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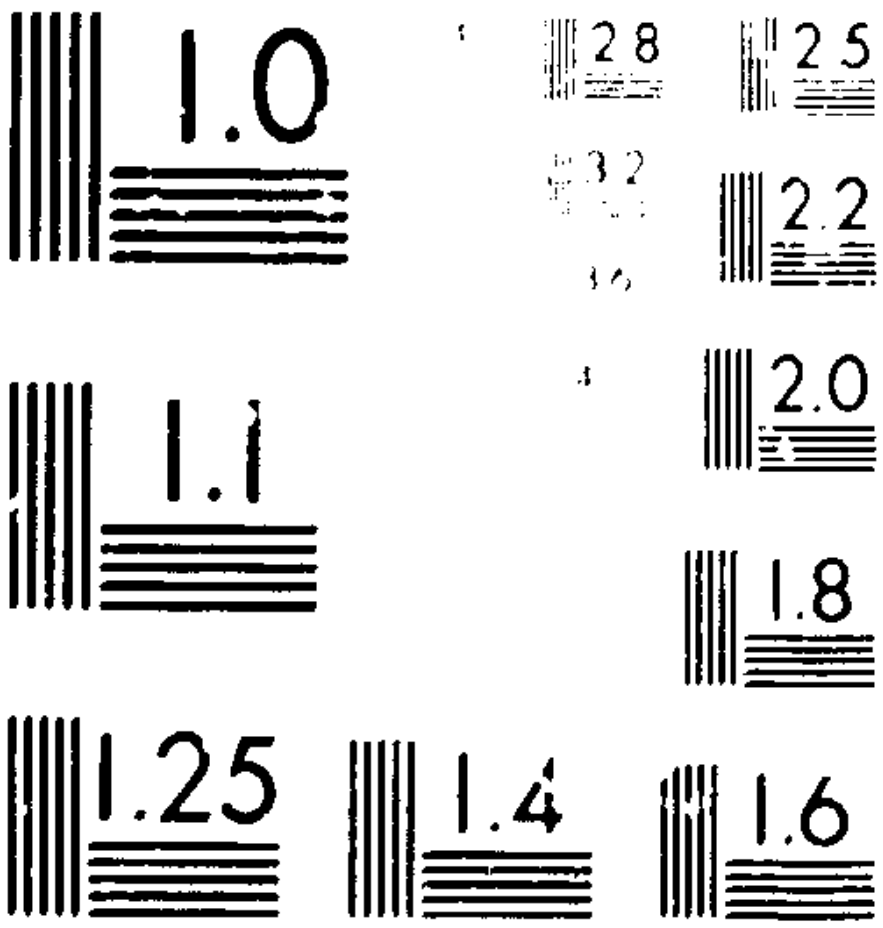
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RECOVERY AND UTILIZATION OF WASTE PRODUCTS IN THE WOOD INDUSTRIES*

by

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** Professor

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1. Introduction

An exact calculation of the amount of timber cut in a forest and of the real volume of the finished products obtained from it often gives a surprisingly low yield; by yield we mean the ratio: volume of finished products/volume of uncut timber. This disappointing result is partially due to the inevitable losses which occur at each step of the whole production process, but it is also caused by waste which a rational organization should be able to eliminate.

We must - in the economic interest of the whole world and in accordance with an intelligent ecological policy which calls on us to save our forests, which are a renewable source of raw material - achieve the following objectives:

a) reduce the amount of this raw material - wood - which is wasted throughout the production process;

b) recover all the refuse and waste products and turn them into by-products whose sales value is higher than the cost of the recovery operations themselves.

2. Waste and Recovery Possibilities in the Various Production Processes

2.1 In the timber cutting process

Some wastage is absolutely inevitable: the sawdust and chips produced when the trees are felled, for example; but some

other material can be recovered, at least partially. This is true of the parts of the tree that are left in the ground (stump and roots) and also the tops and the branches which have to be cut off in order to prepare the logs.

The stump and the top (including branches of all sizes, twigs and leaves) constitute a large portion of the biomass of every tree and their utilization is a big problem. On the one hand, they could be used as fuel or as the raw material in the manufacture of panels or wood-pulp, but on the other hand removing them from the forest impoverishes the soil noticeably and this would be detrimental to productivity in the forestry industry in the future.

The cost of labor being what it is today, nobody would dream of removing stumps by hand but now there are very powerful machines for this job (they are discussed in the report on forest exploitation). Therefore we can say that from the theoretical point of view, recovery of this waste material would be possible. However this does not mean that it would be profitable and possible: if there is no market for fuelwood or chips recovering this waste would be pointless. This is the case in the tropical forests or in inaccessible regions, for example. But when the trees are cut and the forest must be totally exploited because the land has to be cleared for farming, then the stumps and roots will have to be removed and all the possibilities of utilizing them will have to be thoroughly examined.

In the case of rapid-growth industrial tree farms total removal of the biomass can be tolerated, especially since everything which would hinder tillage has to be removed from the ground. Proper fertilizers will have to be used to make the ground fertile again. In these plantations (the trees are often poplar, tropical pine or eucalyptus) the roots are seldom very large or extensive and they can be removed by modestly powerful machines. Good results have been obtained using a hole auger driven by the power take-off on a tractor; this machine cuts the lateral roots so the tap-root can be pulled out. There is also another machine which has a cutter revolving around a vertical axis which reduces the tap-root into fragments. Obviously in both cases the ground will have to be cleared by removing the stumps.

Once all the stumps, roots and branches have been removed they will have to be reduced to chips, etc. by one of the several types of reducing machines available. From the purely technical point of view, this job is not particularly difficult but if the operation is to be successful from the economic point of view a careful study must be made in order to decide whether the best solution is a fixed machine with roots and branches being brought to it or a mobile machine (drawing a trailer for loading the chips) which travels along the rows of trees. We must not forget that the stumps have to be carefully washed

with water under pressure and cut up into small pieces before they can be fed to the reducing machine; obvioulsy both these operations are rather expensive.

One possible way of recovering forest waste products (espeically branches) is by transforming them into charcoal. This operation, which has been in practice since the dawn of civilization, is still in use in many forest regions of the workd. The traditional local methods employed are not always very rational, but it would not be very profitable to change them now. Generally these methods are based on the use of stacks covered with a sort of mantle of earth and clay which has a chiminey in the center and smaller holes all around to regulate the draft. The only machines required for this highly artisanal process are saws and axes.

In those regions where a regular supply of charcoal is indispensable for certain activities (in the steel industry, for example), charcoal burning is organized on a semi-industrial basis at fixed locations. Sometimes a series of stacks or ovens are used; the lower part of these consists of a masonry shell: once the stack has been completed it is covered with a layer of clay. In this case the wood has to be transported from the place where it was cut to the production site; this is not always easy and it is quite expensive. Transprotation costs can be cut by using knock-down metal ovens which can be set up where the timber is being cut. Research on these ovens has been done in

several countries and different models are available; these are undoubtably better than open air stacks. The essential qualities of these ovens should include: metal elements which are easy to transport and assemble and use of a type of steel which is abel to withstand the high temperatures developed in charcoal burning without deformation.

2.2 Waste and recovery possibilities in log yards

The volume of wood lost during the storage and preparation phases is due to the debarking process and to the butts which are sawed off to make the logs even before cutting them up or during peeling.

Whereas in the past bark was removed by hand using specially shaped knifes, today debarking machines are preferred. A vast range of these machines is on the market, for both fixed and mobile installations; the main type are discussed in the reports on sawmills and plywood mills.

The bark which has been removed occupies considerable space and it often creates problems: fermentation which pollutes the environment and gives off a bad smell, fire hazard and the danger of infestation by xylophagous insects or mushrooms....Therefore the bark must be eliminated completely by one of the two following means:

a) using it as a fuel in industrial plants;

b) using it in agriculture.

A third possibility would be to reduce it to chips for

manufacturing panels but the bark is often already partially decayed when it arrives and in any case it has a high moisture content (therefore it would have to be dried first). Furthermore, the fact the panels would have less value than wood panels eliminates this possibility.

Before the bark can be used as a fuel its moisture content has to be reduced to a convenient level. Part of this moisture can be eliminated by "wringing" the bark between two horizontal plates or by "Laminating" it between two vertical cylinders. After this treatment the material can be reduced to pieces about 4 cm long and fed to the burner through a pipe. The hot gases produced during combustion also travel along this pipe and they remove much of the remaining water. A bark burner must provide for three different stages of combustion: final drying, elimination of volatile gases and combustion of fixed carbon. It must allow the gases to burn completely by suppling the proper mixture of oxygen. Mechanical or inclined-grate furnace should be used. Their design should also take account of the fact that the bark often contains dirt and sand which will cause scaling, making combustion more difficult. The boiler fire surfaces have to be placed in such a way to prevent the combustion chamber at the level of the grate from cooling and to prevent ignition from becoming less rapid.

Waste wood or sawdust should always be burned together with the bark; a mixture of bark and oil fuel may also be used.

Obviously a special furnace would have to be designed and a process for preventing scaling from forming on the water pipes would have to be found.

Bark can also be pressed into briquets, either by itself or together with sawdust, and these briquets can be used for domestic heating.

The most simple use for bark in agriculture consists in breaking it up into fragments and mixing it with the earth to reduce surface evaporation and to facilitate grass planting: it will take a long time for this to be transformed into humus. Today this transformation can be accelerated by processes based on microbiological activity which in a short time produce a compost having a high percentage in nitrogen-rich humic acids without any disagreeable odor. Besides its fertilizing properties, it aslo improves the structure and the compactness of the soil. However, we must underline the fact that the appearance and the initial characteristics of bark are not the same for all wood species; therefore tests must be made in order to determine what is the best way of using it.

The butts cut off the logs can be used as fuel or they can be used for making panels or wood-pulp. In the first case they should be split roughly becuase they will have to be reduced to chips.

2.3 Waste and recovery in sawmills

Sawing logs creates a large amount of waste material in

the form of:

a) slabs and pieces which are shorter than the logs (these are caused by the fact that the tree gets thinner near the top);

b) sawdust;

c) edgings;

d) pieces which can not be sawed because they contain defects.

The pieces of wood in a) and b) can be recovered by breaking them up or by dividing them into strips to be used in the manufacture of lumber-core plywood. For this purpose, the short pieces or defective lumber are cut to the desired length, then they are run through a multi-blade circular sawing machine. The boards obtained are usually not dry enough and they have to be put through the dryer. Once their moisture content has reached the proper level, they can be assembled using one of the systems indicated in the report on plywood manufacture.

All the pieces which cannot be used for manufacturing panels, together with the edgings, can be used without any further treatment for fuel in the sawmill's heating plant or it can be used for making chips. A large amount of waste products can be recovered and made into wood-pulp or panels and today almost every sawmill has its own chipping machines (see the report on sawmills).

In order to avoid having to saw the wood first and then reduce it, one can use the American system called "Chip N" where one machine saws and reduces the outer portions of logs which cannot be used for lumber.

Sawdust constitutes an important part of the waste from sawing (often more than 10%) and there are many recovery methods which utilize it either in the natural state or after it has been transformed. We will not discuss the applications for sawdust in the natural state (which do not require any special machines), or the chemical transformations (manufacture of oxalic acid) or its use in the manufacture of panels (see the report on particleboard). We just want to mention that sawdust in the form of briquets can be used as a fuel. These briquets are compressed without any adhesives or other substances because the temperature to which the mass is heated during compression (100 - 170 N/mm^2) makes it stay together. There are two very well known machines for manufacturing these bricks: Glomera (Swiss) and Pres-to-log (USA).

2.4 Waste and recovery in plywood mills

For the recovery of bark, the same solutions as described before are available.

The other waste material includes:

a) round-ups, edgings and all the veneer which cannot even be used for the internal plies;

b) cores left after the log has been peeled;

c) sawdust from sanding:

d) waste material produced when the panels are finally edged and all rejected material.

For the material in items c) and d) the only possible use is as fuel.

It is more advantageous to reduce the round-ups than to burn them.

The cores can either be reduced or sawed up into thin boards which can be used for light crates; a special saw will be required for the second operation.

2.5 Recovery of waste wood for the manufacture of wood flour

Wood flour is a product with several very interesting applications and this is why it deserves special consideration.

Nevertheless, the basic raw material must absolutely meet certain conditions, i.e., it must come from a single wood species (possibly light in color) and it must not have too many impurities such as pieces of bark, sand, foreign matter, resin, glue, etc.

If the waste material is sawdust (more or less fine), then the transformation process begins by sending the sawdust along a helical pipe fitted with diaphragms which stop the non-wood particles. Magnets are also used to remove all metal powder or fragments deriving from tool wear. Then the sawdust is sent to the mills of which there are the following types:

- with two grindstones, one fixed and one rotating or both rotating in opposite directions; steel discs with small radial grooves may be used instead of grindstones;

- with two cylinders with grooved surfaces; the cylinders rotate in opposite directions, crushing the sawdust into a very fine powder;

- with balls inside a cavity; the inside surface of the cavity is covered with spiral reliefs and by making the whole thing vibrate the balls repeatedly strike against the protuberances and the sawdust is reduced to an extremely fine powder;

- hammer type with sharp edges

When it leaves the mill the material is sifted in order to separate the particles of different diameter. Then is is dried in rotating dryers; great care must be used in order to prevent the material from igniting. This danger exists from the beginning of the process to the end and therefore one must ensure that all the electrical installations are perfectly insulated and enclosed.