RENEWABLE BLENDED NATURAL GAS AND ROCK WOOL PRODUCTION FROM A PLASMA-BASED SYSTEM

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ABSTRACT

A method and system for cost effectively converting a feedstock using thermal plasma or other styles of gasifiers, into an energy transfer medium using a blended gaseous fuel. The feedstock can be any organic material or inorganic combination to generate a syngas. The syngas is blended with any fuel of a higher thermal content (BTU) than the syngas. The resulting blended high thermal content fuel is used on site or reinjected into the fuel supply pipeline. Rock wool and accessory heat are produced to increase the efficiency of the plant.
RENEWABLE BLENDED NATURAL GAS AND ROCK WOOL PRODUCTION FROM A PLASMA-BASED SYSTEM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates generally to processes and systems for generating a blended Natural Gas of a BTU content high enough to be reinjected into the gas main. This is also combined with the production of rock wool to develop a high efficiency renewable energy plant at a low capital cost when the feedstock is renewable such as Municipal Solid Waste (MSW). This design of plant is becoming more desirable as high tipping fees and high transportation costs demand small, distributed, cost effective, MSW/renewable energy facilities.

[0003] 2. Description of the Related Art

[0004] There is significant interest in renewable energy projects. Thermal plasma has consistently distinguished itself as a high efficiency, low emissions gasification process for just about any feedstock, and has been identified as one of the most desirable processes for use in producing energy from renewable fuels.

[0005] If an analysis of plasma MSW (or other renewable fuels) relative to other energy facilities is conducted, it becomes apparent that the lack of existing plasma projects is not exclusively the result of technological challenges, but also results from the relatively poor economics associated with this technology. Plasma technology is not inexpensive when compared to disposition of waste using landfill, incineration, or conventional gasification.

[0006] Many plasma projects fail at the onset, notwithstanding extensive initial marketing efforts, usually as a result of inadequate financing and low or nonexistent profitability. Recently some states have allocated bonuses for development and use of renewable energy, and such efforts have stimulated the use of plasma systems in the production of energy. Unfortunately, it is expected that this modest boon to plasma usage will be short lived, as it represents an artificial market that is a poor model on which to build a business. This is particularly problematical when one considers that these facilities are expected to operate cost effectively for at least thirty years.

[0007] Many plasma projects in the past have pinned false hopes on high tipping fees for hazardous waste without fully understanding the complications that are associated with such materials. The handling of these materials are not only complex and expensive, but also potentially dangerous if not properly engineered. The entire process and the facility itself thus becomes unduly expensive. Most counties emphatically state that they do not desire large quantities of hazardous waste to be transported through their communities. However, large quantities of such waste must be generated if the facility is to achieve profitability. The production and delivery of the hazardous waste have to be carefully coordinated since it is dangerous to store biological and other hazardous waste feedstock.

[0008] The process and system of the present invention overcomes the economic hurdles noted above for a plasma system. It is to be understood, however, that the invention herein described is not limited to the use of a plasma gasifier. In some embodiments of the invention, conventional gasifiers, inductively heated gasifiers, or inductively heated gasifiers with plasma assist, can be employed. The use of a plasma gasifier in the practice of the present invention simply increases overall system effectiveness.

[0009] The system of the present invention is simple, flexible, and very energy efficient. In short, it produces a large amount of renewable energy from a feedstock such as Municipal Solid Waste (“MSW”), for a very small capital investment. Any feedstock can be used, including, for example, biomass or algae. MSW is but a common example of a renewable feedstock.

[0010] It is, therefore, an object of this invention to provide a simple and cost-effective renewable energy system.

[0011] It is another object of this invention to provide a renewable energy system that can consume virtually any feedstock.

[0012] It is also an object of this invention to provide a simple and cost-effective renewable energy system that can use a conventional gasifier.

[0013] It is a further object of this invention to provide a simple and cost-effective renewable energy system that can use a plasma gasifier.

[0014] It is yet another object of this invention to provide a cost-effective renewable energy system that can use an inductively heated gasifier or an inductively heated and plasma assisted gasifier.

[0015] It is additionally an object of this invention to provide a process and system for blending natural gas with syngas at a ratio that can be re-injected into the natural gas main.

[0016] It is yet another object of this invention to provide a process and system for the production of rock wool to enhance the thermal and financial efficiency of the renewable energy plant.

[0017] It is yet another object of this invention to provide a process and system for extracting heat energy from a plasma gasifier and providing the heat energy to any process that requires heat, including buildings, and thereby increase the efficiency of the renewable energy facility.

SUMMARY OF THE INVENTION

[0018] The foregoing and other objects are achieved by this invention which provides a method of extracting energy from a gasifier and delivering the energy to an energy transfer medium, the method including the steps of:

[0019] extracting syngas from a gas product issued by the gasifier;

[0020] delivering the extracted syngas to a fuel blending system; and

[0021] producing a blended fuel by mixing the syngas with a gaseous fuel, the gaseous fuel having a higher thermal (BTU) content than the syngas.

[0022] In a practicable embodiment of the invention, the gasifier is a plasma gasifier. In this embodiment, there is provided the further step of re-injecting the gas product into a gas main supply. Additionally, there is provided the further step of delivering the gas product to a pre-gasifier to increase system efficiency. Reclaimed heat is, in some embodiments, delivered heat to the pre-gasifier. The gaseous fuel includes any combination of natural gas, butane, propane, pentane, ethane, and any other suitable gaseous fuel.

[0023] In an advantageous embodiment of the invention, there is further provided the step of controlling the thermal content of the blended fuel. The step of controlling the thermal content of the blended fuel includes, in some embodiments, the further step of employing a sensor in a feedback
loop. The sensor can be any of a flame ionization detector, a calorimeter, or a spectrometer.

0024 In an efficient embodiment of the invention, there is further provided the step of producing rock wool. In other embodiments, there is provided the further step of producing accessory heat.

0025 Prior to performing the step of extracting syngas from a gas product issued by the plasma gasifier there are provided, in some embodiments, the further steps of:

0026 oxidizing a feedstock fuel to produce oxidized feedstock fuel; and

0027 delivering the oxidized feedstock fuel to the plasma gasifier,

0028 whereby a work load of a primary heat source of the plasma gasifier is reduced.

0029 In accordance with a further method aspect of the invention, there is provided a method of extracting energy from a plasma gasifier and delivering the chemical and heat energy to an energy transfer medium. In accordance with this further aspect of the invention, there are provided the steps of:

0030 extracting syngas from a fuel product issued by the plasma gasifier; and

0031 delivering the extracted syngas to a fuel blending system for forming a blended fuel having a thermal content that is greater than the thermal content of the extracted syngas.

0032 The invention provides a method of producing blended natural gas to be used on-site, or re-injected into the main, or any other gaseous fuel, rock wool production, and accessory heat production all at a low capital cost. This process is due in part to modern syngas production methods. Syngas production has taken a large step forward in quality when it is produced using a pyrolysis method combined with plasma generated heat. This process has proven itself to be far superior to conventional gasifiers. The thermal (BTU) content of the product syngas can consistently be held to about 300 BTU/Cu ft. This relatively low quality fuel is a step forward for renewable feedstock gasification and falls far short of the requirements of modern boilers, internal combustion engines, and turbines.

0033 When this fuel is compared to others on a Wobbe Index it falls poorly. The low energy density creates a variety of difficulties for all forms of engines or turbines. Turbine manufacturers in particular have found it difficult to produce energy using syngas. These prime movers also add significant cost to any renewable energy project which makes the project less likely to be built, or to be operated profitably.

0034 A key attribute of the plasma based gasification system is the ability to control the process and generate relatively consistent thermal (BTU) content in the resultant gas. This allows the blending of the syngas with other fuels such as natural gas to produce a fuel of consistently high quality.

0035 In addition to the foregoing, feedback systems are also now available with reasonably short time constants to allow continuous closed loop adjustments to the fuel quality. Calorimeters can now be integrated to feed data back in minutes, and devices like flame ionization detector (FID) units can feedback data in seconds.

0036 When the blended natural gas invention described herein is used in conjunction with the production of value added products such as rock wool and facility accessory heat, a very cost effective and efficient method of implementing renewable power is achieved. This is a considerable asset in the endeavor to promote the acceptance of plasma based renewable energy facilities.

BRIEF DESCRIPTION OF THE DRAWING

0037 Comprehension of the invention is facilitated by reading the following detailed description, in conjunction with the annexed drawing, in which FIG. 1 is a simplified schematic representation of a process and system for generating blended natural gas from a renewable energy source constructed in accordance with the principles of the invention.

DETAILED DESCRIPTION

0038 FIG. 1 is a simplified schematic representation of a process and system 100 for generating blended natural gas from an energy source constructed in accordance with the principles of the invention. As shown in this figure, municipal solid waste or other feedstock, designated as MSW 1, is delivered, in this specific illustrative embodiment of the invention, to system 100 by a crane 2. The feedstock can be any organic material, or an inorganic mix. Crane 2 transfers MSW 1 to a shredder 3. The shredded feedstock (not shown) is then delivered to a pre-gasifier chamber 4. It is to be understood that any other form of gasifier can be employed in the practice of the invention. In this embodiment, pre-gasifier 4 helps to reduce the work of plasma torch 21, which is the primary heat source of plasma chamber 9.

0039 The feed system, which includes shredder 3, compresses the incoming feedstock MSW 1 so as to minimize the introduction of air. Plasma chamber 9, or other conventional gasifier is, in this specific illustrative embodiment of the invention, advantageously operated in a pyrolysis mode, or in air and/or oxygen combustion boosted modes of operation. Additives such as lime 5 are added, in this embodiment, to the gasifier to control emissions and improve the quality of an output slag 24.

0040 Methods of chromatically boosted heat such as the use of liquid or gaseous fuels and an oxidant injected into port 6 can be used in the practice of the invention. Additionally, any of several fuels such as propane, recirculated syngas, ethane, butane, pentane, etc. can be used in the practice of the invention to supplement the heat input of plasma torch 21.

0041 The quality of the syngas is improved in this embodiment, by the injection of steam 25 into plasma chamber 9.

0042 A syngas product is supplied via a syngas line 10 to a quench system 23 to reduce particulate and other emissions and to reduce the temperature of the syngas to a level that is acceptable to a final syngas purification system 13. Persons skilled in the art will realize sour water cleanup systems for the quench system have been omitted from the drawing for the sake of clarity.

0043 A final Heat recovery system 14 is generated heat that is used in this embodiment to operate pre-gasifier 4. Alternatively, in other embodiments such heat is sold as accessory heat. Heat produced by quench system 11 can also be sold or delivered to the pre-gasifier. A cooling tower for the facility has been omitted from this figure for the sake of clarity.

0044 Compressor 15 draws a slight vacuum on system 100 and directs the syngas to a three way valve 26 and a calorimeter 16. In other embodiments, other fuel quality mea-
Suring devices, such as a flame ionization detector (FID), can be used in the practice of the invention. The syngas in line 17 is directed to a blending valve 27 that mixes natural gas 18, or any other fuel such as ethane, propane, butane, pentane etc. Mixing valve 27 is employed in a closed loop control arrangement that maintains a quality of fuel appropriate for re-injection into a natural gas main 29. Thus, typically about 5% to 10% concentration of syngas is utilized in this embodiment. It should be understood this invention is not limited to 5% to 10% blend concentrations. The product gas is pressurized by compressor 28 prior to being re-injected into gas main 29.

[0045] Financial productivity and overall system efficiency of the plant are enhanced by spinning or blowing slag 24 into rock wool by apparatus 30. The rock wool is then shipped by truck 31.

[0046] Although the invention has been described in terms of specific embodiments and applications, persons skilled in the art can, in light of this teaching, generate additional embodiments without exceeding the scope or departing from the spirit of the invention described and claimed herein. Accordingly, it is to be understood that the drawing and description in this disclosure are proffered to facilitate comprehension of the invention, and should not be construed to limit the scope thereof.

What is claimed is:

1. A method of extracting energy from a gasifier and delivering the energy to an energy transfer medium, the method comprising the steps of:
   - extracting syngas from a gas product issued by the gasifier;
   - delivering the extracted syngas to a fuel blending system; and
   - producing a blended fuel by mixing the syngas with a gaseous fuel, the gaseous fuel having a higher thermal (BTU) content than the syngas.

2. The method of claim 1, wherein the gasifier is a plasma gasifier.

3. The method of claim 1, wherein the gasifier is an inductively heated gasifier.

4. The method of claim 1, wherein the gasifier is an inductively heated and plasma assisted gasifier.

5. The method of claim 2, wherein there is provided the further step of re-injecting the gas product into a gas main supply.

6. The method of claim 5, wherein there is provided the further step of delivering the gas product to a pre-gassifier to increase system efficiency.

7. The method of claim 6, wherein there is provided the further step of delivering reclaimed heat to the pre-gassifier.

8. The method of claim 5, wherein the gaseous fuel includes any combination of natural gas, butane, propane, pentane, ethane, and any other suitable gaseous fuel.

9. The method of claim 8, wherein there is further provided the step of controlling the thermal content of the blended fuel.

10. The method of claim 9, wherein said step of controlling the thermal content of the blended fuel comprises the further step of employing a sensor in a feedback loop.

11. The method of claim 10, wherein the sensor is a flame ionization detector.

12. The method of claim 10, wherein the sensor is a calorimeter.

13. The method of claim 10, wherein the sensor is a spectrometer.

14. The method of claim 2, wherein there is further provided the step of producing rock wool.

15. The method of claim 2, wherein there is provided the further step of producing accessory heat.

16. The method of claim 2, wherein prior to performing said step of extracting syngas from a gas product issued by the plasma gasifier there are provided the further steps of:
   - oxidizing a feedstock fuel to produce oxidized feedstock fuel; and
   - delivering the oxidized feedstock fuel to the plasma gasifier, whereby a work load of a primary heat source of the plasma gasifier is reduced.

17. A method of extracting energy from a plasma gasifier and delivering the chemical and heat energy to an energy transfer medium, the method comprising the steps of:
   - extracting syngas from a fuel product issued by the plasma gasifier; and
   - delivering the extracted syngas to a fuel blending system for forming a blended fuel having a thermal content that is greater than the thermal content of the extracted syngas.

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