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Cellphone application for computing biogas, methane and electrical energy production from different agricultural wastes

M. Samer*, K. Helmy, S. Morsy, T. Assal, Y. Amin, S. Mohamed, M. Maihoob, M. Khalil, I. Fouda, A. Abdou

Department of Agricultural Engineering, Faculty of Agriculture, Cairo University, 12613 Giza, Egypt

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ABSTRACT

To conduct calculations on biogas, methane and electrical energy production from different agricultural wastes, several calculations should be carried out; this requires time and effort, with the possibility of making mistakes. The objective of this study was to develop a tool to assist farmers and specialists in conducting these computations by providing a software program which can be installed on cellphones and computers to save time and effort. A mathematical model was developed to conduct the calculations. Subsequently, a flowchart was developed, and the mathematical model was integrated into the flowchart. Afterwards, Android Studio and the programming language Java SE were used to develop a software program by integrating the flowchart and the mathematical model and making the user interface. Data were acquired from governmental institutions, farms, NGOs, and literatures. The data acquired were used to conduct the calculations using the traditional method to generate results which were compared with results generated by the developed software. The results of both traditional method and the software were identical. The developed software can compute biogas, methane and electrical energy production from different agricultural wastes, which are: cattle slurry, cattle manure, chicken manure, maize silage, rye silage, and grass cuttings.

1. Introduction

Biogas is a renewable energy source and is a mixture of different gases produced by the decomposition of organic matter under anaerobic conditions. Biogas can be produced from feedstocks such as agricultural waste, manure, agricultural crop residues, municipal waste, sewage, or food waste. Biogas is primarily methane (CH₄) and carbon dioxide (CO₂) and small amounts of hydrogen sulfide (H₂S), water vapor (H₂O) and some trace gases such as ammonia (NH₃), hydrogen (H₂) and nitrogen (N₂). Methane can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat (Amon et al., 2007; Samer, 2012).

A software system is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant expertise for their solution. These computer programs manipulate symbolic descriptions of facts and heuristics to emulate the reasoning processes of an expert. The fundamental task of the knowledge engineer is to capture the heuristics or patterns of

thought used by experts in the performance of complex problem-solving tasks and represent them in the form of spark maps in form of flowcharts, i.e., decision trees (Broner et al., 1990; Greer et al., 1994). The tasks performed by software programs are numerous; the functional categories for software applications are interpretation, prediction, diagnosis, monitoring, debugging, repair, instruction, control, design, and planning (Giarratano and Riley, 2005). The combination of mathematical models and software systems are known as hybrid systems. The advantages of hybrid systems are that simulations can provide quantitative information for the software, which in turn provides missing parameters for the simulation models (Greer et al., 1994). The common form of a software system is a computer program with a set of rules or equations that analyze information or data, supplied by the user, about a specific problem (Yoo, 1989; Giarratano and Riley, 2005).

Recent advancement in the field of biogas production focus on the implementation of new technologies such as: nanotechnology (Abdelsalam et al., 2017; Attia and Samer, 2017), laser radiation (Abdelsalam et al., 2018a, 2018b), and conducting life cycle analysis (LCA) using special LCA software (Abdelsalam et al., 2019).

The objective of this study was to develop a tool to assist farmers

* Corresponding author.

E-mail address: msamer@agr.cu.edu.eg (M. Samer).