Renewable and Sustainable Energy Reviews ■ (■■■■) ■■■–■■■

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Renewable energy scenario and environmental aspects of soil emission measurements

Ahmed Al Makky [a], A Alaswad [a,*], Desmond Gibson [b], A.G Olabi [a]

[a] School of Engineering, University of the West of Scotland, Paisley, United Kingdom
[b] Scottish Universities Physics Alliance, Institute of Thin Films, Sensors & Imaging, United Kingdom

ARTICLE INFO

Keywords:
Soil porosity
Respiration chambers
Global warming
Renewable energy
Climate change

ABSTRACT

European Commission has set clear targets for 2020 regarding energy and environment policy; these targets include 20% cut in greenhouse gas emissions against the 1990 levels. It is believed that adopted strategy has encouraged the renewable energy applications during the last two decades. Moreover, measurement deviations of carbon dioxide flux occurring in respiration chambers has been seen of a great importance to explain the biochemical parameters affecting the climate change issue. This is attributed on many occasions to chamber design constraints and the way they are coupled with the studied site location. This is illustrated by external disturbances whereby when they happen while gas measurements are taken measurement deviations become more evident. This paper surveys the different soil physical, biological and geotechnical parameters and links them to meteorological ones. Consequently it explores their direct and indirect effects to the produced soil efflux. Furthermore this paper proposes several soil temperature models according to the studied case constraints to see what affects soil efflux production. Moreover a clear understanding of what affects the measurement process was achieved through surveying all the internal and external pressure parameters and how they influence the chamber in relation to time. The conclusion is that respiration chamber designers need to preserve chamber internal temperature and pressure to be equal to the outer atmosphere for the case of stabile external conditions. For the case of unstable external conditions design counter measures are incorporated. Furthermore the appropriate gas sensor needs to be selected professionally with emphasis on the importance of installation location inside the chamber. Likewise soil bacterial type and soil temperature also has an influence on efflux production.

Contents

* Corresponding author. Research Fellow, School of Engineering, University of the West of Scotland, Paisley, United Kingdom.
E-mail addresses: Ahmed.AlMakky@uws.ac.uk (A.A. Makky), abed.alaswad@uws.ac.uk (A. Alaswad), Des.Gibson@uws.ac.uk (D. Gibson), Abdul.Olabi@uws.ac.uk (A. Olabi).

http://dx.doi.org/10.1016/j.rser.2016.05.088
1364-0321/

1. Introduction

Climate change is one of the most critical challenges that are facing the mankind, and it is well related to the greenhouse emissions which help trapping heat and making the earth warmer that affect directly weather patterns, people, plants and animals. European Commission (EC) has responded and starts to set plans and policies to encourage renewable energy and energy efficiency applications. Consequently, greenhouse emissions in 2012 were reported to be decreased by 18% relative to the 1990 emissions. The new challenge which was set by the EC is to achieve 40% of greenhouse gas emissions by 2030.

Greenhouse fluxes measurement between the soil and the atmosphere is of a great importance to help to understand the biochemical parameters effects on the global warming issue. Soil can be defined as a complex system, consisting of a mixture of organic and mineral particles, soil solution and air, resulting from the interaction between biotic and abiotic factors; it is the medium in which plants acquire water and nutrients through their roots system.

An efflux is something that flows out or forth from a porous medium (Soil) which for our case of concern is carbon dioxide. Carbon dioxide gas in the soil is produced due to the occurring biological activity in the soil domain. Measuring accurately the production of gas species from the soil is a complex problem. This is due to the great spatial variability in soil emissions and to the fact that the quantification of these emissions is complicated by the high spatial variability exhibited by many microbial processes [1]. What also enforces the spatial variability is that soil chemical composition varies from one location to another [2]. To quantify the amount of the produced carbon dioxide at one location, it is captured in an enclosed cavity or space which can be a chamber. This method was first proposed by Henrik Lundegardh [3] in the form of the respiration bell. In the general context using respiration chambers can give scientists some insight to how fertile the studied site is. That is by measuring the rate of carbon dioxide produced for a certain site of concern and predict its impact on global warming issues [4]. Consequently with the increase of carbon dioxide concentrations in the atmosphere, planet earth responds to it in the form of the greenhouse effect [5]. For instance global warming is attributed to burning excessive amounts of fossil fuels [6] furthermore it is also linked to the rise of human population around the world. Therefore using sustainable sources of energy to support the growing in population nations comes of priority for future, as the study showed for the country of Sudan [7]. Scientists showed that switching to renewable sources of energy is achievable as shown in the global energy policy study by [8]. To help the gradual introduction and use of solar power governments have set solar energy polices. For instance for a country such as Malaysia the government has set its solar energy policy as mentioned in [9]. Energy planning algorithms for energy resource allocation can also assist in managing renewable energy sources. This is through using Multi-Criteria Decision Making techniques used to take care of multiple, conflicting criteria to arrive at better solutions [10]. Wind forecasting algorithms are also being used for the purpose of managing renewable energy sources, this is based on the assessment of wind power forecasting models done by [11]. Fuel cells are another efficient clean source of energy as mentioned by [12] whereby electrical-generation efficiencies of 70% where achieved along with a heat recovery possibility. Moreover future wise fuel cell based power systems will render an ideal distribution power-generation system characterized to be: reliable, clean, quiet, environmentally friendly, and fuel conserving.

A matter of immediate concern in the hazardous energy situation in most African countries is that forest resources are gradually declining. Hence the supply of fuel wood is becoming more difficult to sustain and demand especially that it is already exceeding the potential supply [13]. Therefore one of the main requirements of green energies is to be characterized as efficient systems furthermore for governments to apply policies that make citizens gradually use less fossil fuels [14]. Consequently new fuels are being introduced to the global market as for example in Malaysia palm oil is considered a sustainable source of fuel particularly that palm oil is one of the most productive bio-diesel crop. Moreover, its waste streams can be used to produce vast amounts of bio-gas and other values added products [15]. Another promising method is to use small scale gasifiers for domestic use in rural areas especially for cooking [16]. Likewise another sustainable type of fuel is ethanol what was evident that more research needs to be applied to get convincing proofs of its environmental friendliness as shown in the comparison between E10 and E0 [17].

In this paper: The required gas sensor type to be used in respiration chambers is covered furthermore its location of installation inside the chamber is advised. Additionally types of used gas sensors in static and dynamic chambers are surveyed. On the other hand an inner chamber temperature effect on gas sensors is considered in a discussion. For the reason that infrared gas sensors are becoming commonly used in respiration chambers furthermore mentioned is a set of required considerations for gas sensors. Moreover gas sensor calibration methods are covered in particular that no sensor measurement occurs without sensor calibration is performed on a frequent basis. Lastly a recommendation to what types of sensors to be used on chambers to monitor

Please cite this article as: Makky AA, et al. Renewable energy scenario and environmental aspects of soil emission measurements. Renewable and Sustainable Energy Reviews (2016), http://dx.doi.org/10.1016/j.rser.2016.05.088