Recycle of Tall Oil Plant Waste Water Effluent[1]

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ABSTRACT

Increasingly stricter specifications for plant effluents, may now require tertiary treatment to meet water soluble chemical oxygen demand and biochemical oxygen demand limits. This paper describes a system in which the effluent water from a tall oil plant is treated and recycled to the process instead of being treated and discharged.

RECYCLE OF TALL OIL PLANT WASTE WATER EFFLUENT

Effluent water from industrial plants generally may be classified as originating from two basic sources. The first results from a process where water is produced as a reaction product and must be discarded. A typical example is the production of urea fertilizer from ammonia and carbon dioxide in which 0.3 lb water are produced/lb urea. A problem facing designers of new urea facilities is the requirement that nitrogen be eliminated almost completely from the synthesis water before it is sewered.

The more usual role of water in process plant operations is as additive, i.e. to slurry a solid to be fed to a system, or as a filter cake wash and so on. One of the commonest ways water is added to a process is as stripping steam in the vacuum distillation of high boiling compounds.

Water used in a process in this fashion, is almost always discharged contaminated by the material being processed. Environmental requirements concerning effluents have become progressively stricter to the point where some effluents require tertiary treatment, such as ozonation to reduce water soluble chemical oxygen demand (COD) and biochemical oxygen demand (BOD) to acceptable limits. This paper will describe a system in which the effluent water is treated and recycled to the process instead of being treated and discharged.

Because C_{16}/C_{18} fatty acids and rosin acids are high boiling compounds, the fractionation of split fatty acids, such as those derived from tallow, or of crude tall oil is carried out under vacuum using appreciable amounts of stripping steam. A modern tall oil or fatty acid fractionation system will include a low temperature condensing zone and an efficient entrainment elimination device to minimize the amount liquid or vapor organic passing overhead to the vacuum producing equipment in which the stripping steam is condensed. However, organic material always will be present to contaminate the stripping steam condensate, and the amount will depend upon the type of feed stock. For example, freshly split acids prepared from a good grade of bleachable tallow will contain no more than 0.5% unsaponifiable matter, most of which is high boiling. At the other end of the scale is Finnish crude tall oil containing up to 15% total unsaponifiables, of which 4-6% is light unsaponifiables. This high content of volatile impurity in the feed naturally increases the organic content of the condensed stripping steam.

Another factor contributing to organic overhead is that there is a certain amount of degradation or cracking during the distillation operation. This results in additional low boiling unsaponifiables, but the amount can be minimized by using a well designed vaporizer in which injected steam is used to assist vaporization and minimize retention time.

When processing the poorer grades of Finnish tall oil, the condensate, even after heating and decantation, still can contain up to 0.4% of dissolved and emulsified organic. This material cannot be reduced except by chemical, biological, or some other treatment, such as ozonation.

As mentioned above, another possibility is to treat the condensed stripping steam, so that it can be recycled as steam to the process. Patents (1) granted in the United States and abroad cover such a water recycle system.

The process will receive its commercial baptism later this year when a 70,000 ton/year tall oil fractionation plant being constructed for Harima M.I.D. Company is started up in Japan. Engineering, procurement, and erection is being carried out by Ishikawajima Harima Heavy Industries Co., Ltd., according to the process designs of Foster Wheeler Corporation.

The fractionation of the various products is done continuously using four vacuum towers. Stripping steam is added via specially designed steam injection reboilers for which heat requirements are supplied by a high temperature heat transfer medium.

To eliminate odor, a closed stripping steam condensation system is employed. Most of the condensate is re-evaporated and reused as stripping steam or motive steam for the ejectors.

FRACTIONATION

The crude tall oil fractionation system is shown schematically in Figure 1. Crude tall oil from a day tank is fed to an eductor where it is mixed with a heated recirculating stream of dehydrated crude. This mixed stream then is sprayed into a dehydrator, where moisture is removed under vacuum and dissolved salts thrown out of solution. This method of heating and dehydrating the crude prevents fouling of the feed heaters and eliminates the need for spare exchangers.

The dehydrated recycling crude is used as the cooling medium to generate reflux in the pitch stripper. The normal throughput of crude is heated further and flashed at a reduced pressure in the presence of steam into the first tower.

In the first tower, pitch stripper T-101, most of the volatile fatty acids and rosin acids are taken overhead as a vapor feed to the second tower. Stripped pitch, containing the less volatile fatty acids, heavy unsaponifiables, rosin, and esters, is pumped from the bottom of T-101 on level control, cooled, and sent to storage.

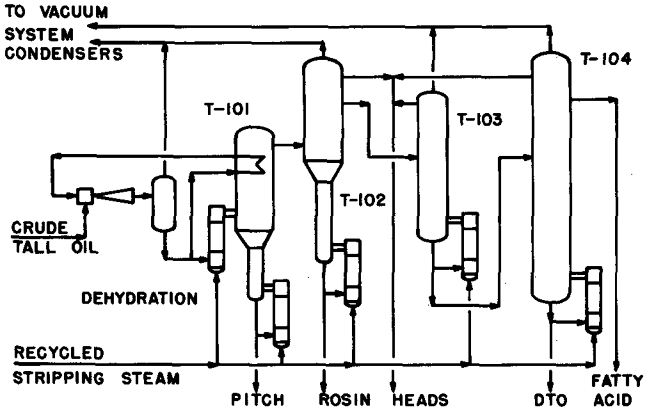

FIG. 1. Fractionation. Courtesy: Foster Wheeler Corporation.

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

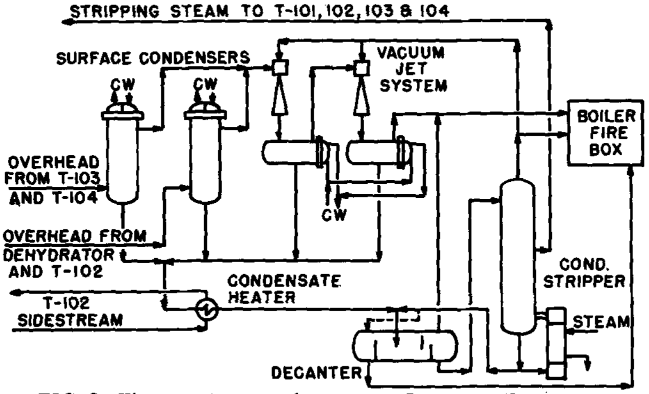

FIG. 2. Waste water recycle system. Courtesy: Foster Wheeler Corporation.

In the second tower, T-102, the fatty acids and volatile unsaponifiables are stripped from the product rosin. The high quality rosin is pumped from the bottom, cooled, and sent to storage or drumming.

The upper part of T-102 includes a fractionation section and a condensing section. In the fractionation zone, the fatty acids and unsaponifiables are separated from the rosin. In the section just below the condensing zone, the more volatile unsaponifiables and C_{16} fatty acids are separated, to some degree, from the C_{18} fatty acids. Crude fatty acid is fed to the third tower from below the condensing zone. A heads product is taken from the condensing circuit at the top of the tower, cooled, and sent to storage.

To produce fatty acid of low unsaponifiable content, it is necessary to fractionate light ends away from the crude fatty acids prior to distilling the high quality product. This operation is carried out in the third tower, T-103, from which a heads cut, containing C_{16} acid and light unsaponifiables, is sent to storage.

The stripped crude fatty acid is transferred to the fourth tower, T-104. It consists of two rectification sections and a stripping section which yield the high quality fatty acid product, a heads fraction, and a distilled tall oil bottoms cut.

The sidestream from the top of the lower rectification section is high quality fatty acid product, which is cooled and sent to storage.

The upper rectification section is where any remaining volatile unsaponifiables and C_{16} fatty acids are separated from the C_{18} product acids. This heads fraction is used internally as the condensing medium for the tower, and a small cut is pumped from the top collector pan, cooled, and sent to storage.

The stripping section of T-104 separates high boiling fatty acids, rosin acids, and decomposition products from the fatty acid. This material, called distilled tall oil, is pumped from the tower, cooled, and sent to storage.

Stripping steam from the distillation towers carried with it the most volatile and, therefore, the most odorous of the unsaponifiable material in the crude. Although the odor is reported to be completely harmless with respect to health, it is basically objectionable; and, in some cases, it is necessary to eliminate all odors from any source including storage tanks.

WASTE WATER RECYCLE

The waste water recycle system is shown in Figure 2.

To eliminate the prime source of odor, the condensation of the steam and organic vapors from the dehydrator and the stripping steam from the fractionating towers are done in two large shell and tube surface condensers operating under vacuum. Noncondensibles and some water vapor from the surface condensers are drawn into a jet vacuum system. The noncondensibles from the last stage of the vacuum system are fed to the steam boiler firebox to be incinerated.

It should be noted that this water recycle system is not restricted to use with surface condensers. It can be applied to barometric condensers using a circulating stream of process water, which is indirectly cooled in an air or water cooled heat exchanger. A purge from the circulating stream is treated for recycle.

The condensate from the surface condensers in the vacuum system contains small amounts of fatty acids and odor bearing light unsaponifiable material. It is pumped to a decanter, through a heat exchanger, in which it is heated to facilitate the separation of oil from the water. Heat comes from exchange with T-102 sidestream fatty acids.

In the decanter, oil separates from the water and overflows into one end of the vessel, from which it is pumped to the steam boiler firebox where it is burned. The clarified underflow water in the bottom of the vessel is pumped to the oily water stripper.

The decanter is pressurized with inert gas and vented under pressure control to the steam boiler firebox to burn odorous vapors leaving the system.

In the stripper the oily water is stripped of odor and air which may have dissolved in the water during condensation under vacuum. This tower consists of two stripping sections and is operated under enough pressure to produce steam for the jet vacuum system. A thermosyphon reboiler heated with boiler steam is employed to supply the heat required for vaporization at the bottom of the tower.

In the upper stripping section, the feed on the top tray is vaporized partially and stripped of odor and air. Part of the vapor from the top of the tower is used as the motive steam for the three stage jet vacuum system. The remainder passes to the firebox of the steam boiler for combustion of the odor content. This stream is the means by which odor, air, or other gases dissolved in the condensate are purged from the system. The unvaporized portion of the feed flows down over the lower stripping trays and is vaporized further.

The vapor from the central portion of the tower is superheated with the high temperature heat transfer medium and used as stripping steam in the fractionating towers. A small fraction of the bottom liquid is recycled back to the front of the decanter to combine with the condensate stream. This stream is a purge of less volatile acids and unsaponifiables. The oily portion of this purge stream will then exit from the decanter in the oily layer to be burned.

To avoid the accumulation of organic material, it is desirable to blow down the liquid from the bottom of the tower. This blow down stream passes into the oily side end of the decanter, and then it is pumped to the firebox of the steam boiler together with the separated oil. A small amount of pure steam is fed via level control into the bottom of the tower to maintain the level of the bottom liquid.

Thus, the condensate of the stripping steam and organic vapors from the tall oil fractionation system and motive steam from the ejectors are clarified, re-evaporated, and then recycled back to the distillation system and the jet vacuum system. There is no foul waste water.

Finally, it should be noted that boiler feed water makeup requirements are reduced since the recycle water is vaporized in a shell and tube exchanger producing clean condensate to be returned to the plant deaerator.

REFERENCE

1. Foster Wheeler Corp., U.S. Patent 3,709,793 (1973); Can. Ser. 086,951 (1970); Ger. Serial P2034372.0 (1970); Holl. Serial 7,010,252 (1970); Ital. Patent 906,754 (1970); G.B. Serial 2118/70 (1970).

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