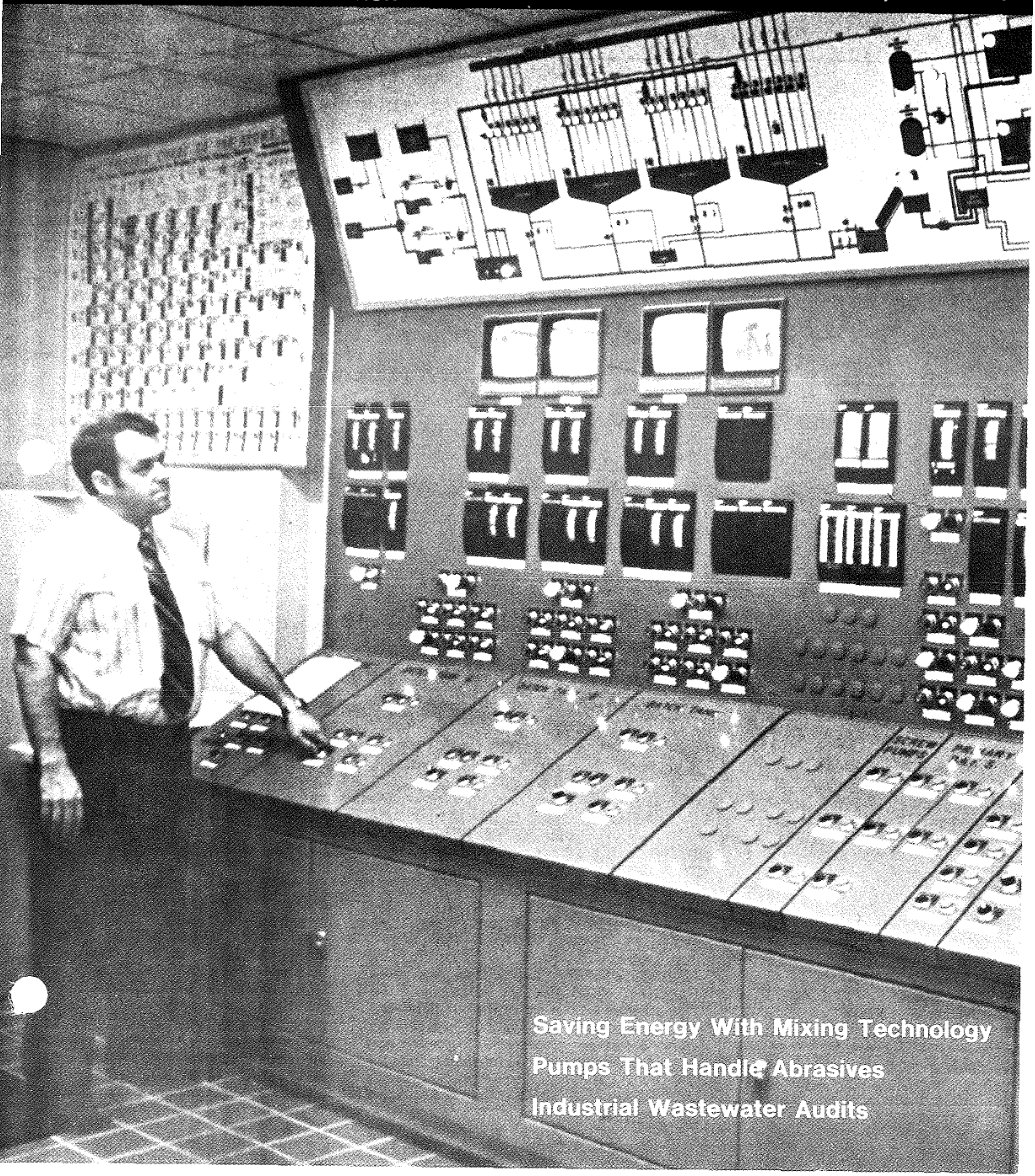
INDUSTRIAL WASTES

A SCRANTON GILLETTE PUBLICATION

MAY/JUNE 1980



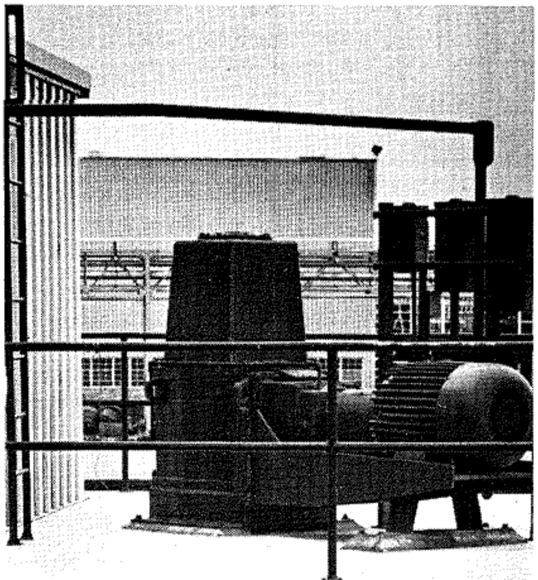
Saving Energy With Mixing Technology

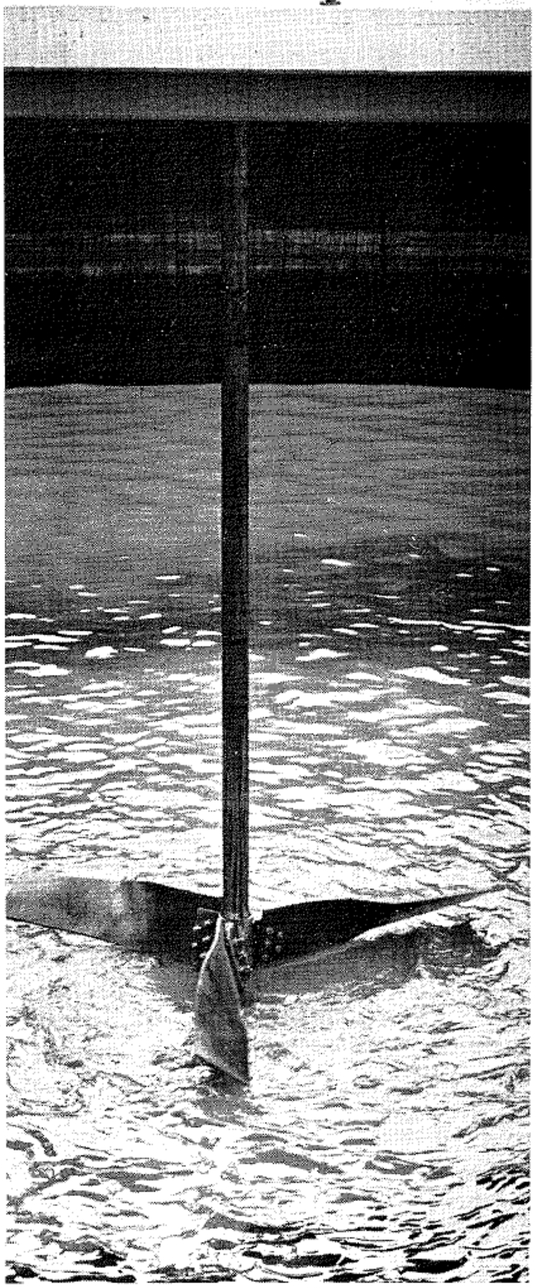
Pumps That Handle Abrasives

Industrial Wastewater Audits

At wastewater treatment plant

Mixing Technology



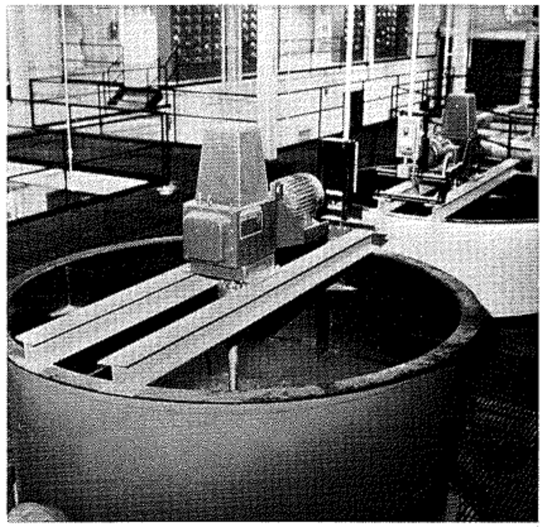


Primary mixing tanks are fitted with LIGHTNIN 60 hp mixers.

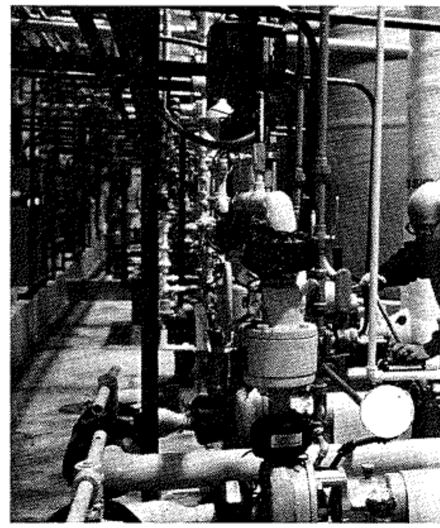
by H. Gary Peters, Sr., Architectural & Mechanical Engineer, Saginaw Steering Gear Div., General Motors Corp.

Disposal of 1.5 million gallons of industrial wastewater per day has long been a problem at the Holland Road Complex of General Motors' Saginaw Steering Division. The plant's needs called for a wastewater treatment facility that would meet the following design criteria:

- The facility would have to have the ability to handle an immediate treatment load of 1.5 mgd, with a longer-term daily treatment potential of 2.5 mgd and a short term emergency capacity of 5 mgd.
- It would be capable of extracting soluble as well as insoluble oils, eliminating Saginaw's major disposal



One of the series of staged, three-compartment treatment tanks.



Chemical make-up tanks supply a variety

treatment facility that could extract both soluble and insoluble oils and reduce phosphate and metal contaminates to proposed acceptable levels, while requiring the lowest levels of energy consumption possible. Such a facility was completed in 1979. Operating experience has shown the plant to capably meet all design criteria.

Saginaw installed American Petroleum Institute (API)-type separators to remove floating oils and extract settleable solids in 1965. Up to one million gallons of cutting, stamping and broaching oils a year are reclaimed by the process for reuse. The API separators, however, did not deal with the soluble oils present, which ranged from 1,000–1,500 ppm, with surges as high as 5,000 ppm. In 1969, the Saginaw municipal wastewater code was amended to limit soluble oil in entering wastewater to 100 ppm. This necessitated a costly and, at times, an unreliable arrangement for the plant, involving outside contractors hauling spent soluble oils to licensed disposal firms.

In 1973, the company began formal design work on a new wastewater problem, and also be able to reduce phosphate and metal contaminants to acceptable levels.

- A prime design objective was to achieve treatment criteria with as few mechanical functions, and the lowest energy consumption possible. Energy consumption, Saginaw has found, can be 15 percent of the total cost of operating a treatment plant.

Early in the design process, it was questioned whether the mixing required to facilitate emulsion-breaking in the new system should be achieved by mechanical means or by aeration. Two existing treatment systems at Saginaw Steering Gear plants, in other locations, use air for mixing. However, these plants also use aeration for BOD reduction, and mixing takes almost eight hours to achieve workable results. It appeared that the necessary mixing at Holland Road might be accomplished mechanically in a fraction of the time needed with air-type mixing.

Achievement of a homogeneous mixture of the batched wastewater and additives, in the minimum amount of time possible, was critical

R›duces Energy Use

to the ultimate size of the facility to be built. Obviously, a system with a mixing time of eight hours or more would impose a larger mixing vessel size requirement than a system with a mixing time parameter that might be substantially less. More importantly, time gained by reducing the mixing cycle requirement could be made available to the balance of the treatment cycle. By reducing the processing volume requirement per given unit of time, the overall size and peak-energy requirement of the facility could also be reduced.

Tests at Mixing Equipment Company's* Laboratories, Rochester, in May of 1977, utilizing a 24 in. tank as a pilot plant, confirmed that mixing time for complete chemical contact with flocculants could be drastically reduced, relative to mixing by bubble-type aeration, with properly designed mechanical impellers. Design work was completed in the late summer of 1977. An innovation was the inclusion of some 14 Lightnin Inliner Mixers for dilution of treatment chemicals with recycled water (normally at 10:1) to facilitate uniform mixing in the huge batch tanks.

The final design of Saginaw's Holland Road wastewater treatment plant called for two API-type oil separators (existing), each of 1,000 Gpm wastewater capacity, to mechanically remove floating oils and settleable solids. This important treatment operation is considered primary or first-stage. The secondary treatment stage consists of a batching operation followed by a pumping system and a flow-splitter feeding dual dissolved air flotation cells (DAF's).

Three 1.5 mil. gal. concrete batch tanks, each 112 ft. in diameter and 23 ft., 5 in. deep, were equipped with two-speed 60 hp Lightnin mixers, each driving a 23 ft. stainless steel shaft with no in-tank bearing. Each shaft was fitted with dual Lightnin A210 impellers: a large upper unit and a small lower unit. The high speed setting develops impeller pumping rates up to 270,000 Gpm, while the low speed maintains the homogeneity of the tank contents.

A wastewater lift system consisting of three Archimedes screw pumps, each rated at 20 hp, 1,800 Gpm, are designed for a vertical lift of 28 ft. to the secondary treatment system. After this single lift, the wastewater flows by gravity through the entire system.

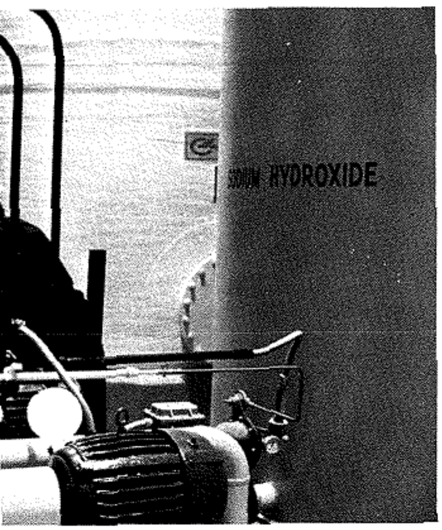
A pair of primary DAF's are provided for addition of a coagulant and aeration to float the floc into a surface-skimmable sludge that ranges between 40–60 percent oil. The tertiary treatment stage consists of two parallel systems, each fed by the two secondary DAF's. Each of the parallel treatment lines consists of the following:

- Treatment tank 1, a three-compartmented, staged column where chemicals are introduced as needed: sodium hydroxide to elevate pH and knock down heavy metals; sodium aluminate as a coagulant; and sulfuric acid to lower pH back to neutral.

The tank is equipped with a Lightnin 5 hp high-speed mixer, including shafts fitted with impellers at three levels to permit mixing in each chamber. Short circuiting is prevented by chamber baffles. An anionic polymer is added prior to a Lightnin 12 in. static mixer, to prepare wastewater for treatment tank 2.

- Treatment tank 2 provides a three-chambered vessel with a slow speed Lightnin one hp paddle mixer. The mixer has an extended shaft and special low-shear blade configuration. This vessel provides contact time for polymer to react with prepared wastewater prior to floating floc in tertiary DAF cells.
- A tertiary DAF, where a last addition of an anionic polymer is introduced, skims the final floc. The treated effluent is released to a final clarifier. The water is then checked for required qualities prior to being released for reuse. The excess water which cannot be reused is discharged to the municipal sewer.

All stages of the system, from batch treatment tanks to tertiary DAF's, are supplied with additives from a chemical make-up system of tanks and metering pumps. Chemicals utilized in this process are acid, sodium hydroxide, sodium aluminate, alum, and both organic and inorganic emulsion breakers. The four tanks, which make up the polymer feeding system, specified small Lightnin mixers. Additive flows would be governed from a control center on the



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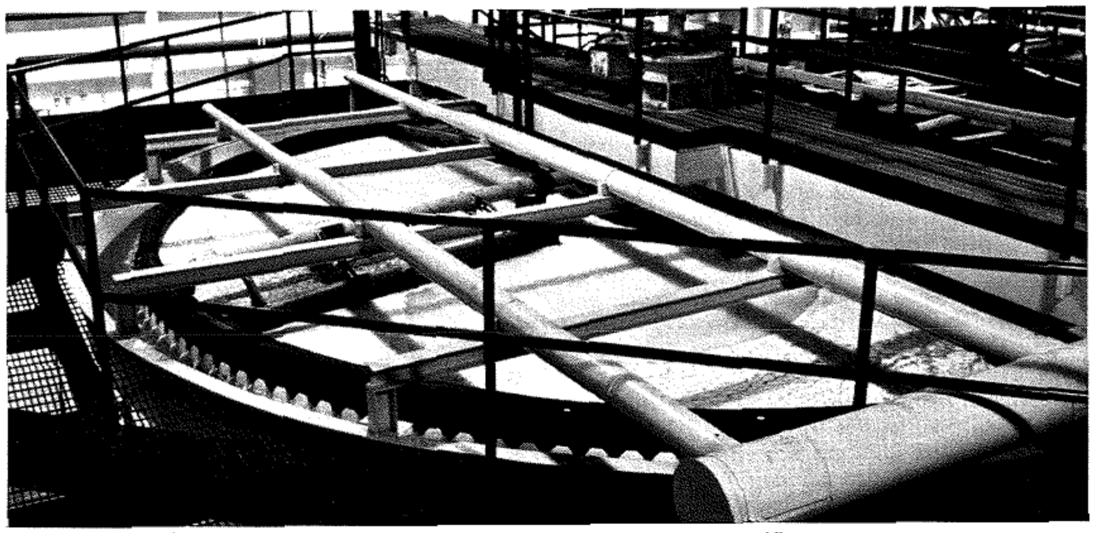


Tertiary DAF'S do "polishing" of wastewater prior to discharge to final clarifier.

*A unit of General Signal.

basis of jar tests made on incoming wastewater.

All additives are diluted with reprocessed water on leaving the supply tank for more uniform results in mixing, particularly in the large batching tanks. The dilution, usually at a ratio of 10:1, would be accomplished with a series of 14 Lightnin Inliner mixers. A dozen standard units ranged in diameter from 1–3 in. A pair of 12 in. units, as previously described, are fitted with fiberglass-reinforced plastic housings, and were custom-fabricated. The latter units would blend flocculating polymers into treatment tank 2, with wastewater rates up to 900 Gpm.

Construction of the Holland Road Complex wastewater treatment facility started in the fall of 1977, and was completed in the early summer of 1979. The goal of reducing mixing time in the 1.5 million gallon batch tanks has been met dramatically. Once the needed additives are fed into the batch tanks, the required mixing can be attained in about 10 minutes at high speed. There are no dead spots in the entire tank. There is good chemical contact, and a homogeneous mixture. After the batch is chemically prepared, the mixer speed is reduced, resulting in an impeller pumping capacity of 135,000 Gpm, at very low shear. The latter is important so as not to damage the newly-created floc, yet a uniform wastewater is needed all day for maximum efficiency and minimum sizing of the DAF's and other secondary and tertiary treatment components.

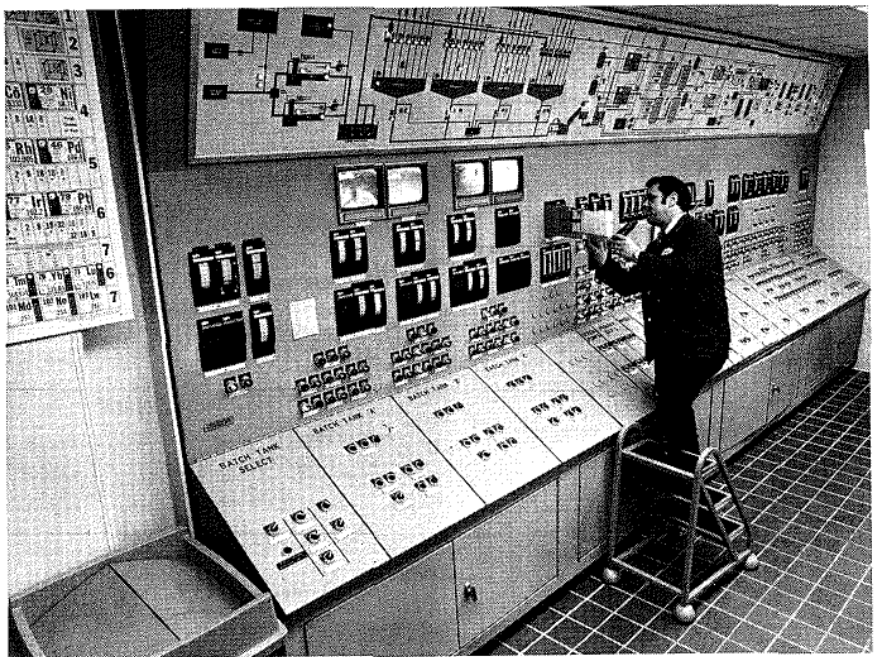
Thorough and rapid mixing does an effective job of dosing; there is no overtreating. This pays off in chemical savings and also reduces tank-cleaning labor. Efficiency of the entire process is greatly improved by good, uniform mixing. The batch treatment phase accomplished this.

With the extended flowtime available for secondary and tertiary processing, made possible by the extremely rapid mechanical mixing, the entire daily process flow at Saginaw is achieved in a two-shift operation. Other energy saving design features of the system include: vertical mixing systems, waste heat recovery, reuse of treated effluent water, oil recovery, and gravity conveyance of water through the treatment process. The entire 1.5 mgd process flow is being sustained by a single 20 hp screw pump running 14 hr. a day. Another important characteristic of the screwlifts is their gentle action. Centrifugal pumps are not used because the high shear forces would break up the floc just created in the previous operation.

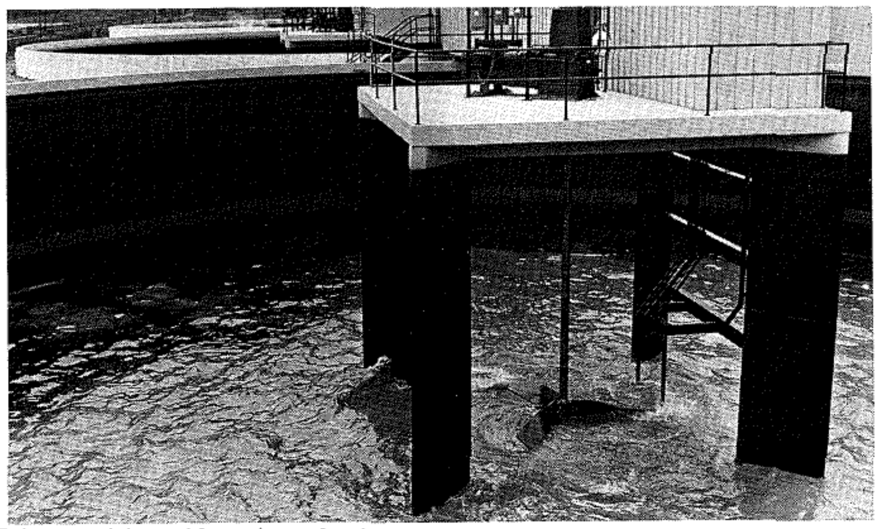
In the secondary DAF's, floc is skimmed off at a rate of 7–9,000 Gpd. Since the floc is about 40–60 percent oil, with an original cost of upwards of $1.30/gal. the company is working vigorously on a feasible method of reclaiming the oil. Meantime, the plant is already benefitting from the elimination of the need for costly outside disposal of wastewater. The saving in being able to remove soluble oil from our wastewater and send the effluent to the municipal disposal facilities is on the order of approximately $70,000 a year.

Wastewater passing through a final DAF is monitored at the exit clarifier for turbidity. An automatic interlock/reject system prevents the release of any wastewater that does not meet discharge standards. Actual oil in the discharge wastewater has ranged from 5–20 ppm, versus the 100 ppm code requirement.

Reports on Saginaw's new water treatment facility to date indicate that it is meeting its assignment in all respects. Since coming onstream in July, 1979, there has not been a single shutdown of a major operating component. Costs for treatment chemicals and energy are well within design criteria. Meantime, there is the potential of substantial additional recovery of oil from the large volumes of flock removed in the process of bringing the wastewater within the discharge standards. ■ Q5



The control room is the heart of Saginaw Steering Gear's new facility.



Primary mixing with various chemicals is accomplished with three 1.5 mg batch tanks.

About the Author

H. Gary Peters has been employed at Saginaw Steering Gear for 17 years. Born in Saginaw, MI, he received a B.S. degree in Business from Ferris State College and a B.S. degree in Engineering from Western Michigan University. He has done additional course work at Michigan State University, General Motors Institute, and Delta College. Mr. Peters is also a member of the Engineering Advisory Board of the Saginaw-Midland Water Supply System.