Waste Water Treatment and Waste Disposal in the Eastern Area

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The beginning of the stream pollution problem by the sugar factories in the eastern area can probably be dated back to the early 1900's, when most of the factories were discharging all process waters direct to the streams, but it did not become a real problem until the Michigan State Legislature created a Stream Control Commission in 1929, with the power to compel industries to abate pollution. In 1949, another act of the Legislature changed the name of the Commission to the Water Resources Commission, giving it more power and a wider scope covering all the water resources of the state, and defining unlawful pollution as follows:

> "Unlawful pollution is any substance which is injurious to the public health or to the conducting of any industrial enterprise or other lawful occupation, or whereby any fish or migratory bird life or any wild animal or aquatic life may be destroyed; or the growth or propagation thereof be prevented or injuriously affected, or the value of lawfully taken fish or game be destroyed or impaired as a consequence of said pollution."

The first order of the Stream Control Commission against the sugar factories in the state prohibited the discharge of Steffens waste in any combination, into any stream or waters of the state, and limited the strength of other wastes combined, to 5 pounds of 5-day B.O.D. per ton of beets, based on the rated capacities of the plants involved. This order did not include Sebewaing because of its location on a large body of water, Saginaw Bay, which it thought could not be seriously harmed by the addition of our wastes. However, repeated complaints of fish killings near Sebewaing made it necesary for the Commission to issue a special order against the Sebewaing plant in 1949, making us responsible for any fish killing in this area during the operating season.

Our relations with the Water Resources Commission have been on a very cooperative basis, with the realization by them that they could not ask the impossible, and with our efforts to comply with their wishes always indicating that we are trying.

The foregoing gives you a brief outline of the legal aspect of our waste disposal problem, and now I shall attempt to describe the development of the process of treating sugar factory waste waters.

The Engineering Experiment Station at Michigan State College in East Lansing started investigative work on the treatment of beet sugar factory waste waters in 1933 with small pilot plants at Lansing and Mt. Pleasant, then used a large experimental plant at the Monitor plant in Bay City, with the cooperation of a committee sponsored by the Farmers & Manufacturers Beet Sugar Association, after which a quarter-size full scale plant was built at Monitor. This work resulted in the final treatment plant installed there and completed in 1939.

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The data collected during these years determined the classification of various wastes and their various strengths and volumes. They are described as follows:

Flume Water is classed as water used for fluming beets into the factory, including discharded beet washer water and water from the roll conveyor.

Pulp Water includes the water contained in the diffusion cells when they are dumped, plus the wash water necessary to clean the cells. Tt is all the water which can be drained from the pulp before pressing.

Pulp Press Water is the water separated from the pulp in the pulp presses.

Process Water is a mixture of the pulp water and pulp press water, and is defined here separately from the pulp water and pulp press water because, at some plants, the two waters are mixed and handled together.

Lime Sludge Drainage is the effluent from lime settling basins.

Their approximate volumes and strengths will vary with slope and condition of flumes, condition of beets, type of diffusion battery (bottom dump, side dump, continuous), and design of the pulp pit. Table 1 is a representative comparison of these waters.

Table 1.

Item	Flume Water	Pulp Water	Press Water	Lime Sludge	Total Waste
Gal./Ton Beets	2,640	440	250	75	3,405
B.O.D. ppm.	200	700	2,050	1,420	450
Total solids ppm.	2,060	1,290	3,740	3,310	3,140
Susp. Solids ppm.	1,460	210	2,560	450	2,215
B.O.D. Lbs./Ton	4.4	2.6	4.3	0.9	12.2
B.O.D. % Total	36.1	35.3	21.5	7.3	100.0

Steffens waste will contain about (0,000 ppm. of 5-day B.O.D., but has been omitted here because all Steffens houses in this area have been discontinued.

In the completed Monitor Waste Water Treatment plant, the condenser water was used for fluming beets, and the flume water was combined with the pulp water and pulp press water ahead of a Dorr drum screen. From there the water flowed through three grit chambers with chain-type sludge collectors on the bottom discharging onto a belt conveyor above the surface of the water, for grit disposal. This grit comes out of the collector at about 85 to 90 percent moisture. From the grit chambers, the water then flowed to the flocculators where it was mixed with Steffens waste as a coagulant. The sludge from the settling tanks was pumped into a pond, and the overflow of this pond was directed back to the system ahead of the flocculators. The effluent from the settling tanks went direct to the Saginaw river. Excess condenser water not used in the beet flumes bypassed the system and went into the river without treatment, and you will note that the lime slurry from the filter presses was flumed to a pond with no overflow during campaign.

This system worked satisfactorily, giving an average of slightly under the 5 pound of B.O.D. per ton of beets in each campaign after the plant was put in operation. Recently, Monitor has installed a continuous diffuser and has discontinued the Steffens process. The basic operation of the waste water treatment system is practically the same, with the exception that pulp water has been eliminated and pulp press water is now used as battery feed water on the diffuser. As a fiocculant, the operators now add a small portion of the lime slurry from their Oliver filters, and discharge the dust from a lime kiln dust collecting system into the main sewer. There is also a slight overflow from their house milk of lime tank which is also added at the main sewer. Another major change to this system is the fact that they now pump part of the effluent from their settling tanks back to the flume for use as flume water, providing about 50 percent of the water necessary for fluming beets to the factory. This serves to reduce their output to the river, and consequently keeps the B. O. D. within the limits of the Water Resources Commission.

Blissfield was the next plant to install a waste disposal system. Its system was a little bit different, in that the process water was used for battery washout, with the excess returning to the flume water at the beet wheel, after which all of the waste water was screened and flowed into a single thickener. The effluent from the thrickener was recirculated as flume water, and the sludge from the thickener and the excess effluent went to a series of storage ponds where it was retained for the entire campaign and finally discharged to the river during spring flood. A small amount of condenser water, or makeup, was added to the flume water, the remainder going direct to the river. The lime cake was flushed to the same series of ponds with pulp press water, and the Steffens waste was evaporated during campaign and shipped to a mono-sodium glutamate plant.

This system has been changed somewhat recently in that process water is now being chlorinated and used as battery supply water, similar to the operation at St. Louis, which will be described later.

Our first waste water treatment plant was installed at Alma in 1939 on a little different basis. Here we had a Dorrco bar screen through which flowed all of the flume water, into a large grit chamber. This grit chamber measured 14 feet wide by 55 feet long by 7 feet average water depth and was designed large to accommodate excessive surges which we were aware of in the fluming system.

The effluent from the grit chamber was pumped back to the flumes, with a certain portion being diverted to a flocculator and clarifier. While operating Steffens, about 6 percent of our Steffens waste was added to the flocculator as a coagulant. The effluent from the clarifier was discharged direct to the river, and the sludge was pumped to our lime pond. Pulp press water was used for flushing out the lime cake, and pulp water was used for battery wash water. We had a means of supplementing the battery wash water with condenser water and also using condenser water for makeup at the beet washer. While operating Steffens, our Steffens waste was stored in a pond until after campaign and pumped back to the house for evaporation and shipping to a mono-sodium glutamate plant.

This system was not without its faults, and a considerable amount of difficulty has been experienced with it. While there have been a few years that we have been under the 5 pound B.O.D. limit, our average is not worth bragging about. The Dorrco bar screen was not adequate for handling the volume of leaves and tails in the system, and it was necessary for us to add a scraper type of bar screen with wedge-shaped screen bars about 3/8 inch apart. The last year Alma operated, pulp was found in the main sewer to the river, and no one could tell how it got there. Since discontinuing Steffens, we have added milk of lime to the flocculator in quantities heavy enough to bring the pH up to about 11. Records at this plant indicate that this amounted to about .35 percent on beets.

The scheme at Lansing, no longer in operation, was similar to that at Alma, except that that part of the process water which was not used for battery washout or lime sludge removal, went to the flocculator and clarifier without being mixed with flume water. Here, we had foam trouble in the flocculator and clarifier and never were able to clear this up. During one year of the Lansing plant operation, we had an agreement with a municipal sewage treatment plant to return the process water to the city sewers, but this played hob with the sewage treatment plant and we were not allowed to continue.

At our Caro plant, we were fortunate in having a lot of property with good sandy soil on which we could locate our ponds. Here, we constructed a sand filter bed by burying field tile in rows about 20 feet apart under a sizable pond area, discharging to the river. Our first several years of operation included the discharge of all of our water to these filter beds without any treatment. We soon found that the capacity of the filter beds was not enough to accommodate all of our flume water, so we installed a pump at the factory for recirculation of flume water.

Recently our results were not so satisfactory so we added a means of recovering our pulp press water for use in flushing the lime cake to the lime pond where this water could be held for the campaign and released during the spring high water. This has improved our operation at Caro so that we are well under the 5 pound per ton B.O.D. limitation.

Our system at Croswell involves mainly a series of ponds large enough to contain process water and lime sludge for the entire campaign. We are permitted to drain these ponds in the spring of the year when the river is in flood stage or nearly so. We discard our condenser water direct to the river, and run our flume water through a grit collector similar to the *one* at Alma, and pump back from the grit collector to the flumes. The excess from the grit collector is discharged direct to the river. Our coarse screen ahead of the grit collector consists of a Link Belt NRM 148 vibrating screen with a slot wire screen cloth with about 1/4 inch mesh. We have experienced difficulty with fine grasses and hair-like roots wrapping around the screen wires and plugging the screen, causing the water to overflow the screen, and are still working on an answer to this problem.

At Carrollton we have a scheme similar to Lansing. The flume water is nearly 100 percent recirculated, being freshened with the addition of condenser water at the washer, with an equivalent amount discarded to the river at the end of the grit chamber. Pulp press water is screened over a 30-mesh vibrating screen and returned to the house for flushing out the lime cake. This water is held in ponds until the spring floods. Pulp water is also screened over 30-mesh vibrating screens before being returned to the house for battery wash, with the unused water being discarded to a flocculator and clarifier, and thence to the river. We have foam trouble here. It forms at the entrance of the floccuiator and covers most of the flocculator and clarifier and half of the yard before the campaign is over. Tests with several anti-foams were made this year, and we think we have found the answer in Nalco No. 71-D5 Anti-foam, which may cost us about §10.00 per day. In these tests, we found that, by keeping the pH in the fioccuiator at 11.3, a maximum floc would form which would settle in the clarifier if the foam were not present, holding too much entrained air in the clarifier water.

Sebewaing was the last of our plants to be affected by an order of the Water Resources Commission. After several years of trying to get by without having to install expensive equipment, and studying the changing conditions in Saginaw Bay at our outlet, we found that, when there is no ice on the bay, the wind will generally circulate the bay water enough to disperse our waste waters to the point that they are not harmful. But when the bay freezes over, circulation ceases and even a small amount of waste will deplete the oxygen content of the water so it will not support fish life.

We have developed a system of ponds and pumps which makes it possible to control our flow to the bay. Condenser water is not considered harmful, so it goes in a separate channel to the bay. Flume water is recirculated from a grit pond which is cleaned daily with our yard crane, and the excess water is pumped to other ponds where it can be stored or discarded to the bay as desired. Process water all goes to the lime pond and overflows to storage ponds where outlets can be opened or closed, depending on the condition of the bay. This year, we had a fisherman collect samples of the bay daily while the water was open, and were able to keep an accurate record of the dissolved oxygen. When it decreased, flow to the bay was lessened, and when it was high, all our waste went to the bay. In the last month of campaign, the bay is usually ice covered, and during this period, all waste water is held in the ponds. In the spring, when the ice is gone, the ponds are drained without damage to fish life.

St. Louis was troubled with problems similar to ours, and at first attempted recirculation of flume water without grit removal (coarse screens only) . This resulted in a buildup of mud and B.O.D. in the flume water discard, and having insufficient land for ponding process water, the St. Louis plant finally installed a chlorination system.

Process water is pumped from the pulp efager tank, over a fine mesh vibrating screen, into a feed tank from which the flow is controlled to a chlorinating tank. Here, lime is added to keep the pH neutral, but I am told it will average about 6, and sometimes as low as 5 pH.

Chlorine is added through a bubble pipe by a Wallace & Tierman Chlorinator, manually regulated according to the residual chlorine in the battery feed water. The outflow from this tank passes through a Dorr thickener which happened to be left over from the Steffens operation, that allows retention time and, incidentally, settling time for removal of settle-able solids. The sludge is drained back to the Efanger or to ponds, and the effluent goes to a head tank from which it is sent to the battery, one cell ahead of the water cell. The overflow from this tank goes to the battery supply tank where it mixes with condenser water for battery feed. Excess water from the battery supply tank goes to the flume water ponds. Water from the vibrating screen tank is used for battery washout, with overflow being returned to the Efanger tank. Pulp press water and also evaporator seal tank water are added to the system in the Efanger tank. The bulk of this water is used in the flumes, with necessary makeup flume water pumped back from the flume water pond.

A similar system was installed at Fremont, Ohio, and at Blissfield. The Buckeye Sugar Company in Ottawa, Ohio, did the preliminary work on this system under the direction of Dr. E. A. Pearson, who made a study of "Sugar recovery and elimination of waste waters by chlorination in the beet sugar industry," for his doctorate thesis at M.I.T. He claimed that, by eliminating the discard of process water, the sugar in this water could be recovered. Laboratory figures after several years of plant operation indicate an increase in the amount of molasses produced, but no increase in granulated sugar. The principal advantage of this system is the elimination of the discharge of process water to the river.

Our Canadian cousins at Wallaceburg and Chatham have a system of ponding with which I am not too familiar, but I understand that, at present, the pollution problem there has not yet reached the force of law as it has in Michigan and Ohio.

Conclusions

The experience gained in more than fifteen years of attempting to avoid putting an excess of B.O.D., above 5 pounds per ton of beets, into the waters of our state, seems to indicate that reuse of as much water as possible is the best solution. Screening the larger particles out of the flume water and settling most of the sand is sufficient to condition flume water for reuse. Clean water is desirable for beet washers so the flume water settling chamber can be allowed to discharge only an amount equal to the water added at the beet washer. Pulp press water in most instances can be used for flushing out lime cake to settling ponds and be stored for the entire campaign. Pulp water can be cut to a minimum by reusing it for battery washout and addition to pulp pit if necessary, but adequate pond capacity for storage of the remainder for the campaign is preferred if available.

Treatment by coagulation and clarification can be adequate but requires attention and equipment. Condenser water is practically free of B.O.D. and can be discharged direct to the stream or any body of water without serious contamination.