The Douglas-Fir Charcoal Situation
in the Pacific Northwest

by

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INTRODUCTION

One of the major obstacles in the Douglas-fir region lumber industry which retards a successful long term policy is the incomplete utilization of the raw material. It has been found by various investigators that only 60% of the total tree volume is fully utilized. The waste--slashings, slabbing, and sawdust--is generally either left in the woods to rot or burned at the mill.

To treat one of our natural resources in such a manner creates a serious economic problem. Some form of action should be taken to correct the situation. There is no reason to waste land, rainfall, minerals, labor, and machinery by not producing products from this refuse. If this waste could be utilized, in one form or another, so additional revenue might be added to the net profit per acre, perhaps better forestry practices could be inaugurated. This would result in aroused enthusiasm in forestry and renewed vigor in the industry and profession on the part of many individuals. Out of this new interest and activity would arise more second growth forests to support the oncoming generations. Lands which are now bare, idle, and exhausted would once more give life to the tall green tapering Douglas fir which rises skyward into the blue heavens like a Gothic Cathedral--nature's cathedral--attracting people from every far-away corner of this country to admire its beauty and splendor.

These lands would again become valuable to the individual, county, state, and nation. A value whose potentialities
will offer means of supporting a future generation so it may find the happiness and means to fulfill ambitions which every person within a democracy has the right to have and fulfill.

Basically this waste is a result of man's greedy desire for financial success. He does not desire to look into the future and think of the oncoming generations. He does not feel any responsibility for leaving these lands in a productive condition for future peoples. No, he becomes so involved in his own selfishly created little world that other people's interests are totally disregarded.

If he would only stop this mad race for financial power; think--rationalize the situation, and form a set of conclusions which would be beneficial to future generations, he could feel he had really accomplished something worthwhile during his life span. After all, land is not owned or possessed by any one man; he merely leases it for use during his lifetime. Upon his death someone else takes the same privilege of leasing these lands and finding a living on them, and upon his death they pass into the hands of another person. In such a manner does the use of land pass from one individual to another. These persons do not possess the right to totally deplete the productive capacity so the next individual will be handicapped. Each person has the right to expect the same opportunity on the land that his predecessor had.

The purpose of this paper is to point out various uses for a portion of this waste after it has been manufactured
into charcoal. If this and other ideas expand and are brought into reality sometime in the near future, forestry will rest on a more sound financial foundation. There is no reason why forestry and lumbering will not always remain one of the major extractive industries in the Pacific Northwest if we can provide efficient utilization.
PART I
THE PRESENT PROBLEM

The difficulty involved in this problem is the present lack of information on Douglas-fir charcoal. There has been very little work done on this specific problem. Bruce E. Hoffman recognized the lack of research and advocates such activity to find new uses and markets for wood waste. Large companies and organizations have become concerned during the last few decades with closer, more complete utilization. Weyerhaeuser Lumber Company, for example, has done splendid work in this field. The Western Pine Association recently completed a research laboratory for developing new products and finding new uses for wood waste. These organizations so far have not shown much concern in charcoal production.

With no local charcoal industry to study the problem in this region, it becomes necessary to go where this industry exists and make a study of conditions which support the enterprise. Charcoal production flourishes in Norway, Sweden, and surrounding countries; however, economic conditions are not similar in these countries to those in the United States, therefore an accurate parallel cannot be drawn between countries. Mexico also produces charcoal, but here also the same reasoning applies; their economic system is not similar to ours. There does exist in our own country a hardwood charcoal industry and it has been chosen for study because of similar economic conditions from which a more accurate parallel can be drawn.
HISTORY OF CHARCOAL PRODUCTION

In order to gain a complete understanding of the factors which favor charcoal production, it becomes necessary to go into the history and briefly trace its production down through the years, ending with our present hardwood industry in the East and Midwest.

There are no records which go back far enough in the history of civilization to describe the first use of charcoal. It is supposed that charcoal was accidentally discovered by prehistoric man. Perhaps the cave dwellers noticed blackened pieces of wood left in the ashes of a dead fire reignited rather easily and immediately produced a hot fire with very little smoke. Since prehistoric man had not discovered the use and value of metal in developing his civilization, he had no use for charcoal other than for heating and cooking purposes.

The next step in man's development, namely the bronze age, started the metallurgical industry. In order to smelt the copper and tin satisfactorily, a fuel which would produce a hot, smokeless, even fire was necessary. From his past experience with charcoal, man recognized its value in this new age and began to use it in large quantities. During this period charcoal began to be produced commercially to supply the increasing demands. Little is known of these early production methods; however, it is thought wood was simply piled and burned with no attempt made to regulate the supply of oxygen. When it had sufficiently burned, it was
drenched with water or sand. The final product was a mixture of charcoal, ash, and partly carbonized wood. The method was very ineffective and crude, but under the circumstances served the purpose.

As civilization progressed into the iron age, the use of metals in the industrial arts increased in great strides, thereby creating an urgent demand for charcoal. The tempo continued with great rapidity until early in the 18th century when coke replaced charcoal as a fuel in the production of iron. English metallurgists were first responsible for this substitution. Wood, as a source of charcoal, was becoming scarce and the manufacturers had to look elsewhere for a new type of fuel. The abundance of coal in England made coke the most logical source of fuel for use, so coking procedures were developed and soon coke-iron appeared on the market. The success of these new manufacturing techniques with coke soon spread into France and Germany, where the scarcity of wood was also becoming a serious problem.

Various scientists became interested in by-products of the coking procedure and began to devise methods of recovery. Their success led to profitable recovery and soon most manufacturers had turned to producing coke by these methods. Wood charcoal was having difficulty competing with coke, consequently the industry gradually diminished. However, charcoal was still used in making the better grades of steel.
RISE OF THE HARDWOOD DISTILLATION INDUSTRY IN AMERICA

About this time America was being founded and settled. All iron products during this early period were imported from England. However, as the country developed, local ore deposits were discovered, and soon a small iron industry flourished. Because of the abundance of wood in the immediate vicinity of the production centers, charcoal was used as a fuel. The whereabouts of coal was known, but the early transportation system could not be depended upon to furnish these plants with a steady, sufficient supply, and the situation was totally in favor of using charcoal as a fuel.

The fast-growing country soon expanded into new virgin areas. Transportation systems extended into these new areas almost as quickly as they were being settled. This created a huge demand for iron products which had to be supplied by American industries. Manufacturing plants sprang up everywhere, and local supplies of wood soon diminished. Here in America, as in England, a local fuel scarcity existed. Progressive manufacturers began to locate their plants as near to the essential supplies as they could and still stay within the locality of markets. The Pennsylvania steel industry is an outcome of this movement. Coke, as substituted for charcoal, became the cheaper to use and huge quantities were readily available.

The charcoal industry, having lost its best customer, had to look elsewhere for new markets and products. The success of by-product recovery in the coking process led
scientists to investigate by-product recovery in the coking process. Kilns and retorts used in the coking process were redesigned to fit their use for wood distillation, and when tried they proved successful. The recovery of by-products became profitable. The first recovery in American from the distillation of hardwoods occurred in New England. The textile industry needed a mordant or fixing agent, and the "smoke" from the charcoal kilns contained dilute acetic acid suitable to that need. Later this product was refined to produce both acetic acid and methanol.

These new by-products saved the industry from failure for the next few decades. The industry changed its methods of production. Instead of charcoal being the chief product, now acetic acid and methanol are equally as important.

The developments and improvement of modern foundry practices which produce a good grade of iron from coke, has resulted in the past few decades in a declining demand for charcoal. This trend is clearly illustrated by Graph No. 1. However, other uses have been keeping the charcoal market open and the industry has been weakly surviving on these uses. The present day uses of charcoal as outlined by H. K. Benson are as follows:

1. Blast furnaces for charcoal iron
2. Case hardening and forging
3. Electric melting
4. Electrodes and resistances
5. Metallurgical industry and smelters
6. Insulation in the refrigerating industry
7. Gasoline refining
8. Black powder
9. Drugs and medicines
10. Laboratory and research work
11. Production of calcium carbide and cyanide
12. Sugar refining
13. Candy and syrup manufacture
14. Manufacturing of glucose, table oils, and gelatine
15. Glue, cream of tartar, alcohol, and lithophone
16. Fruit canning industry
17. As an absorbent base for fertilizers
18. Poultry and cattle food
19. Filtration and gas adsorption
20. Decolorizers and deodorizers
21. Restaurant and dining car fuel
22. Domestic fuel, heaters, etc.
23. Fuel for gas producers, water gas generation
24. Briquetting
25. Collodial fuel

The hardwood distillation industry survived quite well for a few decades after by-product recovery was introduced. In 1926 chemists dealt the industry a severe blow when they began to produce commercially, by synthetic methods, acetic acid and methanol. These new methods enabled these two products to be produced at a cost much cheaper than they could from recovery. This naturally reduced the market price. Graph No. II and No. III illustrate this trend. Therefore, wood distillers had to reduce the price of their product to meet the new competition. Inefficient plants that could not meet this competition were forced to go out of business. Only the larger, more modern plants were able to compete with the products produced synthetically. The industry today rests in a precarious position. The margin of profit depends upon the disposal of charcoal.
CONCLUSIONS

1. Charcoal production is dependent upon an industrial region.

2. Markets must be near production centers because charcoal is too bulky to be profitably shipped great distances.

3. It is no longer feasible in most cases to produce charcoal without utilizing the by-products.

4. The hardwood distillation industry has become a marginal industry the past few decades. Synthetic production of acetic acid and menthonol are chiefly responsible for this change.

5. Unless new uses for charcoal are found, the hardwood distillation industry will continue on a downward trend.
Graph 1

Percentage of Pig-Iron Manufactured Using Charcoal
Graph 2
Past Prices for Acetic Acid

PRICE PER POUND

1926 1927 1928 1929 1930 1931 1932 1933 1934
YEARS

$0.10 $0.9 $0.8 $0.7 $0.6 $0.5 $0.3 $0.2 $0.1 $0

R.S.
Graph 3
Past Prices for Methanol

Dollars per Gallon

Years

The factors which developed the charcoal industry in the East were pointed out to be industrialization of the region, which in turn created markets. And later on, by-product recovery continued to keep the industry alive. If an accurate parallel can be drawn between the East and the Pacific Northwest, charcoal production on a large scale has very little chance of success in this region.

The reasons are obvious. First, this area is not industrialized, which means there are no immediate available markets for the product. The economy of the State of Oregon is chiefly based upon agriculture and lumbering, as illustrated by the following table.11

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>52.7</td>
</tr>
<tr>
<td>Timber and wood products</td>
<td>33.5</td>
</tr>
<tr>
<td>Food products</td>
<td>5.2</td>
</tr>
<tr>
<td>Textiles and clothing</td>
<td>1.9</td>
</tr>
<tr>
<td>Metal production</td>
<td>1.9</td>
</tr>
<tr>
<td>Extraction of minerals</td>
<td>1.9</td>
</tr>
<tr>
<td>Fishing</td>
<td>1.0</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Whether this region will continue along this economy is rather difficult to predict. The recent development of hydroelectric power along the Columbia River is going to have some effect on the economy of the Northwest. Already large industrial concerns have moved into the region to take advantage of cheap electrical power. The corporation
which will be of greatest value to a charcoal industry is Union Carbide's Electrometal Sales Corporation. This industry is contemplating the possibility of a 25 ton-a-day waste wood distillation plant. The State of Oregon is experiencing an economical transition period at present. To what extent industrialization will take place is difficult to predict.

Almost every charcoal use listed by Benson is utilized by industries which are not common in this region, therefore if charcoal were manufactured on a large scale basis, it would have to be shipped back to markets in the midwest or eastern part of this nation. Transportation charges on the charcoal would raise the price so high that the cost would be prohibitive if consuming markets were found. Looking into the situation a little deeper, such an idea seems very illogical, since the potential charcoal capacities of regions which lie much closer to the Midwest and East would be first called upon to supply these markets. For example, there are great quantities of wood suitable for charcoal production in the Lake states.

Weed species, so called, suitable for charcoal, cover millions of acres in these three states. Local farmers in this region would be only too glad to supply a charcoal market. It would give them a source of income which they are in need of at the present time. So it clearly appears the idea of supplying markets which lie without the region does not seem very logical. Generally this can be safely assumed for other regions throughout the country.
The second reason why Douglas fir charcoal production seems very illogical is the small value which can be realized from the sale of its by-products. By-products from Douglas fir have a value far below the by-products produced from hardwoods. This is the opinion of Professor G. W. Gleeson, Head of the Chemical Engineering Department, Oregon State College.
EXPERIMENTAL WORK DONE WITH THE DOUGLAS-FIR CHARCOAL

The only references which could be found which show the yields obtained from distilling Douglas-fir was done by R. S. Hunt. He analyzed 3600 pounds of Douglas fir, or approximately one cord, with the following results:

TABLE II

<table>
<thead>
<tr>
<th>Product</th>
<th>Amount</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charcoal</td>
<td>1025 lbs.</td>
<td>$6.00</td>
</tr>
<tr>
<td>Acetate of lime</td>
<td>64 lbs.</td>
<td>1.28</td>
</tr>
<tr>
<td>Alcohol</td>
<td>4 gal.</td>
<td>1.60</td>
</tr>
<tr>
<td>Light oil</td>
<td>4 gal.</td>
<td>.80</td>
</tr>
<tr>
<td>Still tar</td>
<td>13 gal.</td>
<td>1.56</td>
</tr>
<tr>
<td>Retort tar</td>
<td>15 gal.</td>
<td>2.40</td>
</tr>
</tbody>
</table>

Total value...... $13.64

Unfortunately in his analysis he did not keep record of the costs involved. However, other industries have found the cost of a cord of wood delivered at the plant amounted to $6.00. This automatically eliminates any profit on charcoal. The cost of production for the other products cannot be determined from similar industries, but a fair assumption can be made that the net profit would be very small, if any. Acetate of lime still sells for $.022 a pound, and alcohol at $.45 a gallon. Current prices for light oil, still tar, and retort tar are difficult to obtain, but it can safely be assumed that they would follow the same trend given in the analysis.

Subtracting $6.00 from the gross value of $13.64 leaves a remainder of $7.64 on which to operate a recovery plant. Out of this $7.64 would have to come the cost of labor,
overhead, insurance, depreciation, taxes, social security, and many other items. It appears, therefore, very doubtful if such a venture would remain a paying proposition.

**INDUSTRIAL WORK DONE WITH DOUGLAS-FIR CHARCOAL**

An attempt has been made in the past to establish an iron industry at Oswego, Oregon. Douglas fir was the source of the fuel used. The plant remained in operation a few years, but was forced to close. The charcoal was produced by the retort method, thereby obtaining the by-products. In the operation they found one ton of charcoal was needed to produce one ton of pig iron.

The following table shows the cost of producing a ton of charcoal:

**TABLE III**

<table>
<thead>
<tr>
<th>Amount</th>
<th>Unit Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 cords of wood</td>
<td>@ $6 a cord</td>
<td>$18.00</td>
</tr>
<tr>
<td>Labor and overhead</td>
<td>@ $4 a cord</td>
<td>$12.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$30.00</strong></td>
</tr>
</tbody>
</table>

From one ton of charcoal, 40 gallons of tar and 5 gallons of fir oil were recovered, with a value of $10. The cost of this recovery amounted to $5, leaving the company a profit of $5. These figures are very crude and no further analysis can be made. As compared to Hunt's analysis the ratios are not at all identical. This is not strange, however, because one operation was carried out under experimental conditions and the other under commercial conditions. From all appearances labor and overhead were not charged against the recovery process but were lumped
under the cost of charring the wood. Following through and subtracting the $5 profit of recovery from the $30 cost of producing one ton of charcoal, one has a remainder of $25, which is still a very high price to pay for a ton of fuel as compared to $6-8 a ton for coke in the Midwest and East.

The reasons why this company failed and why other companies would run into difficulty under normal conditions are the high cost of fuel and the low grade of ore which exist in this region. The author does not believe an iron industry will exist until the higher grades of ores are depleted in other parts of the country or unless an emergency arises which makes it necessary to establish an industry in this region. So as far as producing charcoal for an iron industry, the probabilities seem far in the future.

**SUGGESTED CHARCOAL PRODUCTION METHODS**

One revolutionary new method which was brought before the attention of various chemical engineers last year after President Roosevelt expressed the need of a steel industry in the Northwest was Dr. Stevan Ruzicka's method. His work appeared in a weekly publication that summarized and correlated it with a proposed steel industry in this region.

Briefly, Dr. Ruzicka's method of charcoal production is to utilize sawmill waste in the form of slabs, sawdust, edgings, and other trimmings. This waste material is carbonized in retorts so the saleable by-products can be recovered during the charring process. The charcoal is then
pulverized by a method which does not destroy the crystalline structure of the carbon. To this mixture, tar, which is a by-product of the carbonization process, is added. The tar acts as a binder which holds the pulverized charcoal together during the coking process. The mixture can be either briquetted or coked in large lumps. The lumps will crack into smaller pieces when cooled.

Dr. Ruzicka states that by using this method all the charcoal is utilized. Formerly all the fine particles, of which there are considerable quantities, were lost because they cannot be profitably handled in the form of dust.

This method produces a strong porous coke which can be made harder by raising the temperature during the coking process. This fact refers back to the work of Violette, who did early experimental work with charcoal. Charcoal produced in this way is relatively free from sulphur and phosphorus. When used in steel making it produces a steel having a close-grained fiber structure similar to that now associated with Swedish iron and steel.

Various chemical engineers have studied Dr. Ruzicka's process and some declare it is not practical or economically profitable, while others declare it has its merits and all that it lacks are a few minor changes in the procedure. However, only large scale tests can decide the controversy. If such a method is worked out in the future, it will fit into the needs of this region very well.

A second method visualized by Professor Gleeson and Assistant Professor Glenn Voorhies of the Wood Products
Department in the School of Forestry, is almost essentially the same as the Ruzicka process. Their method consists of grinding up sawmill waste material and adding fuel oil which acts as a binder. The proportion contemplated is 74% wood and 25% crude oil. This mixture is then pressed into briquettes and coked in an oven in the absence of oxygen. The temperature is then gradually increased until it reaches 1800°. Destructive distillation of both wood and oil will occur.

The products resulting from distilling the wood will be acetic acid, methanol, furfural, and tars. The products resulting from distilling the oil will be hydrogen, carbon dioxide, carbon monoxide, aromatic hydrocarbons, aliphatic hydrocarbons, and others which are too difficult to determine without testing the idea in the laboratory. This is true because there is a possibility of numerous chemical reactions occurring.

Since the wood is finally coked at a temperature of 1800°, a fairly high density charcoal will be produced suitable for iron production. This would also be relatively free from sulphur and phosphorus and will produce a good grade of iron and steel. The other by-products could be separated and sold, a fact which will tend to reduce costs.

Here again the merits of this process will not be fully determined until large scale tests have been completed. Both methods warrant further investigation.
CHARCOAL USES APPLICABLE TO THE ECONOMY OF THIS REGION

Since this region is not industrialized there are automatically eliminated many of the uses listed by H. K. Benson. However, there are a few uses which seem suited to the economy of the Pacific Northwest.

Charcoal for feeding purposes has been receiving much attention the past few years by poultry and livestock men. Sales have been increasing very rapidly the past decade. California alone has been using approximately 1,300,000 bushels annually. This charcoal, incidentally, is being imported from Mexico. There seems no reason why a charcoal plant could not be constructed somewhere in California to supply this local market. The situation bears further investigation.

Carbon in the form of charcoal is not an essential constituent in the diet of fowls and animals, according to a statement made by Professor J. R. Haag, Chemist of Animal Nutrition at the Experiment Station. To his knowledge there have been no experiments carried out which prove carbon is an essential element in the diet of animals, as there have been experiments proving calcium, phosphorus, and other elements a necessity.

Mr. Haag believes the only value of charcoal is in its capacity to absorb waste material in the digestive tract of fowls and animals. In order for this cleansing to take place effectively, the animal must consume considerable quantities of the charcoal.
Therefore, in dismissing this possibility, we might say that the average farmer is feeding charcoal to his poultry and livestock with the wrong idea in mind. He believes that it is a necessity in the diet. If he becomes aware that charcoal is not necessary, it is doubtful whether he will continue to purchase charcoal for this purpose.

A second use of charcoal in this region is for filtration and adsorptive purposes. Since the water supply of the Northwest is becoming more of a problem because of stream pollution, it will soon be necessary to treat the water. Odor removal will be one of the treatments, and charcoal, because of its high adsorptive qualities, will be best suited for that purpose.

Activated charcoal would be advisable to use in water treatment because the adsorptive capacity is greatly increased by reducing the charcoal to a fine powder. This form of charcoal is more or less a specialty product, bringing a fairly good price.

Considerable thought has been given during the past few years in the Southwest and Eastern part of this country to the use of charcoal for cooking purposes, especially when camping outdoors. The United States Park Service has a project in the Southwest whereby charcoal is manufactured by the pit method, sacked, transported to National Parks within the area, and sold to recreationists at twenty-five cents a sack. At the present time the profit equals the production cost. The same procedure is being followed by the Pennsylvania State Forest Service.
Such an undertaking seems quite suited to this region, especially where highly developed recreational areas exist and fuel has become a major problem. It would be ideal to have local farmers and ranchers in the vicinity of these areas supply the charcoal. This would enable these local people to have a source of cash income which would augment their earnings from the sale of farm produce.

The charcoal could be made by the pit method, which does not require any large initial investment, thus being suited to the financial status of the local people. The actual burning operation is relatively simple. Only a few precautionary measures are needed which can be easily comprehended by the layman.

Charcoal might be used as a potential fuel supply for outdoor fireplaces that are increasing rapidly in popularity. Charcoal makes an ideal fire for foods broiled by this method. If some home economics expert could be hired to publicize such methods of cookery, it would tend to increase the demand for charcoal.
CONCLUSIONS

1. Further research is greatly needed on Douglas-fir charcoal and its derived products.

2. The present economy of the Pacific Northwest is not suited to large scale charcoal production.

3. Due to hydrelcic development of the Columbia River, this region is in an economic transitional period. To what extent industrialization occurs is difficult to predict. Charcoal possibilities will increase with further industrialization.


5. By some publicity work, it is believed a demand could be created for charcoal for broiling purposes.


10. "To Make a Product Better," *The Timberman*, vol. XLII, no. 6, p. 12 (April, 1941)

