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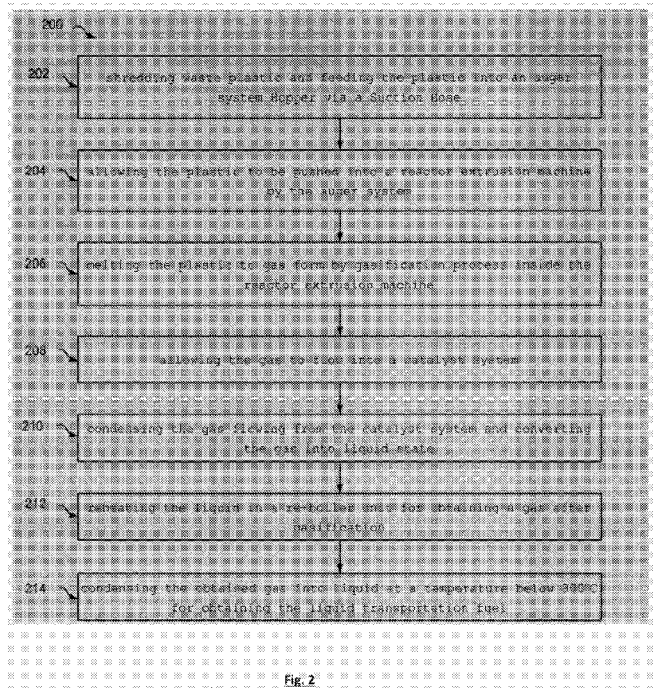
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(54) Title: A CONVERSION SYSTEM AND PROCESS FOR PRODUCING LIQUID TRANSPORTATION FUEL



(57) Abstract: The present invention relates to a system and a process for producing liquid transportation fuel from plastic waste materials. The process includes the steps of shredding the plastic waste material and melting it into gas form, converting the gas into liquid form by reacting with a catalyst, reheating the liquid from the catalyst to gaseous form in a re-boiler, condensing gas obtained from re-boiler to obtain liquid transportation fuel.



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**A conversion System and Process for producing liquid
transportation fuel**

FIELD OF INVENTION

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The present invention relates to a liquid transportation fuel. More particularly, relates to a conversion system and process for producing liquid transportation fuel from plastic waste materials.

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BACKGROUND OF INVENTION

Increasing awareness on environmental and health-related problems associated with most conventional waste plastics management methods, in which the plastic wastes has generally
15 been burned, buried or landfilled has become a driving force to the scientists and inventors nowadays, to propose more environmentally responsible waste management solutions- pyrolysis and de-polymerization of plastic wastes.

20

The pyrolysis and de-polymerization processes, unlike current plastic waste disposal methods, however, have successfully recovered resources, crude oils and/or natural gas of particular, from the plastic wastes. Such waste management

solutions thereby provide opportunities for the complete reuse of plastic wastes instead of degradation of such wastes in nature, where problems associated with the increasingly volume of plastics disposed in landfills remain unsolved.

5

An example relating to pyrolysis of waste plastic materials includes U.S. prior art document, US2003047437 (A1) which teaches a two-stage pyrolysis process, in which shredded plastic wastes are initially melted and pyrolyzed into hydrocarbon oils by means of entrained inert gas from a fluidized bed with hot circulating grainy inert heat carrier at a temperature between 300°C and 600°C. In the subsequent step, untransformed waste plastics, the heat carriers, and the entrained inert gas are separated from pyrolysis products and are subjected to the fluidized bed, where pyrolysis is completed. Pyrolysis products from the first stage and second stage are thereafter fractionated and condensed into liquid transportation fuels.

20 Such waste plastics pyrolysis process, as understood by one skilled in the art, has successfully alleviated limitations generally observed in fluidized bed process, for example, back mixing of pyrolysis products, non-uniformity of the fluidized bed, and more importantly low yield of valuable aromatic and

high molecular hydrocarbons. However, this technology is relatively expensive since it is a multistep stage process and requires high temperature and high pressure conditions to completely decompose the plastic wastes into hydrocarbon oils.

5 Furthermore, additional step such as removal of coke deposited on the fluidized bed by means of combustion at a temperature between 600°C and 900°C is required and thus contributes to a high maintenance cost.

10 Accordingly, thermal catalytic de-polymerization process of plastic wastes to obtain its original monomers under a milder thermal condition is rather preferred than any pyrolysis methods in the art. An example of such thermal catalytic de-polymerization process includes U.S Patent Application No.
15 5369215. This prior document discloses the use of metallic salt catalyst in depolymerization process of waste plastic derived from waste tires and rubbers, preferably which has been exposed to ozone, under a condition of elevated temperature and reduced pressure. Although the ozonized
20 polymers are susceptible to heat, and thus allows the plastic wastes can be completely decomposed in a substantially low temperature, the deleterious effects of the ozone gaseous should not be neglected.

It is required to provide a system and method to overcome the short comings associated with the prior arts.

SUMMARY OF INVENTION

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Accordingly, the present invention provides a process for producing liquid transportation fuel based on plastic waste materials. The process comprising the steps of shredding waste plastic and feeding the plastic into an auger system Hopper
10 via a Suction Hose; allowing the plastic to be pushed into a reactor extrusion machine by the auger system; melting the plastic to gas form by gasification process inside the reactor extrusion machine; allowing the gas to flow into a catalyst system; condensing the gas flowing from the catalyst system
15 and converting the gas into liquid state; reheating the liquid in a re-boiler unit for obtaining a gas after gasification; and condensing the obtained gas into liquid at a temperature below 300 °C for obtaining the liquid transportation fuel.

20 In an embodiment, the present invention provides a conversion system for producing liquid transportation fuel. The system comprising a reactor extrusion machine for gasification by melting waste plastic material, a hopper for pushing the waste plastic material into the reactor extrusion machine; a

catalyst system connected to the reactor extrusion machine for receiving a gas obtained by the gasification process of reactor extrusion machine and reacting the gas with a catalyst for form liquid; a re-boiler unit for reheating the liquid
5 obtained from the catalyst system to obtain gas, wherein the gas obtained from the re-boiler is condensed to obtain liquid transportation fuel.

BRIEF DESCRIPTION OF THE DRAWINGS

10 Other objects, features, and advantages of the invention will be apparent from the following description when read with reference to the accompanying drawings.

Fig. 1 is a system for conversion of plastic waste material to
15 liquid transportation fuel in accordance with an embodiment of the present invention.

Fig. 2 is a flow chart illustrating the process for producing
liquid transportation fuel in accordance with an embodiment of
20 the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described in detail with reference to the accompanying in drawings.

5

Various embodiments of the present invention provide

Referring to Fig. 1 the present invention provides a system 100 for producing liquid transportation fuel by conversion of waste plastic material. The system 100 includes an reactor extrusion machine 110, a hopper 120 connected to the machine, a catalyst system 130 connected to the reactor extrusion machine 110 and a waste disposal unit 150, a collection tank 160, a re-boiler system 170 connected to the catalyst system; a storage tank 180 connected to the collection tank 160, a skid tank 190 connected to the storage tank.

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In an embodiment, the system 100 further comprises a fuel filter 140 and a sight glass 195.

20

The reactor extrusion machine 110 performs gasification by melting waste plastic material. The hopper 120 pushes the waste plastic material into the reactor extrusion machine 110. The catalyst system 130 connected to the reactor extrusion

machine 110 receives a gas obtained by the gasification process of reactor extrusion machine 110 and reacts the gas with a catalyst to form liquid. The re-boiler unit 170 reheats the liquid obtained from the catalyst system 130 to obtain
5 gas, wherein the gas obtained from the re-boiler 170 is condensed to obtain liquid transportation fuel.

In an embodiment, the present invention provides a process 200 for producing liquid transportation fuel based on plastic
10 waste materials as shown in Fig. 2. The process 200 comprises the steps of S202 shredding waste plastic and feeding the plastic into an auger system Hopper via a Suction Hose. In S204, the plastic is allowed to be pushed into a reactor extrusion machine by the auger system. In S206, the plastic is
15 melted to gas form by gasification process inside the reactor extrusion machine. In S208, the gas is allowed to flow into a catalyst system and In S210, gas flowing from the catalyst system is condensed to obtain liquid state. In S212, the liquid is reheated in a re-boiler unit for obtaining a gas
20 after gasification and in S214 the obtained gas is condensed into liquid at a temperature below 300 °C for obtaining the liquid transportation fuel.

In an embodiment, inside the reactor extrusion machine the plastic is gasified at a temperature between 450°C to 500 °C.

In an embodiment, the gas flowing into the catalyst system is
5 a long molecular carbon chain gas that breaks into multiple shorter lengths when reacting with a catalyst in the catalyst system.

In an embodiment, the gas reacts with the catalyst at 400°C.

In an embodiment, the gas flowing out from the catalyst system
10 is a shorter molecular carbon chain Gas.

In an embodiment, the liquid in the re-boiler Unit is reheated at a temperature of 350°C for gasification.

In an embodiment, the liquid obtained after condensing of gas at 300 °C is ultra low Sulphur diesel oil.

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In an embodiment, the waste plastic materials as described herein referred to municipal and/or industrial wastes made of, include but not limited to, polyethylene, polypropylene and polyvinyl chloride.

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In one embodiment of the present invention, the limestone catalyst is resulted by means of sintering a solid composition comprising aluminum oxide (Al_2O_3) ranging from 39% to 41%; calcium oxide (CaO) ranging from 30% to 32%; silicone oxide
5 (SiO) ranging from 0.09% to 0.12%; and magnesium oxide ranging from 0.01% to 0.03%. More preferred the solid composition comprises 40.6% ± 0.1 aluminum oxide (Al_2O_3); 31.7% ± 0.1 calcium oxide (CaO); 0.15% ± 0.01 silicone oxide (SiO); and 0.03 ± 0.01 magnesium oxide (MgO).

10

It is noted that, in addition to enhancing the conversion process, such limestone catalyst allows plastic waste materials to be totally depolymerized into higher olefins (C_4 - C_{25}) at a low temperature, preferably at temperature of below
15 460° under normal atmospheric pressure condition of 1 Bar. As understood, carbonization process, which leads to formation of decomposed residues or coke crystals and unacceptable environmental hazards, for example, greenhouse gases, dioxins and furans, can be suppressed with such substantially low
20 operating temperature. The conversion (thermal depolymerization) of plastic waste materials alongside with said limestone catalysts, therefore, has undoubtedly rendered the technology more economically viable and environmentally acceptable.

In an embodiment, the limestone catalyst (15) results from sintering (S102) a solid composition a solid composition comprising aluminum oxide (Al_2O_3) ranging from 39% to 41%;
5 calcium oxide (CaO) ranging from 30% to 32%; silicone oxide (SiO) ranging from 0.09% to 0.12%; and magnesium oxide ranging from 0.01% to 0.03%. In accordance to the preferred embodiment, solid composition comprises 40.6% ± 0.1 aluminum oxide (Al_2O_3); 31.7% ± 0.1 calcium oxide (CaO); 0.15% ± 0.01
10 silicone oxide (SiO); and 0.03 ± 0.01 magnesium oxide (MgO) is pulverized and sintered (S102) to form the limestone catalyst (15) of present invention.

In an advantageous aspect, the plastic does not require
15 washing, the shredded Plastic is acceptable thereby reducing the cost to re-palletize the Plastic.

In another advantageous aspect the present invention uses only a single process to convert its form from solid to molten and
20 to gas (Reactor extrusion machine).

Further, the present invention does not use Distillation Column.

Although the present invention has been described with reference to the preferred embodiments and examples thereof, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from
5 the scope of the present invention which is intended to be defined by the appended claims.

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Claim

1. A process for producing liquid fuel (15) from plastic waste materials (10), the process comprising the steps of:

5 shredding waste plastic and feeding the plastic into an auger system hopper via a suction Hose;

 allowing the plastic to be pushed into a reactor extrusion machine by the auger system;

 melting the plastic to gas form by gasification process
10 inside the reactor extrusion machine;

 allowing the gas to flow into a catalyst system;

 condensing the gas flowing from the catalyst system and
 converting the gas into liquid state;

 reheating the liquid in a re-boiler unit for obtaining a
15 gas after gasification; and

 condensing the obtained gas into liquid at a temperature
 below 300 °C for obtaining the liquid transportation fuel.

 2. The process as claimed in claimed 1, wherein inside the
20 reactor extrusion machine the plastic is gasified at a
 temperature between 450°C to 500 °C.

3. The process as claimed in claim 1 wherein the gas flowing into the catalyst system is a long molecular carbon chain gas that breaks into multiple shorter lengths when reacting with a catalyst in the catalyst system;

5 4. The process as claimed in claim 3 wherein the gas reacts with the catalyst at 400°C.

5. The process as claimed in claim 1 wherein, the gas flowing out from the catalyst system is a shorter molecular carbon chain Gas.

10 6. The process as claimed in claim 1 wherein, the liquid in the re-boiler Unit is reheated at a temperature of 350 °C for gasification.

7. The process as claimed in claim 6 wherein, the liquid obtained after condensing of gas at 300 °C is ultra low Sulphur
15 diesel oil.

8. A conversion system for producing liquid transportation fuel, the system comprising:

a reactor extrusion machine for gasification by melting waste plastic material;

20 a hopper for pushing the waste plastic material into the reactor extrusion machine;

a catalyst system connected to the reactor extrusion machine for receiving a gas obtained by the gasification process of reactor extrusion machine and reacting the gas with a catalyst for form liquid;

5 a re-boiler unit for reheating the liquid obtained from the catalyst system to obtain gas;

wherein the gas obtained from the re-boiler is condensed to obtain liquid transportation fuel;

10 9. The system as claimed in claim 8 further comprising a waste disposal means connected with the catalyst system.

10. The system as claimed in claim 8 further comprising a collection tank connected to the catalyst system.

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11. The system as claimed in claim 8 further comprising a skid tank connected to the collection tank.

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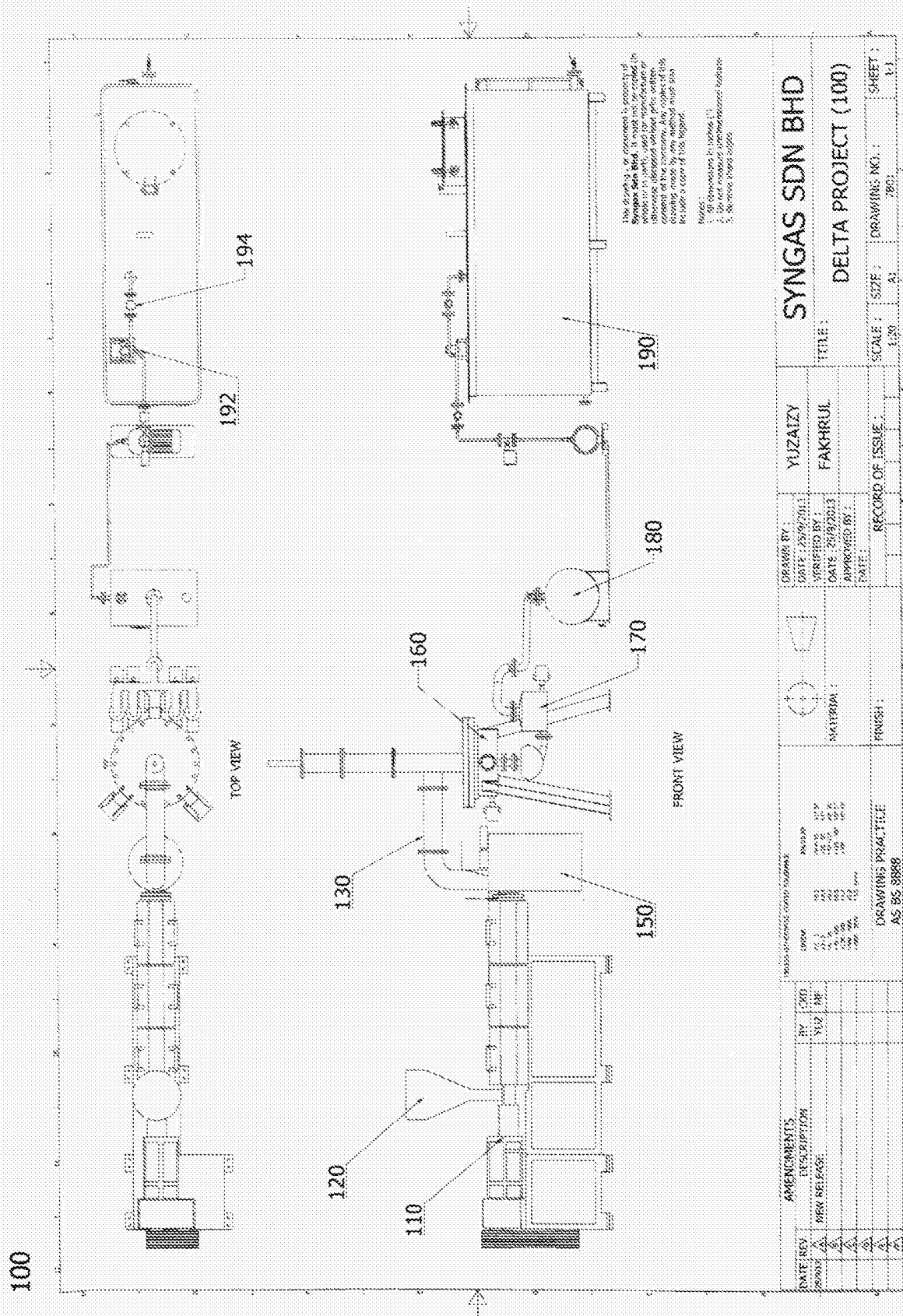
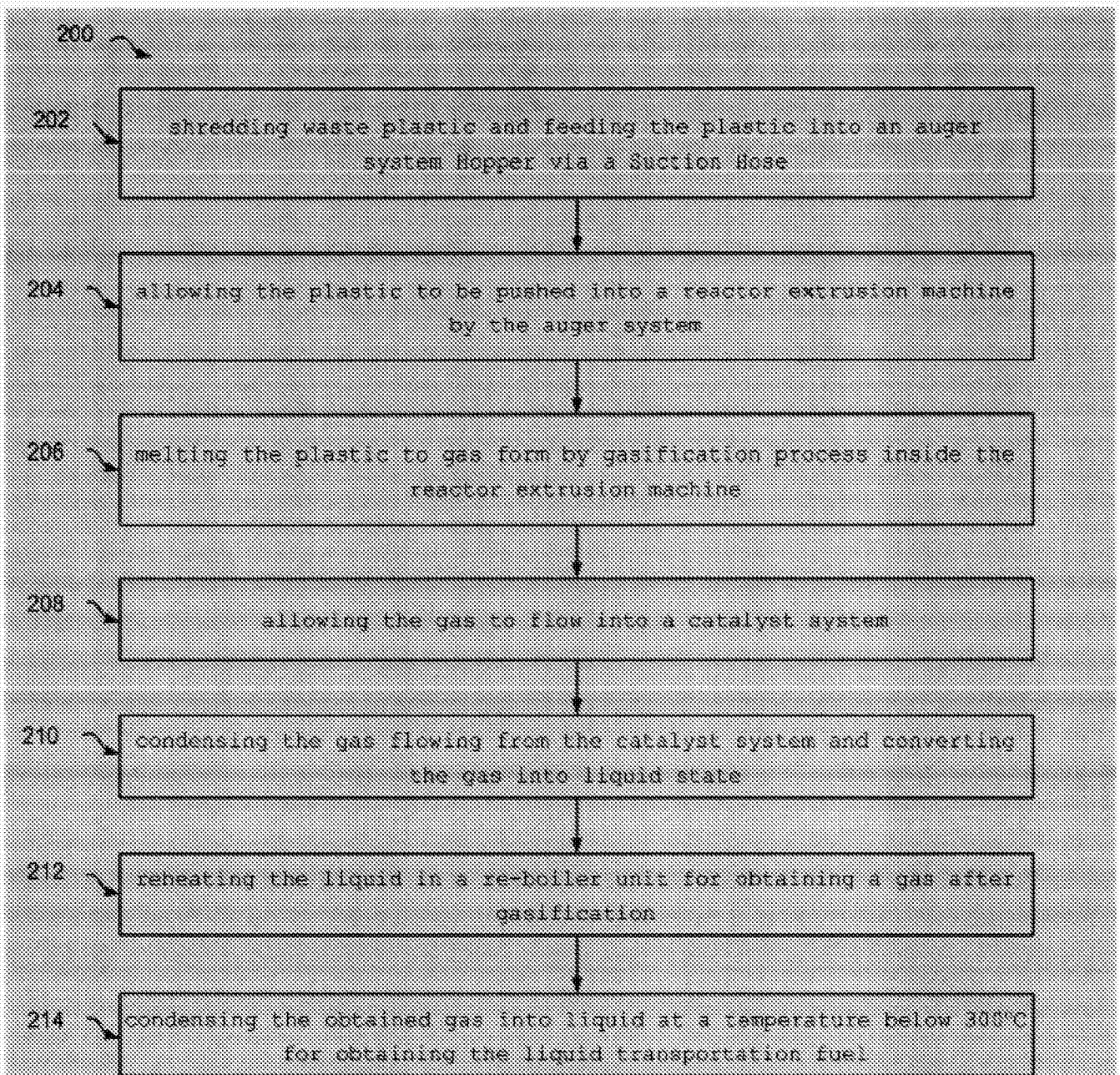


Fig. 1

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/MY2014/000171

A. CLASSIFICATION OF SUBJECT MATTER

C10G 1/00 (2006.01) C10G 1/10 (2006.01) C08J 11/00 (2006.01) C10B 49/02 (2006.01) C10B 53/07 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Databases: WPI, EPODOC, TXTAU1, TXTCA1, TXTEP1, TXTGB1, TXTSG1, TXTUS0, TXTUS1, TXTUS2, TXTUS3, TXTUS4, TXTUS5, TXTWO1, IPC/CPC marks: C10G1/-, C10G2300/-, C10G2400/-, C10B49/-, C10B53/-, C08J11/- and keywords such as plastic, rubber, tire, tyre, waste, polyethylene, polypropylene, polyvinyl chloride, shred, crush, disintegrate, cut, melting, heating, hot, gasification, catalyst, SiO, Al₂O₃, CaO, Aluminium oxide, silicone, oxide, calcium oxide, condense, cool, chill, cold, reheat, reboil, liquid, fuel, diesel and similar keywords search through Google patent and Espacenet and Applicant "SAHAM UTAMA SDN BHD" and Inventor "SHAMSUL BAHAR BIN MOHD NOR" search through Espacenet and AusPat.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 21 November 2014		Date of mailing of the international search report 21 November 2014	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustalia.gov.au		Authorised officer Heramb Bal AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262837966	

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/MY2014/000171
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2007/037768 A1 (GEP YESIL ENERJI URETIM TEKNOLOJILERI LIMITED SIRKETI) 05 April 2007 Abstract, claim 1, figure 1, page 9 lines 9-37	
A	US 2003/0047437 A1 (STANKEVITCH) 13 March 2003 abstract, claim 1, figure 1-3, paragraphs 0031-0033, 0047-0049	

Form PCT/ISA/210 (fifth sheet) (July 2009)

INTERNATIONAL SEARCH REPORT Information on patent family members		International application No. PCT/MY2014/000171	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
WO 2007/037768 A1	05 April 2007	None	
US 2003/0047437 A1	13 March 2003	US 6534689 B1	18 Mar 2003
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2009)			