SYMPOSIUM: TALL OIL

Presented at the AOCS 64th Annual Spring Meeting

New Orleans, Louisiana

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Tall Oil Refinery Waste Water Treatment Systems[1]

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ABSTRACT

An efficient recovery system for oils incorporated in recycle and waste water from tall oil fractionation operations is described. The basic system consists of American Petroleum Institute separators and a floating skimmer. Further improvements also are discussed.

INTRODUCTION

Arizona Chemical Company has two refinery systems located at Panama City, Fla., and Springhill, La. The refinery at Panama City was started in 1949 with additions in 1954 and 1967. The plant at Springhill was built in 1960 with no additions. The Panama City operation also includes a turpentine refinery complex with associated chemical treatment equipment, isomerization unit, synthetic pine oil plant, and a large terpene resin plant. The published capacity of our Panama City plant is 100,000 tons/year of crude tall oil and 50,000 tons/year for the Springhill plant. We will discuss the facilities at Panama City first.

PANAMA CITY REFINERY

The tall oil refinery at Panama City utilized a once-through flow of salt water from a nearby bayou to the barometric system, as well as for secondary interchange with a fresh water cooling system for the exchangers. Ca. 8000 gal/min salt water were pumped through the system. Entrained oils from the towers formed insoluble curds of fatty acid soaps and free acid agglomerates in the barometric system. The effluent was discharged after some retention in two baffled lagoons. The water leaving the lagoon impounds generally was of sufficient quality to be mixed with the effluents from the paper mill and eventually discharged to the bay. Ca. every five years it was our practice to dredge 4 or 5 ft of fatty acid soaps from the bottom of the lagoons where they eventually settled. Ca. 5000 yd^3 were removed on each occasion. A later refinement of the system was to add an oil and soap impound which was burned off every other day. This resulted in less buildup of soap curds in the main lagoons. Both these operations would be intolerable by today's ecological demands. Although the system sounds crude, it was, to a great extent, effective in removing oils and greases from the salt water; and, because of the large volume of water used, the concentration of pollutants leaving the plant was tolerable, especially when mixed with large quantities (28-30 million gal/day) of paper mill effluent.

When plans for a new refinery were started in 1965, it was decided to plan on a recycle system for both the barometric water and the process water cooling for the tall oil refinery system. A flow sheet of the facilities for handling tall oil effluents at Panama City is shown in Figure 1. Barometric water from three plants is combined in a common gravity return system consisting of a 48 in. cast iron underground pipe. This discharges to a group of five American Petroleum Institute (API) separators (designed according to standards of American Petroleum Institute *Manuals on Disposal of Refinery Wastes* [1,2]) arranged in parallel (Fig. 2). The incoming flow of ca. 12,000-13,000 gal/min is distributed equally to the five parallel branches and flows down the channel to the effluent chamber where oil is retained by a movable weir system. The underflow passes to the effluent channel which serves the vertical cooling tower feed pumps. The four-cell cooling tower system uses polypropylene fill and polyester siding. It is a counter flow unit designed for 0.1% drift loss.

Water from the cooling tower basin then is pumped to

[1]One of seven papers presented at the symposium "Tall Oil," AOCS Meeting, New Orleans, May 1973.

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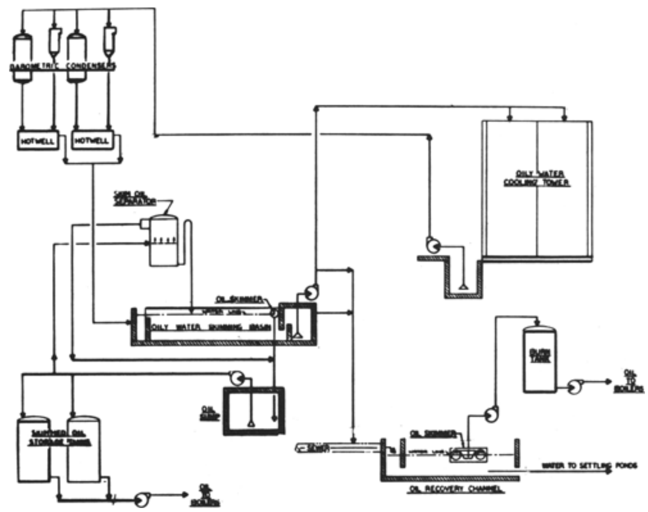

FIG. 1. Effluent system, Panama City tall oil refinery.

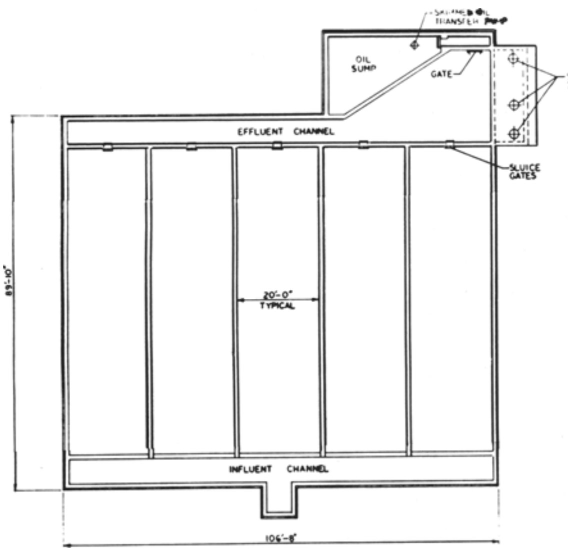

FIG. 2. Plan–American Petroleum Institute oily water skimming basin, Panama City, Fla.

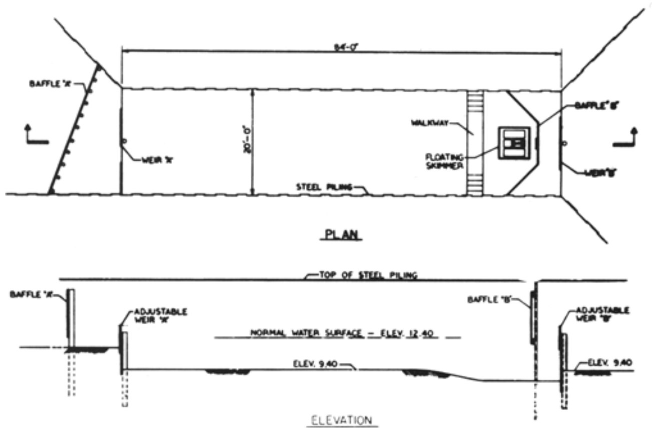

FIG. 3. Detail–oil recovery channel, Panama City, Fla.

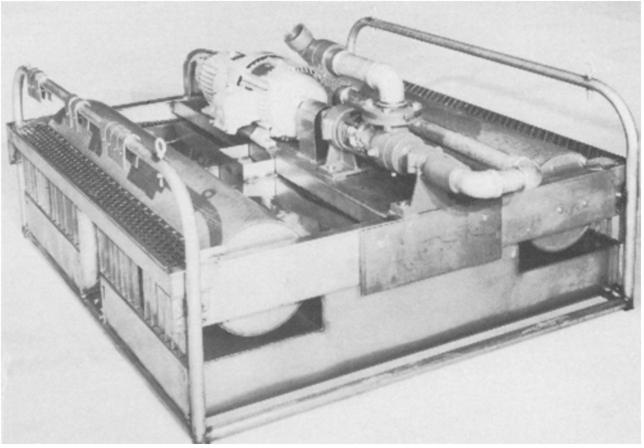

FIG. 4. Model BD-213R industrial oil skimmer. Surface Separator Systems, Inc., 103 Mellor Ave., Baltimore, Md. 21228. Rated oil recovery capacity–600 gal/hr. Maximum viscosity at pumping temperature–50,000 Saybolt Seconds Universal.

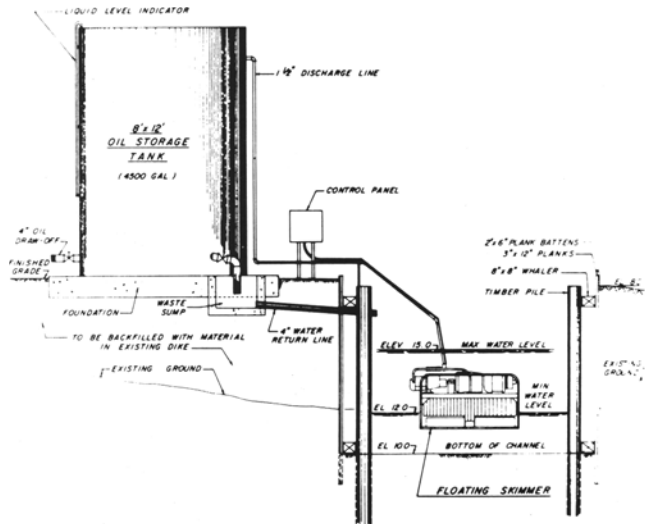

FIG. 5. Arizona Chemical Company, Panama City, Fla. Schematic diagram, secondary oil recovery system.

the various barometric systems and a number of large exchangers which serve the fresh water cooling system of some of our old plants. Through previous experience at Springhill, La., we decided to use type 304 stainless steel piping for the oily water pressure supply system to the refinery.

Before continuing with a description of the rest of the oil collecting and recovery system, we will digress for some detail of the API separator and the oily water circuit shown in Figure 2, a plan view of the API skimmer. The overall length is 89 ft, and the width is 107 ft. Each channel holds ca. 85,000 gal of oily water. The depth is ca. 7 ft. Each channel has its own individually adjusted oil skimming weir. Although the system theoretically can be operated continuously, we find it more efficient to allow oil to accumulate and skim each channel separately. This facilitates subsequent separation of oil from water. The underflow channel, which feeds the cooling tower feed pump sump, has a total volume of ca. 60,000 gal and a depth of ca. 6 ft. The oil sump has a capacity of 18,000 gallons.

The skimming basin is constructed of concrete with a fiberglass reinforced polyester coating 1 ft above and below the interface surface and at all places where eddying or higher velocities are encountered. The effluent chamber also is coated. The skimmed oil sump is lined with type 316 stainless steel sheet and equipped with type 317 stainless steel coils. The pumps are constructed of cast iron with stainless steel or bronze impellers.

Referring to Figure 1, the method of skimming oil from the five API chambers is as follows: Once daily the skimmer pipe of each compartment is rotated so that a screened slot is immersed below the liquid level just sufficient to cause an oil-water mixture to flow into one of two collector lines leading to a header that feeds the skimmed oil sump. Steam-out connections are provided in case of plugging. As

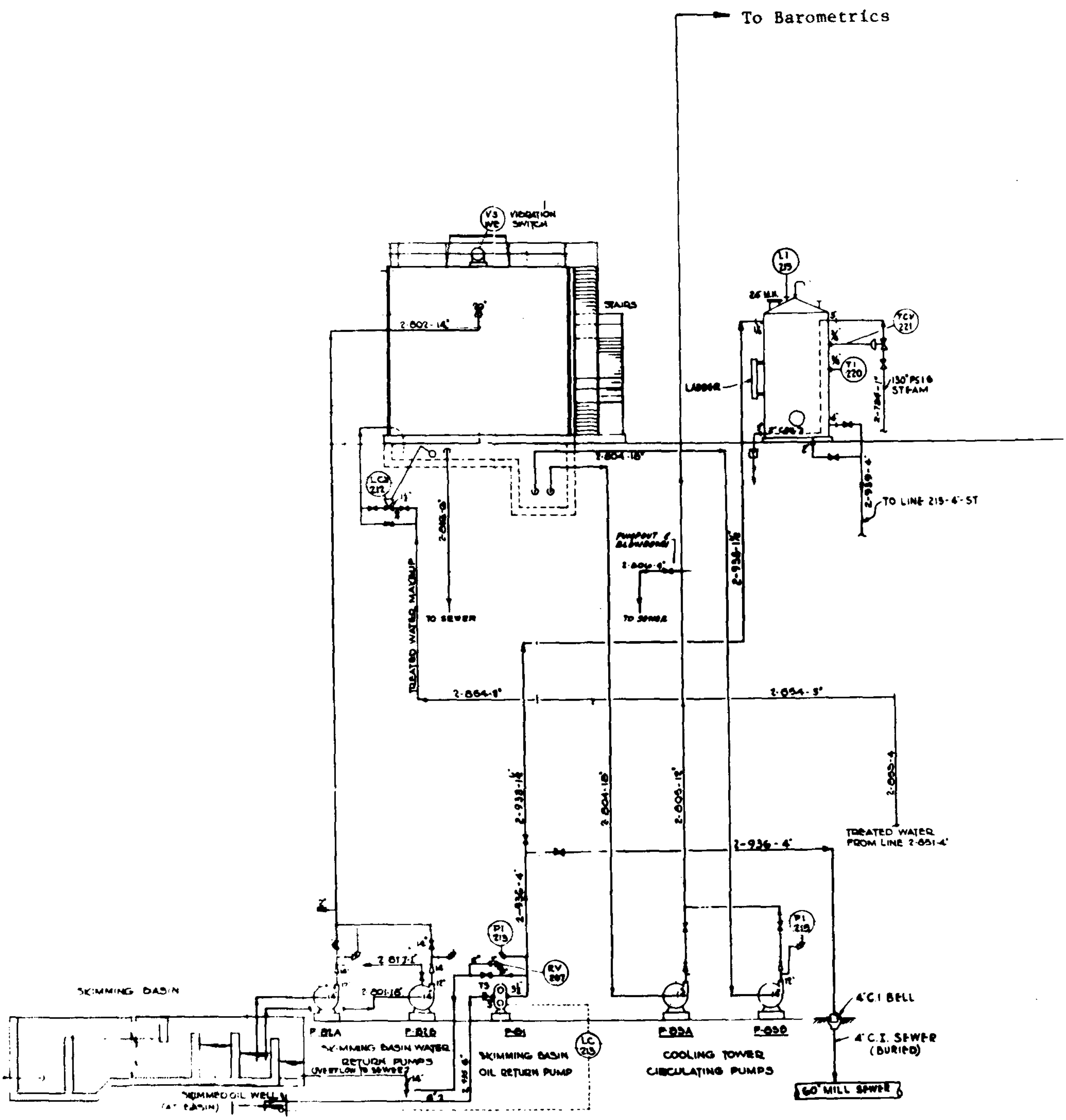

FIG. 6. Barometric oily water cooling and effluent system, Springhill, La. refinery.

soon as the coils in the sump are immersed, steam is turned on to begin heating. Skimming is continued until the sump is full, after which the skimmer pipe is rotated to prevent further oil from discharging from the skimming basin. The skimmed oil transfer pump then is started and discharges through the separation tank at a rate which will prevent excessive turbulence. Pumping is continued until excess water, which is returned to the skimming basin, is removed and the oil is substantially dry (less than 5% moisture). This usually requires several hr. The oil then is pumped to a tank where it is stored at a temperature of ca. 75 C for several days to allow residual water to separate to a point where the moisture content is below 2%. The oil then is pumped to International Paper Company and burned in their recovery boilers. We average ca. 110 tons/month of skim oil from this separator.

A purge of skimmed oily water is maintained from the system. This enters a common sewer with the tall oil plant clean-up wastes, pump cooling gland water, some free discharge cooling water streams from a number of exchangers, tank car clean-up stations, etc. The common sewer system also drains storm water from a large part of the plant area. This amounts to ca. 12 acres. A normal flow of ca. 500 gal/min during dry weather may be inflated to as much as 10,000-15,000 gal/min during heavy rains. (A 50-year storm may be as much as 30,000.)

Next, the total tall oil refinery plant effluent flows to a secondary recovery facility which contains a floating mechanical oil skimmer designed to accommodate flows in excess of 30,000 gal/min. The underflow from this system enters a series of two settling lagoons before final discharge to the paper mill effluent system.

A drawing of the secondary oil recovery channel is shown in Figure 3. This channel was designed carefully to provide quiet flow characteristics to allow oil globules to separate as thoroughly as possible before reaching the baffled underflow outlet beyond the floating skimmer. The channel was constructed of steel piling which was coated with a bituminous epoxy coating. Baffle A was constructed of creosoted wood. Baffle B and the adjustable weirs were constructed of aluminum, which has stood up well over a three-year period. The system was designed using modified API criteria (1-4) with a mass flow of 3 ft/min serving as a design base. It was realized that during heavy rains flows considerably in excess of that would result in some entrainment. This, however, proved to be minimal. During heavy rains, water level builds up in our lagoons which are fed from this skimmer and other natural drainage areas. The level in the oil recovery channel has risen over 2 ft on occasion. The floating skimmer is designed to accommodate a 3 ft rise in level.

A photo of the floating mechanical skimmer is shown in Figure 4. It consists of a frame which is equipped with flotation blocks, two rotating cylinders ca. 12-3/4 in. O.D. by 5 ft long made of glass fiber reinforced centrifugally cast epoxy plastic pipe, wipers of synthetic oil-resistant rubber, and the necessary drive motor and pump system. The skimmer depends upon the adherence of oils to the surface of the special revolving cylinder. This oil is picked up preferentially and wiped off mechanically into a sump from which it is pumped (using a positive displacement pump) to a collection tank. The oil generally contains less than 3% water. Additional water is removed in the collection tank which is equipped with steam coils.

Another detail of the oil recovery system is shown in Figure 5. The unit is designed for a maximum viscosity of ca. 10,000 cycle/sec and is rated to recover 600 gal/hr at 95% oil concentration. With tall oil type effluents, it is doubtful that this capacity could be achieved; but it has performed well for us, and we normally recover 30-80 tons of oil/month from this equipment. This variation is accounted for by accidental spills, tank car washing operations, etc., in addition to the normal loss from the API separators at the refinery.

It has been found that intermittent oil skimming is more efficient than allowing the skimmer to run continuously. Continuous operation results in discontinuity in the oil film, and there is a tendency for the oil to pocket, leaving the floating skimmer with no film to pick up. We generally build up a layer of oil which tends to keep itself fed into the mechanism by the fluid pressure behind it. It may sometimes, however, be necessary to force the film into the skimmer by playing a water spray at the surface. Tall oil films have poor cohesion and do not pull themselves along readily. During the winter months, occasional skimming is difficult, due to the buildup of solid acid curds. We have provided a surface heater to aid in skimming under those circumstances. In our climate, the sun usually melts the curds, and skimming is accomplished in the warm hours of the day. One more necessary addition to the unit, since it was built, was a coarse grating along the channel to catch large floating objects and scum which would interfere with the operation of the oil rolls.

Our primary API separators average ca. 110 tons of oil recovery/month. The total average recovery from the primary and secondary separators is 150 tons/month. Our analysis of the oily water being purged from the primary system indicates only 1 1/2-7 1/2 tons/month enter the secondary separator from this source.

The total amount of skim oil recovered from the five API cells at the refinery and the auxiliary floating mechanical skimmer is inventoried monthly. The overall efficiency of our oil and grease recovery can, therefore, be determined by taking into account the oil and grease being discharged in the water effluent leaving the two retention lagoons. Our average recovery is 99%.

Currently, we are engaged in the construction of a system which will separate our storm drains from process effluents. While simple in concept, in an older plant like ours with many existing underground lines and with small elevation differences, it became quite complex. After separation of the contaminated process effluents, an additional, or tertiary, skimmer is provided for the effluents before they are discharged into a line which will lead to International Paper Company's secondary treatment facilities. These facilities are now in final phases of design and planning and will be treating our comingled effluents in a 60 acre aerated lagoon.

As an addition to the project, we intend to remove settled solids from one of our lagoons and replace with fresh fill. This land will then be reclaimed for plant use in the future.

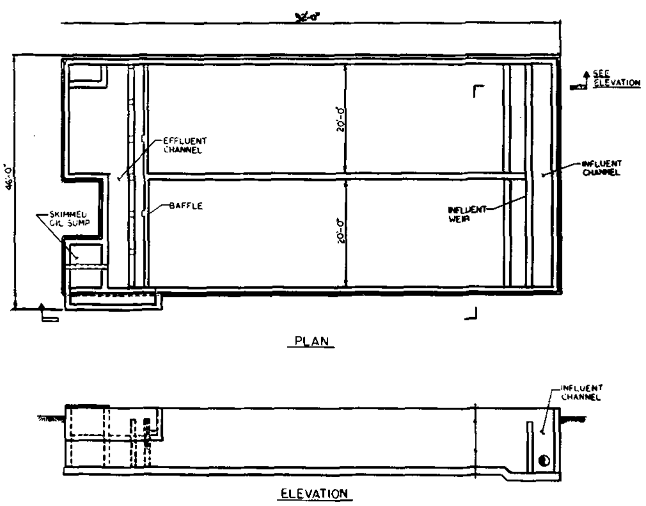

FIG. 7. Plan–American Petroleum Institute oily water skimming basin, Springhill, La.

SPRINGHILL REFINERY

The Springhill system is much simpler than that at Panama City. The operations here are less complex. A sketch of the cooling tower system and API skimmer are shown in Figure 6. Ca. 6000 gal/min of oily water is circulated through the system. Oil is skimmed off in a two-cell concrete basin as shown in Figure 7. Oil is removed by an adjustable weir on one side of the skimmer basin. The areas of the basin adjacent to the interface were strongly attacked by the acidic oily water, as well as the concrete in the influent channel. It was necessary to line some of these areas with redwood planking. Ca. 60 tons/month oil are recovered from this system, and the total oily water purge amounts to 50 gal/min. The biochemical oxygen demand of this effluent is 20 and the oil content 43 ppm. Since all exchangers, pump cooling glands, etc. are on a recycle system, the 50 gal/min purge from the skimming basin is substantially the only effluent leaving the refinery.

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[Received June 4, 1973]