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[54]	Title:	METHOD AND DEVICE FOR CARBONIZE THE OIL PALM BIOMASS AND SIMULTANEOUSLY PRODUCING ACTIVATED BIOCHAR CARBON FROM THE OIL PALM BIOMASS USING A SELF-SUSTAINED SYSTEM		
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[57]	Abstract:	There is provided a method (100) for carbonizing oil palm biomass and simultaneously producing activated biochar carbon from the oil palm biomass using a self-sustained carbonization system, the method comprising the steps of (a) filling oil palm shells into a self-sustained carbonization reactor (202), (b) heating oil palm shells to carbonize the oil palm biomass in the self-sustained carbonization reactor (202), (c) applying steam to activate the activated biochar carbon in the self-sustained carbonization reactor (202) through plurality of steam generator (208), wherein the activation process initiates after approximately 5 hours of carbonization with temperature at 700øC-900øC for 60 minutes to 300 minutes and (d) cooling down the temperature of the activated biochar carbon in a brick reactor (210) before removing the activated biochar carbon from the brick reactor (210). Also provided is a device for carbonizing oil palm biomass and simultaneously producing activated biochar carbon from the oil palm biomass using a self-sustained carbonization system. The most illustrative drawing: FIG. 2		

For the self-sustained system, after the oil palm shell was fed into the reactor, the fire was started manually at the top of the reactor using a portable propane gas burner for approximately 30 min. The cover of the reactor was then closed completely, and the carbonization temperature was self-sustained on its own using oil palm shell biomass.

Thereafter the method (100) includes the step (106) of applying steam to activate the biochar in the self-sustained carbonization reactor (202). Further the method (100) includes the step (108) of cooling down the temperature of the activated biochar in a brick reactor (210) before removing the activated biochar from the brick reactor (210). The method (100) further includes the step (110) of drying the activated biochar prior to proximate analysis. Then the method (100) includes the step (112) of treating uncondensed gas leaving a condensing unit through a chiller unit (214) and first water tank unit (216). Furthermore the method (100) includes the step (114) of removing the moisture and tar from the treated gas through a rock bed filter integrated with a gas purification unit. Lastly, the method (100) includes the step (116) of emitting the treated gas through a chimney (220).

FIG. 2 illustrates a device (200) to carbonize the oil palm biomass and simultaneously produce activated biochar from the oil palm biomass using the self-sustained system, in accordance with at least one embodiment. The device (200) includes a self-sustained carbonization reactor (202), a plurality of steam generator (208), a condensing unit (212), a chiller unit (214); and a first water tank unit (216), rock bed filter, a gas purification unit, and a chimney (220).

The self-sustained carbonization reactor (202), simultaneously receives oil palm shells. In an embodiment the self-sustained carbonization reactor (202) is made up of brick.

The plurality of steam generator (208) apply steam to activate the biochar carbon in the self-sustained carbonization reactor (202). The activation process initiates after 10 to 12 hours of carbonization with temperature at 700°C -900°C for 60 minutes to 300 minutes.

For example, the combustion of oil palm shell biomass is conducted in a self-sustained carbonization reactor (202). Approximately 60 kg of oil palm shell (OPS) carbonized per batch of operation. After the OPS sample fed into the self-sustained carbonization reactor (202), the fire starts manually at the top of the self-sustained carbonization reactor (202) using a portable propane gas burner for approximately 30 minutes. The cover of the self-sustained carbonization reactor (202) was then closed completely and the carbonization temperature is self-sustained on its own using OPS biomass as the fuel. All of the parts of the self-sustained carbonization reactor (202), especially the stainless steel cover, closed tightly to avoid any entrance of oxygen. The temperatures inside the self-sustained carbonization reactor (202) monitored by three k-type thermocouples positioned at different heights from the bottom of the self-sustained carbonization reactor (202), i.e., T1 (0.46 m), T2 (0.25 m) and T3 (0.04 m). A tray is installed 0.02 m from the bottom, so there is an empty space at the bottom of the self-sustained carbonization reactor (202) to circulate smoke before it can be discharged through the 3 meter chimney (220).

The temperatures are automatically recorded after every 60 seconds using a data logger. In this stage, for both of the reactors (202) and (204), the biochar is subjected to higher temperature, between 700-900 °C, and simultaneous physical activation by applying steam treatment to produce high quality of activated carbon. The chiller unit (214) and the first water tank unit (216) treats the uncondensed gas leaving from the condensing unit (212). The rock bed filter integrated with a gas purification unit to remove the moisture and tar from the treated gas. Then the chimney (220) emits the treated gas.

FIG. 3 illustrates temperature vs time characteristics during carbonization using the self-sustained carbonization system

Table 1 illustrates the proximate, ultimate and lignocellulosic analysis of raw oil palm shell (OPS) and activated OPS pilot-scale brick.

Proximate analysis (%)	OPS-Char	OPS-AC	Literature references	
Moisture content	6.2±0.0	4.3±0.3	1.9-4.6	(Nizamuddin *et al.*, 2016; Rugayah *et al.*, 2014; Arami-Niya *et al.*, 2010)
Ash content	5.0±2.5	2.6±0.2	2.6-10.6	(Rugayah *et al.*, 2014; Nizamuddin *et al.*, 2016; Choi *et al.*, 2015; Arami-Niya *et al.*, 2010)
Volatile matter	13.1±1.8	3.5±0.9	10.2-45.9	(Rugayah *et al.*, 2014; Nizamuddin *et al.*, 2016; Arami-Niya *et al.*, 2010)
Fixed Carbon	74.9±1.2	88.6±2.4	44.5-83.0	(Nizamuddin *et al.*, 2016;Rugayah *et al.*, 2014; Arami-Niya *et al.*, 2010)
Ultimate analysis				
C	65.5±0.8	78.5±4.6	59.6-85.0	(Nizamuddin *et al.*, 2016; Rugayah *et al.*, 2014; Hidayu and Muda, 2016; Arami-Niya *et al.*, 2010)
H	3.3±0.0	2.17±0.0	0.5-4.1	(Rugayah *et al.*, 2014; Nizamuddin *et al.*, 2016; Hidayu and Muda, 2016; Arami-Niya *et al.*, 2010)
N	0.2±0.0	0.41±0.0	0.02-2.9	(Rugayah *et al.*, 2014; Nizamuddin *et al.*, 2016; Hidayu and Muda, 2016;

				Arami-Niya *et al.*, 2010)
S	0.0	0.0	0.1- 0.9	(Rugayah *et al.*, 2014; Nizamuddin *et al.*, 2016; Arami-Niya *et al.*, 2010)

The activation process enhances the carbon structure, either into making the carbon more porous or more crystalline. In this stage, the biochar is subjected to lower temperature, between 250-400°C, and sequential physical activation by applying steam treatment (physical activation) with total operation will be 10-12 hours. The activation of the carbon creates carbon which is highly porous providing a large surface area of the carbon for adsorption. The main applications of activated carbon is in waste water treatment, pharmaceutical, refrigerator odor removals, air conditioners and air cleaners, laboratory uses, municipal water treatment, etc.

The carbonization of oil palm shell as a biochar and activated carbon also provides some advantages to the industry. Not only it is helping the industry to manage their abundant oil palm shell waste, but it also helps in generating extra profit and at the same time reducing the release of gaseous pollutants and particulate matter emissions into the atmosphere.

Thus the present method (100) and the device (200) provides simultaneous biochar activated carbon production using the self-sustained reactor (202) with reduced energy, time and activation steps for activated carbon production. Additionally the present method (100) and the device (200) provides integrated activation carbon production under single steam generation channel for self-sustained system.

No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the invention

While the present disclosure has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from its scope. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed, but that the present disclosure will include all embodiments falling within the scope of the appended claims.

METHOD AND DEVICE FOR CARBONIZE THE OIL PALM BIOMASS AND SIMULTANEOUSLY PRODUCING ACTIVATED BIOCHAR CARBON FROM THE OIL PALM BIOMASS USING A SELF-SUSTAINED SYSTEM

FIELD OF INVENTION

The presently disclosed embodiments are related, in general, to produce activated biochar from the oil palm biomass. More particularly, the presently disclosed embodiments are related to method and device to carbonize the oil palm biomass and simultaneously produce activated biochar from the oil palm biomass using a self-sustained system.

BACKGROUND OF INVENTION

Currently, the industry obtains the biochar by purchasing biochar from the locals or from the backyard industry. The backyard industry producing the biochar domestically using the conventional drum kiln or pit kiln methods. However, this conventional heating method causes to environmental issues such as gaseous pollutants and particulate matter emissions which contravene DOE (Department of Environment) requirements. Also, the conventional heating methods results in surface heating from the hearth wall, which do not ensure a uniform temperature for different shapes and sizes of samples, thereby resulting in long carbonization and activation time and higher energy consumption (Kunbin et al., 2010).

Further, in the existing self-sustained carbonization oil palm biomass is combusted to provide the heat for carbonization in inadequate oxygen to produce charcoal using biomass feedstock without an electrical heater is more preferable to industry due to its simplicity, ease of operation and low energy requirement (Idris et al., 2015).

For instance, it involves two main step processes, 1) the carbonization of carbonaceous precursor below 800°C, in the absence of oxygen, and (2) the activation of carbonized product (char), and

either using physical or chemical activation methods. These two processes are normally carried out separately. In the chemical activation process, either the previously carbonized product is impregnated with a suitable chemical agent, such as potassium hydroxide (Cardoso et al., 2008; Lozano-Castello et al., 2001), zinc chloride (Caturla et al., 1991; Hu et al., 2001) or the raw material is impregnated with phosphoric acid (Molina-Sabio et al., 1995); then the mixture is heated up under neutral atmosphere at temperatures ranging from 500°C to 800°C. These three chemical activation methodologies/agents were compared in the publication by Molina-Sabio et al. 1995. Physical activation is generally carried out by heat treatment in the presence of suitable oxidizing gases such as steam (Su et al., 2008; Zhang et al., 2007), carbon dioxide (Gonzalez et al., 1997), air (Wang et al., 2007) or a mixture of these gases (Vargas et al., 2010). During the activation step, the existing pores are opened and broadened and new pores are created. For carbonization and activation processes contributes to energy and time consumption, and the cost for materials and apparatus.

Any combinations of these processes into a single step or step that may be carried out simultaneously may reduce the production cost, energy and time. Therefore, there is need of a method and device to produce activated carbon from oil palm shells. Further, there is also need of simultaneous two-in-one carbonization and activation steps.

Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of described systems with some aspects of the present disclosure, as set forth in the remainder of the present application and with reference to the drawings.

SUMMARY OF INVENTION

According to embodiments illustrated herein, there is provided a method for carbonizing oil palm biomass and simultaneously producing activated biochar carbon from the oil palm biomass using a self-sustained carbonization system, the method comprising the steps of (a) filling oil palm shells into a self-sustained carbonization reactor, (b) heating oil palm shells to carbonize the oil palm biomass in the self-sustained carbonization reactor, (c) applying steam to activate the activated biochar carbon in the self-sustained carbonization reactor through plurality of steam generator, wherein the activation process initiates after approximately 10-12 hours of carbonization with temperature at 700°C-900°C for 60 minutes to 300 minutes and (d) cooling down the temperature of the activated biochar carbon in a brick reactor before removing the activated biochar carbon from the brick reactor.

According to embodiments illustrated herein, there is provided a device to carbonize the oil palm biomass and simultaneously produce activated biochar carbon from the oil palm biomass using a self-sustained carbonization system, the device including (a) a self-sustained carbonization reactor, wherein the self-sustained carbonization reactor receives oil palm shells, (b) a plurality of steam generator to apply steam to activate the biochar carbon in the self-sustained carbonization reactor, wherein the activation process initiates after 10-12 hours of carbonization with temperature at 700°C -900°C for 60 minutes to 300 minutes and (c) a brick reactor (210) to cool down the temperature of the activated biochar, and further dries the activated biochar prior to a proximate analysis.

These and other features and advantages of the present disclosure may be appreciated from a review of the following detailed description of the present disclosure, along with the accompanying figures in which like reference numerals refer to like parts throughout.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings illustrate the various embodiments of systems, methods, and other aspects of the disclosure. Any person with ordinary skills in the art will appreciate that the illustrated element boundaries (e.g., boxes, groups of boxes, or other shapes) in the figures represent one example of the boundaries. In some examples, one element may be designed as multiple elements, or multiple elements may be designed as one element. In some examples, an element shown as an internal component of one element may be implemented as an external component in another, and vice versa. Further, the elements may not be drawn to scale.

Various embodiments will hereinafter be described in accordance with the appended drawings, which are provided to illustrate and not to limit the scope in any manner, wherein similar designations denote similar elements, and in which:

FIG. 1 illustrates a flowchart of a method for carbonizing the oil palm biomass and simultaneously producing activated biochar from the oil palm biomass using a self-sustained carbonization system, in accordance with at least one embodiment;

FIG. 2 illustrates a device to carbonize the oil palm biomass and simultaneously produce activated biochar from the oil palm biomass using the self-sustained carbonization system, in accordance with at least one embodiment; and

FIG. 3 illustrates temperature vs time characteristics during carbonization using the self-sustained carbonization system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present disclosure may be best understood with reference to the detailed figures and description set forth herein. Various embodiments are discussed below with reference to the figures. However, those skilled in the art will readily appreciate that the detailed descriptions given herein with respect to the figures are simply for explanatory purposes as the methods and systems may extend beyond the described embodiments. For example, the teachings presented and the needs of a particular application may yield multiple alternative and suitable approaches to implement the functionality of any detail described herein. Therefore, any approach may extend beyond the particular implementation choices in the following embodiments described and shown.

References to "one embodiment," "at least one embodiment," "an embodiment," "one example," "an example," "for example," and so on indicate that the embodiment(s) or example(s) may include a particular feature, structure, characteristic, property, element, or limitation but that not every embodiment or example necessarily includes that particular feature, structure, characteristic, property, element, or limitation. Further, repeated use of the phrase "in an embodiment" does not necessarily refer to the same embodiment.

FIG. 1 illustrates a flowchart of a method (100) for carbonizing the oil palm biomass and simultaneously producing activated biochar from the oil palm biomass using a self-sustained system in accordance with at least one embodiment. The method (100) initiates with the step (102) of filling oil palm shells into a self-sustained carbonization reactor (202). The self-sustained carbonization reactor is built with double walls of clay bricks (1000 mm x 1000 mm external dimension, 220 mm thick).

CLAIMS

1. A method (100) for carbonizing oil palm biomass and simultaneously producing activated biochar carbon from the oil palm biomass using a self-sustained carbonization system, the method comprising the steps of:

(a) filling oil palm shells into a self-sustained carbonization reactor (202);

(b) heating oil palm shells to carbonize the oil palm biomass in the self-sustained carbonization reactor (202);

(c) applying steam to activate the activated biochar carbon in the self-sustained carbonization reactor (202) through plurality of steam generator (208), wherein the activation process initiates after approximately 10-12 hours of carbonization with temperature at 700°C-900°C for 60 minutes to 300 minutes; and

(d) cooling down the temperature of the activated biochar carbon in a brick reactor (210) before removing the activated biochar carbon from the brick reactor (210).

2. The method (100) according to claim 1 further includes the step of drying the activated biochar carbon prior to proximate analysis.

3. The method (100) according to claim 1 further includes the step of treating uncondensed gas leaving a condensing unit through a chiller unit (214) and first water tank unit (216).

4. The method (100) according to claim 1 further includes the step of removing the moisture and tar from the treated gas through a rock bed filter integrated with a gas purification unit.

5. The method (100) according to claim 1 further includes the step of emitting the treated gas through a chimney (220).

6. A device (200) to carbonize the oil palm biomass and simultaneously produce activated biochar carbon from the oil palm biomass using a self-sustained carbonization system, the device (200) comprising:

(a) a self-sustained carbonization reactor, wherein the self-sustained carbonization reactor (202) receives oil palm shells;

(b) a plurality of steam generator (208) to apply steam to activate the biochar carbon in the self-sustained carbonization reactor (202), wherein the activation process initiates after 10-12 hours of carbonization with temperature at 700°C -900°C for 60 minutes to 300 minutes; and

(d) a brick reactor (210) to cool down the temperature of the activated biochar, and further dries the activated biochar prior to a proximate analysis.

7. The device (200) according to claim 6 further comprising: a condensing unit (212), a chiller unit (214) and a first water tank unit (216), wherein the chiller unit (214) and the first water tank unit (216) treat the uncondensed gas leaving from the condensing unit (212).

8. The device (200) according to claim 6 further includes a rock bed filter integrated with a gas purification unit to remove the moisture and tar from the treated gas.

9. The device (200) according to claim 6 further includes a chimney (220) to emit the treated gas.

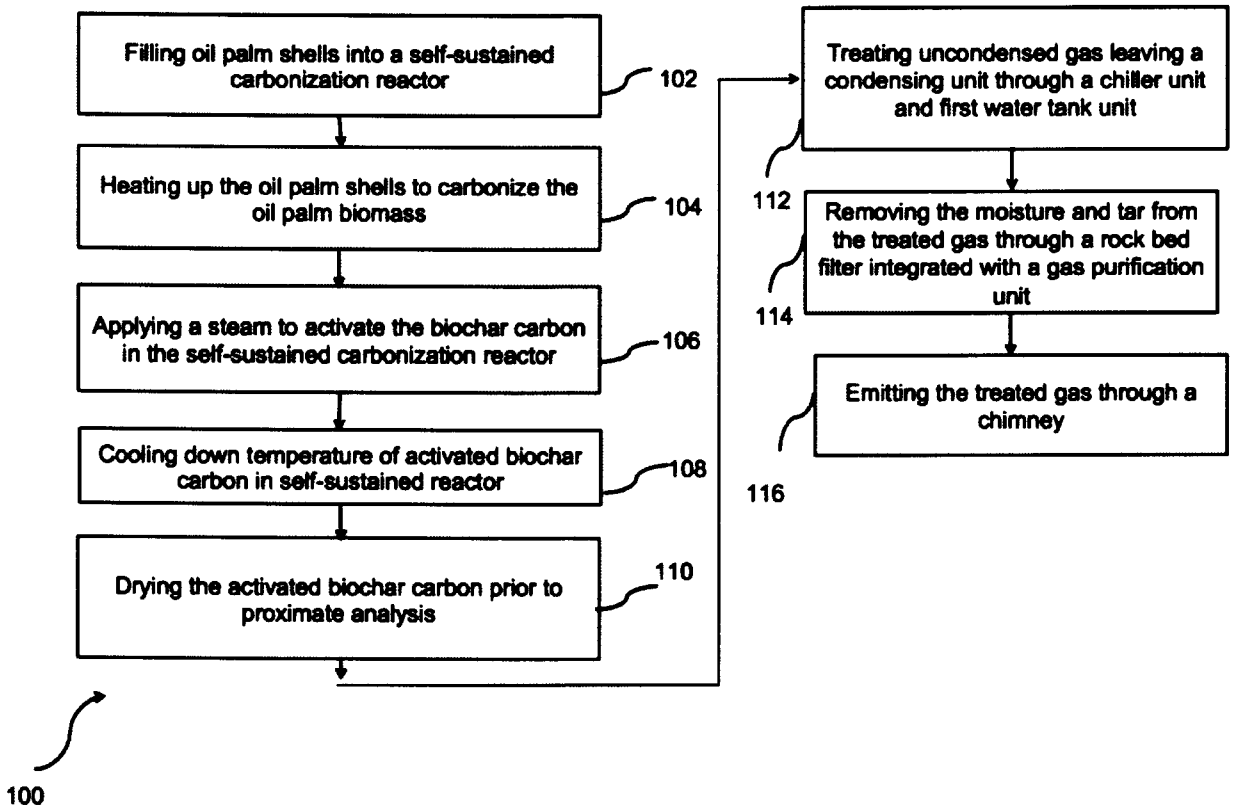

Fig. 1

Malaysian Palm Oil Board (MPOB) and
Universiti Putra Malaysia (UPM)
Applicants
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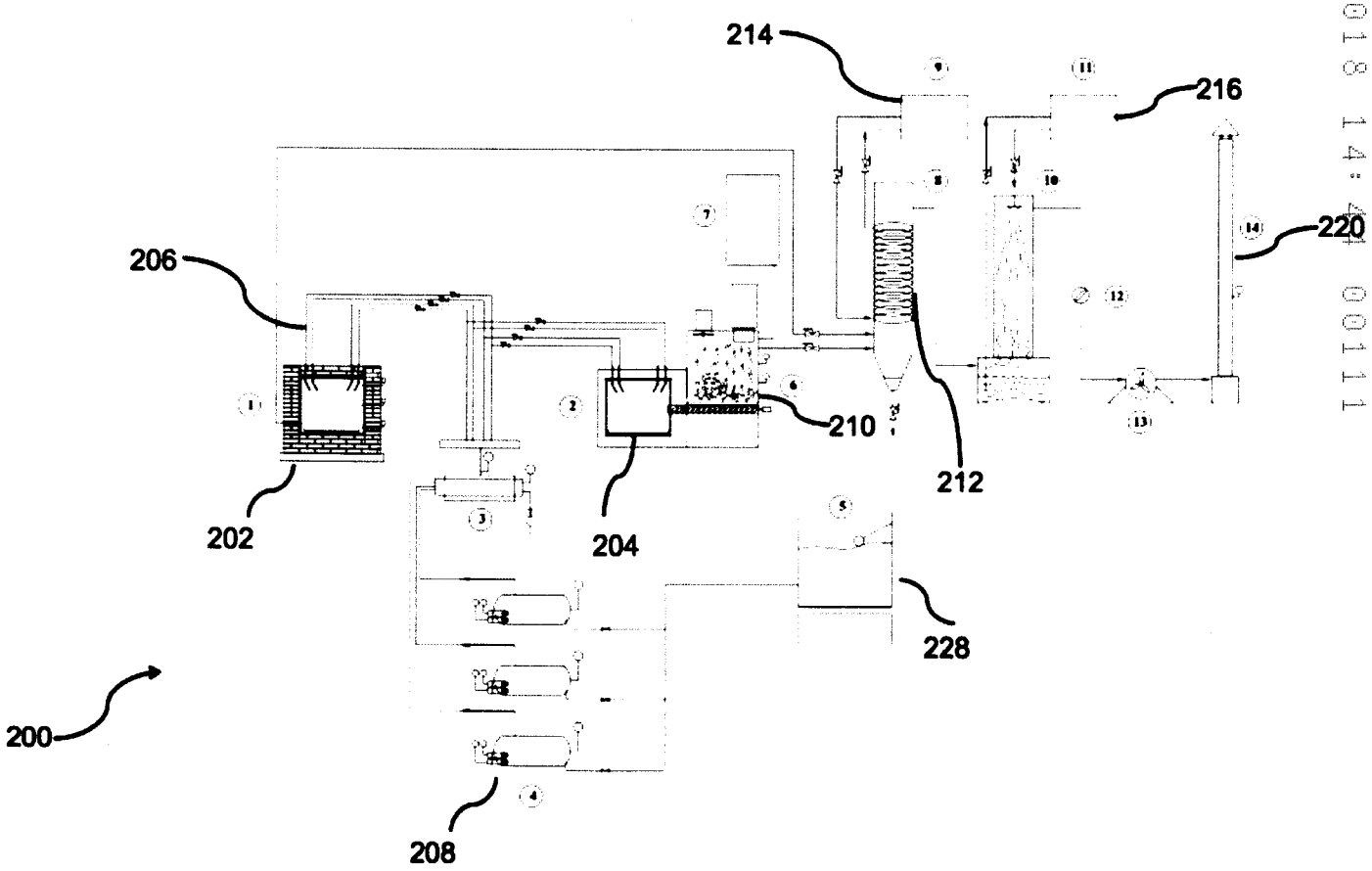

Fig. 2

Malaysian Palm Oil Board (MPOB) and
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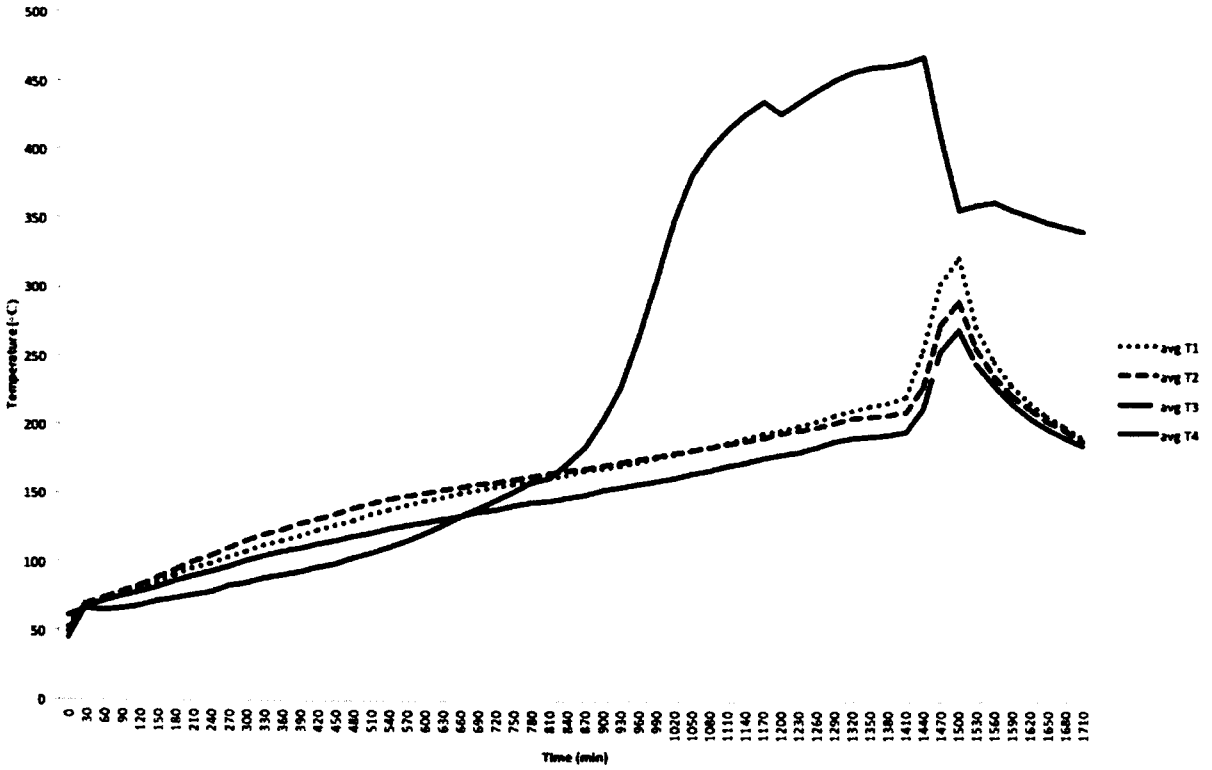

Fig. 3

Malaysian Palm Oil Board (MPOB) and
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