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The Utilization of Sawdust

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THE UTILIZATION OF SAWDUST.

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The question of the more complete utilization of sawdust has seemed to me a matter of considerable interest; and more especially so since the beginning of my residence in this city. Here, during the past Summer, I have visited some of the numerous saw-mills at work converting pine logs by the thousand into boards and other forms of building stock, and at the same time, in no inconsiderable proportion, into fire-wood and into sawdust. Some persons have held the opinion that when the sawdust is thrown into the river, as most of it has thus far been, it is worse than thrown away. Now I do not enter into a discussion of the question whether the sawdust which is thrown into the Mississippi at this place may prove to be of any detriment to the navigation of the river, or may cause disadvantage in any other way. If I were to offer an opinion on this point, I should say that the sawdust could do very little harm in the river,—and this although I long since learned to support the general proposition that the less waste and refuse matter of any kind we throw into our rivers and lakes and harbors the better it will be. But at all events, we see this immense amount of material being constantly thrown away; and if it is capable of being utilized with profit, we

should naturally like to see it so utilized. I learn that estimates of the amount of sawdust made here, place the total at about three hundred thousand cords per year, this being the sawdust from about two hundred and thirty million feet of lumber.

Some methods of utilizing sawdust are already practiced. It seems as if more of it might be burned as fuel. A process recently introduced, of forming the sawdust, mixed with a proportion of peaty material, into blocks by compression, seems to promise well. It is to be hoped that the expenses of the process may be so small as to render the compression of sawdust in such a manner a profitable business. I have tried to procure a specimen of the pressed material from Mr. Walker, editor of the *Mississippi Lumberman*, but he had none on hand at present. Doubtless some of those present have seen the material. It is intended, I understand, to carry on the business of preparing it on a considerable scale.

Illuminating gas is in some places, especially in Europe, made from wood. It is said to be gas of the highest quality in all respects. Sawdust could be used for this purpose. But the apparatus required is somewhat different from that used in making ordinary gas from coal. One important consideration is in the fact that wood-gas is free from sulphur. In regard to the illuminating power of gas produced by heating wood, I shall have occasion to say a few words later.

But the method of utilizing sawdust which I have had especially in mind, and which in fact might have been called the subject of this paper, consists in the use of it for the production of acetic acid and other condensable substances which wood forms when it is submitted to destructive distillation. The production of these substances falls more strictly into the province of chemistry; the processes and the products are of the kind generally known as "chemical." And

some mention of these processes and products I now wish to make.

When any kind of wood is strongly heated in a nearly closed vessel—a retort—the wood becomes in a short time decomposed; and the elements of the wood, though few in number and familiar in their nature, arrange themselves in a great many ways, forming a multitude of combinations and giving a remarkable variety of products. Those products may be classified in four groups; First, those which are produced as gases and remain as gases; second, an acid watery liquid; third, tarry matter; fourth, the residue in the retort. In giving a partial list of the gaseous substance above referred to, I may mention carbonic oxide, carbonic acid, hydrogen, marsh-gas, olefiant gas, acetylene. In the acid watery liquid we have water, acetic acid, several other acids, methyl alcohol, creosote. In the tarry matter are found paraffine, naphthaline, benzol, creosote, resin. These are but partial lists. I will take a moment to illustrate, on a small scale, the formation of some of these substances. Using for our retort a small cylinder of glass, I partly fill it with sawdust and close the mouth of the cylinder with a stopper carrying a small open pipe. We now heat the part containing the sawdust with this spirit lamp. The wood soon begins to carbonize or char, and now fumes are given off and escape from the pipe. These fumes have a peculiar, pungent smell, acid and smoky at the same time. On holding a piece of moistened blue litmus paper in the fumes, the paper becomes reddened, showing the presence of acid. I will now attempt to light the gaseous matter which is passing off. This we find to be inflammable, but it is so mixed with watery vapor that it burns but poorly. Now the sawdust has become quite fully charred, and we see in the tube a quantity of tarry matter. This matter is characterized by the peculiar odor, somewhat complex, known as "empyreumatic." It contains creosote.

The odor of smoked hams is essentially the same and due to the same substance. The residue in our cylinder is charcoal. The best charcoal is made by this plan. The mineral matter of the wood, mainly carbonate of potash, is left with the charcoal.

Now let us attend briefly to the quantities of the several products from a given quantity of wood. I have recently made some experiments on this point, at the laboratory of the University. I will state some of my results. I brought from one of the saw-mills a quantity of ordinary sawdust, and let it become pretty well air-dried. I weighed out two pounds of the sawdust and placed it in an iron retort provided with an outlet pipe, this pipe being connected with a large Liebig's condenser. The retort was heated up moderately with a wood fire, and the vapors distilling off were condensed as far as possible, and the condensed matter was collected in a proper receiver. The apparatus was so arranged that the uncondensed gases passed through another tube from the receiver, and could be disposed of in any way desired. I simply ignited them at the end of this tube, and for over an hour had a flame of considerable brightness burning from an opening of about one-eighth of an inch diameter. I continued the heating for about two hours, raising the retort to a moderate red heat at last. When the gases and liquids ceased to be formed, the apparatus was taken apart. Here I have nearly all of the distillate which was formed from the two pounds of sawdust. The whole of it weighed fifteen ounces, nearly one-half the weight of the material taken. On testing this liquid with litmus paper, we find a strong acid reaction. Here is a part of the charcoal which was left in the retort. The whole residue weighed seven and one-half ounces, about one-fourth the weight of the sawdust. It is bright and clean charcoal. The carbonization was very perfect. It appears from my figures that

rather more than one-fourth of the products of the decomposition of the sawdust escaped condensation. A large part of that quantity consisted of permanent gases. Some uncondensed vapors were doubtless present, mixed with those gases, just as they are in ordinary illuminating gas. I may mention particularly the vapor of benzol. Then, too, some matter which might have been condensed with a more perfect apparatus doubtless escaped. Yet the condensation was good; the liquids and gases issued from the condenser quite cold. Here is a bottle containing a sample—nearly three quarts—of the gaseous matter which came from my apparatus. I have kept it tightly stoppered. We ignite this gas and see that it burns with a moderate amount of light. It certainly would not be a good illuminating gas. It does not contain enough of the light-giving hydrocarbons. In order to make good gas from wood, the products from heating the wood in the retort must be passed through a second heating arrangement by which vapors that would condense before the gas could be used, would be decomposed and permanent light-giving gases formed. This can be done. Illuminating gas of the highest excellence can be made from wood. How the cost of making it from sawdust would compare with the cost of making it from coal and from petroleum residues and other materials, I am hardly prepared to say. As to the amount of the gas produced in the process of which I have been speaking, as applied to sawdust, I have some results of experiment. I weighed out one-fourth of a pound of the air-dried sawdust and heated it in a small retort, in the same manner as before, and collected the gas produced. It amounted to a little over six gallons, nearly one cubic foot. From my two pounds of sawdust I should, therefore, have obtained about seven cubic feet of gas. Although not a good gas for lighting, it has heating power, and would be practi-

cally utilized by conveying it into the fire to help heat the retort.

I find that the results I obtained in these experiments show a sufficiently close agreement with results that have been previously obtained and published. Now, to come back to the liquid distillate from the sawdust,—for it is this with which we are particularly concerned,—what may be done with this liquid that will make it of practical account, and what may be obtained from it that will be of actual value? *Acetic acid* and *wood-spirit* may be extracted from it. The remainder may be disposed of as *tar*, or it may be burned as fuel under the retorts, or the *creosote* it contains may be separated by distillation, leaving pitch as a final residue. I must mention, however, that in the tar from pine wood, with which we are dealing, the amount of creosote is less than in tar from hard wood. The amount of acetic acid obtained in the distillation of pine wood is also less than that obtained from hard wood, beech, oak, birch. The quantities of the first product of the heating process—in the experiment here described, fifteen ounces from two pounds—differ but little for the different kinds of wood, whether hard or soft; but the distillate from pine contains considerably less acid. Something further on this point will be brought up later. We will now attend to a short outline of the processes employed for obtaining some of these products. First, the thin liquid is poured off from the tar, the latter having settled, or the apparatus is so arranged that the tar may be kept from running in with the rest. The thin liquid is "raw pyroligneous acid." When this is submitted to distillation at a moderate temperature, crude methyl alcohol or wood-spirit passes off and is condensed. One hundred pounds of the raw pyroligneous acid will yield about one pound of methyl alcohol. Here I have a sample of wood-spirit, partially purified. It has a strong smoky odor and taste from

the fact that some creosote and other volatile matters have distilled over with it. Here is a sample of highly rectified methyl alcohol, having a much milder odor and taste. This, more or less refined, is a useful substance, being used in the preparation of varnishes and coloring material, and for various chemical purposes, also for burning in spirit-lamps instead of common alcohol. Wood-spirit is sold at about half the price of common alcohol I will ignite a small quantity here on this small dish. We see that its flame is nearly non-luminous. After the methyl alcohol has been separated as stated, the remaining liquid is raised to a higher temperature and the distillation proceeded with until most of it has passed over. This constitutes ordinary pyroligneous acid. Here is a sample. This is a common article of commerce, worth about twelve cents per pound. Pyroligneous acid, either raw or distilled, is the material from which the acetic acid of the chemical laboratory and manufactory, as well as the numerous acetates of the dyer and color maker, are produced. Here is a sample of strong acetic acid, perfectly colorless and clear. Here is a still stronger acid, called 'glacial," which will solidify at a temperature a little lower than that of this room. Here is acetate of soda, here acetate of lead (sugar of lead,) acetate of copper, (crystallized verdigris.) All these are important salts in the arts. To obtain the acetic acid, pyroligneous acid is saturated with lime. Acetate of lime is thus formed in solution. This is evaporated, and the solid mass obtained is heated with muriatic acid, whereby the acetic acid is set free and distilled off; or acetate of soda is formed from the acetate of lime, by adding sulphate of soda. From the acetic acid all the acetates may be made. From one hundred pounds of pyroligneous acid made from pine wood may be obtained about ten pounds of strong acetic acid, containing about thirty-five per cent. of monohydrated acetic acid, and worth about thirty cents per

pound. Acetate of soda is worth fifty to eighty cents per pound. From one hundred pounds of pine sawdust would be obtained about two and one-half pounds of strong acetic acid, one pound of methyl alcohol, and a quantity of tar. The products together would be worth about one dollar.

Reference may now be made to the question of the expense of the processes for the utilization of sawdust here outlined. For, of course, everything depends on this. The great question is, "will it pay?" There would be needed first, arrangements for collecting the sawdust at the mills and conveying it to the works; secondly, apparatus and fuel for the distillation of the material; thirdly, chemicals for the separation of the products. As to the first requisite, it would seem as if arrangements could be made by which the sawdust might be collected and conveyed to some point at small expense. Unless the cost of it when so conveyed would be a good deal less than the cost of solid wood, we should of course hardly be justified in saying anything further about using sawdust in this manner. On the second point, the apparatus required is not very complex, and for fuel we ought to use mainly sawdust itself and the charcoal formed in the retorts, and—an important item—the gas generated in the decomposition would be conveyed into the fire. The chemicals required, lime, muriatic acid, sulphate of soda, are sufficiently cheap.

I do not claim to have exhausted this subject,—the subject, that is of the production of these substances derived from sawdust by the treatment described. There are besides other uses in chemical industry to which sawdust has been applied, of which I may mention the manufacture of oxalic acid.

In conclusion, I may say that in bringing this subject before the Academy I cannot, of course, profess to be making known discoveries of my own, or to be bringing forward any-

thing which is new either to scientific or to practical chemistry. But it may be added that there is nothing visionary about the matter. These processes are in common use, the products from the destructive distillation of wood are made on a large scale in this country and in Europe. The object of the paper is to suggest *this* as a possible method of disposing, profitably, of a part at least of the great quantity of sawdust that now goes into the river.