Resum de Tesi Doctoral

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Títol de la tesi	Mathematical modelling of heat and mass transfer in the composting process
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(Mínim 1 i màxim 4, podeu veure els codis a http://doctorat.upc.edu/doc/impresos/impres_codunesco2.pdf)

Resum de la tesi de 4000 caràcters màxim (si supera els 4000 es tallarà automàticament)

SUMMARY

The interaction of phenomena of different nature in the composting process makes it complex. Mathematical modelling is a helpful tool to analyse such complex systems, but its development and application to the composting process has been rather scarce up to date. The present study presents a deterministic mathematical model of the composting process which allows the explanation and quantification of the main phenomena observed during the process and is based on the basic laws of physical and biological elementary processes.

The developed model sets up a methodology for the presentation of the biological phenomena involved, making possible to couple models developed by different authors to the proposed physical model. This one considers the substrate as a porous media in which the three phases, solid, liquid and gaseous, are present. Mass and energy flows between them are governed by basic transfer laws. The gaseous phase is considered, in the base model, as a completely stirred mixture of oxygen, CO2, ammonia, water vapour and nitrogen, both considered as ideal gases. Its extension to the 1D space incorporates the movement of the gaseous phase due to pressure gradient, the conductive heat transfer in the solid matrix, the convective energy transport, both as sensible and latent heat, and the convective mass transport of gaseous components.

Three vertical static reactors at lab scale with forced aeration have been designed, built up and operated with different solid waste mixtures in order to pick up data for checking the model predictions. Several process variables have been measured and registered during the experiments: temperature at different points inside the reactors, oxygen and CO2 concentration in the exhaust gases, total mass in the reactors, airflow rate, air pressure at the reactors inlet, and the settlement at different levels of the composting mass. The moisture content at different positions of the material has also been measured at the start and at the end of the process.

The simulations, run with a unique set of physical, stoichiometric and kinetic parameters for the experiments with different substrates, reproduced satisfactorily the main trends observed by the experimental data, although these show that the hypothesis of radial symmetry in the reactors does not always holds on. A sensitivity analysis allowed the identification of the physical parameters with greater influence on the process. A three parameter equation is proposed to describe the settlement field inside the composting mass as a function of time. An equation linking settlement with the cumulative oxygen consumption has also been proposed.

In summary, the developed model simulates satisfactorily the main trends observed during the evolution of the observed process variables, integrates the different phenomena present in the composting process, and allows the quantification of its relative importance. The open structure of the model simplifies the incorporation of new phenomena.

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