TECHNICAL PAPER # 47

UNDERSTANDING NON-FUEL USES OF WOOD WASTES

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ISBN: 0-86619-261-1

PREFACE

This paper is one of a series published by Volunteers in Technical

Assistance to provide an introduction to specific state-of-the-art technologies of interest to people in developing countries. The papers are intended to be used as guidelines to help people choose technologies that are suitable to their situations. They are not intended to provide construction or implementation details. People are urged to contact VITA or a similar organization for further information and technical assistance if they find that a particular technology seems to meet their needs.

The papers in the series were written, reviewed, and illustrated almost entirely by VITA Volunteer technical experts on a purely voluntary basis. Some 500 volunteers were involved in the production of the first 100 titles issued, contributing approximately 5,000 hours of their time. VITA staff included Marjorie Bowens-Wheatley as editor, Suzanne Brooks handling typesetting and layout, and Margaret Crouch as project manager.

VITA Volunteer Jon Vogler, the author of this paper, is widely published in the field of recycling. His book Work From Waste, published by the Intermediate Technology Development Group, Ltd., London, England, describes how to recycle paper, plastics, textiles, as well as metals. Mr. Vogler, an engineer, worked in Oxfam's "Wastesaver" program in developing countries. He has done much research in the field of recycling waste materials.

VITA is a private, nonprofit organization that supports people working on technical problems in developing countries. VITA offers information and assistance aimed at helping individuals and groups to select and implement technologies appropriate to their situations. VITA maintains an international Inquiry Service, specialized documentation center, and a computerized roster of volunteer technical consultants; manages long-term field projects; and publishes a variety of technical manuals and papers.

UNDERSTANDING NON-FUEL USES OF WOOD WASTES

by VITA Volunteer Jon Vogler

I. BACKGROUND

We can define wood wastes as wastes arising from human operations on wood: extracting it from forest, woodland, and plantation; converting it into planks and other "stock"; fabricating these into products--buildings, furniture, tools, and thousands of other items; and, finally, discarding these when broken or even just "out of fashion." To this definition may be added "nature's wastes," such as leaves, twigs, and branches that fall from the tree due to natural causes such as ageing, wind, lightning, or animal disturbance.

With this broad definition in mind, tree and wood wastes can be categorized as follows:

Forest Wastes	Converting Wastes	User Wastes
Thinnings(*)	Bark	Sawdust
Reject Trees	Sawdust	Shavings
Leaves	Slabs(*)	Sander Dust

Bark Edgings(*) End Trim(*)
Branches(*) Rejects(*) Off Cuts(*)
Topwood Veneer Clippings
Stumps and Roots(*)

The use of waste wood is as old as humankind. Stone-age people probably used wood waste to fuel fire since greenwood is very difficult to burn. Manufacture of items from wood also began very early. Wood was used for tools and weapons and, no doubt, cut-offs from the production of long implements were used for short axe-handles or pegs, while chips and shavings served for fire kindling.

This paper focuses on non-fuel uses of wood wastes. However, the reader must remember that by far the most important use of wood wastes in large areas of the world is as fuel. This aspect of the use of wood wastes is covered in a separate paper, "Understanding the Use of Wood Wastes as Fuel." People throughout the

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(*) Widely used directly as domestic fuel, as kindling, and as the raw material for charcoal.

developing world, both urban and rural, consume fuel wood and charcoal faster than it can be renewed. Meanwhile, an insatiable demand for paper made from woodpulp, wooden building components, furniture, and other goods also contributes to deforestation. Economical use of wood wastes instead of new wood helps to preserve forest and woodland in developed countries and is becoming essential to the survival of the poor in many parts of the Third World, as fuel becomes more scarce.

II. BUILDING MATERIALS FROM SAWDUST AND WOOD WASTES

Rapid changes in manufacturing technology, particularly the development of plastics and lightweight foams, have reduced the use of wood wastes in building technology in many countries. However, because the new products are often expensive, imported, or unavailable outside major metropolitan areas, many uses of wood wastes that have been replaced in some regions may still be cost-effective and useful in other regions. In villages all over the world, such products may remain invaluable for decades to come.

FIBERBOARDS AND PARTICLE BOARDS

There are two common processes in making these products:

o Dry Particle Bonding - The dry and semi-dry processes consist of mixing graded material with bonding resins and forming them into the finished product, using a power press and molds. This process produces material with superior hardness and better nail and screw holding properties, desirable in boards used as timber substitutes. These are generally referred to as particle boards or chipboards.

o Wet Process - The wet process reduces sawdust and chips to, a semi-liquid state of wood fiber. This is mixed with bonding resins and a fiber mat formed in a decklebox, similar to those used in hand papermaking. From this point on, a variety of different kinds of board can be produced, but all may be classed as fiberboards.

Hardboard

To produce the most dense hardboard for interior partitioning or dense ceiling boards, the matted fibers are pressed between the platens of a hot press. Existing plywood presses may be used to avoid a new capital investment.

Fiberboard

Medium density fiberboards are produced when binders are introduced into the fiber mat and the board is hot pressed to a density of 26 to 50 pounds per cubic foot. After partial drying, they may be laminated with one or more plies of low-grade veneer, to produce a wood-faced panel.

Insulation Board

Insulation board is produced when such mats are dried without further hot pressing. The board is held together by the normal fiber bonding. Insulation board plants usually must be large-capacity because of the cost of continuous dryers. There may not be sufficient whole wood waste to justify the installation of conventional insulation board plants competitive with existing plants using pulpwood. Insulation boards require little or no resin, but resin and alum are added to decrease water absorption. Asphalt may be added to increase wet strength. It is reported that dried mats, unpressed, may be soaked in molten sulphur and cooled to a fiber-reinforced product, sometimes called poor man's fiberglass, with good strength and water resistance.

PARTICLE BOARDS

Panels, doors, furniture, and wallboard can be made from sawdust and woodchips, bonded with resin. The materials and processes for fabricating panels, doors and wallboard are similar. Most of them can only be operated on an industrial scale as heavy presses are required.

Materials - The Wood Waste

Particles are produced by hammer milling planer shavings and chips, chipped or hogged veneer, or slab wood. Because of their higher moisture content, green planer shavings are damaged less by the planer and when hammer milled, break into sliver-like components. The properties of board made from them are better than those of boards made from dry shavings. Little bark is included in either fiber or particle board because (a) Dirt and grit are almost always present; (b) Pulping bark may require different conditions than wood; (c) Particle bark may be stringy or flaky. This creates problems in screening, resin distribution and mat formation; (d) Bark is dark colored and shows up in the finished boards, either as dark flecking or as a uniform dark tinge.

Equipment that will reduce whole wood to fiber and fiber bundle, suitable for insulation and hardboard such as hammer mills, chippers, grinders, defibrators, continuous steam cookers, and disc refiners can be obtained from manufacturers of wood pulping machinery.

Materials - Resins

The bond in particle boards is produced by the cured (hardened) resin. The small amount or resin required, even though only 6 to 10 percent, is by far the most expensive ingredient of particle board. The amount depends on the size and shape of the wood particles, so selection of an optimum particle size is economically very important. However, the quality of the resin binding agent has more influence than that of the sawdust and chips on the quality of the finished product. Conditions of use determine choice of resins. Hygroscopic resins (water absorbing) should not be used for products that will serve in damp conditions. Thus, urea-formaldehyde resins are used only for interior wallboard where moisture is no problem, because they are lower in cost than phenolic resins (pheno-formaldehyde) but cannot withstand high temperatures and moisture. Phenolic resins are most suitable for exterior use products or where water resistance or surface hardness must be increased. However, even this product is not suitable for exterior use in damp climates. Resins that dehydrate (lose water) completely are not suitable when the finished product is to be used in warm, dry climates.

Phenolic and urea-formaldehyde resins and casein glue are known as synthetic binders; they do not occur naturally. There are also a number of naturally occurring binders that are cheaper and, if selected with the service conditions of the board in mind, may be equally good. These include animal glues, blood glue, starch glue, and, for some uses, the resinous properties of naturally occurring materials such as tannin (tannin formaldehyde resin), lignin, and the products of wood decay. In addition, binders such as Portland and magnesite cements may be used to produce building products such as wall ceiling slabs or hollow building blocks.

Manufacturing Operations

Commercial board manufacture involves receipt of the raw wood waste. Particle or solid material passes through a hogger or hammer mill, then rejoins small size waste (chips, flakes, and sawdust) to pass through grinding mills and screens for final sizing. The milled material is conveyed, often by air blowers along ducting systems, to a cyclone separator, which removes dust, then into dryers (usually of the rotary drum type) to adjust the moisture content to 6 or 7 percent. It is then stored in bins until needed.

Dry wood material is weighed into a mixing vat and the required quantity of liquid or powder binders added. Liquid binder may be sprayed on the particles in a continuous operation or mixing may be carried out in batches, by tumbling the particles and binder in a drum or mixer. The moisture content of the particles must be controlled while the resin is being added. The mixture is measured out in measuring boxes, then conveyed to trays that are loaded into the press. Presses are multi-daylight, that is to say, many boards can be pressed in each operation. Pressing time depends on thickness, temperature, and whether or not a preform is used. For 1/4-inch thick board, pressure is maintained for 15 minutes; for 5/8-inch thick board: 35-45 minutes. Pressures vary from about 200 pounds per square inch to 450 pounds per square inch, depending on the final board density required and the type of waste material used. Pressing temperatures used are 250 to 300 degrees Fahrenheit. After pressing, the boards pass through trimming saws and go to storage awaiting dispatch.

In some particle board plants, an extrusion press is used--a continuous operation in which the board is squeezed out between heated rollers. The particle board produced in this way has X-definite directional properties. It is weaker or less rigid in one direction than in the other. Cost of the equipment may be less than for hot presses.

After manufacture, boards may be either (a) dipped in moisture repellents, such as asphalt; (b) humidified (placed in racks in humid chambers); (c) oil tempered--passed through a bath of oil, then baked until the oil diffuses through the board (tempering improves both strength and water resistance); or (d) painted, scored, sanded, or embossed to improve appearance.

Economics of Particle Board Manufacture

Particle board manufacture requires an expensive capital plant--grinding mills, dryers, trough mixers and multi-daylight hot presses, conveying equipment (conveyor belts, exhaust fans, and cyclone separators), storage floors and bins, and, where dryers or press are steam heated, a steam raising boiler. Also needed are plates and trays for the pressing operation, trim saws for sizing the processed sheet, pump and piping to convey liquid binder to the mixer. For this reason, particle board plants are usually large and require large quantities of wood waste to feed them.

A production rate of approximately one ton of half-inch board per hour can be obtained from two 25-HP grinding mills, two 6-foot by 20-foot rotary drum dryers, three 8-foot by 4-foot mixing troughs and two 10- or 12-daylight, hot presses. Consumption of electricity is 80 to 150 kilowatt-hours per ton of production. Labor required, with a batch process, is 20 person-hours per ton of production and with a continuous process, six person-hours per ton of production.

Authorities differ on what is the minimum size of an economical plant and in practice this will vary from place to place. One U.S. source states that:

A one-ton per hour plant, manufacturing medium density board (equivalent to some 1,200 square feet of 1/2-inch thick board, or 960 square feet of 5/8-inch board per hour) is regarded as the smallest. In special circumstances a plant with a production rate of 1/2 ton per hour could operate

effectively.

Another source, on the other hand asserts that:

The minimum daily required of all necessary to produce wallboard ranges from 50 to 100 tons per day. Hand-operated facilities produce 35 kg of panel per day, while machine powered, semi-automated plants are producing 10 to 20 tons per day.

Another expert has yet a different view.

Conventional hardboard mills are economical for installations of about 35 tons per day. Such a plant, with a 4-foot by 16-foot, 20-opening press, will use about 70 tons of raw wood each 24 hours. Wood can be used for fuel to generate power and to provide steam to heat the platens of the hot press. Fuel requirements amount to two to three tons of wood waste per ton of board.

The cost of dry processing plants is about two-thirds that of wet processing plants, but the cost of resin binders makes the product more expensive.

OTHER BUILDING MATERIALS

Blocks

Sawdust can be used as a cheap, lighweight aggregate for building blocks. Such blocks are light and porous, hold nails and screws well, and have fair insulation properties. However, there is a disadvantage of using sawdust in masonry. It undergoes comparatively large movements with changes of moisture content that result from changes in humidity or wetting and drying. When using it with Portland cement, it is necessary to ensure that materials in the sawdust, such as resins and acids, do not upset the hardening qualities of the the cement. Adding hyrdrated lime to the mix, between one-sixth and one-third volume of lime per volume of cement, will normally guard against this, but certain sawdusts give setting difficulties even with lime present. Other special treatments include immersion of the sawdust in boiling water for ten minutes, followed by washing with water, followed by further immersion in boiling water containing two percent ferric sulphate, more washing and draining. Alternatively, use of 4 or 5 percent by weight of a setting accelerator, such as calcium chloride, has been found useful. However, to avoid expensive additives, first check test whether the proposed mix hardens satisfactorily using only hydrated lime.

Use of the correct quantity of water is most important. The strongest mix will be that on which it is impossible to draw a cement "skin" to the surface during trowelling, while a smooth surface can still be produced. It should have a moist earth consistency with no appearance of free mositure. For a 1:3 mix (by volume) of cement, and sawdust, the weight of water should be from 80 to 140 percent of the weight of cement. (The variation is due to the degree of dryness of the cement). Excess water causes shrinkage during setting, deep crazing several months after laying, and lower strength as well.

The practical ratio of cement to sawdust is from 1:1 to about 1:5 by volume, ranging from heavy, strong, and dense products from the former to lighter products from the 1:5 mixes, low in strength and fire resistance and prone to increases in movement with moisture changes. Leaner mixes can be cut and nailed readily but the richer ones become difficult to nail as drying proceeds. Addition of an inert aggregate, such as sand or granite chips, reduces shrinkage but also reduces insulation properites and nailability. Methods employed to minimize movement include water proofing by tar or bitumen after installation and designs that allow movement to be taken up within the building. Manufacture is by the same processes as for cement-sand blocks, ranging from hand molding into wooden molds to the use of fully automated block-making machinery.

Concrete

Mineralized sawdust (treated with zinc chloride) can be used to produce a light-weight concrete. With sawdust forming one third to one half of the mix by weight, the resulting product is reported to be wear-resistant, a non-conductor of sound, comfortable to walk on, and can be sawed, nailed, screwed, and polished.

Porous Bricks and Tiles

Beautifully mottled wall and floor tiles can be produced by incorporating a high percentage of shavings in the tile mix. The use of attractively grained hardwoods is particularly successful. Test tiles should be done before mixing a batch to ensure substances of shavings in the tile mix. The use of attractively grained hardwoods is particularly successful. Test tiles should be done before mixing a batch to ensure substances in the wood do not affect the curing properties of the binder used in the tile mix.

Flooring Compounds

Fine hardwood sawdust (of 24 to 40 mesh) can be used as a filler in magnesium oxychloride flooring. The proportion of sawdust may be varied 4 to 70 percent. Sawdust makes the floor light and porous, so nails can be readily driven into it. It is particularly used for composition floors to which a covering is to be nailed. A more economical formula is to use 20 mesh, kiln-dried hardwood sawdust for the top layers and coarse softwood sawdust for the base.

Roofing Felt

Forest and mill waste is shredded by "defibrators" to yield a coarse wood fiber. This is used as a filler in rolls of roofing felts and composition shingles. The preferred species are maple, birch, and aspen, but other wood types can also be used, in proportions of up to 50 percent.

Gypsum Products

Sawdust can be used in the manufacture of gypsum commodities to decrease weight and increase sound and heat insulation qualities. This can also make them porous and soft so they can be nailed and sawn. Such products are used for interior partitions, floor insulation, wall boards, and roofing material. Composition stuccos and plasters also use sawdust as fillers to make them lighter and more porous than normal, able to be nailed, and higher quality insulators. Shavings can also be mixed with limestone during burning to produce lime. The resulting product is said to be of high quality.

Protection of Fresh Concrete

Sawdust, spread in a layer three or four inches deep, thoroughly wet down, provides the moisture needed for proper curing and reduces the rate of evaporation and the impact of the sun's heat.

Insulation

Sawdust can be used in wall construction--mixed with asphalt and resins, then rolled into sheets and used as insulation on the sides of buildings or floors. Alternatively, it can be packed into a sandwich between corrugated galvanized sheeting, commonly used as roofing for low-cost dwellings, but very hot under direct sunshine. Sawdust serves as an effective insulator in construction of ice-houses, refrigerated trucks, and cold storage sheds. When properly packed it does not add to the fire risk and can be additionally protected against fire and insects by the use of low cost chemicals.

Paths and Sport Facilities

Sawdust forms a practical covering for paths over muddy fields and a soft, yielding surface for jump pits at sports grounds and other such facilities.

III. AGRICULTURAL USES

LIVESTOCK AND KENNEL BEDDING

Coarsely ground shavings or sawdust make excellent bedding for small animals such as chickens or rabbits. It is cheap, soft, warm, and free from dust associated with straw. It absorbs urine and excreta, and especially from fowl has some fertilizer value. By adding superphosphate and permitting this to rot, an even better grade of fertilizer can be produced.

MULCH

A mulch is a layer of material laid of top of (or mixed with the top layer of) soil, often around young plants, for the purpose of reducing water evaporation from the soil, controlling surface temperatures (protection from frost or strong sun), or preventing weed growth. Mulches may serve to prevent soil splashing during heavy rainfall and resulting erosion and may improve the rate of water movement into the soils. The action of a mulch is physical; organic mulches also break down chemically to provide necessary elements and humus to the soil. Sawdust is considered to be an excellent mulch for fruit orchards, tobacco and similar seedlings, and for soft-fruit, vegetables, and flower gardens. However, if the sawdust mulch is mixed in with the soil, it is essential that adequate nitrogen be added also.

THE USE OF SAWDUST IN SOIL CONDITIONERS

Wood contains only small amounts of inorganic chemicals valuable as fertilizers: 31 pounds of nitrogen, 21 pounds of phosphate, and 2 pounds of potash per ton of dry material. Only when composted with other materials is the nutrient value of wood waste raised. The principal organic compounds present in wood that are of agricultural interest are cellulose, the pentosans, and lignin (the tough fibers that make a material "woody"). When sawdust is added to soil, the cellulose and the pentosans are attacked most rapidly by bacteria and fungi. The lignin and its degradation products and the residue of micro-organisms tend to remain in the soil as humus, the network of fibrous and granular material that is important for improving the physical condition of the soil.

When undecomposed sawdust is mixed with soil, however, a temporary harmful effect on crops may occur, indicated by yellowing plants. This is caused by depletion of the available soil nitrogen, which takes place because the decomposition of wood particles by bacteria and fungi requires more nitrogen than the small amounts provided by the sawdust. This extra nitrogen is drawn from the soil, decreasing the amount of nitrogen available to plants. The effect seldom extends beyond the first season if no more than three to four tons of dry material per acre are added to the soil, but the addition of larger amounts may result in nitrate depression over several years. Ultimately, the nitrogen used by the microorganisms is released as they die and becomes available to plants.

Factors that influence nitrogen removal:

o The resistance of the material to decomposition (hardwoods and resinous timbers decompose far more slowly)

o The size of wood particles

o The nature of the soil: coarse-textured soils allow air to penetrate, speeding up the action of the bacteria, so they require a greater amount of nitrogen. In heavy soils, micro-organic activity will be less and the nitrogen drain will be less swift.

o Whether the woody material is mixed into the soil; it will decompose more rapidly than if only spread on the surface.

A number of methods are possible to overcome this effect of the sawdust:

o Chemical nitrogen can be added, often with limestone and phosphate: 10 to 20 pounds of elemental nitrogen per ton of sawdust during the first year (equal to 30 to 60 pounds of ammonium nitrate, or 50 to 100 pounds of ammonium sulphate). Half this amount should be added during the second and third-years.

o The wood can be decomposed before addition to soil, usually by composting. An organic material used to decompose woody composts should contain 2 percent or more nitrogen content and be mixed one part of sawdust to one part of organic material, by volume. A high-protein material, such as fish meal, can be added to sawdust in a ratio as low as one to ten. Animal and chicken manures, wastes from fruit, vegetable, and fish canneries, spent hops from breweries, pea vines or other legume waste, and sewage sludge are all suitable. Addition of a small amount of superphosphate or gypsum pounds of dry compost) saves nitrogen lost (as ammonia gas) from the actively decomposing compost pile. Under conditions of adequate moisture, sawdust compost should be ready to use in three to six months. Inocculation of the sawdust composting material with a cellulose-decomposing fungus may speed up the process.

o Using woodwastes that have served as bedding for animals and poultry. The sawdust acts as an absorbent for liquid manure, which contains 90 percent of the total nitrogen in manure. As above, the nitrogen in the liquid manure should be "fixed," so that it does not readily evaporate, by adding slightly more superphosphate

(50 pounds per ton of dry wood).

o Use wood chips instead of sawdust. These support a smaller microbe population so nitrogen is not noticeably depleted when the material is added to the soil, yet the soil still gains many of the advantages described above.

It is also possible that phosphate deficiency may be brought about by sawdust addition. Most kinds of sawdust are acid but, unless the sawdust is applied to lime-requiring crops, the acid is of minor importance. In the case of acid-requiring plants such as blueberries and azaleas, the resulting acidity is beneficial.

INSECT CONTROL

Sawdust has been employed as a carrier for arsenic and other poisons. It has also been described as an excellent repellent of fleas, moths, and other insects. In Mexico it is used to control certain tree-destroying worms. Flies are imported that eat the worms and are, in turn, trapped on beds of sawdust treated with insecticide.

IV. INDUSTRIAL USES

DEALING IN SAWDUST

The many uses described here for sawdust, chips, and shavings mean opportunities exist in some places for traders to become dealers--to buy from sawmills, furniture factories, and other large-scale producers, and to transport, grade, store, and market to small-scale users. Shavings and sawdust are generally classified by dealers as softwood, hardwood, or mixed softwood and hardwood. This product can also be purchased as green, air dry, or kiln dry sawdust. It may also be graded by size. Common grades of sifted sawdust are: eight mesh, 20 mesh, 40 mesh, etc. (Eight mesh sawdust will pass through a wire sieve having eight wires to the inch.) Softwood sawdust is low in value and is seldom sifted.

MISCELLANEOUS INDUSTRIAL USES

Anti-slip Covering for Floors

In workshops where liquids such as blood or oil may be spilled, sawdust absorbs the liquids and improves the floor friction.

Floor-sweeping Compounds

There are two general types of sweeping compound that contain sawdust. One, containing oil, is for use on cement, terrazzo, wood, and other floors not affected by mineral oil. In the other type, the oil is replaced by a water-wax emulsion. This is suitable for use on linoleum, rubber, asphalt, tile, and mastic floors. Usually finer grades of sawdust, well aired and dried to absorb oil and wax, are used. Types of oil used in sweeping compounds vary: heavy refined mineral oils, medium grades of mineral oil with a high boiling point (cylinder oil), low-grade lubrication oils, and paraffin oil may all be used. Paraffin wax is melted in small quantities in hot paraffin oil to improve its dust-gathering properties. Sweeping compounds are usually colored with low-cost dyes, such as vermillion, bluing, iron oxide, or water-soluble dyes like malachite green. The amount of dye required is very small. Cedar oil, oil of sassafras, or oil of mirbane are sometimes added for fragrance. The principal equipment required is a mixer (a clean concrete mixer would serve), a tank or steel drum for heating the oil, and a sieve for screening the sand and sawdust.

A typical recipe might be:

15 pounds Sawdust

1 ounce Powdered wax

1/2 pint Paraffin oil

1/2 ounce Oil of mirbane

as desired Analine dye

1/2 pound Common salt

5 pounds Fine sharp sand

To prepare:

Melt the wax and add it to the warm paraffin oil. Add the oil or mirbane and any analine dye desired. Saturate the sawdust with this mixture and stir; then add the salt and sand. Adjust the dampness by adding more sawdust if required.

Hand Soaps

Soaps for mechanics often contain sawdust, which serves as a gentle abrasive, carrying the soap in to the folds and creases of the skin. Usually very fine grade hardwood sawdust is used.

Fire Extinguishers

Sawdust can be more effective than sand as an extinguisher of oil, gas, and lacquer fires. Because it is light, it remains on the surface of the liquid and smothers the fire. It is more effective if mixed with soda. Pine sawdusts with high resin content should not be used.

Filters

Lubrication oil containing sludge can be passed through a sawdust filter to remove impurities.

Packing

Wood shavings are widely used for packing fragile objects.

Clean, dry shavings are essential. Fragile articles, such as glass bottles of chemicals, are packed in wood wastes. Others may require insulation from heat or cold. In other cases, staining liquids (like ink) might damage other goods if the container is broken. Because sawdust absorbs moisture, it prevents rusting of iron and steel goods (such as nails and screws) in damp climates. Sifted sawdust without smell or taste, preferably light colored such as spruce, is preferred.

Fur Cleaning and Dyeing

Sawdust is used in cleaning, glazing, and dyeing fur pelts and garments by dusting and brushing. Dry, raw furs are first moistened by covering with damp sawdust. They are cleaned by tumbling in drums with dry sawdust, which absorbs the grease and dirt. Often the sawdust is treated with solvent that cuts the grease. After the pelts have been tanned, they are again tumbled with sawdust to give the hair a light, fluffy appearance and to restore luster reduced in the dyeing process. Sawdust for furriers is fine, clean, granular, and absorptive, commonly kiln-dried hard maple and other hardwood stock.

Leather Working

Tanneries use sawdust to moisten the hides for stretching. Wet sawdust is evenly distributed over the surface and the stretching done with minimum loss from tearing. The sawdust must be free of splinters, foreign matter, and grease.

Metal Finishing

Ground very fine, sawdust is used in the plating industry to clean, dry, and polish metals after removal from plating solutions. Coarse, sifted eight-mesh sawdust is used. Softwood sawdust contains objectionable pitch, resins, and oils so only kiln-dried acid-free hardwood sawdust (18 to 24 mesh) is employed. Woods containing acid, such as oak, stain the polished surfaces and are not used. metals that have been cleaned in a pickling bath are dried and polished by tumbling in sawdust. Greasy components made in large volume on automatic machine tools can be cleaned, dried, and polished by agitation in a tumbling barrel with sawdust. Aluminumware is cleaned and polished by sawdust after degreasing in a solvent solution.

Wallpaper Manufacture

Sawdust and fine chippings are included in the pulp from which "oatmeal" or "anaglypta" wallpapers are made, with various distinctive embossed surfaces.

Molded Products

Sawdust bonded with resin has been used to manufacture molded wooden items such as breadboards, cups, bowls, or similar items. Artificial wood is made of sawdust, paper waste, casein glue, and limestone or chalk. The ingredients are ground together, moistened with water and molded. The finished product is said to possess many of the properties of natural wood.

Toys

Fine dry sawdust is also used to stuff dolls and toy animals.

FOOD PROCESSING INDUSTRIES

Poultry Picking

After the main wing and tail feathers are removed, the carcass is partially scaled, then covered in fine, dry sawdust. In three or four minutes most of the water is absorbed, making picking, and removal of the pin feathers easier, without injury to the skin.

Smoking Meat and Fish

Raw hardwood sawdust and chips are used to smoke meat and fish. Meats that have been pickled or cured (such as ham, bacon, fish, and sausage) are smoked to give flavor and increase their keeping qualities. Usually a smoldering fire of hardwood blocks and sawdust is built and meat hung over the smoke for four or five days at about 75 F. A quicker method of curing can be done in one day, but requires a higher temperature. Hickory, maple, mahogany, oak, and walnut are all commonly used in the smoking process.

Packing for Ice

Sawdust used in packing ice helps to keep the ice clean, insulates it from heat, and makes it less slippery for handling.

WOOD FLOUR

Wood flour is not the same as sawdust. It is a uniform, fine powder of much smaller grain size. Commercially, it is used as an absorbent, a chemically reacting substance, a chemically inert filler, a modifier of physical properties, a mild abrasive, and a decorative material.

Uses of Wood Flour

Wood flour can be used as an absorbent to remove water, oils, or greases from delicate machinery parts, jewelry, and furs. In the manufacture of dynamite, the sensitivity of the explosive can be reduced by absorbing it in wood flour, thus solidifying the liquid nitroglycerine.

The chemically reactive property of wood flour is utilized in incense and in the coatings of arc-welding rods where it provides a neutral gas to protect the weld puddle from air. In reaction with polyurethane foaming resins it produces a rigid foam-in-place structure. Wood flour is also used in fireworks intended to burn for a time rather than explode.

As a chemically inert diluting agent or filler, wood flour is used in the manufacture of plastic products. When utilized in this manner it increases impact resistance or toughness, reduces stresses, and minimizes shrinkage on cooling after molding. Wood flour is sometimes added to make transparent plastics opaque. It is also used in the manufacture of patching materials, cements and glues, insecticides, soap powders, and rubber. The natural resins in wood flour are used for their binding properties, notably in linoleum manufacture.

In foundries, wood flour is used as an anti-binding agent to modify the physical properties of an item--for example, to help ease castings out of their molds. In chinaware and fire-brick manufacture, it is used as a burn-out material to increase porosity. In special paints, it gives sound insulating properties and in electrical equipment, wood flour improves insulation.

As a mild abrasive, wood flour is sometimes added to soaps and is used in cleaning furs. It is also used to polish soft materials such as buttons and for removing the flash (material that sweeps out at the mold joint) from newly molded plastic articles.

Wood flour is also used decoratively in interior decorating. In velvet or raised wallpaper for example, colored wood flour is sprinkled over the sized surface.

Wood flour has also been used in biochemical processes as a culture medium for the growth of bacteria, for example. This produces valuable organic acids such as acetic, lactic, gluconic, and citric.

Manufacture of Wood Flour

Light colored flour is required for many applications. Since bleaching is not practiced, light woods such as spruce, pine and fir teak, beech, mahogany, and cedar are the most desirable. The chief source of raw materials for wood flour is the residue of other wood processing industries. Wood flour can be produced by a variety of method: recovery of dust from sanders; screening, using meshes as fine as 350 to 400; abrasion by corrugated metal discs revolving in opposite directions; cutting and shock, using impact hammermills; and crushing by passing the material between a moving roll and a stationary surface.

A plant that produces one ton per hour of fine mesh wood flour from hardwood shavings and coarse sawdust requires the following:

o the raw material is reduced in an 18-inch hammer mill, driven by a 75-HP motor, then conveyed directly to a 35-inch double head attrition (grinding/wearing) mill with two 75-HP motors;

o the material falls through a sifter mill with 80-mesh screens;

o the overage from the sifter is recycled back to mill and the accepted fraction goes to the bagging equipment.

Prices charged for wood flour increase with the mesh number: 100-mesh is more valued than 40-mesh and finer meshes will bear higher prices.

INDUSTRIAL CHEMICAL PRODUCTS

Most wood waste still retains the fibrous structure of the original wood. Wood is composed mainly of cellulose and lignin, and from the standpoint of chemical utilization these are the main constituents. They are highly complex and relatively inert substances, closely held together by chemical bonds. They can only be separated by drastic chemical treatment. In addition, wood contains small amounts of extractable materials such as resins, fats, tannins, and essential oils. The main processes for chemical utilization of wood are manufacture of chemical pulp, destructive distillation, and wood hydrolysis. None of these processes fully utilize the chemical properties of wood waste.

In the production of wood pulp, both mechanical and chemical, the wood is converted to fibers and the products derived from the wood pulp are in general dependent on the properties of these fibers. In the production of chemical pulp, there is a loss of approximately 50 percent of wood substances in the form of lignin, hemicelluloses, and degraded cellulose.

Manufacture of wood pulp from waste is usally more expensive than using roundwood or complete tree trunks. Some mills that employ the kraft or sulphate process, however, in which the presence of varied wood and bark is not objectionable, add waste to the roundwood.

The process of distillation involves heating the waste in a limited supply of air so that gases are given off that can be collected and condensed, leaving a char behind. The products of .distilling hardwoods are charcoal, hardwood tars, acetic acid or calcium acetate (also called acetate of lime), methanol, and wood alcohol. In the case of soft woods, distilling products include charcoal, turpentine, pine oil, and pine tar. Products of dry distillation of resinous pine are wood turpentine, tar oils, tar, and charcoal.

Shavings and sawdust are also heated with a mixture of caustic soda and lime. Approximately 20 percent of the gases given off are oils, of which 50 percent are ketones, and 25 percent hydrocarbons that can be used as solvents and plasticizers.

Oxalic acid, which also can be produced by other processes, may be made according to the Othermer method. This yields a quantity of oxalic acid equal to 75 percent of the dry weight of the wood plus considerable quantities of acetic and formic acids and methanol. The general materials and yield are as follows:

Material Used - Pounds Product Formed - Pounds

100 dry sawdust 44.5 [oxalic acid]

9 sodium hydroxide 11.7 [acetic acid)

34.7 lime 2.48 formic acid

61.1 100% sulfuric acid 5.5 methanol

85.5 calcium sulfate
(waste)
3.0 wood oil

Acid Hydrolysis

Hydroloysis (chemical combination with water) of a cellulosic material such as wood results in carbohydrates, chiefly glucose, with lesser quantities of sugars such as xylose, mannose, galactose, and arabinose. Fermentable carbohydrates convert to yeast or ethyl alcohol. Other fermentation products such as butylene glycol, butanol, acetone, and organic acids can also be produced.

To manufacture industrial alcohol from sawdust and other mill waste, the wood is placed in rotary digesters and treated with dilute acid at high temperatures, converting the cellulose into fermentable sugars. These substances are then separated and fermented into alcohol, which is distilled and rectified to make a product equivalent to grain alcohol. The commercial success of Wood hydrolysis depends on the demand for alcohol, the availability and price of molasses (a competive raw material), and the extent to which alcohol is produced more cheaply from petroleum refinery by-product gases.

Potash

Potash is manufactured from wood ashes. Hardwood ashes are desirable and will yield 10 percent of potash.

OTHER USES FOR WOOD WASTES

In the manufacture of softwood lumber, material in lengths under eight feet is often wasted. Such short length stock (or off-cuts) constitutes five percent of the total volume of stockwood lumber. Even smaller sawed pieces from sawmills, furniture manufacturers, and carpentry shops often still have value and may be used to make boxes, children's toys, beehives, brooms, cable reels, dowels, drying racks, farm equipment, furniture, handles, hardwood flooring, picture frames, seating, signs, step ladders, or other goods.

Slabs are strips of wood removed from the outside of the tree trunk before it is converted into planks. They are often about six inches wide and six to eight feet long, with one flat side, and when the other covered with bark. Slabs can be used as lumber and the other covered with bark. Slabs can be used as lumber, whenever the finished product does not have to be uniform and tight-fitting. Appropriate usage of slabs include animal pens, shed shelves, loose storage bins, or rustic furniture. Slabs will rot quickly if exposed to the ground, to they need to be preserved with creosote. Slabs nailed to posts, with the bark side facing outward has the appearnce of rustic fencing. In gentle climates, slabs can be used as roof boards if tar paper is spread under them. A slab sandwich consists of a layer of slabs, nailed to cross pieces with the bark side down, then a double layer of tar paper, another layer of slabs, with the bark side up overlapping like shingles. Such a roof is not permanent, but may last about five years, so it is suitable for storage or other temporary uses.

Forest wastes such as leaves make the finest compost, and should be used for this wherever possible. Wood bark protects the tree but it is harmful to many forms of life. Therefore waste bark has in the past, had little commercial value other than for fuel. Chopped bark can be used as animal bedding and in chipbaord. Because of its color, however, it may not always be acceptable. Recently composed bark has been used for soil conditioning after processing to remove any danger to plant life. Some tree barks have special uses including the following: The cork oak tree for cork mats, lifebelts, or bottle stoppers; oak bark for the production of tanning extract for leather tanning, and as a brown dye; birch bark for canoe building; cinnamon bark as food flavoring; and cinchona bark for quinine medicine.

V. THE COCONUT TRUNK: AN UNEXPLOITED RESOURCE

Unlike other parts of the coconut tree, the trunk has been underutilized. With shortages of timber in many parts of the world, there is increased interest in taking fuller advantage of coconut timber.

Huge amounts of the wood are available, and in some areas such as Jamaica, due to the spread of yellow leaf disease, a vast number of trees have been destroyed. Because of this, coconut tree trunks must be utilized within a few years if they are to be used at all. Otherwise, this resource will be vulnerable to rotting.

Given the widespread shortage of hardwoods and the high price of hardwood timber, why is this attractive commercial opportunity not exploited? There are two principal reasons.

First, extraction is difficult. Coconuts often grow interspersed with other crops such as bananas. The trunk is very heavy due to its high moisture content. It contains a high amount of silica, making it extremely hard, and its unique fiber structure makes it very tough. The tree trunk can be cut down with a chain saw or an ax, but because of its hardness, the saw wears rapidly. An additional burden is that the lower trunk must be disposed of because it serves as a breeding point for insects, principally the palm beetle and the coconut rhinoceros beetle. Disposal of the lower trunk can be accomplished by digging around the roots of the tree, then using a rope to transport it away. If a quicker method is desired, a bulldozer or a cable winch may be used. If bulldozing standing trees, caution should be taken to guard the driver from falling coconuts. Waste wood should be burned.

The second major reason coconut trunks are under utilized is that in selecting timber only the outer material is suitable for cutting. The inner core is very weak, low density wood, and the higher portions of stem bear a weaker product. However, the trunk is nearly parallel and free from knots, so sawing is easy to plan. Because of the differing strengths of timber, a good plan is to use the bottom portion as timber and the upper stem for posts. All material except that next to the bark should be discarded.

Machinery

The timber is extremely hard due to its high silica content and tough fibers. Normal timber saws will become blunt rapidly, but their sharpness can be prolonged by depositing stellite on the teeth by arc-welding with a special electrode. The stellite is then sharpened with a very hard carborundum stone, a long process. An alternative is to use circular saw blades and planer cutters tipped with tungsten carbide (often used in the machining of steel). These are expensive compared to normal blades and need special sharpening, but their life between sharpening will be .50 times that of ordinary tool steel. They are brittle and may break if used on a saw mill without enough power, so it is best to use slightly oversize machines.

Timber Products

Coconut wood products are attractive and strong due to the absence of knots, provided the correct parts of the tree are selected. The wide range includes sawed lumber for house walls, frames, and roof trusses; tongue-and-groove flooring; furniture with an attractive natural polished finish; doors, windows, and shingles; parquet flooring (small rectangular blocks laid in attractive patterns; rough sawed items such as fork truck pallets, fencing, or roadside guard rail posts.

To produce these products, a medium-sized workshop would need the following equipment: one 34-kw sawmill driving a 75-cm diameter blade; one 15-kw sawmill driving a 64-cm diameter blade; one thicknessing machine; one saw tooth profiling machine; and one runway and electrial block for lifting trunks.

Value of output can be estimated at US$150,000 a year. Total capital cost including a suitable vehicle, chain saws, and other equipment for extracting trunks will be US$80,000 to US$100,000. A single shift will employ between 20 and 30 people.

Production of Poles and Posts

Coconut trunks are widely used for telegraph and other poles in the Philippines. The main problem is preserving them against rot and termites. The timber is dried for four to five months and and soaked in hot creosote (93 to 98 C for 8 to 10 hours drying. For sawed lumber, the times can be reduced by 25 percent. It is important to use insectides in the drying shed as newly sawed timber is very vulnerable to attack by insects.

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Universal Wood Limited, 11120 Roselle Street, Suite J, San Diego, California 99121.

Fred Hausmann AG, Hammerstrasse 46, 4055 Basel, Switzerland

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