat the juice entering the first body. The flow rate of the juice varied from 500 to 700 gpm. After eleven days running the amount of scale was less than normal, and it was soft. The scale was removed more easily with caustic, but some acid treatment was needed to clean all the scale. In the next run, of ten days duration, the amount of scale was again lower than normal and it was soft. This time a short treatment with acid removed the scale, and the caustic treatment was eliminated. However, even though the amount of scale in the fifth body was reduced it was more than was desirable.

Another magnetic unit was therefore installed to treat the syrup as it entered the fifth body. The next run lasted $2^1/_2$ weeks. It should be noted that before installation of the magnetic unit, the runs usually lasted 3 to 4 days before shutdown due to scaling.

Note that magnetic fluid conditioning (MFC) can result in a reduction in the quantity and number of chemicals used.

The tubes after this run are shown in Figures 4A to 4G. Figures 4A and 4F show the tubes in the first and fifth bodies respectively, before a run, and just after being cleaned with caustic and acid. They are clean but the harsh affect of the acid was evident by green copper corrosion product in the tubes. The remaining Figures 4B to 4F show the tubes in bodies 1 to 5 after running $2^1/_2$ weeks. The tubes in the first body (Figure 4B) appear to be greatly scaled, but this is actually a small amount compared to run without the treatment. And even more importantly, the scale is soft and easily removed. To show the softness, the tube shown in the middle of Figure 4B was scratched with a fingernail. All the scale in the evaporators was removed by a 45 minute treatment with acid. This is a great savings in time and money from normal cleaning which was two hours with muriatic acid and six hours with caustic, which took ten to twelve hours including several filling, heating, emptying and rinsing cycles. Very little scale formed in the second body (Figure 4C) and no scale formed in the third, fourth and fifth bodies (Figures 4D, 4E and 4F). In fact, the fourth and fifth bodies looked better after the run than before it because the corrosion was removed, and no new corrosion formed.

In this particular sugar mill, without the magnetic treatment, the deposits in the first bodies were calcium scale, and a **silica scale** formed in the fifth body. The scale in the fifth body was the biggest problem. It was very tenacious and difficult to remove. However, **with the magnetic treatment this scale did not even form.** The reduction in scale in the system manifested itself in the improved economic performance of the mill. The production figures for that season are shown in Figure 5. The season usually lasts from about 35 to 65 days.

The curves in Figure 5 show the variation in the Brix* of the syrup production from the fifth evaporator during three consecutive seasons. The top curve shows the. significant increase in output after the magnetic unit was installed. This resulted in a savings of $1^1/_2$ times the cost of the magnetic units in one season. The unit functioned just as well the next season.

The first season was very short---38 days compared to 52 and 62 days for the two previous season. The cost savings would have been about $2^1/_2$ times the cost of the units if the season had been longer.

* Brix represents the percent of solids in the solution.

Note that the silica scale was totally eliminated when adequate magnetic units (MFCs) were installed.
Silica scale is a harder scale than calcite and more difficult to remove.
Also, silica has a dramatically higher impact on the heat transfer coefficient than calcite does and therefore the plant requires cleaning when the silica is much thinner than the thickness tolerated for calcite scale.