Sustainable heat production using biological wood oxidation

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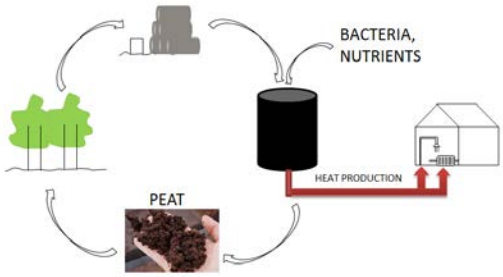
Motivation

Heating is one of the main energy consuming processes in countries with moderate temperatures. Heat is mostly produced from fossil fuels such as natural gas and fuel oil. A sustainable alternative energy source is biomass, however, combustion of biomass results in harmful emissions to the environment, such as emission of SO_2, CO, NO_x, fine particles and Polycyclic Aromatic Hydrocarbons (PAHs). Moreover, the remaining ashes cannot be reused. Biological wood oxidation has been proposed as a new technology for heat production at temperatures around 40-55 °C.

Wood oxidation, or aerobic wood oxidation, is a process in which wood is composted by microorganisms in the presence of oxygen. In this process, sustainable heat is produced. Compared to wood combustion, only CO_2 and H_2O are released to the atmosphere (see the following equation). Besides, the residue from this process is peat instead of ash. Peat soil is rich in organic matters and can be used as fertilizer.

$$CH1.5O0.7 + 1.03O2 \rightarrow CO2 + 0.734H20 + \text{Heat}$$



Technological challenge

The central challenge is to increase the rate of biological wood degradation. This rate is determined by, for example, types of microorganisms, types of wood, and size. Also other factors, , such as the nutrient supply (i.e. N, P, K), moisture content, temperature and aeration will influence heat production.


Sterile


Non sterile

The main challenges are:

(1) To optimize the temperature, moisture content, aeration strategy, and nutrient supply
(2) To study the interactions between different microorganisms, especially fungi and bacteria
(3) To study the heat production for different types of woods, different wood sizes
(4) To study the suitability of the wood residues as soil improvement
(5) To operate a scale-up reactor for heat recovery from wood

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