

PYROLYTIC WASTE TREATMENT SYSTEM HAVING DUAL KNIFE GATE VALVES

Field of the Invention

The field of the invention is pyrolytic waste treatment.

5 Background

Pyrolysis is a known method for treatment of waste. Examples of pyrolytic waste treatment systems can be found in U.S. Patent Nos. 4,759,300, 5,653,183, 5,868,085, 6,619,214, and U.S. Patent Publication 2005/0039655A1 (all which are hereby incorporated
10 by reference in their entirety). Unlike incineration, pyrolysis is the destructive decomposition of waste materials using indirect heat in the absence of oxygen. Burning wastes through incineration with direct flame in the presence of oxygen can be explosive, causing turbulence in the burning chamber, which fosters a recombination of released gases. Waste destruction in an oxygen-rich atmosphere makes conversion far less complete, is
15 highly inefficient and creates harmful substances.

In contrast, the pyrolytic process employs high temperature in, most desirably, an atmosphere substantially free of oxygen (for example, in a practical vacuum), to convert the solid components of waste to a mixture of solids, liquids, and gases with proportions determined by operating temperature, pressure, oxygen content, and other conditions. The
20 solid residue remaining after pyrolysis commonly is referred to as char. The vaporized product of pyrolysis is often further treated by a process promoting oxidation, which "cleans" the vapors to eliminate oils and other particulate matter there from, allowing the resultant gases then to be safely released to the atmosphere.

Pyrolytic waste treatment systems generally includes a thermal chamber, an feed-
25 stock inlet, and a feed-stock outlet. Known pyrolytic treatment systems typically have at least one single-blade knife gate valve, disposed near the entry point and/or the exiting point of the thermal chamber. These single-blade knife gate valve are provided to keep air out of the pyrolytic chamber, control the passage of waste material into the thermal chamber via feed-stock inlet, and to control the exiting of waste material (or char) out of the thermal
30 chamber via feed-stock outlet. A typical knife gate valve is disclosed in U.S. patent 5,295,661, herein incorporated by reference in its entirety.

However, these single-blade knife gate valves have several disadvantages. For example, as the single knife blade closes by sliding the blade towards a receiving end (the seat) of the valve assembly, waste material is often jammed into the receiving end of the blade. Overtime, substantial cleaning is required to continue proper operation of such valves. And it has been found that if such valve jams once, it will continue to jam on a regular basis. It is typical to disassemble the single-panel valve to clean and clear the jamming. All of these cause undesirable waste of resources in time and labor.

Furthermore, known knife gate valve that are available for pyrolytic systems has a knife blade that does not retrieve completely into the valve housing, leaving a portion of the blade exposed in the interior lumen of the inlet when the valve is in an open position. This incomplete opening of the valve is inefficient and hinders passage of waste material.

Despite these disadvantages, pyrolytic systems typically use single-blade knife gate valves because the single blade design is generally perceived to have a strong, rugged construction. A single blade that receives into the seat of a valve is typically perceived to be relatively strong to withstand the weight of waste material directly above it. Also, the blade-to-seat engagement is perceived to provide effective chopping of bulky trash, much like the way a chef chops meat by using a butcher knife against a cutting board. Moreover, since disassembly and assembly is required to clear up jamming, single blade valves are advantageous because it has fewer moving parts to disassemble/assemble.

What has long been needed and heretofore has been unavailable is an improved pyrolytic waste treatment system with feed-stock inlet control and feed-stock outlet control that is relatively more efficient and is relatively easier to maintain. The thrust of the present invention is to provide such an improved pyrolytic waste treatment system.

All referenced patents, applications and literatures are incorporated herein by reference in their entirety. Furthermore, where a definition or use of a term in a reference, which is incorporated by reference herein is inconsistent or contrary to the definition of that term provided herein, the definition of that term provided herein applies and the definition of that term in the reference does not apply.

Summary of The Invention

The present invention is directed to apparatus, systems and methods for treating waste material. The apparatus comprising a thermal reactor having a thermal chamber disposed

within the thermal reactor, a feed-stock inlet coupled to the thermal reactor for feeding waste material into the thermal chamber of the thermal reactor, a heater for heating the thermal chamber, and at least one knife gate valve positioned in the apparatus for restricting the passage way of the waste material through an interior space of the apparatus.

5 Among the many different possibilities contemplated, the apparatus can have a first knife gate valve having a first blade and a second blade. It is further contemplated that the first blade is a moveable knife blade, capable of moving towards and make contact with the second blade.

10 Further, it is contemplated that the first blade and the second blade cooperates with each other to sever a portion of waste material passing through the interior space of the apparatus.

 Contemplated apparatus can have an actuator coupled to the first blade, wherein the actuator is driven by at least one of electric force, hydraulic force, and pneumatic force.

15 In preferred embodiments the first and second blades each has a longitudinal axis, an upper side, a lower side, a blade side, and a blade edge. The blade edge and the longitudinal axis is contemplated to converge at an angle other than 90 degrees. In still further preferred embodiments, the blade edge and the longitudinal axis is at an 75 degree angle.

20 Contemplated apparatus has a first blade that is capable of moving towards the second blade such that the edge side of the first blade makes contact and abuts with a portion of the edge side of the second blade, so as to substantially block the passage way of the waste material passing through the interior space of the apparatus.

25 Another contemplated configuration of the blades provides where a first blade is capable of moving towards a second blade such that the lower side of the first blade makes contact with a portion of the upper side of the second blade to decrease a cross sectional area of the passage way, thereby substantially blocking the passage way of the waste material passing through the interior space of the apparatus.

 In preferred embodiments, the blade edge of the first blade is a ridge created where lower side and edge side of the first blade meet. In further contemplated apparatus, the lower side and edge side of the first blade meet at a 45 degree angle.

Optionally, the apparatus has a second knife gate valve operatively disposed between the first knife gate valve and the pyrolytic chamber. The second knife gate valve has third and fourth blades that mate and cooperate with each other to restrict the passage of the waste material through the interior space of the apparatus.

5 Many different arrangements of a number of knife gate valve in various locations within the apparatus is contemplated. At least one such valve can be disposed in the inlet section. At least one other such valve can also be disposed in the outlet section. For example, the first knife gate valve and the second knife gate valve can be coupled to the feed-stock inlet such that the first and second blades of each of these two valves are movably
10 disposed within an interior lumen of the feed-stock inlet. Further, a third and fourth knife gate valves can be coupled to the feed-stock outlet such that the blades of third and fourth valves are movably disposed within an interior lumen of the feed-stock outlet. In this configuration, the first and second knife gate valve operatively restrict entering of waste material and gas into the thermal chamber, and wherein the third and fourth knife gate valve
15 movably restrict exiting of waste material from the thermal chamber and limit entering of gas into the chamber from the feed-stock outlet.

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like
20 components.

Brief Description of The Drawing

Fig. 1 is a side view of a first embodiment of a pyrolytic waste treatment system having dual gate knife valves according to an aspect of the inventive subject matter.

25 Fig. 2 is a top view of the pyrolytic waste treatment system having dual gate knife valves of Fig. 1.

Fig. 3 is a perspective view from a proximal end of the pyrolytic waste treatment system having dual gate knife valves of Fig. 1.

30 Fig. 4 is a top view of a first embodiment of a dual knife gate valve according to an aspect of the inventive subject matter.

Fig. 5 is a bottom view of the valve of Fig. 4, in an open position.

Fig. 6 is a side view of the valve of Fig. 4 operatively coupled to a feed-stock inlet.

Fig. 7 is a top view of first and second blades of a first embodiment of the invention.

Fig. 8 is a side view of the blades of Fig. 7.

Fig. 9 is a side view of a first embodiment of the blades according to an aspect of the
5 inventive subject matter.

Fig. 10 is a side view of a second embodiment of the blades according to an aspect of the inventive subject matter.

Detailed Description

10 The invention and its various embodiments can now be better understood by turning to the following detailed description of the preferred embodiments, which are presented as illustrated examples of the invention defined in the claims. It is expressly understood that the invention as defined by the claims may be broader than the illustrated embodiments described below.

15 Many alterations and modifications may be made by those having ordinary skill in the art without departing from the spirit and scope of the invention. Therefore, it must be understood that the illustrated embodiment has been set forth only for the purposes of example and that it should not be taken as limiting the invention as defined by the following claims. For example, notwithstanding the fact that the elements of a claim are set forth below
20 in a certain combination, it must be expressly understood that the invention includes other combinations of fewer, more or different elements, which are disclosed herein even when not initially claimed in such combinations.

The words used in this specification to describe the invention and its various embodiments are to be understood not only in the sense of their commonly defined meanings,
25 but to include by special definition in this specification structure, material or acts beyond the scope of the commonly defined meanings. Thus if an element can be understood in the context of this specification as including more than one meaning, then its use in a claim must be understood as being generic to all possible meanings supported by the specification and by the word itself.

30 The definitions of the words or elements of the following claims therefore include not only the combination of elements which are literally set forth, but all equivalent structure, material or acts for performing substantially the same function in substantially the same way to obtain substantially the same result. In this sense it is therefore contemplated that an

equivalent substitution of two or more elements may be made for any one of the elements in the claims below or that a single element may be substituted for two or more elements in a claim. Although elements may be described above as acting in certain combinations and even initially claimed as such, it is to be expressly understood that one or more elements from a claimed combination can in some cases be excised from the combination and that the claimed combination may be directed to a subcombination or variation of a subcombination.

Insubstantial changes from the claimed subject matter as viewed by a person with ordinary skill in the art, now known or later devised, are expressly contemplated as being equivalently within the scope of the claims. Therefore, obvious substitutions now or later known to one with ordinary skill in the art are defined to be within the scope of the defined elements.

The claims are thus to be understood to include what is specifically illustrated and described above, what is conceptually equivalent, what can be obviously substituted and also what essentially incorporates the essential idea of the invention.

Thus, the detailed description set forth below in connection with the appended drawings is intended as a description of the presently preferred embodiments of the invention and is not intended to represent the only forms in which the present invention may be constructed or utilized. The description sets forth the functions and the sequence of steps for constructing and operating the invention in connection with the illustrated embodiments. It is to be understood, however, that the same or equivalent functions may be accomplished by different embodiments that the spirit of the invention also intends to encompass.

The inventors have discovered that by using a knife gate valve having dual blades in a pyrolytic waste treatment system, instead of using a knife gate valve having only a single knife blade, is advantageous in reducing the need to remove waste material jammed in the seat of knife gate valve.

As used herein, the term "pyrolytic chamber" is synonymous with "pyrolysis chamber," "reaction chamber," and "thermal chamber." These terms all refer to the chamber where pyrolysis of waste material takes place.

FIG. 1 generally depicts the basic structure of a pyrolytic waste treatment system in accordance with the present invention. The pyrolytic waste treatment system 100 comprises of a pyrolytic chamber (or reaction chamber) 110, a feed-stock inlet 120, a feed-stock outlet 130, a heating source, and a plurality of dual gate knife valves 160A-D. The pyrolytic chamber receives waste material and subjects the waste material to heat, and sufficiently

limits gas presence in the chamber such that the material in the chamber is substantially pyrolyzed. The plurality of dual gate knife valves cooperates with each other to limit presence of gas in the chamber.

Pyrolytic chamber 110 couples to the feed-stock inlet 120, and receives waste material which first passes through a top opening of the feed-stock inlet 120. System 100 in figure 1 has an optional feed-stock sight window 122. Feed-stock inlet 120 also has a feed-stock sight window 122 positioned on the side wall of the inlet, allowing visibility to the inside of the feed-stock inlet 120. The window 122 also allows an operator to monitor passage of waste material through the feed-stock inlet 120. As illustrated in figure 1, feed-stock sight window is positioned immediately adjacent to and above dual gate knife valve 160A. Such arrangement allows an operator to advantageously monitor the operation of dual gate knife valves 160A and 160B. Other locations are also contemplated for having such sight window, such as having a sight window located inbetween valves 160A and 160B. Similarly, other parts of the system 100 can also have such sight windows to provide visibility to the inside of the system 100.

Pyrolytic chamber 110 also couples to the feed-stock outlet 130 such that after the waste material is processed in the pyrolytic chamber, the waste material, or feed-stock, passes on through the feed-stock outlet 130. The waste material eventually passes through feed-stock outlet 130 and out of feed-stock outlet through a bottom opening (not shown) as char. The system has an off-gas pipe 135 that channels any organic gas generated in the chamber 110 to an oxidizer (afterburner) where the gas is burned.

Pyrolytic chamber 110 thermally couples to a heating source. Heating source as illustrated in figure 1 comprises combustion air manifold 140, combustion blower 142, and natural gas burner manifold 144. This constitutes a typical gas heating source for pyrolytic treatment systems. Combustion blower 142 facilitates intake of air through combustion air manifold 140. And natural gas burner manifold 144 cooperates with gas burner to produce heat needed to the pyrolysis process.

As those of ordinary skill in the art will recognize, the heating source described may readily be modified by other known heating mechanisms as dictated by the aesthetic or functional needs of particular applications.

Pyrolytic treatment system 100 has a hydraulic drive 150 that couples to a shaft (not shown) positioned inside of the pyrolytic chamber 110. The drive 150 mechanically engages the shaft and rotates the shaft to manipulate waste materials in the pyrolytic chamber. There

are many known sizes and configurations of the such shaft in the art, one skilled in the art would immediately recognize the compatibility of the current invention with any known such shafts. Furthermore, drive 150 can be driven by alternative sources of power, for example, drive 150 can be driven electrically, or magnetically.

5 Here, four dual gate knife valves 160A-D are shown. Dual gate knife valves 160A, B are disposed upstream of the chamber 110 such that at least a portion of the waste material passes through valves 160A, B before entering the chamber 110. As shown in figure 1, dual gate knife valves 160A, B are coupled to the feed-stock inlet 120 in such way that closure of valves 160A, B restricts passage of waste material through the inlet 120. As will be
10 described in more details later, dual gate knife valves 160A-D each has two movable blades that can move toward each other to substantially close the passage way. And, the two blades can move in opposing directions to open the passage way. Optionally, one blade can be movable while the other blade of the same valve remains stationary.

The passage way for the waste material is defined as the intended route where waste
15 material travels within the pyrolytic waste treatment system 100 to effectuate the pyrolysis process. Both the feed-stock inlet 120 and feed-stock outlet 130 are shown as having a generally longitudinal shape with interior space for passage of waste material. The interior space is also considered a lumen. Passage way for the waste material also includes interior space of the pyrolytic chamber 110. In a typical pyrolytic waste treatment process, waste
20 material first passes through the lumen of feed-stock inlet 120, then into the interior space of pyrolytic chamber 110, then travels to and through the lumen of the feed-stock outlet 130.

Each dual gate knife valve 160A-D is independently capable of substantially restricting the passage of waste material by completely or partially closing the valve. The dual gate knife valve 160A-D can be operated and controlled individually. As discussed
25 earlier, functions of dual gate knife valve 160A-D include limiting the presence of gas in the pyrolytic chamber 110, controlling the passage rate of waste material through the system 100, pre-treat waste material by severing them into appropriate length and sections, and process pyrolyzed waste material by severing them in the lumen of feed-stock outlet 130.

In operation, it is preferred that dual gate knife vales 160A and 160B do not open at
30 the same time. Waste material is first introduced into the system 100 via a top opening of the feed-stock inlet 120. Valve 160A opens while valve 160B remains closed, allowing waste material to enter into the lumen space between valves 160A and 160B. Valve 160A then closes, shearing waste material caught across the opening of valve 160A. When valve 160A

is closed, valve 160B opens, allowing waste material in the lumen space between valves 160A and 160B to leave feed-stock inlet 120 and enter into pyrolytic chamber 110. Note that the feed-stock inlet is kept sealed by the closure of at least one of valves 160A, 160B, at any one time. It is contemplated that such design would minimize the intake of gas (and/or air) into the pyrolytic chamber 110. Preferably, the amount of gas (and/or air) introduced into the pyrolytic chamber from outside of the system 100 (as opposed to gases produced by organic trash while in the chamber) is limited so that the presence of gas (and/or air) in the pyrolytic chamber 110 is less than 25% of the total volume of the chamber 110, more preferably less than 15%, even more preferably less than 5%, most preferably less than 1%. Likewise, it is preferred that dual gate knife valves 160C and 160D do not open at the same time as described for valves 160A, B. In other words, at any one time, the chamber 110 is closed/sealed at both ends by at least one dual gate valve at each end.

Figure 2 is a top view of the pyrolytic waste treatment system 100. Feed-stock inlet 120 is shown such that the blades (in a closed position) of dual gate knife valve 160A is visible looking through the top opening of the feed-stock inlet 120. Dual gate knife valve 160B lies directly below dual gate knife valve 160A, and is therefore not visible from the top view in figure 2. Dual gate knife valve 160C is shown partially, and lies below off-gas pipe 135. Dual gate knife valve 160D lies directly below dual gate knife valve 160C, and is therefore not visible from the top view in figure 2.

Figure 3 is a view of the pyrolytic waste treatment system 100 from a proximal end towards the distal end of the system 100. Looking from the proximal end of the system 100, feed-stock inlet 120 with dual gate knife valves 160A, B are visible. Visibility to dual gate knife valve 160C, however, is obscured by the pyrolytic chamber 110.

Figure 4 provides a closer look of the contemplated dual gate knife valve 160 from a top view in a closed position. Dual gate knife valve 160 has knife blades 170A, B. Here, blades 170A and 170B of the same valve 160 moved into a space confined by valve frame 196, and mate each other to substantially close off passage way of waste material. In figure 4, the two blades 170A, 170B mate at their ends. As will be discussed later, and shown in figure 10, the two blades may mate at overlapping surfaces.

Contemplated dual gate knife valve 160 has valve actuators for moving blades 170A, B from an open to closed position, and from a closed to open position. Valve actuator is shown in figures 4-6 as a pneumatic valve actuator 190. Pneumatic valve actuator 190 adjust position of the dual gate knife valve 160 by converting air pressure into linear motion.

Typically, linear motion devices open and close gate, globe, diaphragm, pinch and angle-style valves with a sliding stem that controls the position of the closure element. Here, valve actuator 190 has an actuator body 191 coupled to a sliding stem 192. The sliding stem 192 receives into the actuator body 191 and is capable of sliding in and out of the actuator body 191 in a piston-like action.

One of ordinary skill in the art would recognize that valve actuator of the type can also convert air pressure into rotary motion, depending on the type of blade and utility of the valve.

Rotary motion devices move ball, plug and butterfly valves a quarter-turn (90°) or more from open to close. Many actuation methods for pneumatic valve actuators are known in the art. Diaphragm actuators are used mainly with linear motion valves, but are suitable for rotary motion valves when used with some type of linear-to-rotary motion linkage. Piston cylinder actuators are suitable for both linear and rotary motion valves. Typically, rack- and-pinion actuators can also be used to transfer the linear motion of a piston cylinder actuator to rotary motion. Rack-and-pinion designs are also known in the art to be suitable for adjusting manually-operated valves. To transfer linear motion to rotary motion, a scotch yoke device can be implemented.

On the distal end of sliding stem 192 is blade anchor 194, for attaching blade 170 to sliding stem 192. Blade anchor 194 securely attaches blade 170 to sliding stem 192, such that sliding motion of the sliding stem 192 also moves blade 170 in the same direction. When sliding stem 192 is actuated by valve actuator 190 to move in a distal direction, sliding stem moves out of the actuator body 191 and towards the valve frame 196, which is coupled to the actuator body via actuator frame 193. Linear motion of the sliding stem towards the valve frame 196 also moves blade 170 in the same direction, causing blade 170 to move into valve frame 196. Actuator frame 193 provides structural support, coupling actuator body 191 to the valve frame 196.

Figure 5 illustrates valve 160 of figure 4, from a bottom view with the valve in an open position and the blades 170A, B drawn. Here, the passage way (defined by the square-shaped area surrounded by valve frame 196) is unrestricted and not blocked. In an open position, no portion of the blade remains in the passage way to restrict movement of waste material through the valve.

Figure 6 illustrates dual gate knife valve 160 disposed across a section of feed-stock inlet 120, with the valve in a closed position. Here, passage of waster material through the lumen of feed-stock inlet 120 is effectively blocked and substantially restricted.

Pneumatic valve actuator 190 can optionally include other features. For example, the actuator 190 can have over-torque protection having a torque sensor to stop the power source when a safe torque level is exceeded. Also, actuator 190 can have travel stops or travel limits to restrict or limit the actuator's linear or rotary motion. Further, pneumatic valve actuator 190 can have an electromechanical limit switch (contacts) or non-contact proximity sensor to allow position monitoring from a remote location. Valve actuator 190 can alternatively have local position indicators. Control system of the pneumatic valve actuator 190 can include integral pushbuttons and manual controls. Others control devices can include a hand wheel, manual lever, or hydraulic hand pump that can be used to override the actuator in the event of an emergency.

Contemplated dual gate knife valve 160 can implement a single-acting mechanism which uses air pressure to actuate the valve in one direction and a compressed spring to actuate the valve in the other. More preferably, contemplated dual gate knife valve 190 implements double-acting mechanism which uses air pressure to actuate the valve in both directions.

Operation of the valve actuator 190 can include a number of variables and specifications, such as actuation time, control signal input, acting type, fail-safe position, air supply pressure range, and operating temperature. Actuation time is the time required to fully close the valve. Milliampere, voltage, and pressure signals are common control signal inputs. A failsafe position can be optionally provided to determine whether pneumatic valve actuators open or close the valve in the event of a power failure or the loss of the control signal. Air supply pressure range is the input pressure needed to achieve the desired torque or thrust output. Stroke length, number of turns, and actuator force are other important specifications for contemplated pneumatic valve actuators that move linear motion valves of the type disclosed herein. Furthermore, contemplated valve 160 can optionally implement rotary motion devices with visual indication or electronic display to indicate whether the full range of motion is a quarter-turn, a nominal 180° or 270° turn, or multiple turns for more than 360°.

Figure 7 shows blades 170A, B in more detail. Blades 170A, B have upper sides 171. Upper sides 171 are upward facing sides of blades 170A, B, when dual gate knife valve 160

is positioned and operational on pyrolytic waste treatment system 100. Similarly, blades 170A, B have lower sides 172. Lower sides 172 are downward facing sides of blades 170A, B, when dual gate knife valve 160 is positioned and operational on pyrolytic waste treatment system 100.

5 Blades 170A, B each has a longitudinal axis 179. Side edges 178 are the outer edges of upper sides 171 and lower sides 172 that parallel axis 179 as shown in figure 7. Although not specifically indicated on figure 7-10, one skilled in the art would immediately recognize that due to a thickness of the blades, each of blades 170A, B has four side edges 171 that parallel with axis 179.

10 Contemplated blades 170A, B each has a blade edge 174, defined as a ridge where a blade side 175 converges with either a upper side 171 (as in the case of blade 170A as shown in figure 9) or a lower side 172 (as in the case of blade 170B as shown in figure 9).

Contemplated blade edge 174 is formed at an angle that creates a relatively sharp ridge to facilitate severing/shearing of waste material. The angle is generally defined as the angle
15 created by adjacent sides which formed the blade edge 174. For example, in Figure 8, blade edge 174 of blade 170A is defined by the ridge where a blade side 175 converges with upper side 171, forming angle 182. Angle 182 can be angled between 90 to 25 degrees, more preferably between 80 to 40 degrees, and most preferably at 45 degrees. 45 degrees has been found as the optimal angle where blades 170A, B can more efficiently cooperate with each
20 other to sever waste material and substantially restrict passage of waste material through the system 100.

Parallel with blade edge 174 is obtuse blade edge 176, defined as a ridge where a blade side 175 converges with either a lower side 172 (as in the case of blade 170A as shown in figure 9) or a upper side 171 (as in the case of blade 170B as shown in figure 9).

25 The blade can have an end orthogonal to its direction of motion. That is, blade edge 174 can be perpendicular to axis 179. Preferably, the blade has an end not orthogonal to its direction of motion as shown in the figures. Blade edge 174 is preferably formed at a slant in relation to axis 179. As shown in figure 7, blade edge 174 forms slant angle 181 with axis 179. Slant angle 181 can be between 40 to 90 degrees, more preferably between 60 to 80
30 degrees, even more preferably at least 70 degrees, most preferably 75 degrees. 75 degrees has been found as the optimal angle where blades 170A, B can more efficiently cooperate with each other to sever waste material and substantially restrict passage of waste material

through the system 100. In figure 7, since axis 179 parallels with side edges 178, the angle formed by edge edges 178 and blade edge 174 is the same as slant angle 181.

The ends of the blades as described above can also be described as having a beveled leading edge. The beveled leading edge can have a preferred angle (angle 182) of 45 degrees.

5 These beveled leading edges can be mating edges for mating of two blades.

With respect to mating, figures 8-10 illustrate the mating where matching ends of two blades abut or overlap, and substantially join so as to leave minimum passage space between the two blades. The blades can or cannot directly touch each other to effectuate mating. The goal of mating is so that the opening of the valve is substantially closed to restrict passage of waste through the opening of the valve. Mating can be done by various matching configurations of the two blades. While figure 9 illustrates mating of straight beveled ends where blade side is straight in a side view, matching beveled ends can very well be curved, indented, conical, frusto-conical, etc. Similarly, from a top view, the leading blade edge can have configurations other than a straight edge as shown in figure 7, such as matching ends that are wavy, irregular, toothed, curved, or corrugated, etc.

As will be illustrated in connection with figures 9 and 10, the cooperating blades 170A, B can make contact with each other in different ways. In figure 9, when blades 170A, B are actuated to substantially close the dual gate knife valve 160, blade sides 175 of blades 170A and B make contact and abut each other. Once the blade sides 175 abut each other, dual gate knife valve is closed, as shown in figures 4 as well.

In figure 10, when blades 170A, B are actuated to substantially close the dual gate knife valve 160, upper side 171 of blade 170A comes into close proximity with lower side 172 of blade 170B. While upper side 171 of blade 170A can or cannot make physical contact with lower side 172 of blade 170B, the dual gate knife valve effectively severs waste material and substantially restricts the passage way of waste material. In comparison to figure 9, blade sides 175 in figure 10 do not abut each other and are advanced pass the point where they meet, creating an overlap region where the two cooperating blades overlap.

While the figures illustrate blade 170A and 170B to be mirror image of each other, it is important to appreciate that the two cooperating blades 170A, B can be different from each other in size, configuration, shape, degrees of angle 182, degrees of obtuse angle 183, and degrees of slant angle 181. The goal is to have movable cooperating blades that can or cannot physically contact each other to be suitable for severing waste material and to restrict a passage way of the waste material. For example, it is still possible to achieve such goal by

have mating blades overlap each other as illustrated in Figure 10, and each blade having different size and shape of the blade edge.

Contemplated components to the dual gate knife valve can be made of suitable materials to withstand environmental factors (temperature, moisture and chemical) in a typical pyrolytic waste treatment process, such materials include natural and synthetic polymers, various metals and metal alloys, naturally occurring materials, textile fibers, glass and ceramic materials, and all reasonable combinations thereof. The blades are most preferably made of stainless steel.

Thus, specific embodiments and applications of dual gate knife valve have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced. Where the specification claims refers to at least one of something selected from the group consisting of A, B, C and N, the text should be interpreted as requiring only one element from the group, not A plus N, or B plus N, etc.

CLAIMS

What is claimed is:

1. An apparatus for treating waste material comprising:
a thermal chamber;
5 a feed-stock inlet operatively coupled to the thermal chamber to feed the waste material to the thermal chamber;
a first knife gate valve coupled to the feed-stock inlet to substantially restrict a passage way of the waste material through an lumen of the inlet; and
wherein the first knife gate valve includes a first blade and a second blade.
- 10 2. The apparatus of claim 1, wherein the first blade is a moveable knife blade, capable of moving towards and make contact with the second blade such that a portion of the waste material passing through the interior space of the apparatus is severed by such contact.
3. The apparatus of claim 2 further comprising an actuator coupled to the first blade,
15 wherein the actuator is driven by at least one of electric force, hydraulic force, and pneumatic force.
4. The apparatus of claim 2, wherein the first and second blades each has a longitudinal axis, upper side, a lower side, a blade side, and a blade edge.
5. The apparatus of claim 4, wherein the blade edge is angled at 75 degrees to the
20 longitudinal axis.
6. The apparatus of claim 4, wherein the first blade is capable of moving towards the second blade such that the blade side of the first blade makes contact and abuts with a portion of the blade side of the second blade, so as to substantially block the passage way of the waste material passing through the interior space of the apparatus.
- 25 7. The apparatus of claim 4, wherein the first blade is capable of moving towards the second blade such that the lower side of the first blade makes contact with a portion of the upper side of the second blade to decrease a cross sectional area of the lumen.
8. The apparatus of claim 7, wherein the lower side of the first blade is angled at 45 degrees to the edge side of the first blade.

9. The apparatus of claim 2, wherein the first knife gate valve is coupled to the feed-stock outlet such that the first and second blades are movably disposed within an interior lumen of the feed-stock outlet.
- 5 10. A pyrolytic waste treatment system, comprising;
a pyrolytic chamber that receives a waste material and subjects the material to heat,
and sufficiently limits gas presence in the chamber such that the material is
substantially pyrolyzed; and
a first valve having first and second blades, and disposed upstream of the chamber
10 such that at least a portion of the waste material passes through the valve
before entering the chamber.
11. The pyrolytic waste treatment system of claim 10, wherein the first blade mates with
second blade.
12. The pyrolytic waste treatment system of claim 11, wherein the first blade mates with
15 second blade at their ends.
13. The pyrolytic waste treatment system of claim 11, wherein the first and second blades
mate at overlapping surfaces.
14. The pyrolytic waste treatment system of claim 12 further comprising a second valve
having third and fourth mating blades, wherein the second valve is operatively
20 disposed between the first valve and the chamber.
15. The pyrolytic waste treatment system of claim 11, wherein the first blade has a
beveled leading edge.
16. The pyrolytic waste treatment system of claim 15, wherein the beveled leading edge is
angled at between 40 degrees and 80 degrees.
- 25 17. The pyrolytic waste treatment system of claim 12, wherein first and second blades
have mating beveled edges
18. The pyrolytic waste treatment system of claim 10, wherein the first blade is moveable
and the second blade is stationary.

19. The pyrolytic waste treatment system of claim 10, wherein each of the first and second blades are moveable in opposing directions.
20. The pyrolytic waste treatment system of claim 10, wherein the first blade has an end orthogonal to its direction of motion.
- 5 21. The pyrolytic waste treatment system of claim 10, wherein the first blade has an end not orthogonal to its direction of motion.
22. The pyrolytic waste treatment system of claim 21, wherein first blade has an end angled at least 70° to its direction of motion.