SYMPOSIUM ON THE CONTRIBUTIONS OF THE CHEMIST TO AMERICAN INDUSTRIES

Papers presented at the 51st Meeting of the AMERICAN CHEMICAL SOCIETY, Seattle, August 31 to September 3, 1915

CONTRIBUTIONS OF THE CHEMIST TO THE NAVAL STORES INDUSTRY

By JOHN E. TEEPLE

Consulting Chemist and Chemical Engineer

The Naval Stores Industry includes primarily the production of rosin and turpentine, and secondarily that of tar, pitch and various oils. The raw material in this country is the long-leaf pine and some similar pines in the South Atlantic and Gulf States. The United States produces more turpentine and rosin than all the rest of the world, our total annual production being probably worth over \$40,000,000; our exports in one year exceeded \$27,000,000, and are usually above \$20,000,000.

The industry is not a new one. When America was discovered, Russia was furnishing tar and pitch and turpentine for the cordage and ship building industries, and in our own country we were exporting turpentine and rosin in considerable quantities before the year 1800. Nearly forty years ago our exports were nearly half in quantity what they have been in recent years, though having only about one-fifth the present value.

Notwithstanding the magnitude and age of the Naval Stores Industry, however, it developed largely without the aid of the chemist. Only within the last ten or fifteen years can he claim to have played more than a minor part, but recently his contributions have been of extreme importance. We may discuss the chemical contributions under four heads:

1—Improving the quality and quantity of rosin and turpentine produced from the living tree.

2—Providing standards, and detecting and preventing adulteration.

3—Finding new uses and enlarging the markets, particularly for rosin.

4—Utilizing the rich dead pine (lightwood) and various pine wastes for the manufacture of Naval Stores.

This last field is usually classed as wood distillation, or wood extraction, and as there is a special symposium on that subject at this meeting it will not be further discussed here. When this utilization reached its maximum in 1911 to 1913, it is probable that it furnished over 10 per cent of the total Naval Stores production of the United States, and it seems likely to increase in importance in the future when conditions and prices have readjusted themselves.

The methods of producing rosin and turpentine from the living tree made very little progress during the whole nineteenth century. Timber was plenty, land, leases and labor were cheap, there was a profit to be had by existing methods, so why worry. The method consisted in hollowing out a cavity near the base of a pine tree, and cutting away bark and wood, to leave a smooth face for a few inches above it. Then every week from Spring till Fall a V-shaped chip about an inch wide was cut through bark and wood above this face, each chip being just above the preceding one. Thus inch by inch the scarred face crept up the tree, to the extent of say thirty inches a year, and at each chipping the oleoresin from the wound flowed down the scarred face till it reached the cavity at the bottom, whence it was dipped out for distillation with water over direct fire, to produce volatile turpentine and non-volatile rosin. Every year the thick, gummy exudate had to flow over a longer stretch of discolored scarred face, and be exposed to longer evaporation of turpentine before it reached the collecting cavity at the bottom. And so every year the producer's rosins were darker colored, and his yield of turpentine smaller.

But conditions began to change. Many lumber men refused to have their trees bled for turpentine, as it decreased the value

of the lower end of the tree for lumber, and very largely increased their loss of timber from forest fires and from windstorms. Timber was not so plentiful as had been supposed. Prices of lands, leases, labor and materials were all rising. The cost of producing turpentine and rosin to-day is probably three times what it was twenty-five years ago. So the producer called for help. He looked first to France. There they were able to bleed a tree for many years—one is said to have survived two hundred years—while here four years was about the limit of profitable operation. There they planted large orchards of pine trees for the express purpose of turpentinizing them. There they made much narrower gashes in the trees, used a cup and gutters to collect the oleoresins, instead of allowing them to flow long distances over the scarred face into a hole in the tree, and there they accordingly made lighter colored, higher priced rosins, and bleached them still further in shallow pans in the sun, changing for example a K rosin into the much more valuable water-white rosin.

A study of the French methods seemed, however, to show that they were not, as such, applicable to existing conditions here. But there was an idea there, and to C. H. Herty is due the credit first of working out that idea in a scientific and practical way to fit conditions here, and second, what was probably much more difficult, of persuading the operators to use his methods for their own good. Herty conducted careful comparative scientific experiments, and showed clearly:

I—That there was no physiological reason for the marked coloration of rosins during the later years of operation as compared with the first or virgin year, but that this coloration was due to oxidation of the resin acids during the longer flow from the point of exudation to the receptacle, "the box," a large hole cut with an axe in the base of the tree, and especially to the absorption by the fresh oleoresin of the old oxidized resin on the face of the tree scarified during the previous years. By using an outside receptacle attached to the tree and moving it annually up the tree near the point of scarification, only the best grades of rosin were obtained.

II—The flow of the oleoresin over long surfaces resulted in heavy loss of the volatile spirits of turpentine.

III—The cutting of "the box" resulted in destruction of much of the timber by fire, wind and insects.

IV—Most important of all, it was demonstrated that the unboxed pine tree would produce 25 per cent more crude turpentine than the boxed tree, due to greater vitality of the tree.

The total value of the annual Naval Stores output is approximately \$40,000,000. It is easily seen, therefore, that the above losses in material, both as to quantity and quality, represent an annual waste of from \$10,000,000 to \$15,000,000.

Early commercial confirmation of the experimental results led to the rapid substitution of the long used "box system" by the practical, cheap and efficient "cup system." The use of the cup system was not thoroughly efficient for several years, as was evidenced by the low yields of early Spring as compared with the later yields. The explanation of this shortcoming was apparent when Tschirch, of the University of Berne, published his views on resin flow and then by a slight modification of woods practice the difficulty was overcome and a further annual increase of crude turpentine valued at a half million dollars was effected.

But the end is not yet in sight, for, according to Herty, laboratory experiments on perfectly fresh specimens of crude turpentine show that its normal content of spirits of turpentine is approximately 30 per cent, while under most favorable methods

of collection and distillation at present yields of only 18 to 20 per cent are obtained. This loss of at least one-third of the volatile oil by evaporation remains still to be overcome.

Some chemists have established new industries, and many have coöperated to improve old ones, but this work of Herty's in making, practically alone, such a change in an industry that had been stationary in methods for a hundred years, is almost unique.

As to other improvements in manufacture, not much progress has been made. The French method of bleaching rosin seems too slow and laborious, and many chemical methods have been suggested instead, but up to the present have not made much headway. Methods of distillation without the use of direct heat, such as using superheated steam, or distillation in vacuum have been suggested but have had little influence as yet on methods of manufacture. The United States Bureau of Forestry has recently been studying the question of chipping, and has published results indicating that a $\frac{1}{2}$ inch chip gives about as good a flow of oleoresins as an inch chip, besides being less injurious to the tree. They further recommend chipping every four days instead of once a week, thereby increasing the yield in a season. It has been objected that the tree may not be able to stand this excessive bleeding. The method is still to be tried in practice.

When turpentine was comparatively high in price, many substitutes, chiefly from petroleum distillates, and many methods of adulteration were found. Presumably we must give the chemist credit for these too. The question of adulteration particularly became a serious problem and provoked a flood of literature devising tests for various impurities and additions. Most of the large consumers finally evolved specifications to fit their requirements, and many states have passed laws for preventing and punishing adulteration, so that conditions now are much improved, for which we may also thank the chemist. There is still much work to be done, however, in standardizing turpentine specifications to fit the consumers specific requirements. As they now stand, with rather arbitrary figures on specific gravity and distillation, we, no doubt, often include material he really does not want, and exclude material he could perfectly well use.

Rosin has usually been too cheap to suffer from adulteration except with dirt or brickbats. The chemist has little to do with its purity or grading. Recently, however, the United States Bureau of Chemistry has proposed a series of permanent standards, for the different grades of rosin, based on definite transmissions of red and yellow light for each grade.

In extending the markets for Naval Stores the chemist has done little for turpentine. It has had three uses for many years: (1) As a solvent for gums in the manufacture of varnishes; (2) as a vehicle in the manufacture of paints; (3) as a thinner in the application of paints. The chemist has more often striven to avoid its use in these fields than he has to extend it. Two new fields have been opened within recent years, by chemists—one the manufacture of synthetic camphor. This has been carried on to a considerable extent in a commercial way, and will be again, whenever satisfactory relations exist between the market prices of turpentine and camphor. If the yields of camphor could be made more satisfactory it would no doubt become a permanent industry. But at present, with the price of the raw material, turpentine, and of the finished product, camphor, independent variables, and no large margin in any case existing above the fixed manufacturing cost, the outlook is not enticing to the investor. The second new field opened by the chemist is the manufacture of synthetic rubber. Synthetic rubber can be made from isoprene, and isoprene can be made from turpentine, but whether this is the best way to make synthetic rubber, and whether turpentine is the best source of isoprene, and whether synthetic rubber can compete with natural rubber in the long run anyway, are still open to discussion.

With rosin the chemist has had more opportunity. He puts it into shrapnel shells and sometimes into varnish. In the presence of an alkali, rosin acts as an acid, forming resinates. Combined with an amount of soda insufficient to saponify the whole, it forms rosin size, extensively used in the manufacture of papers, where the rosin deposited in the paper prevents the spreading of ink and moisture. This accounts for a very considerable amount of the medium grades. A somewhat higher grade of rosin, when saponified, forms a valuable constituent of, or addition to, many soaps. Combined with zinc, manganese or the alkaline earths, rosin gives resinates used extensively in varnishes.

A very large amount of rosin, particularly of the lower grades, is distilled for the production of rosin oil. The lower grades of rosin oil when mixed with lime, set to form a semi-solid mass (axle grease) extensively used as a lubricant. Better grades are used extensively in the manufacture of printing ink, so that the marvelous increase in printing and paper during the last fifty years has furnished an outlet for rosin in two directions. All of these varnish, soap, paper and printing industries have furnished abundant fields where the chemist has exercised and continues to exercise his ingenuity on rosin and its products.

In the manufacture of rosin oil the yields and quality are not always what they should be. Recent suggestions of different methods of distilling promise much larger yields of better quality oil with smaller amounts of by products.

To conclude, we find the chemist has been particularly valuable in three departments of the Naval Stores Industry. He has improved largely the quality and quantity of product, has standardized grades and prevented adulteration, and has been very successful in finding products and derivatives to fit the markets, or in finding markets to fit his products. This last field especially is far from worked out. There is still a wide scope for the energies of the chemist.

50 EAST 41ST ST., NEW YORK

CONTRIBUTIONS OF THE CHEMIST TO THE STEEL INDUSTRY

By GEO. W. SARGENT

Vice-President, Crucible Steel Company of America

To demonstrate the service that chemistry has rendered to an industry such as that of steel, whose whole foundation is chemistry, and where even the messenger boys about the works speak of carbon, phosphorus, sulfur, silicon, etc., almost as freely as they use the terms of the baseball field, would require volumes. In fact, volumes have been published on the part taken by one element alone. To present, therefore, in a brief outline the success that chemistry has achieved in this tremendous industry is a most difficult task, and it is with considerable hesitation that this paper is presented. Perhaps by picturing the past at a time when the chemist was an almost unheard of factor in the iron and steel industry, in contrast with the present conditions, the object of this paper might be attained.

Harking back somewhat more than half a century with an old furnace man who possessed a mind as active and clear as it was at the time of which he spoke, despite his ninety years, he made the following statement: "A water wheel at the flour mill ran the blower, supplying air to us at the forge several hundred feet distant. Here the pig iron, brought up in canal boats from a charcoal furnace forty miles down the river, was melted in the run out, subsequently tapped into two forge fires, there worked to nature, and forged into blooms under a trip hammer run by the old-fashioned overshot water wheel... The blooms were cut in two pieces about 80 to 100 pounds each and then shipped by canal to Pittsburgh to be rolled into sheets, bars or rods, and then into wire; or to be melted in crucibles and made into steel. Charcoal was the fuel we used. It made mighty fine iron and steel, and that without your chemists. Two tons was a day's output, but we made it right and never had any rejected."