Journal of Chemical Engineering and Applied Chemistry
ISSN: 2235-9007
Volume 01, Issue 01, April,2019

Advancement of Food Waste Disposal Technology Using Sodium Hydroxide

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Abstract— In this exploration, we concentrated on the reusing of sustenance waste utilizing sodium hydroxide (NaOH). Pyrolysis of rice, one of the real components of sustenance squander in Japan, was done to get carbon material with adsorption capacity, together with fuel gases (H_2, CH_4). Subsequently, it was conceivable to change over rice into carbon material while producing fuel gas. With expanding the NaOH expansion and temperature, the substance of CO and CO_2 diminishes, those of H_2 and CH_4 expanded in the produced gas, and the mass of the buildup after pyrolysis with NaOH diminishes to one-tenth load of crude rice. The buildup after pyrolysis is a carbonaceous material with around 80% carbon content, and the buildup after pyrolysis with NaOH (rice test: NaOH = 1: 1) has smooth permeable surface with higher explicit surface territory (901 m_2/g) than that after pyrolysis without NaOH (72 m_2/g).

Keywords— Nourishment squanders, sodium hydroxide, fuel gas, pyrolysis, permeable carbon material.

1. Introduction

Worldwide sustenance creation added up to 4.33 billion tons, and 1.3 billion tons were deserted (FAO, 2011), which is about 12.4% of the worldwide strong waste (11 billion tons for every year) [1]- [3]. In Japan, the measure of sustenance waste was evaluated in 2015 to be 28.42 million tons for each year, which 1.12 million tons are burned or land filled [4]. The nourishment waste is degradable at the landfill destinations, bringing about ecological effects, for example, irresistible illnesses, vermin, dirtied water, awful stench [5]- [7]. From this circumstance, Food Waste Recycling Law was implemented in December 2007 in Japan, and the rate of reuse and reusing for all out sustenance waste was 71 % in 2015 [8]- [12].

Sustenance waste contains a lot of water (80 %) natural substances (16.7 %) and inorganic issues (3.3 %) [13]. Thusly, as a reusing strategy for nourishment squander, there are different advancements that have been investigated for sustenance squander to-vitality change including organic (for example feed, manure, and methane maturation), warm and thermochemical advances (for example burning, pyrolysis, and gasification) [14]- [18].

In 2015, the reusing rate of the nourishment waste is 74 % for compost, 17 % for feed, 4% for methane aging, and 2 % for warmth recuperation [19]. Feed and compost should be possible with a little discharge of ozone harming substances utilizing little beginning speculation. Nonetheless, there are issues that the scent was created during the generation procedure, and it is important to keep away from pollution for horticultural uses [20]. Methane maturation requires explicit conditions for breaking down of natural issue utilizing microorganisms for quite a while [21], and the delivered gases by methane aging are methane gas, carbon dioxide, and hydrogen sulfide to be expelled for fuel gas. Along these lines, fermenters require an enormous site region for different procedure and long response time [22].

Pyrolysis treatment is one of the thermochemical methods to create gases from natural issues, for example, rural yields and their side-effects, civil strong waste, and waste from sustenance handling, utilizing high temperature by means of an outer warmth source in a dormant climate [23]. The waste is carbonized to diminish the volume utilizing the smaller contraption. In any case, the transformation of sustenance squander with high dampness content into helpful gases and carbonaceous materials needs high vitality. The past examination demonstrated that the utilization of the sodium hydroxide advanced pyrolysis of waste plastics and empowers effective pyrolysis and gasification. Be that as it may, there are no instances of pyrolysis utilizing sodium hydroxide for nourishment squander by any stretch of the imagination.

In our past investigations, pyrolysis of waste can be elevated by sodium hydroxide to acquire the oil, gas and carbon buildup [24], [25]. Be that as it may, little data can be accessible on pyrolysis utilizing sodium hydroxide for sustenance squander [26].

In this exploration, we endeavored to change over rice, which is one of the primary substance in sustenance squander in Japan, into combustible gases to be utilized as fuel and carbonaceous material with high explicit surface zone to be utilized as adsorbent utilizing pyrolysis with sodium hydroxide.

2. EXPERIMENT

2.1 Materials

The rice test utilized in this examination was a business rice pack which was delivered from Niigata Prefecture, Japan. Prior to the investigation, the pack was warmed and after that cools to room temperature for use. Modern and essential examination of the rice test is appeared Table I, which was broke down utilizing JIS M 8812. Granular sodium hydroxide was acquired from Hayashi Pure Chemical Industries Co., Ltd, Special evaluation reagent, Japan.

2.2 Test Apparatus and Procedures

The test device utilized in this investigation is exhibited in Fig. 1. A blended example of rice (20 g) and sodium hydroxide (0 - 20 g) was put in the reactor, and nitrogen gas was infused into the reactor for 60 min at 50 mL/min to expel oxygen from the reactor. After nitrogen substitution, the nitrogen gas was ceased, and the reactor was warmed to the setting temperature, 600ºC or 700ºC, at warming rate of 10ºC/min utilizing the cylindrical heater. In the wake of warming for 60 min or 70 min, the reactor was cooled to room temperature. The buildup after pyrolysis was washed with refined water, filtrated and dried in a drying broiler medium-term to get the item. The heaviness of the item was estimated to compute decrease proportion to crude rice. The non-considerable gases delivered during pyrolysis were recouped in a gas pack in the wake of going through a watery antacid arrangement. The aggregate sum of the produced gases gathered in the gas pack was thought to be created by the pyrolysis.

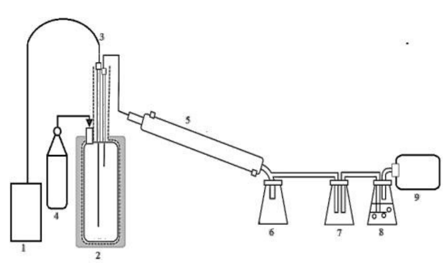

Fig. 1. Experimental apparatus.

2.3 Examination

The created gas was subjectively and quantitatively dissected utilizing gas chromatography (Shimadzu, GC 2014). The morphologies of the item surface when pyrolysis was seen by a checking electron magnifying instrument (Joel Ltd, SM-6510LA), and synthetic examination of the item surface with a vitality dispersive

ISSN: 2235-9007
Volume 01, Issue 01, April,2019

X-beams analyzer (BRUKER, Quntax70) that appended to a tabletop electron magnifying lens (Hitachi High Technologies Co, Miniscope, TM3000). The particular surface zone of the item was estimated utilizing a Macsorb HM model-1210, Manufactured by MOUNTECH Co., Ltd.

3. RESULTS AND DISCUSSION

Table II and III demonstrate the gas age sum and structure from the gas created in the investigation at 600 ºC and 700ºC, separately.

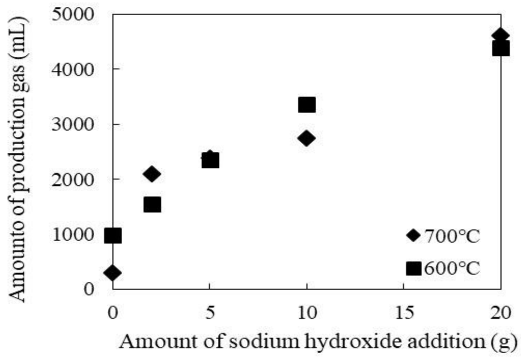

Fig. 2. Total volume of generated gas.

Fig. 2 demonstrates the measure of absolute volume for created gas by pyrolysis. In examination with rice without sodium hydroxide, the measure of all out gas produced expanded around 4 overlay at 600ºC, 15 overlap at 700ºC when an equivalent mass of sodium hydroxide was included.

Fig. 3 demonstrates the measure of hydrogen gas created by pyrolysis. Nearly a similar measure of hydrogen gas is produced at 600ºC and 700ºC. At the point when an equivalent mass of sodium hydroxide was included, the measure of hydrogen gas produced expanded around 42 overlap at 600ºC, and 115 overlay at 700ºC as contrasted and the instance of just rice.

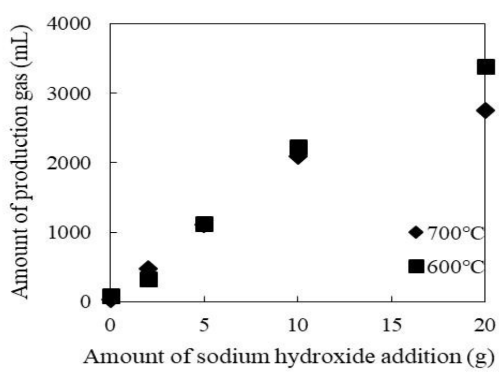

Fig. 3. Volume of H_2 in generated gas.

Fig. 4 demonstrates the measure of methane gas produced by the pyrolysis. Increment in the expansion of sodium hydroxide expanded the measure of methane gas produced by the pyrolysis of rice. With expanding sodium hydroxide, the measure of methane slowly increments, and methane produced at 700ºC is higher than that at 600ºC. The measure of methane gas produced roughly 8 overlay at 600ºC and 27 overlap at 700ºC when an equivalent mass of sodium hydroxide was included.

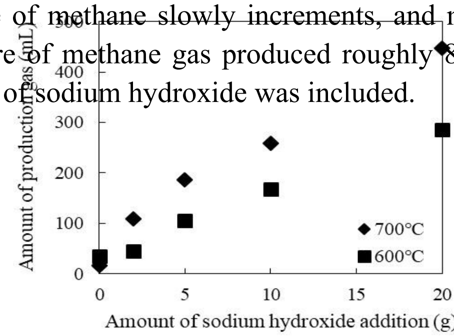

Fig. 4. Volume of CH_4 in generated gas.

Fig. 5 and 6 demonstrate the measure of carbon monoxide and carbon dioxide in the produced gas. Expansion of sodium hydroxide influenced the generation of carbon monoxide and carbon dioxide. At the point when the measure of sodium hydroxide builds, the measures of carbon monoxide and carbon dioxide bit by bit decline.

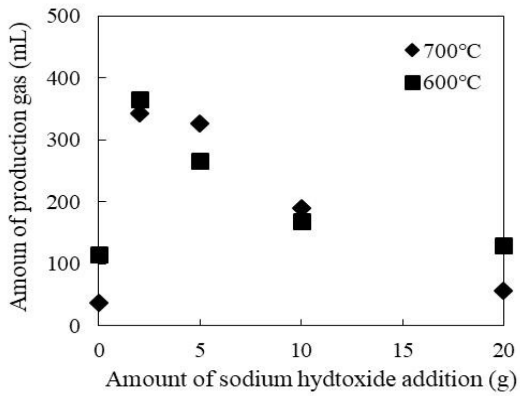

Fig. 5. Volume of CO in generated gas.

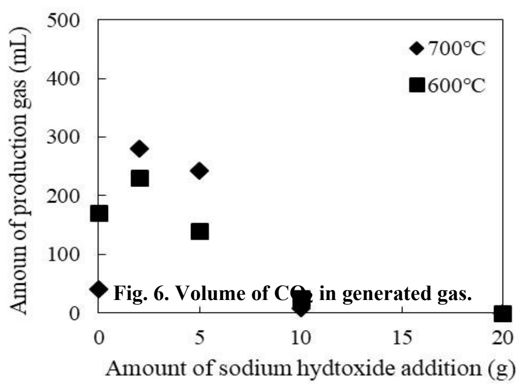

Fig. 6. Volume of CO_2 in generated gas.

Fig. 5 and 6 demonstrate the measure of carbon monoxide and carbon dioxide in the produced gas. Expansion of sodium hydroxide influenced the creation of carbon monoxide and carbon dioxide. At the point when the measure of sodium hydroxide expands, the measures of carbon monoxide and carbon dioxide bit by bit decline.

Fig. 7 and Fig. 8 demonstrate the yield of the gas created from rice with the expansion of sodium hydroxide at 600ºC and 700ºC, separately. At the point when sodium hydroxide was not included, the gas piece was the equivalent at 600ºC and 700ºC, yet as the additional sum was expanded, the creation proportion of carbon monoxide and carbon dioxide decline and those of hydrogen and methane gas expanded. The sythesis proportion of burnable gas made out of hydrogen and methane gas demonstrated a higher structure proportion at 700ºC than at 600ºC.

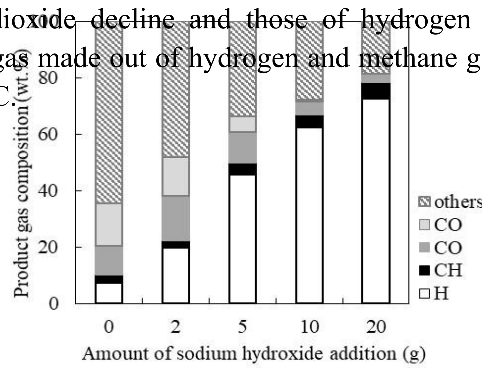

Fig. 7. The production rate of gas generated at 600 °C.

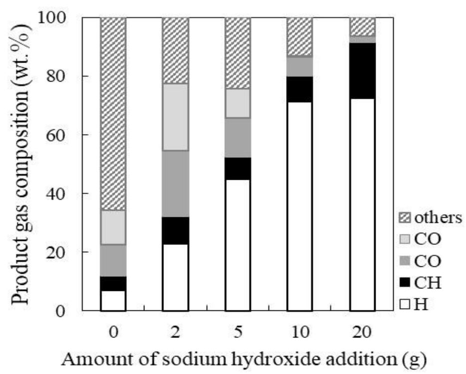

Fig. 8. The production rate of gas generated at 700 °C.

Fig. 9 demonstrates the mass of buildup after warm deterioration without and with sodium hydroxide in 700ºC. The buildup got after pyrolysis diminished to 99 wt % carbon.

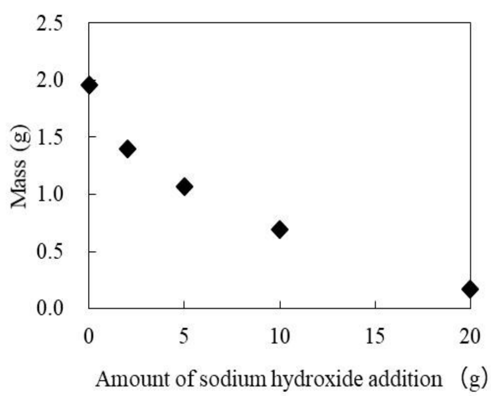

Fig. 9. Mass of residue after pyrolysis.

Fig. 10 demonstrates the carbon substance of buildups without and with sodium hydroxide in 700ºC. This buildup principally comprises of carbon (around 80%), paying little respect to sodium hydroxide expansion.

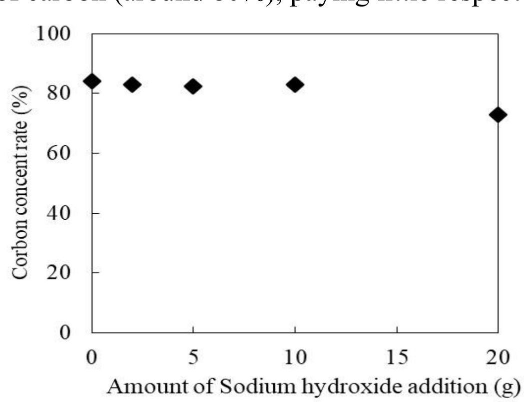

Fig. 10. Carbon content of residues.

Fig. 11 demonstrates the filtering electronic magnifying lens pictures of buildups without (an) and with (b) equal sum expansion of sodium hydroxide. The buildup with expansion of sodium hydroxide had a permeable structure while that without sodium hydroxide shows no permeable structure.

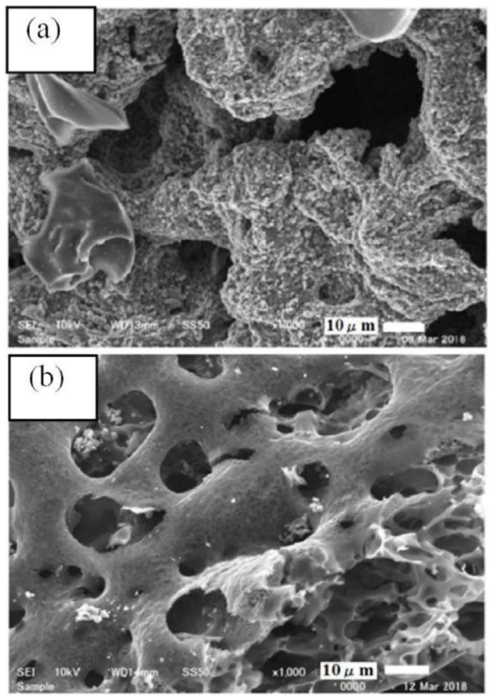

Fig. 11. Residues (a) with out and (b) with addition of sodium hydroxide.

Table IV demonstrates a particular surface zone of buildup without and with included sodium hydroxide in correlation with monetarily accessible initiated carbons (Junsei Chemical Co., Ltd., Activated carbon). As the measure of sodium hydroxide is expanded, the particular territory expanded from 72 m 2/g to 901 m 2/g, which was practically same as the particular surface zone of the enacted carbon (966 m 2/g).

4. Conclusion

In this investigation, rice, one of the principle substance by and large waste, was changed over into combustible gas and carbonaceous adsorbent by pyrolysis with sodium hydroxide. Crude rice can be changed over into a combustible gas, chiefly including hydrogen, methane, carbon monoxides and carbon dioxide gases. With expanding the expansion of sodium hydroxide or warming temperature, the combustible gas including higher substance of hydrogen and methane can be acquired. The heaviness of the buildup after pyrolysis with proportional sum expansion of sodium hydroxide at 700 o C is 1 % of crude rice test, and the buildup had a permeable structure with high explicit surface territory, which is proportionate to industrially accessible initiated carbon.

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