Tall Oil Soap Skimming—the State of the Art[1]

R.W. ELLERBE, Rust Engineering Company, P.O. Box 101, Birmingham, Alabama 35201

ABSTRACT

This paper calls attention to the increased interest in tall oil production within the past 5 years and the simultaneous increase in the market price of tall oil. It points out that tall oil has grown from a relatively unknown product to a well established commodity of considerable commercial importance, which has given kraft pulp mills a renewed interest in soap skimming. This paper also covers the state of the art in soap skimming.

INTRODUCTION

During the past 5 years, a great deal of attention has been focused on tall oil production. This, of course, is not too surprising in light of the fact that the price of tall oil rose from $64/ton to $80 during the same 5-year period. A price increase of 25% in such a short time is naturally a striking economic fact.

Such an economic climate always causes industry executives and technical men to look critically at current tall oil yields. It was, therefore, appropriate that last year Ellen (1) spoke to the Pulp Chemicals Association about the future of the pulp chemicals industry. His comments on paper industry trends, which will undoubtedly affect tall oil production, were extremely perceptive. He mentioned trends toward: (a) more paper recycling; (b) more hardwood usage; (c) use of more sawmill wastes; (d) use of more immature, low-density wood; and (e) use of more outside chip storage piles. Naturally, these trends have a retarding influence on the future growth of tall oil production. They should, however, keep the supply tight enough to support current price levels. Figure 1 shows how tall oil yield/ton sulphate pulp peaked in 1968 and has declined steadily since then.

At the 1970 Alkaline Pulping Conference, Stengle (2,3) chaired a panel discussion on "Tall Oil Manufacturing." He and the panel had some interesting comments on the importance of tall oil and on the factors affecting its recovery. It is particularly interesting that tall oil production increased from 115,000 tons/year to ca. 800,000 tons during the 21-year period 1949-1969. This is a compound growth rate of ca. 10%. Figure 2 shows how tall oil production and sulphate pulp production have increased during the past 15 years.

This growth clearly illustrates the importance of tall oil. The fact that over 80% of the 1969 tall oil production was fractionated suggests even another important economic fact: tall oil is the cheapest known source of fatty acids (2,3). It competes with fatty acids from soybeans and cottonseed. Crude oils from these sources sell for 14.5 cents/lb, but crude tall oil sells for 8.5 cents/lb (5).

Tall oil obviously has a comfortable niche in the chemicals market. It is so important commercially that its recovery is now an economic imperative for alkaline pulp mills. In fact, the recovery of 60 lb of tall oil/ton of pulp reduces a mill's wood costs by ca. $2.70/cord. This is a savings of ca. 12% on wood costs. No mill can afford to ignore that kind of savings.

An impressive economic background always stimulates a keen interest in less glamorous aspects of a product or process. What could be less glamorous to papermakers than the recovery of soap skimmings for tall oil manufacture? A survey of the literature on tall oil manufacture makes it clear that the recovery of soap skimmings is a little understood subject. This article will discuss why, where, and how mills recover soap.

WHY MILLS RECOVER SOAP

Everyone generally concedes that tall oil soap skimmings have proved to be a valuable by-product of alkaline pulping operations. Soap recovery also has important corollary benefits, but not much has been said about them. The following paragraphs show that pulp mill evaporator operation is a major consideration in soap recovery.

Soap recovery can influence two aspects of evaporator operation. It can affect: (a) the time between boilouts and (b) the frequency of evaporator upsets. Both of these factors directly affect a pulp mill's productivity, soda losses, and contribution to stream pollution. Good soap recovery means good evaporator performance.

Soap in the black liquor causes trouble when it gets to the hot end of an evaporator. The presence of soap in the liquor, along with pulp fibers, accelerates fouling of the evaporator. Fouling increases the temperature difference (ΔT) required for heat transfer in a given body. This, in

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

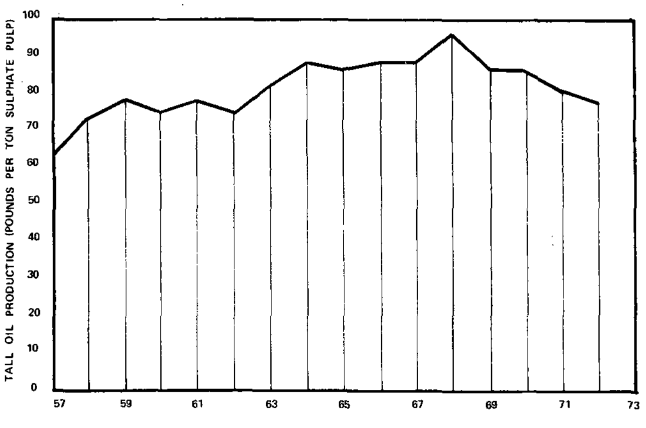

FIG. 1. Tall oil/ton sulphate pulp. Sources: American Paper Institute and Pulp Chemicals Association.

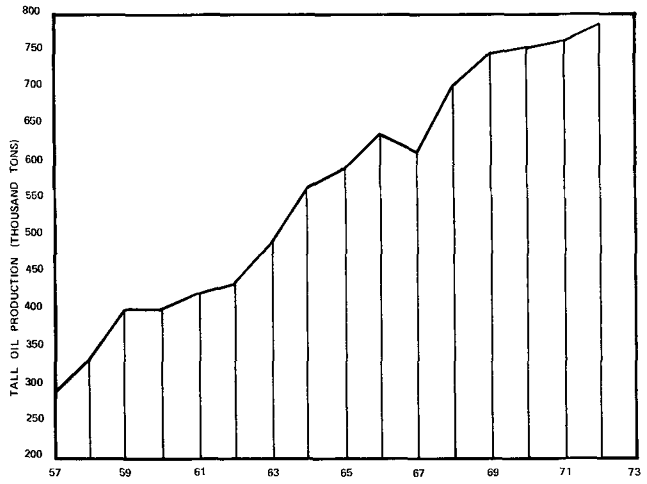

FIG. 2A. Production history—tall oil. Source: Pulp Chemicals Association.

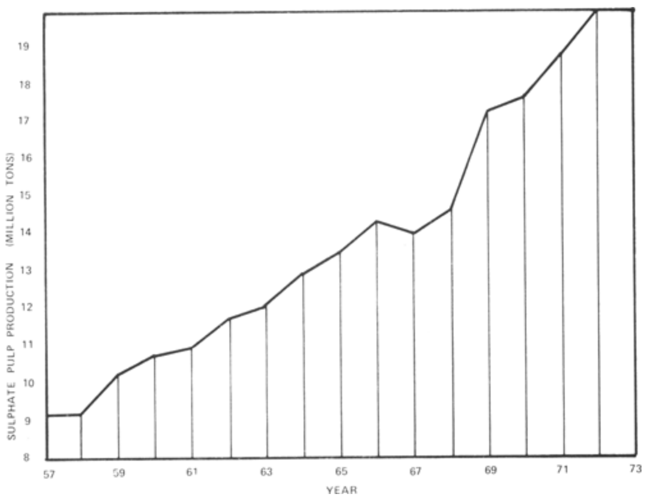

FIG. 2B. Production history–sulphate pulp. Source: American Paper Institute (sulphate pulp, paper grades only).

turn, reduces the ΔT available for the balance of the evaporator. The net effect is a loss of evaporative capacity, because of soap, fiber, and scale deposition on the tubes of the first one or two bodies.

Ordinarily, the scale is removed easily by flushing the evaporator with water and then boiling for a few hours. But, this removes evaporative capacity from service during the boil-out period. Liquor losses and its attendant pollution inevitably occur at this time. Depending upon the weak liquor inventory, the boil-out may even cause a loss of pulp production. This is a condition that operating people continually guard against.

Southern kraft mills that have expanded several times during the past 40 years can see for themselves how soap removal affects boil-out frequency. These mills usually have three or four sets of evaporators. In many cases, home-made soap skimmers were added using any convenient, abandoned vessel in the mill yard. Usually the liquor retention time in the vessel is too short. Consequently, the skimmers have varying soap removal efficiencies. The boil-out frequency on these several evaporators ordinarily runs from a few days to a few weeks–just as the retention time in their soap skimmers ranges from 45 min-2 1/2 hr. Again, good soap recovery correlates with good evaporator performance.

The evaporator soap skimmers recover most of the soap, but no pulp mill can operate for long without skimming its weak liquor storage tanks. Good soap removal from these tanks is essential. Otherwise, evaporator upsets eventually will be traced to pulling soap into the evaporator feed at a time of low liquor inventory. The foaming that this soap causes in an evaporator creates an unstable operation. And

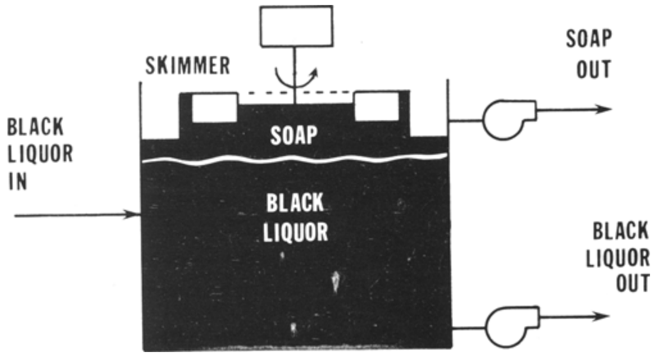

FIG. 4. Continuous soap skimmer.

the evaporator may have to be boiled out to restore stability.

Naturally, production people guard against the chance of such an upset by operating with certain minimum levels in their weak liquor storage tanks. This keeps the soap blanket well above the pump suction. And it makes a part of their operating liquor inventory unavailable. So good skimming at the weak liquor tanks improves evaporator operation two ways: (a) it minimizes chances of upset, and (b) it increases the available operating liquor inventory.

WHERE MILLS RECOVER SOAP

Up to this point, it should be clear *why* mills recover soap. Soap recovery is profitable, and it has corollary process advantages. Where mills recover may at first seem trivial. But, it is important, because *where* mills recover soap has a bearing upon *how* they collect it.

Generally, it is known that soap becomes less soluble and rises to the surface of black liquor whenever the liquor cools and whenever the liquor concentration increases. It also is known that air entrainment helps separate soap from liquor by increasing the difference in the soap and liquor densities.

With these facts in mind, and a little knowledge of the kraft chemical recovery cycle, it is easy to predict *where* soap can be collected. Figure 3 schematically represents part of the chemical recovery cycle of a kraft pulp mill. (a) Aeration of the liquor and some cooling more than offset the reduction in liquor concentration occurring at the brown stock washers (BSW). So soap recovery at the BSW foam tower is customary. (b) More cooling and 6-8 hr retention time in the weak liquor storage tanks make them a natural accumulation point for soap. (c) The next point of collection is at some intermediate point in the multiple-effect evaporators. Tests indicate maximum recovery occurs at 25-28% liquor solids. So most soap skimmers are located just after the effect having this concentration. (d) Heavy black liquor oxidation (HBLO) systems throughly aerate

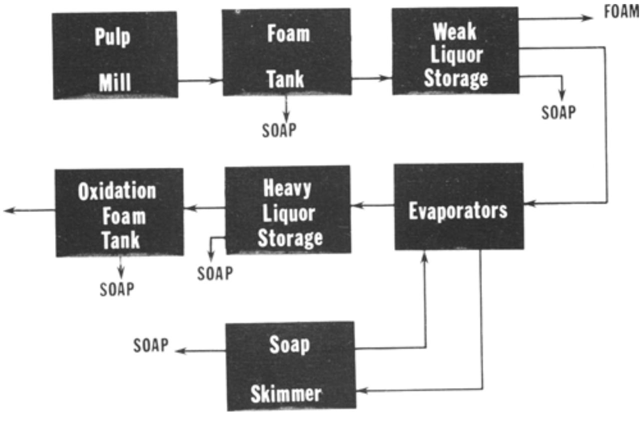

FIG. 3. Points of soap recovery kraft pulp mill.

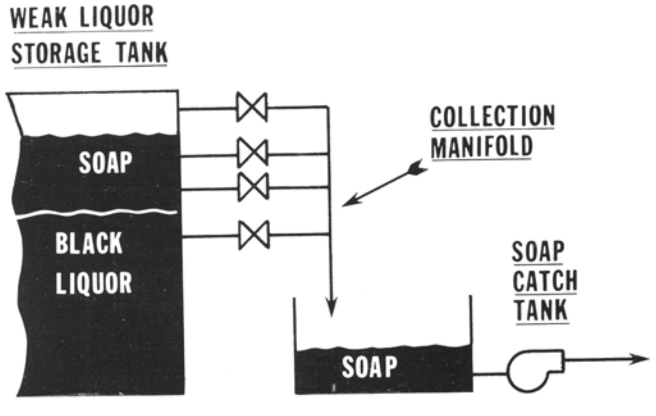

FIG. 5. Soap recovery manifold.

the heavy liquor. This causes even more soap to spring loose from the liquor. So soap recovery at the HBLO foam tower is common. (e) More cooling and another 6-8 hr retention time in the heavy liquor storage tanks cause even more soap to rise to the liquor surface. Soap collection at the heavy liquor storage tanks is, therefore, a necessity. Otherwise, at times of low liquor levels, soap may be drawn into the recovery boiler.

The five process locations just mentioned are commonly recognized points of soap recovery. A closer look at these points shows soap recovery occurs at: (a) two foam towers, (b) two liquor storage points, and (c) the evaporator soap skimmer.

Aeration, cooling, and concentration of the black liquor obviously promote soap recovery, and *where* mills recover soap is quite predictable. *How* they recover soap is not usually as predictable.

HOW MILLS RECOVER SOAP

Soap recovery can be intermittent or continuous. Usually, the only point of continuous recovery is the evaporator soap skimmer; all other points of recovery are intermittent. None of the equipment used for soap recovery is complicated. And this, undoubtedly, is one reason soap yields are no higher than they are.

The continuous soap skimmer (Fig. 4) amounts to no more than a specially designed, cylindrical tank having about 2 1/2 hr retention time. It is equipped with an internal launder and a rotating paddle. The paddle skims the continuously accumulating soap into the launder. The soap then flows by gravity to a sump, and from here it is pumped to soap storage.

The black liquor flows over an adjustable weir into a sump and is pumped to the next effect of the evaporator. The adjustable weir controls the thickness of the soap blanket. Automatic controls hold the liquor and soap levels at a set point in their respective sumps.

Skimmers of this type have been found completely satisfactory for good soap recovery at the evaporators. Measured skimmer efficiencies of ca. 75% are typical. Some pulp mill operators find that adding a little air to the liquor-soap mixture improves the skimming efficiency. Experience has taught that this air is important to good soap recovery.

There are several schemes commonly used for intermittent soap recovery. Most of them involve a series of manifolded valves for recovery of soap from a tank with a fluctuating level. The changes in level cause the soap-liquor interface to fluctuate. So, to recover the soap on a regular basis, it is necessary to mount several valves on the tank. One of the valves is usually above the liquor level and below the soap level, so that soap can be drawn off into a small catch tank. From there it is pumped to soap storage.

Figure 5 illustrates a typical system for intermittent soap recovery. These usually are found on foam tanks and liquor storage tanks. Sometimes, however, an altogether different system is needed on the weak liquor storage tanks, particularly the tank into which the weak liquor is

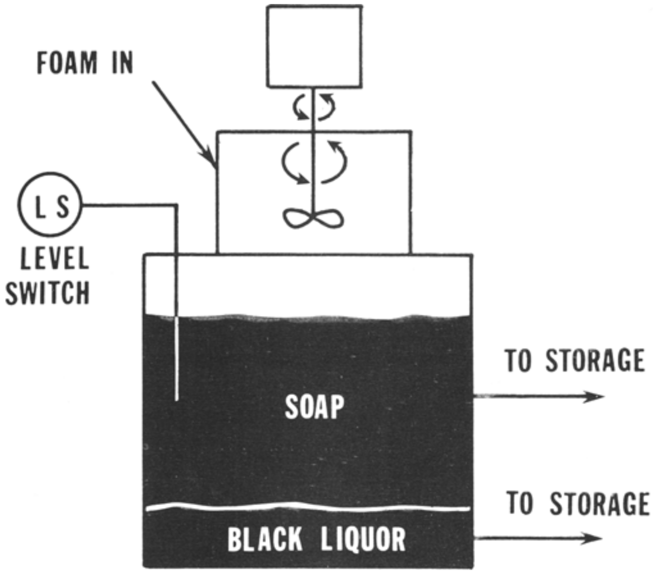

FIG. 6. Soap concentrator.

introduced first.

Many pulp mills generate a soapy foam during BSW startups and rate changes. The foam usually overflows to the sewer at the weak liquor tanks. Since this foam can represent a substantial soda and soap loss, it logically is recovered at the first weak liquor storage tank.

Recovery of the foam is another question. Some mills find a soap concentrator effective. It mechanically concentrates the foam to a good soap of 6-7 lb/gal density. The principle of operation is simple.

Foam overflows the weak liquor storage tank and passes through a centrifugal concentrator. The concentrated foam drops into a collection tank where the liquor and soap form two phases. Pumps take suction on the layers and transfer them to storage.

Figure 6 shows a soap concentrator. Its construction and instrumentation are simple. The concentrator can be a four-blade fan rotating at ca. 1000 rpm. A float can be mounted in such a way that it starts and stops the soap pump to maintain the level between a 4-5 ft range. The liquor pump is started manually as required.

Methods of soap recovery are varied. Some mills use the three methods just mentioned. Others do not. Some, however, go a little beyond even these methods.

REFERENCES

1. Ellen, B.P., Southern Pulp and Paper Manufacturer, Sept. 1973, p. 26.
2. Stengle, W.B., Ibid. Oct. 1971, p. 18.
3. Stengle, W.B., Ibid. Dec. 1971, p. 26.
4. Spitz, R.J., and A.B. Doran, "Tall Oil," Institute of Paper Chemistry, Appleton, Wisc., 1957.
5. Chemical Marketing Reporter, March 26, 1973.

[Received June 4, 1973]