Rapid Pulse Carbonization to Convert Organic Solid Waste into Carbon

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Abstract

This invention describes a quick and efficient carbonization technology that converts solid waste into bio-carbon after a few tens of minutes of reaction time. Our work is based on adequate parameters such as temperature, pressure and catalytic heat diffuser, this work emphasized the heat and control of pressure within a packed bed of solid waste. The reaction was complete after 20 min

The solid waste will be transformed into bio-fuel with almost zero waste. Only steam water was ejected from the reactor.

Keywords: Carbonization, Rapid, pulse, solid organic waste, pressure, temperature, catalytic heat diffuse.

Introduction

There are various options available to treat Municipal Solid Waste (MSW). Mainly, the following types of technologies are available: (1) sanitary landfill, (2) incineration, (3) gasification, (4) anaerobic digestion, and (5) other types. Sanitary landfill is the scientific dumping of municipal solid waste due to which the maturity of the waste material is achieved faster and hence gas collection starts even during the procedure. Incineration technology is the controlled combustion of waste with the recovery of heat, to produce steam that in turn produces power through steam turbines. **About 75% of weight reduction and 90% of volume reduction is achieved through burning.** A gasification technology involves pyrolysis under limited air in the first stage, followed by higher temperature reactions of the pyrolysis products to generate low molecular weight gases with calorific value of 1000–1200 kcal/m3. These gases could be used in internal combustion engines for direct power generation or in boilers for steam generation to produce power. In bio-methane, the digested pulp produces the combustible gas methane and inert gas carbon dioxide. The remaining digestive is a good quality soil conditioner. Other technologies are available such as Pyro-plasma, and flash pyrolysis. All these technologies have merits and demerits. The choice of technology has to be made based on the waste, its quality and local conditions. **The best compromise would be to choose the technology which (1) has lowest life cycle cost (2) needs least land area (3) causes practically no air and land pollution (4) produces more power with less waste and (5) causes maximum volume reduction.** Our invention is based on the temperature , pressure and catalytic heat diffuser. The organic solid waste can be transformed into carbon within 15 minutes and with a low coast of energy. The advantages of our technology are summarized as follow:

1- Carbon production
2- Low cost
3- Small space
4- Steam Water emission
5- No toxic gas
6- Zero waste technology

Materials and Methods

2.1. Equipments

2.1.1. The apparatus used for the carbonization is a home-made machine presented in figure 1

20kg/15 minutes | 1000 kg /15 minutes | 3500 kg /15 minutes

Figure 1: three prototypes of the RPC machine with different capacities: 20 kg, 1000 kg and 3500 kg per 15 minutes

The main elements of the apparatus are:

1- Cylindrical stainless steel home-made reactor.
2- Heating system which can be electric, fuel oil, or carbon produced by the machine itself.
3- Pressure system.
4- Diffuse heat catalytic

2.1.2 Organic solid waste

The organic solid waste treated in our technology can cover all the waste delivered from municipalities, hospitals and from expired drugs.

Results and Discussion

3.1. Carbonization of municipalities' solid waste

Our first experiments were focused on small scale waste. In the beginning, a mixture of solid waste was collected from municipalities (MSW). The total mass of the waste was 1kg. This mass was transferred into our small reactor which was closed tightly to avoid the leak of gases during the carbonization. An electrical heater was installed to heat the system at 400 0C and an air compressor to assure the adequate pressure.

The time of the reaction was estimated by 14 to 20 minutes according to the kind of solid waste.

*An internal cracking of the organic compounds was obtained and thus a conversion of organics into carbon was produced

Figure 2 shows the behavior of the solid waste before and after treatment

Figure 2: Mixture of SolidWaste MSW before carbonization.

After carbonization.

* As can be observed, the final product is a black material without any odors. The elemental analysis of this product showed 90% to 98% of carbon and it is up to the initial raw materials treated. However the rest of the materials are supposed to be minerals.

It has been shown that the mass of solid waste was reduced up to 20 to 25% of the initial mass.

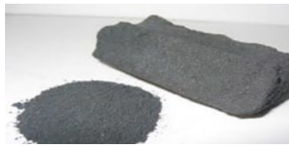
3.2. Carbonization of other solid waste

We demonstrated that the carbonization of some fruits, industrial materials and expired drugs is also one of our objectives.

Figure 3 shows the conversion of different organic solid waste.

Meat

Before carbonization



After carbonization

Poly-ethylene

Before carbonization

After carbonization

Expired drugs

Before carbonization

After carbonization

Figure 3: carbonization by RPC of different organic solid waste.

N0 of different MSW samples	%N	%C	%H	% S
1	0	98	0	0.2
2	0	98.5	0	0.1
3	0	94	0	0
4	0	97	0	0
5	0	93	0	0.07
6	0	97.5	0	0.5
7	0	99	0	0
8	0	98.8	0	0

3.3. Elementary analysis of carbon obtained by RPC

The product obtained after the carbonization was analyzed by an elementary analysis machine (Flash EA 1112). The results were collected in the table 1.

Table 1: Elemental analysis of charcoal obtained after carbonization of different MSW samples.

The results presented in this table show that about 98 % of the dry material is carbon and the residual part is made of several minerals like potassium, calcium or others non toxic compounds.

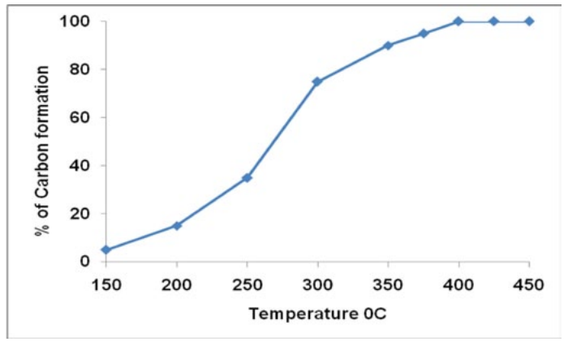
3.4. Mechanism of the carbonization

After ejection of water outside of the reactor, as vapor of water, the dry materials are submitted to the cracking phenomenon. This leads to the formation of carbon which presents the majority of the mass of the dry materials.

3.5. Effect of the temperature on the carbon formation

The pressure was fixed at 10 bars and the temperature was changed from 100 0C to 400 0C. For each value of temperature a sample was withdrawn and analyzed by Flash EA 1112, “Thermo”, a plot of the carbon formation in function of temperature shows that the percentage of carbon formation increases with the increase of the temperature to reach the maximum at 350 0C and become stable at 400 0C. The elementary analysis to measure the percentage of carbon for each sample was determined after keeping the time of treatment at 15 minutes.

Figure 4: presents the plot of the percentage of carbon formation in function of temperature at the same pressure (10 bars).



3.6. Effect of the pressure on the carbon formation

The temperature was fixed at 450 0C and the same mass of solid waste was treated at several values of pressure (starting from 1 to 12 bars). Each sample was analyzed to determine the carbon obtained during the carbonization. The time of the reaction was determined at 15 minutes. Figure 5 shows that after 4 bars the carbonization starts to become significant. At the atmospheric pressure the material was completely burned and all the mass converted to ash. After 4 bars there was no ash formation but the organic material was converted into carbon.

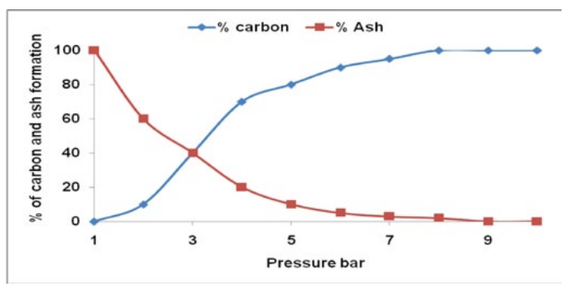


Figure 5 : Plot of percentage of carbon and ash formation in function of pressure

3.7. Comparison of different technologies

Landfill	1-Dangerous gases are given off from landfill sites that cause local air pollution and contribute to: 2-global warming. 3-There is also the possibility of local streams becoming polluted with toxins seeping through the ground from the landfill site. 4-Finally, once the site has been filled, it might not be able to be used for redevelopment as it might be too polluted.
Compost	Generates odors and leach ate which must be managed
Incineration	The disadvantages of incineration is that it produces dangerous fumes and also requires a source of energy to start.
Pyrolysis	1. The product stream is more complex than for many of the alternative treatments; 2. The product gases cannot be vented directly in the cabin without further treatment because of the high CO concentrations 3. Low capacity, low efficiency, high sophisticated, high expensive
RPC	Environmental friendly, Rapid, Low cost, Easy to use

3.8. Breif feasibility study

Items	Cost	Profit
Reactor 500 Liters	250.000 $	---------
Number of runs per day	10	
Diesel consumption per run	2.25 $	
Diesel consumption per day	22.5 $	
Diesel consumption per year	8100 $	
Waste treated per day	5000 Liters or 4 tons	Zero waste 1.2 tons of carbon
Waste treated per year	1440 tons	Zero waste 432 tons of carbon
Benefit from carbon per year	432x100 $	43200 $
The amount currently paid to treat municipal waste	1440 x 70	100800 $
The amount currently paid to treat hospital waste	1000kg x 1$	1000$ per ton
Total benefit from municipality waste per year	100800- 43200 + 8100	65700 $
number of years required to recover the cost of the machine	250000/65700	3.8 years

Conclusion

- Rapid Pulse Carbonization RPC is a new technology for the carbonization of organic materials such as MSW, blood, meat, bones and expired drugs.
- The byproduct is carbon
- Processing time is 10-20 minutes.
- Zero waste
- Environmental friendly
- Economical method

The carbon produced can be used for heat or in cement manufacturing

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Infos

Les Gens Lents Meurent Plus Vite!

Selon une étude publiée dans PlosOne, les gens dont le temps de réaction est lent ou variable sont aussi les plus susceptibles de mourir jeunes.

Les adeptes de la lenteur seraient-ils en danger? C'est en tout cas ce que suggère une étude publiée dans PlosOne , menée par une équipe de l'University College London et de l'Université d'Edimbourg. Les chercheurs ont fait passer à 5134 adultes, âgés de 20 à 59 ans, un test de réactivité simple: il s'agissait de presser un bouton lorsqu'une image apparaissait sur un écran d'ordinateur. Ce type de mesure, nous disent les chercheurs, est un bon indicateur des capacités cognitives des individus. Et contrairement à des exercices plus complexes ou qui imposent de faire un choix, il a l'avantage de ne pas pénaliser les indécis ou les incultes

Les participants ont été testés à cinquante reprises, sans bénéficier préalablement d'un quelconque entraînement. Puis les chercheurs les ont suivis pendant quinze années, durant lesquelles 378 participants de l'étude (soit 7,4%) sont décédés. Constatation des chercheurs: ceux qui avaient les temps de réaction les plus lents au début de l'étude, tout comme ceux dont le temps de réaction était variable d'un test à l'autre, étaient aussi ceux qui, statistiquement, étaient les plus susceptibles de mourir jeunes. Les «lents» avaient ainsi 25 % de risques en plus de mourir jeunes (toutes causes de mortalité confondues) et les inconstants 36 % de risques supplémentaires, indépendamment de leur âge, de leur sexe ou de leur origine ethnique. «Le statut socio-économique, l'hygiène de vie et les facteurs de risques cardio-vasculaires avérés expliquent partiellement, mais pas complètement, ces associations», précisent les chercheurs.

Hypothèse évoquée par le Dr Gareth Hagger-Johnson, qui a dirigé l'étude: **le temps de réaction lent ou variable refléterait un système nerveux central qui se détériore en même temps que le reste du corps.**