THE PRODUCTION OF OIL PALM-BASED ACTIVATED CHARCOAL AND PYROLIGNEOUS ACID (wood vinegar)

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Charcoal production is a re-emerging industry. It not only supplies fuel in developing countries, but in recent decades, it has also supplied new multifunctional materials for environmental improvement and agricultural applications in developed countries. These applications include air dehumidification and deodorisation, water purification and soil improvement using charcoal's excellent adsorption capacity. Paradoxically, charcoal production might also help curb greenhouse gas emissions. With regards to the carbonisation process towards carbon fixation, a model has been formulated for the computation and the benefits evaluated (Lin and Hwang, 2009). The results showed that the recovered fixed carbon reached 33.2%, *i.e.*, one-third of the biomass residual carbon was conserved as charcoal which if left on the forest ground would decompose and turn into carbon dioxide. Charcoaling thus appears to be a feasible alternative to promote reutilisation of woody residues or biomass which would not only reduce greenhouse gas emissions, but also provide potential benefits to regional economies in developing countries.

Pyroligneous acid or wood vinegar has many benefits and one of it is it improves the soil quality, eliminates pests (Nakai *et al.*, 2007) and control plant growth (although study on the concentration needed to be applied is crucial before application as it is slightly toxic to fish and very toxic to plants if too much is applied). If it is used in plant, it accelerates the growth of roots, stems, tubers, leaves, flowers and fruit. A study shows that after applying wood vinegar in an orchard, fruit trees produce increased amount of fruits. Wood vinegar is safe to living matter in the food chain, especially insects that help to pollinate plants (FFTC, 2009). Apart from that, wood vinegar (has been claimed) can be used for health improvement and remove toxins from the body. In industrial usage, wood vinegar has been found to be able to replace industrial vinegar in the rubber latex industry. It acts as a natural coagulant during the preparation of the latex sheets (Baimark and Niamsa, 2009).

THE PROCESS

We have developed an environmental-friendly earthen kiln to carbonise the palm kernel shells and other biomass into charcoal in a commercial scale and the pyroligneous acid was collected at the end of the process. The kiln (*Figure 1*) is connected to a scrubber to collect the smoke and dust, and a long tube is connected to the scrubber that allows the gases to flow and cool down (condensation). The condensate consists of pyroligneous acid and a tarry residue, which will separate and settle upon cooling (*Figure 2*). Raw wood vinegar

Figure 1. The kiln and the condensation chambers of the system.

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Figure 2. The condensation and collection of palm-based pyroligneous acid.

has more than 200 chemicals, such as acetic acid, formaldehyde, ethyl-valerate, methanol, tar, *etc.* The carbonisation process produces about 30%-40% of charcoal and the rest volatile gases. From the volatile gases, about 60%-65% is condensate of water vapour, volatile matter and smoke, 5% tar and the rest of about 30% will be emitted through the chimney as treated smoke.

THE ECONOMICS

The two-kiln system can carbonise up to 2.24 t of oil palm shells, and with 30% yield will produce about 0.67 t of activated charcoal. Four operations can be carried out per month, producing about 2.69 t of activated charcoal. From each of the cycle, about 500 litres of pyroligneous acid can be collected, which is about 2000 litres per month.

The basic calculation of the economics of this process is as shown in *Table 1*.

TABLE 1. BASIC CALCULATION ON THE ECONOMICS OF THE SYSTEM

Cost	RM
Capital Investment:	**300 000**
- land, office building, furnace and infrastructure	
Electricity	15
Water	15
Transportation	600
Labour	6 000
Raw material	1 560
Fire-wood	3 000
Total cost of production:	**11 190**
Sales of activated charcoal (RM 4 per kg)	10 752
Sales of wood-vinegar (RM 10 per liter)	20 000
Total sales per month:	**30 752**
Profit per month:	**19 562**
Payback period:	**15.34 months**

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