APPENDIX XII

BROOKES GASIFICATION PROCESS

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GAIA Inc.
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Att'n: Philip Birett
Project Manager

Re: RFI for the Destruction of SRM Waste

The following gives a brief description of the high temperature gasification equipment that BGP manufactures for the destruction of pathological waste. These units are batch systems and the sizes can range from as small as 50 kgs. per cycle up to several tonnes per cycle. The small units can be cycled as much as twice per day, but the large units are usually set up for one cycle every 24 hours. The sizes you have indicated in your table seem to suit the single primary chamber unit design which can be sized up to about 6 tonnes per cycle. BGP is presently building a prototype dual primary chamber unit for the U.S. government that should be capable of destroying up to 25 tons (22.7 tonnes) per day of pathological waste. This system will be pump fed with macerated material and will function more like a continuous feed unit. It appears to be much larger than the requirements you have indicated and is intended for emergency situations.

Basic Description of the BGP Technology:

Attached is the lead page of the Brookes Canadian patent number 2,170,781. The sketch gives a side cross-sectional view of the apparatus and its features. The apparatus and the process is very simple compared to most incineration systems and it has the added feature of being quite environmentally friendly and very fuel efficient. When the secondary chamber (52) has reached the required set point temperature (850 C or greater) waste (22) is loaded into the primary chamber (30). The hearth (36) transmits heat into the waste mass causing the evaporation of water and hydrocarbon fumes to occur at an ever-increasing rate as the temperature of the waste mass increases. The fumes travel into the afterburning chamber through passageway (38) and oxidize in chamber (52). This is an exothermic reaction and heat is transferred back through the hearth to continue the evaporation of the waste material until essentially only mineral salts and minimal carbon remain as the ash residual.

No complex hydrocarbon structures can leave the process as either fume or ash residual without being exposed to the set point temperature for a significant period of time. In the case of the fume, the dwell time can be set for 2 or more seconds. In the case of the ash residual, it will be exposed to the set point for at least an hour. The temperature in the primary chamber reaches or exceeds the set point toward the end of the cycle and then subsides when the waste is fully gasified.

The excellent fuel efficiency is a result of the fact that the energy in the waste is used to help evaporate the waste. During the mid-gasification phase the secondary chamber burner (48) modulates to a very low fire position. Note that no burner fires into the primary chamber. A minimal amount of air is allowed into this chamber by draft only through (34) toward the end of the cycle to allow for a more efficient and complete carbon cycle. Secondary air to oxidize the fume enters the afterburning chamber through (49).

Background Experience:

Various sizes of the Brookes technology have been put into use for applications such as medical waste destruction, animal disposal for humane societies, etc. However, most directly related to your specific requirements, the Brookes technology was employed in the U.K. to dispose of bovine carcasses and SRM when the BSE crisis hit in the late 90's. The original units placed in Brechin, Scotland, were designed to destroy 4 tonnes per day each of bovine carcasses and eight units were put into operation at that site. Air emission testing was done on an ongoing basis and the units met EU emission standards without the need for abatement.

The emissions were tested for the standard items including particulate, VOC's, NOx, SOx and dioxins. The average particulate was below 25 mg/cu.M. VOC's were well below the limits as were dioxins. Oxides of nitrogen were in the range of the limits and SOx emissions depended on the feedstock. Blood does contain suphur so SOx can spike if large amounts of blood are contained in the waste.

Because of the sensitive situation ash residual samples were taken a multitude of times and tested for amino acids. They were essentially undetectable indicating that no proteins and thus, no prions, survived the process.

Capacities and Sizes:

Animals can be put in these units whole or in parts. Also, a maceration and pumping system can be utilized and this will increase the overall throughput and efficiency. For the purposes of this RFI we are assuming that the material will not be macerated.

For the smaller units ash removal can be manual. With the larger systems ash removal can be partly automated by using an auger system .

The secondary chamber burner can be fired with any of the standard fuels; natural gas, propane, or fuel oil. Fuel usage depends on many factors including the composition of the waste and the frequency of operation. A unit that is only operated occasionally will use much more fuel per kg. of waste than a unit that is operated every day and thus maintains its heat.

<u>50 kg./cycle unit:</u> 8-15 hours

Approx. size: 5 ft. long x 4.5 ft. wide x 5 ft. high.
Approx. price: $35,000.00 CDN

<u>4 tonne/cycle unit:</u> 8 - 10 hours

Approx. size: 25 ft. long x 10 ft. wide x 11 ft. high.
Approx. price: $450,000.00 CDN

Note that these prices do not include shipping, installation, taxes or commissioning costs. These are only estimates and more detail would be required to give a proper quotation.

BGP can custom design these units to suit each individual application ranging in size from very small to very large. In the case of high volume throughput situations such as 1000 tonnes per year or more, we suggest using a modular approach. As an example, for the 1000 tonnes per year of dead stock we would suggest supplying two 2 tonnes per cycle gasifiers as opposed to one large unit. This allows for some redundancy during periods of maintenance or when emergency repair work is required.

The main maintenance issue with this type of equipment is the refractory lining. The life of this lining will depend on many factors including the type of waste, the method of loading, etc. We usually recommend allowing for a maintenance cost of about 10% annually of the capital cost of the equipment. Depending on the application, the refractory may need replacing every two to three years. In cases where there is minimal abuse it can survive in excess of five years.

We would be pleased to answer any questions you may have about the BGP units. Please do not hesitate to contact Gary Ainlay if you require further details.

Sincerely,

David Brookes, P.Eng.

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PROPERTY OFFICE

(12) (19) (CA) **Brevet-Patent**

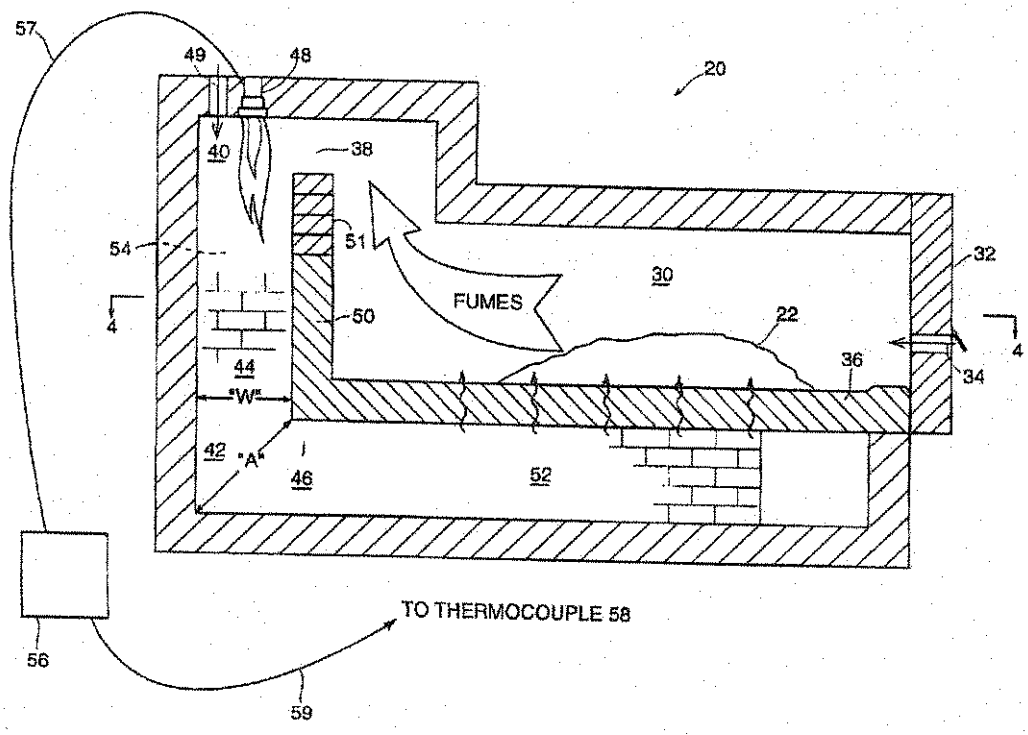
(11) (21) (C) **2,170,781**
(22) 1996/02/29
(43) 1996/09/29
(45) 1999/05/04

(72) Brookes, David, CA
(73) Brookes, David, CA

(51) Int.Cl.[6] A61L 11/00
(30) 1995/03/28 (08/413,980) US

(54) **GAZEIFIEUR POUR DECHETS DE BIOMASSE ET SOLIDES VOLATILS CONNEXES**

(54) **GASIFIER FOR BIOMASS WASTE AND RELATED VOLATILE SOLIDS**



(57) Cette invention concerne un gazéificateur qui comprend une enceinte principale destinée à recevoir les déchets de biomassse et autres solides volatils à gazéifier. Cette enceinte comporte un évent d'évacuation des fumées vers une chambre de mélange communiquant avec une enceinte de postcombustion où un brûleur produit une flamme servant à l'oxydation totale des constituants des fumées. Un cloison de séparation est disposée entre l'enceinte de postcombustion et l'enceinte principale afin d'empêcher la flamme ainsi que sa chaleur radiante de pénétrer dans cette dernière et d'entrer en contact direct avec les déchets ou d'y avoir un

(57) A gasifier is disclosed. The gasifier comprises a primary chamber for receiving therein biomass waste material and other related volatile solids to be gasified. A fume transfer vent permits the escape of fumes from the primary chamber. A mixing chamber accepts the fumes from the fume transfer vent. The fumes then flow to an afterburner chamber where a burner member produces a heating flame so as to cause the additional full oxidization of the constituents of the fumes so as to oxidize the constituents. A partitioning wall is disposed between the flame chamber and the primary chamber so as to preclude the heating flame from entering the