Compost Heat Recovery

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Heat and Temperature Rise of Compost

As decomposition occurs in a compost pile, bacteria releases heat via the respiration or decomposition (reverse photosynthesis) chemical equation:

$6O_2 + C_6H_{12}O_6 \Rightarrow 6CO_2 + 6H_2O + 2800\ kJ$

The release of heat can be taken advantage of due to the thermal conductivity of the compost material and the water (can be in the form of condensate or steam) produced by the same process. This allows the compost pile and the water produced to rise in temperature.

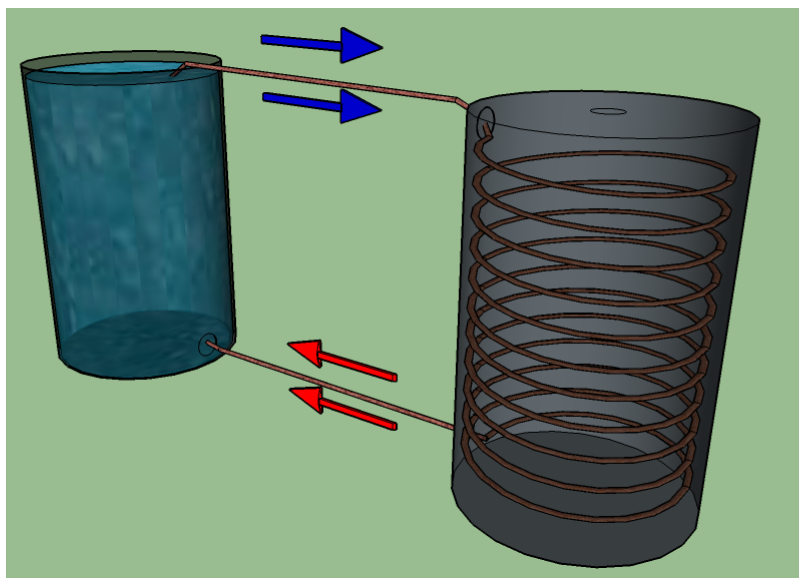
Heat Recovery System

A piping system was built to use the heat produced in a composted pile by running water through the pile in a copper pipe. The system is composed mainly of two barrels: one containing the compost pile mixed with wood (used as a bulking agent), and the other used to complete the water cycle.

This system allows the water to rise in temperature using the heat produced by the bacteria as they decompose the different organic materials in the pile. This is possible due to the thermal conductivity of the materials used in the system, which transforms a portion of the heat produced to temperature rise of those materials. To build the piping system, copper was the material chosen due to its relatively high thermal conductivity and durability. The pipe was made to spiral inside the barrel in order to have maximum amount of surface area exposure to the heated materials in the barrel.

Measurements and Calculations

In order to determine the amount of energy that was recovered from the compost decomposition process, the volumetric flow rate of water and its temperature rise from the inlet (marked with blue arrows) to the outlet (marked with red arrows) need to be measured accurately and consistently.



Two different flow measurement methods are used in order to compare the results and ensure their accuracy:

1- An electronic flow meter, which converts the water flow to a voltage difference, is hooked to a computer, which translates the voltage difference to volumetric flow rate units.

2- This method is done by simply measuring the time the water flow from the exit pipe takes to fill a graduated cylinder to the 1-L mark. The exit pipe is extended inside the water barrel to reach the surface of the water, which allows measuring the flow rate easier and allows water to flow at consistent rates.

The temperature rise is measured by attaching two thermocouple wires to the inlet and exit pipes, and connected to a thermocouple meter to read and record the temperatures at those locations.

By identifying the water mass flow rate (which can be calculated from the volumetric flow rate), the rate at which heat is recovered can be found by using the following equation: $\dot{Q} = \dot{m} * c_p * \Delta T$.
Where "Q" is the rate at which heat is recovered from the compost pile, "$\dot{m}$" is the mass flow rate of water, "c_p" is the heat transfer coefficient of water, and "ΔT" is the temperature rise of water from the inlet to the outlet pipes.

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