Recovery of Fatty Acid Lights From Still Vapors

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ABSTRACT

A fatty acids still operating primarily on coconut oil fatty acids has two condensers in series to condense the top product. Nonetheless, until recently 1% to 2% of fatty acid lights normally passed through to the hot well. Here the caproic, caprylic and capric acids dissolved in the warm water and these dissolved acids ultimately found their way to the plant effluent stream where they contributed to the biochemical oxygen demand loading. Early in 1969 a Croll-Reynolds Scrub-Vactor was placed in operation to remove fatty acids from the vapors leaving the still. A normal scrubber installation could not be employed because of the volatility of the lights, but a modification was devised in which coconut oil low in free fatty acids is sprayed into the scrubber. The coconut oil is removed continuously at such a rate that the free fatty acids content of the oil does not build up to over 10% to 15%. This material then goes to the fat splitter. By this means 80% of more of the fatty acids are removed from the vapor stream with resulting reduction in polution of plant aqueous effluent and collection of salable fatty acid lights.

At Hammond, Indiana, the Lever Brothers plant pumps cooling water from the south end of Lake Michigan and after use discharges it into nearby Wolf Lake which straddles the Indiana-Illinois state line. Thus federal water pollution authorities as well as state and local authorities are interested in any plant effluent discharging into Wolf Lake.

Lever has been working for years to close off any sources of pollution of Wolf Lake and by 1968 had brought the average biochemical oxygen demand level of the plant effluent down to 50 ppm or below.

Lever operates a fractionating fatty acids still with an input rate of about 3,000 lb/hr at Hammond. The still which is used primarily for whole and hardened coconut oil fatty acids and their various fractions is equipped with two condensers in series but none the less until recently 1% to 2% of low molecular weight fatty acids has normally been carried to the hot well as vapor or in solution. Here the caproic, caprylic and capric acids are soluble enough to dissolve in the warm water and these dissolved fatty acids eventually find their way to the plant effluent stream where they contribute to the BOD loading.

In recent years there have been many installations of recirculating scrubbers in our industry in the barometric type vacuum systems of semicontinuous and continuous deodorizers and it occurred to us that a similar scrubber might make it possible to remove and recover the low molecular weight fatty acids ahead of the barometric condenser on the Hammond still.

Initial discussions with the manufacturers of vapor scrubbing equipment were not too encouraging because the normal use of such scrubbers relies on the circulation and

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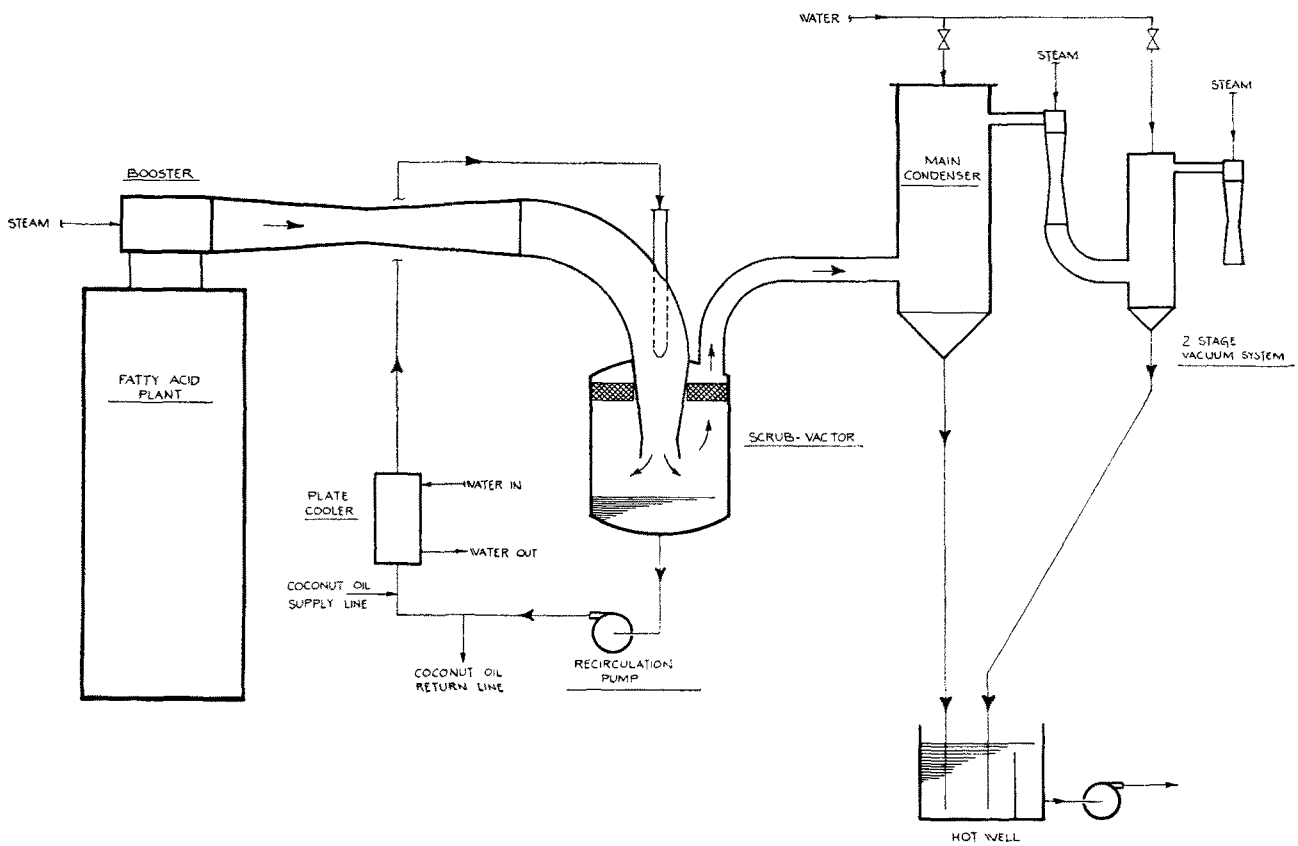

FIG. 1. Diagram of Scrub-Vactor installation and auxiliaries.

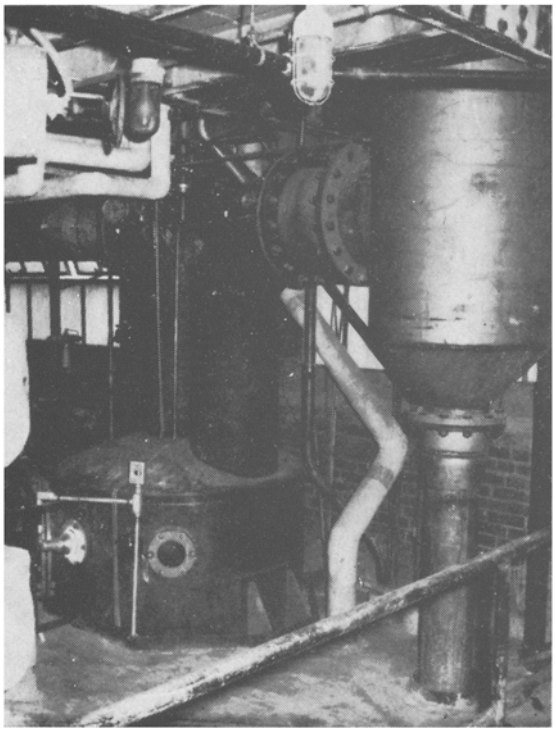

FIG. 2. View showing top of Scrub-Vactor. Barometric condenser is at right.

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spraying of the cooled recovered fatty material for partial condensation of the fatty matter being carried off as vapor with the steam. Under these conditions, only a 50% recovery of fatty acids could be anticipated at Hammond because of the high volatility of coconut oil light fractions.

Subsequently it was suggested that soybean oil be sprayed into the scrubber as the medium for collecting fatty acids and it was only a short step from here to the concept of using crude coconut oil as the scrubbing agent assuming that draw-off and make-up could be balanced so

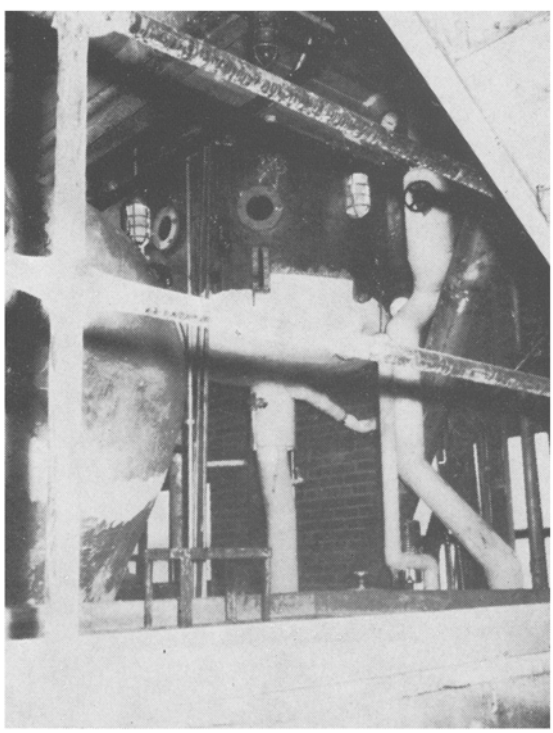

FIG. 3. View showing lower portion of Scrub-Vactor.

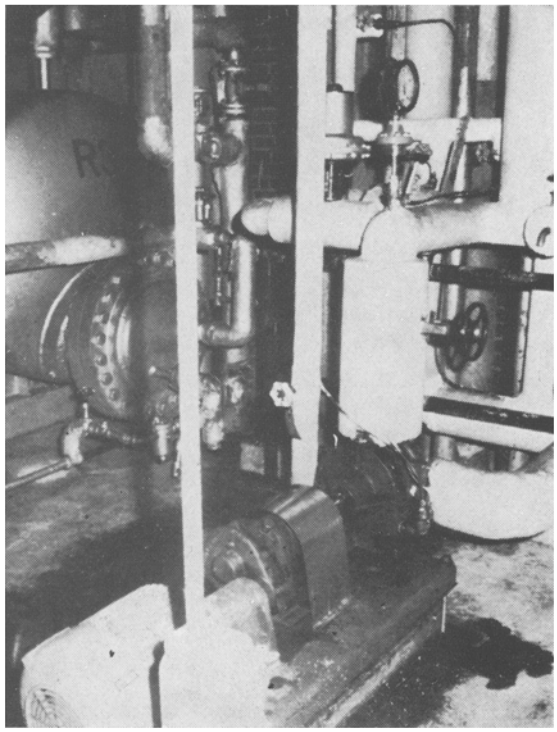

FIG. 4. The circulating pump.

that the free fatty acids level in the cooled, recirculated coconut oil would not exceed 15%. The recovered light fatty acids thus dissolved in the coconut oil could then go to the splitter and distillation plant according to standard procedure.

Under these conditions it was estimated that recovery of the light fatty acids would be higher than 90%. Accordingly a Croll-Reynolds Scrub-Vactor was purchased and installed in the outlet vapor line from the still system between the booster and the barometric condenser to condense and remove fatty acids from the vapor stream.

The Scrub-Vactor is a piece of equipment that resembles a catchall in external appearance. Incoming vapors enter at the top and pass downward through a venturi tube. A recycled and cooled oil or fatty acid drawn from the reservoir in the bottom of the Scrub-Vactor is sprayed into this tube to absorb and/or condense everything but the steam vapor and any material dissolved in the steam vapor. Steam and noncondensibles then pass upward through a York entrainment separator and thence travel to the barometric condenser.

Figure 1 shows a diagramatic sketch of the Scrub-Vactor and the auxiliary equipment needed to circulate and cool the oil.

About 60 gpm of coconut oil are withdrawn from the botton of the scrubber by the Viking pump which sends the discharge through the plate cooler and on to the nozzle in the throat of the Scrub-Vactor. Material passing through the still condensers is short chain fatty acids and, because of their low boiling points under high vacuum, they are difficult to condense and hold in a liquid state. They can be condensed however by a spray of coconut oil containing less than 15% free fatty acids. This level is maintained by adding 2 gpm of crude coconut oil containing 5% or less of free fatty acids to the circulating liquid which is maintained below 15% free fatty acids by withdrawing slightly more than 2 gpm of recirculated coconut oil to storage. It was calculated that this system could remove 93% of the fatty acid vapors from the vacuum system. Finally the crude coconut oil now containing 15% free fatty acids is split and distilled and the recovered lights are taken off as a top product.

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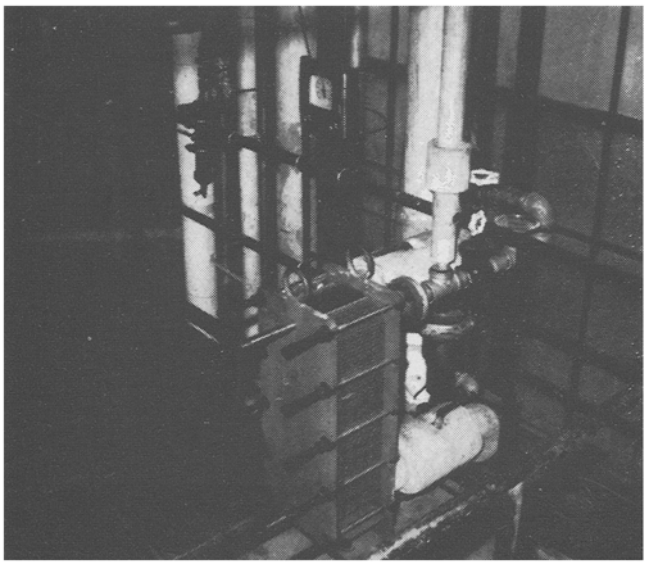

FIG. 5. Heat exchanger used for cooling circulating liquid.

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The scrubber installation and auxilliaries are shown in Figures 2 to 6.

It is very difficult if not impossible to determine the exact efficiency of the Scrub-Vactor in this installation. Different types of still operation have shown a varying still loss due probably to the changing composition of the material in the vapor stream. One might expect the petroleum ether soluble material test run on measured hotwell water samples to be the best indicator, but it has been found that not all of the water soluble fatty acids can be extracted even with 10 extractions. Probably the chemical oxygen demand (COD) as determined for measured samples of hotwell water is the best indicator, but here again, the presence of some material in the hotwell water other than fatty acids is sometimes indicated.

Typical COD analyses of the hotwell water while running hydrogenated coconut oil fatty acids prior to the installation of the Scrub-Vactor showed a total of 2,741 lb in 24 hr. With the Scrub-Vactor in operation the COD in the hotwell water was reduced to 685 lb in 24 hr. This is a reduction of 2,056 lb of COD material in 24 hr which has been removed from the plant effluent and represents a 75% efficiency for the Scrub-Vactor system. The biochemical oxygen BOD in the hotwell water also was reduced by 75% and the BOD level of the total plant effluent discharging to Wolf Lake was reduced from 50 ppm to under 25 ppm.

The total cost of the Scrub-Vactor installation at Hammond was $70,000 and the sale of the recovered fatty acid lights will pay off this cost in less than two years.

With a theoretical recovery of 93% of the lights in the vapor stream, we could not be satisfied with an actual recovery of 75% even though this yield represented a

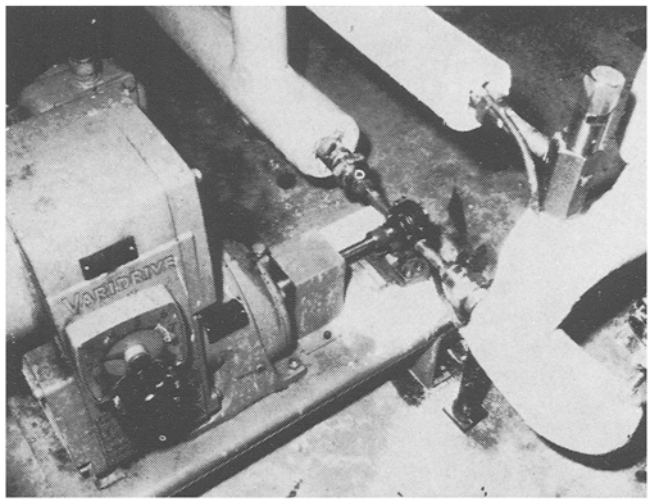

FIG. 6. Close-up view of the feed pump used to deliver about 2 gpm partially hardened coconut oil into circulating medium.

tremendous improvement over previous conditions. A detailed review of the project and its operation led to the hypothesis that the yield could be improved if the pickup of fatty acids by the recycled coconut oil could be limited to a maximum level of 10% rather than 15% in the coconut oil. It was concluded that this could be accomplished by: (a) Increasing the quantity of crude coconut oil circulated through the Scrub-Vactor so that the free fatty acids level of the coconut oil leaving the Scrub-Vactor after pickup of caproic, caprylic and capric acids would not exceed a maximum of 10% instead of the previous maximum of 15%, (b) by replacing the crude coconut oil circulated in the scrubber by refined coconut oil so that the pickup of free fatty acids would range from 0% to 10% content of the coconut oil, instead of from 5% to 15%.

In testing the first of these proposals, the rate at which crude coconut oil was added to the Scrub-Vactor system was increased from 2 gpm to 3 gpm with a corresponding increase in the rate of withdrawal. This procedure was successful in removing about 30% of the fatty acids that had previously been passing through the Scrub-Vactor, raising the total scrubber efficiency to 82%.

While this procedural modification was still undergoing evaluation, it was discovered that a small obscure vapor line from the vacuum dryer preceding the still by-passed the Scrub-Vactor and discharged directly into the hotwell. It was found that the amount of fatty material from this source varies from time to time with small amounts of visible floating oil or fatty acids from the vacuum dryer observable in the hotwell upon occasion. It is estimated that as much as 50 to 150 lb/day of COD and perhaps more are coming from this source.

When this problem is corrected, it is hoped that fatty acids recovery can then be increased to at least 90% efficiency.

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