

MUNICIPAL SOLID WASTE TREATMENT SYSTEM, METHOD AND APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to the Chinese patent application titled "Feed Device for Pyrolysis gasification furnace and Method Thereof" filed on September 19, 2024 with application number 2024113106667, and to the Chinese patent application titled "Feed Device for Pyrolysis gasification furnace" filed on September 19, 2024 with application number 2024222927409. The entire disclosure of each of the above-mentioned patent applications is incorporated herein by reference.

TECHNICAL FIELD

The invention relates to the field of waste treatment technology, in particular to a municipal solid waste treatment system, method and apparatus.

BACKGROUND

The common processing methods for municipal solid waste treatment include landfilling, incineration, and composting, wherein landfilling and composting have fallen into difficulties such as excessive land occupation, low resource recovery rates, and long-term harm to soil and groundwater, while incineration achieves volume reduction and resource utilization, it introduces dioxin pollution and requires substantial investment in emission control.

The emergence of municipal solid waste pyrolysis technology offers an innovative approach and solution for waste treatment. Specifically, the municipal solid waste undergoes drying, sorting, and crushing before being fed into a pyrolysis furnace, under high-temperature conditions, the waste is pyrolyzed into pyrolysis gas and slag, the pyrolysis gas is directly

combusted in a secondary combustion chamber, generating heat, flue gas (or exhaust gas), and fly ash, the generated heat energy is further converted into electrical energy, while the flue gas (or exhaust gas) requires purification before emission, the generated fly ash needs to be solidified and buried together with the slag.

However, the existing municipal solid waste pyrolysis technologies neither recycle the slag resulting in a low resource utilization rate, nor directly convert the pyrolysis gas into electrical energy or other energy forms, the secondary conversion of the energy results in a low energy utilization rate, and the landfilling of fly ash and slag incurs additional high costs, which not only causes waste of land resources but also increases the cost of waste treatment.

SUMMARY

The invention mainly aims at providing a municipal solid waste treatment system, method and apparatus so as to resolve the problems of the low utilization rate of energy and resource produced through pyrolysis of the prior art.

According to an embodiment of the invention, a municipal solid waste treatment system comprises: a pretreatment device configured to perform a pre-treating process to the municipal solid waste, the pre-treating process comprising: dehydrating and drying, sorting and crushing; A pyrolysis device comprising: a pyrolysis gasification furnace and feeder disposed above the pyrolysis gasification furnace, the feeder is configured to feed pre-treated municipal solid waste into the pyrolysis gasification furnace for pyrolysis to generate pyrolysis gas and slag; wherein the feeder comprises a main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state; A pyrolysis gas purification device configured to remove chlorine-containing compounds and sulfur-containing compounds from the pyrolysis gas, and cool the pyrolysis gas to separate macromolecular organic substance from small-molecule combustible gas, the macromolecular organic substance is recycled to pyrolysis gasification furnace for further pyrolysis, the small-molecule combustible gas is collected into an external storage device; A slag sorting device configured to separate the slag into metal, incompletely pyrolyzed organic matter and ash residue; and recycle the incompletely pyrolyzed organic matter to the pyrolysis gasification furnace for further pyrolysis.

Wherein the pyrolysis gas purification device further comprises a spray washing structure configured to reduce temperature of the pyrolysis gas, thereby converting the macromolecular organic substance from a gaseous state into a liquid state, a solid-liquid mixed state, or a solid state to separate the macromolecular organic substance from the small-molecule combustible gas in the pyrolysis gas.

Wherein the feeder comprises three modes: A first mode wherein the feed gate is in an open state while the isolation gate and the discharge gate are in a closed state; A second mode wherein the feed gate is in an open state, the isolation gate is in an open state, while the discharge gate is in a closed state; A third mode wherein the feed gate and the isolation gate are in a closed state, while the discharge gate is in an open state.

Wherein the feeder is configured as a vertical feeder or a horizontal feeder, a discharge gate of the vertical feeder is arranged along a horizontal direction, and a discharge gate of the horizontal feeder is arranged along a vertical direction.

Wherein the horizontal feeder further comprises a pusher disposed opposite to the discharge gate, the pusher is configured to horizontally push the municipal solid waste falling from the upper chamber into the lower chamber, thereby causing the municipal solid waste to be fed into the pyrolysis gasification furnace.

Wherein at least two horizontal feeders are uniformly arranged above feed inlets of sidewalls of the pyrolysis gasification furnace.

Wherein the vertical feeder is arranged centrally above a feed inlet of the pyrolysis gasification furnace.

Wherein the feed gate is configured as a horizontally or downwardly inclined single-side sliding structure.

Wherein the volume of the lower chamber is greater than the volume of the upper chamber.

Wherein the small-molecule combustible gas comprises: carbon monoxide, hydrogen, methane, and small-molecule hydrocarbons.

According to an embodiment of the invention, a municipal solid waste treatment method comprises: Performing a pre-treating process to the municipal solid waste, the pre-treating process comprising: dehydrating and drying, sorting, and crushing; Pyrolyzing the municipal solid waste through a pyrolysis device, wherein the pyrolysis device comprises: a pyrolysis gasification furnace and feeder disposed above the pyrolysis gasification furnace, the feeder is configured to feed pre-treated municipal solid waste into the pyrolysis gasification furnace for pyrolysis to generate pyrolysis gas and slag; wherein the feeder comprises a main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state; Removing chlorine-containing compounds and sulfur-containing compounds from the pyrolysis gas, and cooling the pyrolysis gas to separate macromolecular organic substance from small-molecule combustible gas, the macromolecular organic substance is recycled to pyrolysis gasification furnace for further pyrolysis, the small-molecule combustible gas is collected into an external storage device; Separating the slag into metal, incompletely pyrolyzed organic matter and ash residue; and recycling the incompletely pyrolyzed organic matter to the pyrolysis gasification furnace for further pyrolysis.

Wherein the pyrolysis gas purification device further comprises a spray washing structure configured to reduce temperature of the pyrolysis gas, thereby converting the macromolecular organic substance from a gaseous state into a liquid state, a solid-liquid mixed state, or a solid

state to separate the macromolecular organic substance from the small-molecule combustible gas in the pyrolysis gas.

Wherein the feeder comprises three modes: A first mode wherein the feed gate is in an open state while the isolation gate and the discharge gate are in a closed state; A second mode wherein the feed gate is in an open state, the isolation gate is in an open state, while the discharge gate is in a closed state; A third mode wherein the feed gate and the isolation gate are in a closed state, while the discharge gate is in an open state.

Wherein the feeder is configured as a vertical feeder or a horizontal feeder, a discharge gate of the vertical feeder is arranged along a horizontal direction, and a discharge gate of the horizontal feeder is arranged along a vertical direction.

Wherein the horizontal feeder further comprises a pusher disposed opposite to the discharge gate, the pusher is configured to horizontally push the municipal solid waste falling from the upper chamber into the lower chamber, thereby causing the municipal solid waste to be fed into the pyrolysis gasification furnace.

Wherein at least two horizontal feeders are uniformly arranged above feed inlets of sidewalls of the pyrolysis gasification furnace.

Wherein the vertical feeder is arranged centrally above a feed inlet of the pyrolysis gasification furnace.

Wherein the feed gate is configured as a horizontally or downwardly inclined single-side sliding structure.

According to an embodiment of the invention, a feeder for a pyrolysis gasification furnace of a municipal solid waste treatment system comprises: a main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and

an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state; The feeder comprises three modes: A first mode wherein the feed gate is in an open state while the isolation gate and the discharge gate are in a closed state; A second mode wherein the feed gate is in an open state, the isolation gate is in an open state, while the discharge gate is in a closed state; A third mode wherein the feed gate and the isolation gate are in a closed state, while the discharge gate is in an open state.

According to an embodiment of the invention, a feeding method for a pyrolysis gasification furnace of a municipal solid waste treatment system comprises: a main chamber body comprising: Providing a main chamber body for feeding comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state; Opening the feed gate and closing the isolation gate to seal the lower chamber, allowing material to enter the upper chamber through the feed gate, then closing the feed gate after completion of feeding; Opening the isolation gate to transfer material from the upper chamber into the lower chamber, then closing the isolation gate to seal the upper chamber after completion of transfer; Opening the discharge gate to transfer material into the pyrolysis gasification furnace.

According to the technical solution of the invention, by establishing a complete municipal solid waste treatment system comprising: a pretreatment device, a pyrolysis device, a pyrolysis gas purification device, and a slag sorting device, the municipal solid waste is complete

pyrolyzed, and all final products can be reused as resources, thereby significantly improving resource utilization rate; and the final products further include small-molecule combustible gas substitutable for natural gas, substantially enhancing energy utilization efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings described herein are used to provide a further understanding of the invention and form a part of the present application. The illustrative embodiments of the invention and the description thereof are used to explain the invention and are not unduly limiting the invention. In the drawings:

Fig. 1 is a schematic diagram of a municipal solid waste treatment system according to an embodiment of the invention;

Fig. 2 is an overall structural schematic diagram of a vertical feeder according to one embodiment of the invention;

Fig. 3 is a structural schematic diagram of a discharge gate according to one embodiment of the invention;

Fig. 4 is a structural schematic diagram of a discharge gate according to another embodiment of the invention;

Fig. 5 is a structural schematic diagram of an isolation gate according to an embodiment of the invention;

Fig. 6 is a structural schematic diagram of a U-shaped sealing groove at an edge of a side gate in Fig. 5;

Fig. 7 is a structural schematic diagram of a horizontal feeder according to yet another embodiment of the invention;

Fig. 8 is a structural schematic diagram of a pusher according to yet another embodiment of the invention;

Fig. 9 is a flowchart of a municipal solid waste treatment method according to an embodiment of the invention;

Fig. 10 is a flowchart of a feeding method for a pyrolysis gasification furnace according to an embodiment of the invention.

DETAILED DESCRIPTION

In order to make the purpose, technical solution and advantages of the invention clearer, the technical solution of the invention will be clearly and completely described below in combination with the specific embodiments of the invention and the corresponding drawings. Apparently, the described embodiments are only part of the embodiments of the present invention, but not all of them. Based on the embodiments in the invention, all other embodiments obtained by persons of ordinary skill in the art without making creative labor are within the scope of protection of the present invention.

The technical solutions of the present invention are herein described in detail with reference to the drawings.

In the prior art, the waste incineration or pyrolysis devices typically pre-treat municipal solid waste at first, and the specific steps are as follows: firstly, dehydrate and dry the municipal solid waste; then, sort the dehydrated and dried municipal solid waste to separate soil residue and metal material from the municipal solid waste; next, process the sorted municipal solid waste into small particles via crushing, heating, compaction and other processes to adapt the screw feeders commonly used in prior art. However, the step processing the municipal solid waste into small particles not only requires significant time and labor but also necessitates additional equipment, substantially increasing both temporal and economic costs of municipal solid waste treatment.

The pre-treated municipal solid waste is fed into a pyrolysis furnace via screw feeder for pyrolysis to generate pyrolysis gas and slag. In current engineering practices utilizing pyrolysis equipment for municipal solid waste or other combustible waste, the produced pyrolysis gas is typically directly introduced into a secondary combustion chamber for combustion to generate

heat, which is then used to heat liquids for steam production. The produced steam can drive a steam turbine, which in turn powers a generator set for electricity generation; alternatively, the produced steam can be directly utilized for heating purposes. While the above methods achieve energy conversion and utilization, they exhibit relatively high energy loss rates and low utilization efficiency.

Direct combustion of the pyrolysis gas also generates flue gas, which requires purification before emission, however, the purification process produces hazardous waste such as fly ash that can only be treated through solidification and landfilling, and the slag generated from pyrolysis—comprising intermixed metal, incompletely pyrolyzed organic matter and ash residue—is not subjected to classified resource recovery in the prior art, instead, it is directly solidified and landfilled as waste. The price of solidification landfill treatment is expensive, which increases the cost of waste treatment.

In order to resolve the above issues, a municipal solid waste treatment system is provided according to an embodiment of the present invention. With reference to Fig. 1, the municipal solid waste treatment system comprises: a pretreatment device 10, a pyrolysis device 20; a pyrolysis gas purification device 30 and a slag sorting device 40. Through the municipal solid waste treatment system, the municipal solid waste is ultimately decomposed into small-molecule combustible gas and ash residue, which not only has a high pyrolysis rate with the generated small-molecule combustible gas exhibiting a calorific value of approximately 1100 kcal/m³, but also produces primarily carbon dioxide and water without purifying exhaust gas, the small-molecule combustible gases, instead of natural gas, can be used directly or can drive gas generator sets, which eliminate one heat exchange cycle, the system not only improves thermal efficiency, but also enhances energy utilization rate; the generated ash residue can also be used

as construction material or landfill cover material, thereby increasing resource utilization rate and reducing land resource waste caused by landfilling.

In some regions, the moisture content of municipal solid waste or kitchen waste can reach approximately 60%, with a calorific value of about 1,700 kcal/kg. Excessive moisture not only causes waste to adhere together, making it difficult to separate inorganic soil residues from the municipal solid waste, but also reduces the waste's calorific value and pyrolysis efficiency. The pretreatment device 10 is configured to achieve pre-treatment operations on the municipal solid waste such as dehydration and drying, sorting and crushing. Specifically, the municipal solid waste is first fed into a crushing device to break sealed packaging in plastic or other materials such as bags, bottles or cans, thereby releasing any trapped liquids. The municipal solid waste is then mixed with microbial consortia and placed in a drying chamber, the microbe ferment easily degradable organic matter, generating heat that evaporates partial moisture, thereby realizing dehydration and drying of the municipal solid waste. In the embodiments of this application, fermentation process lasts for about 14 days, and the moisture content of municipal solid waste is reduced to 20%-40% after fermentation process, preferably around 30%. Separate inorganic impurity and metal from the dehydrated and dried municipal solid waste, the inorganic impurity can be stones, glass, soil, etc., the separated inorganic impurity and metal can be recycled in other ways. Due to the fact that the pyrolysis furnace in the embodiment of the present invention does not use the screw feeder commonly used in the prior art, but feeders with better adaptability, therefore, in the embodiments of this invention, neither the municipal solid waste needs to be crushed into small pieces, nor does it need to be squeezed into particles, which not only reduces the number of the devices and saves costs, but also reduces energy consumption.

The commonly used pyrolysis device in the current market generally includes: a pyrolysis gasification furnace and feeder disposed above the pyrolysis gasification furnace, and there are roughly two types of existing feeder: one is the screw feeder, which uses the rotation of the spiral pusher to push the waste material in the material channel forward into the pyrolysis furnace, the opening of the material channel entering the furnace is appropriately narrowed, and a feed inlet is sealed by the flexible compression effect of the waste material, which prevents air from entering into the pyrolysis furnace with the material. This screw feeder is suitable for soft waste material, and can meet the requirements of sealing, air isolation, and continuous feeding, however, the problems of the screw feeder are that the feeding speed is slow, it needs to operate continuously, the power consumption is high, and it is easy jamming and shutdown when hard material such as coal blocks, wood blocks, and straw are mixed in the waste for squeezing, the sealing effect through squeezing deformation is impossible to be produced. The other is feeder suitable for hard material, including rotary feeder, coal feeder, etc. These feeders can be used for coal blocks, wood blocks, hard particles, homogeneous powder materials, etc., but these feeders are not suitable for continuous feeding of flexible material such as municipal solid waste, foam plastic waste, waste textiles, etc., which is easy to block, inefficient, and has poor sealing effect.

Therefore, the embodiment of the present invention provides the pyrolysis device 20, comprising: hydraulic grab, feeder and pyrolysis gasification furnace. The pyrolysis gasification furnace is configured to be selected as vertical pyrolysis furnace with the advantages that: 1. The temperature inside the furnace can be improved over 800°C to meet the requirements of high-temperature pyrolysis; 2. The pyrolysis gasification furnace can continuously pyrolyze for 24 hours without interruption; 3. The processing capacity is large; 4. The energy consumption is relatively low, which is cost-effective; 5. The sealing effect is good and the sealed state can be

maintained during continuous operation, preventing pyrolysis gas from overflowing from the pyrolysis furnace. The vertical pyrolysis furnace comprises multiple feed inlets arranged at the central position of the furnace top or above the sidewalls of the furnace top, the feeders are arranged at the feed inlets of the vertical pyrolysis furnace, the hydraulic grab are used to grab the pre-treated municipal solid waste and discharge it into the feeders, the feeders complete the feeding process into the vertical pyrolysis furnace in a sealed state, the vertical pyrolysis furnace pyrolyzes the municipal solid waste to produce pyrolysis gas and slag. Furthermore, in order to reduce slag clumping, the temperature of the vertical pyrolysis furnace is configured at 800-900°C, thereby keeping the internal temperature of the furnace below the slag clumping temperature, significantly reducing slag clumping; The vertical pyrolysis furnace can be made of refractory materials and insulation materials, which not only reduces the problem of slag adhering to the furnace walls but also improves the thermal efficiency of the pyrolysis reaction, without adding any other fuel or energy, the pyrolysis process can be maintained in a stable and continuous operation solely by the energy from the waste material itself.

With reference to Figs. 2 and 7, the feeder comprises a main chamber body 21, an upper end of the main chamber body 21 is a material inlet, a lower end of the main chamber body is a material outlet. The cross-section of the main chamber body 21 can be rectangular, but can alternatively adopt other geometries as required, without limitation in this application. A feed gate 22 is arranged at the upper end of the main chamber body 21, a discharge gate 23 is arranged at the lower end of the main chamber body 21, an isolation gate 24 is arranged at or near a middle portion of the main chamber body 21. The isolation gate 24 divides the main chamber body 21 into two portions, an upper chamber 211 is formed between the feed gate 22 and the isolation gate 24, a lower chamber 212 is formed between the isolation gate 24 and the

discharge gate 23, when the feed gate 22, the isolation gate 24 and the discharge gate 23 are all closed at the same time, the main chamber body 21 is divided into the hermetically sealed upper chamber 211 and the hermetically sealed lower chamber 212. Wherein the lower chamber 212 has greater capacity than the upper chamber 211 to avoid local height exceeding the height of the middle sliding gate caused by abnormal accumulation of material entering the lower chamber 212, therefore avoid affecting the sealing effect of the isolation gate in the middle. A feed hopper 25 arranged on the top portion of the main chamber body 21 is used to feed material into the chamber. The feeder in the embodiment of this application comprises: vertical feeder and horizontal feeder, the pyrolysis device 20 can choose to set either vertical feeder or horizontal feeder, wherein the vertical feeder is arranged centrally above a feed inlet of the vertical pyrolysis furnace to realize uniform feeding; the number of the horizontal feeders is at least two, preferably 4, accordingly, the number of the feed inlets of the vertical pyrolysis furnace can also be 4, which are evenly arranged above the four sidewalls of the vertical pyrolysis furnace, the horizontal feeders evenly surround the vertical pyrolysis furnace to realize multi-point uniform feeding. The specific structures of the vertical feeder and the horizontal feeder are described as follows.

Continuing to refer to Fig. 2, which shows the vertical feeder, in the embodiment of this application, the feed gate 22 of the vertical feeder is configured as a horizontally or downwardly inclined single-side sliding structure. One side of the feed gate 22 penetrating through the sidewall of the main chamber body 21 is configured to connect with a drive end of a power mechanism 221, the other three sides of the feed gate 22 are equipped with sealing strips that effectively seal the inlet of the main chamber body 21 when the feed gate is closed, the sealing strips are formed by compression-sealing using heat-resistant rubber strips to ensure reliable

sealing between the feed gate edges and the inner walls of the chamber, preventing gas leakage. The power mechanism 221 arranged at the outer side of the main chamber body 21 is used to drive the feed gate 22 to move along the sidewall of the main chamber body 21. During manufacturing, the power mechanism 221 may utilize hydraulic cylinders, pneumatic cylinders, or electric pushing rod to achieve translational motion of the feed gate 22, when the feed gate 22 is opened, the upper chamber is fed through the feed gate conveniently, and waste material in the upper chamber can be discharged into the lower chamber when the feed gate is closed.

The discharge gate 23 arranged at the lower end of the main chamber body 21 is directly connected with feed inlet of the pyrolysis gasification furnace. According to the embodiment of this application, the discharge gate 23 can be implemented in various ways, which are described in detail below.

With reference to Fig. 3, in some embodiments of this application, the discharge gate 23 comprises two flip gates 231 arranged symmetrically, with interlocking steps 232 provided on opposing closing edges of the two flip gates 231, in practice, protruding parts of the steps 232 that match up and down are extending about 5cm, which increase the sealed contact surface when the discharge gate is closed. Two power mechanisms 233 are symmetrically fixed to the main chamber body 21 and the toggle rods of the discharge gate shafts, serving to drive the upward or downward flipping motion of the flip gates 231. The power mechanisms 233 may adopt electric hydraulic pushing rod designs, where the drive ends of the electric hydraulic pushing rods connect to the toggle rods on the flip gates 231, enabling the opening or closing of both flip gates through extension or retraction of the two electric hydraulic pushing rods. The flip gates open when flipped downward, and effectively seal the lower opening of feeder chamber when the flip gates flip upward into the closed position. A controller regulates the opening angles

of both flip gates, allowing material to slide along the inclined gate surfaces for targeted discharge at different locations, thereby increasing material distribution area and achieving uniform feeding. The lower surfaces of the flip gates 231 are equipped with high-temperature resistant layers 234, with the heat-resistant material facing toward the internal space of the pyrolysis gasification furnace, enabling operation in high-temperature environments while preventing the feeder from furnace heat impacts.

With reference to Fig. 4, in some embodiments of this application, gate shaft 235 of the discharge gate 23 is fixed to the sidewalls of the main chamber body 21 via bearing assemblies, the gate shaft 235 is appropriately extended on the outside of the chamber, where a toggle rod 236 is welded to the distal end of the extended gate shaft 235, and the toggle rod 236 is perpendicularly fixed with the gate shaft 235. The other end of the toggle rod is connected to the electric hydraulic pushing rod through a pivot joint, to drive the gate shaft and the flip gate to complete the flipping motion during the movement of extension or retraction of the electric hydraulic pushing rod. The power mechanisms 233 in this embodiment may utilize hydraulic cylinders, pneumatic cylinders, or electric pushing rod to achieve flipping of the discharge gate.

Furthermore, the discharge gate 23 may alternatively configured as a horizontal orientation or a downward-inclined configuration with its opening end tilted downward, the power mechanisms are arranged on both sides of the chamber to drive the discharge gate moving through the chamber sidewalls.

Due to the direct orientation of the discharge gate towards the furnace interior, in order to improve the high temperature resistance of the discharge gate, a lower surface of the discharge gate 23 is equipped with a high-temperature resistant layer 234 to adapt high temperature environments, block and reduce the impact of high temperature inside the furnace on the feeder.

Meanwhile, the other three sides of the discharge gate 23 are further equipped with sealing strips to seal and fit with inner walls of the main chamber body 21. Wherein the high-temperature resistant layer is made of inorganic high-temperature resistant materials.

Combining with Figs. 2 and 5, the isolation gate 24 may configured as a double-sided sliding structure, two side gates 241 of the isolation gate 24 are arranged horizontally and in parallel, guide rails are correspondingly provided on opposing sidewalls of the main chamber body 1 to match the movement of the side gates 241, the power mechanism 242, mounted on the outer side of the main chamber body 21, drives the relative horizontal movement of two side gates 241. Wherein the power mechanism 242 may utilize hydraulic cylinders, pneumatic cylinders, or electric pushing rod to achieve the opening or closing operation of the double gates.

Combining with Fig. 6, the isolation gate 24 comprises mortise and tenon structure 243, one side gate 241 has a U-shaped sealing groove 244 on its edge, and the other side gate 241 has a tenon that can be inserted into the U-shaped sealing groove 244. The use of this structure can ensure the sealing performance of the double gate after closing. When the isolation gate 24 is closed, it can seal and isolate the upper chamber 211 and the lower chamber 212.

It should be noted that the power mechanism 221, the power mechanism 233 and the power mechanism 242 are electrically connected to a controller, which coordinates the start and stop sequence of the power mechanism 221, 233 and 242. When the upper, middle, and lower gates are simultaneously in the close state, the feeder forms two hermetically sealed chambers, the upper chamber and the lower chamber.

According to the embodiment of this application, the lower portion of the sidewalls of the main chamber body 21 is a dual-layer structure set with cooling water, in other words, a water jacket structure is configured on the lower part of the sidewalls of the main chamber body 21.

The water jacket structure has a cooling function, which absorb the heat emitted around the lower part of the chamber through the circulating water, thereby preventing the lower part of the chamber from overheating during the operation of the feeding device, ensuring that the chamber and gate shaft rotating structure do not deform, making the feeding device more stable and safer to complete the feeding work. At the same time, there is an insulation layer arranged at the bottom part of the gate to reduce the deformation of the flip gate panel due to heat. This structure greatly reduces the deformation effect of temperature on the feeder, ensuring that the feeder can still operate normally and stably in high temperature environments and maintain a sealed state. In addition, the heat absorbed by the circulating water can form water vapor, which can be used for production and waste heat utilization.

With reference to Fig. 7, which shows a structural schematic diagram of the horizontal feeder, the feed gate 22 of the horizontal feeder is configured as a horizontally or downwardly inclined single-side sliding structure drove by a power mechanism (not shown in the figure), specifically, the feed gate in the embodiment of this application is a horizontally arranged single-side sliding gate structure; the isolation gate 24 of the horizontal feeder is configured as a horizontally or downwardly inclined double-sided sliding structure drove by a power mechanism (not shown in the figure), specifically, the isolation gate in the embodiment of this application is a downwardly inclined double -side sliding gate structure. In other words, the structure of the feed gate 22 and the isolation gate 24 of the horizontal feeder is same as that of the feed gate 22 and isolation gate 24 of the vertical feeder, which will not be repeated here, the following text only describes the parts that differ from the vertical feeder structure.

Continuing to refer to Fig. 7, the horizontal feeder further comprises a discharge gate 23 arranged at the lower end of the main chamber body 21 and a pusher 26, wherein the discharge

gate 23 is vertically arranged on one side of the lower chamber 212, the pusher 26 opposite to the discharge gate 23 is arranged on the other side of the lower chamber 212, the pusher 26 is configured to move horizontally toward or away from the discharge gate 23, and the discharge gate 23 is configured to open or close, the coordinated movement of the pusher 26 and the discharge gate 23 facilitates pushing municipal solid waste from the lower chamber 212 into the pyrolysis gasification furnace.

In the embodiment of this application, the lower chamber 212 of the horizontal feeder comprises a first space and a second space having a length greater than that of the first space, in other words, the opposite two sides of the second space along the length direction protrude beyond the first space to accommodate the pusher 26 and discharge gate 23. The discharge gate 23 is configured as a vertically arranged single-side sliding structure design, one side of the discharge gate 23 penetrating through the sidewall of lower chamber 212 is configured to connect with a drive end of a power mechanism (not shown in the figure), the power mechanism drives the discharge gate 23 to open or close vertically, the other three sides of the discharge gate 23 are equipped with sealing strips that effectively seal the outlet of the main chamber body 21 when the discharge gate 23 is closed, the sealing strips are formed by compression-sealing using heat-resistant rubber strips to ensure reliable sealing between the feed gate edges and the inner walls of the chamber. During manufacturing, the power mechanism may utilize hydraulic cylinders, pneumatic cylinders, or electric pushing rod to achieve translational motion of the discharge gate 23, when the discharge gate 23 is opened, the pusher 26 starts working, pushing the material that falls from the upper chamber 211 into the lower chamber 212 towards the direction of the discharge gate 23, so that the material falls into the pyrolysis gasification furnace through the discharge gate 23.

Combining with Fig. 8, the pusher 26 comprises a front end pushing the material, a rear end coupled to the sidewall of the lower chamber 212 and a telescopic part positioned behind the front end and the rear end for controlling horizontal movement of the pusher 26. Wherein the shape of the front end of the pusher 26 is configured as trapezium. The height of the pusher 26 is slightly less than the height of the second space in order to avoid material getting stuck in the space above the pusher 26; When the pusher 26 is fully extended toward the discharge gate 23, the pusher 26 protrudes beyond the sidewall edge of the lower chamber 212, avoiding material residue in the lower chamber 212.

Continuing to refer to Fig. 1, the municipal solid waste is pyrolyzed into pyrolysis gas and slag through the pyrolysis device 20, wherein the generated pyrolysis gas is discharged into the pyrolysis gas purification device 30, the slag is transported to the slag sorting device 40.

The pyrolysis gas obtained from pyrolysis of the municipal solid waste specifically comprises: pollutants containing sulfur or chlorine elements, other hazardous substances, macromolecular organic substance and small-molecule combustible gas, the small-molecule combustible gas comprise: gases such as carbon monoxide, hydrogen, methane, and small-molecule hydrocarbons, wherein the small-molecule hydrocarbons specifically comprise: olefin compounds or alkyne compounds, etc., due to the fact that the combustion of small molecule-combustible gas only produces carbon dioxide and water, the small molecule-combustible gas is also known as clean combustible gas. Due to the potential generation of pollutants after the combustion of macromolecular organic substance, the flue gas needs to be purified before being discharged, therefore, it is necessary to separate, collect, and send back the macromolecular organic substance in the pyrolysis gas to the pyrolysis gasification furnace for secondary pyrolysis until they become small molecule-combustible gas. In the embodiment of this

application, the macromolecular organic substance refer to compounds with a molecular weight greater than 200Da or a carbon atom count greater than 6. The pyrolysis gas purification device 30 is configured to remove pollutants and separate the macromolecular organic substance from the small molecule-combustible gas, specifically, the pyrolysis gas purification device 30 comprises: a harmful element absorption structure, a spray washing structure and an air-cooling structure, wherein the harmful element absorption structure can be specifically a turbulent bed reactor or other devices, and the spray washing structure can be specifically a spray tower. The generated pyrolysis gas is introduced into a turbulent bed reactor, where alkaline solutions such as calcium hydroxide or sodium carbonate are used as absorbents to remove chlorine-containing compounds and sulfur-containing compounds from the pyrolysis gas, other harmful substances, including nitrides or heavy metal aerosols, can also be removed through catalytic reduction reactions or ceramic/metal filters. Introduce the gas that has removed chlorine-containing compounds, sulfur-containing compounds and other harmful substances into the spray tower, and reduce gas temperature by using spray water washing method, due to the fact that the boiling point of macromolecular organic substance is much higher than that of small-molecule combustible gas, a decrease in temperature causes a change in the physical form of macromolecular organic substance, from a gaseous state to a liquid state, solid-liquid mixture state, or solid state, thereby separating them from small-molecule combustible gas. The air-cooling structure can further separate the residual macromolecular organic substance in the pyrolysis gas cooled by the spray tower. The separated macromolecular organic substance are sent back to the pyrolysis gasification furnace for secondary pyrolysis to pyrolyze into small molecule-combustible gas. And the separated small molecule-combustible gas are collected through an external storage device for using.

Although the inorganic impurity and metal are separated through pretreatment device 10, there are still inorganic impurity and metal that have not been sorted out in municipal solid waste, the inorganic impurity and metal that have not been sorted out will be discharged together with the slag from the pyrolysis gasification furnace into the slag sorting device 40, the slag sorting device 40 divide the slag into metal, incompletely pyrolyzed organic matter and ash residue through screening, crushing, and other operations and instruments such as magnetic separator, jig machine, or eddy current separator, the separated metal can be directly sold and utilized, while the incompletely pyrolyzed organic matter (such as tar and charcoal) are sent back to the pyrolysis gasification furnace for secondary pyrolysis to continue producing pyrolysis gas, the ash residue is inorganic soil without impurities, which can be used as building materials or landfill cover materials.

In one embodiment of this application, the municipal solid waste treatment system can process 100 tons of municipal solid waste per day. Specifically, about 46kg of the large inorganic impurity and metal are sorted out through pre-treating process, which includes about 26kg of inorganic impurity. The pre-treated waste is discharged into the pyrolysis gasification furnace for pyrolyzing, the generated pyrolysis gas is purified by the pyrolysis gas purification device to obtain approximately 1230m^3 of combustible gas (small-molecule combustible gas), and approximately 53kg of macromolecular organic substance such as tar. Immediately send the macromolecular organic substance back to the pyrolysis gasification furnace for further pyrolyzing. After the above process, the total amount of combustible gas obtained can reach $1580\text{-}1600\text{ m}^3$, which means that an additional $350\text{-}370\text{m}^3$ of combustible gas can be produced by secondary pyrolysis of 53kg of macromolecular organic substance, greatly improving the utilization rate of energy and resources in the pyrolysis products of municipal solid waste. And

according to the testing, the dioxin and related harmful compounds produced by combusting the combustible gas generated by the municipal solid waste treatment system are 0.02ng, far below the international strictest standard of 0.1ng.

With reference to Fig. 9, a municipal solid waste treatment method is provided according to an embodiment of the present invention, which comprising:

S902, Performing a pre-treating process to the municipal solid waste, the pre-treating process comprising: dehydrating and drying, sorting, and crushing.

S904, Pyrolyzing the municipal solid waste through a pyrolysis device, wherein the pyrolysis device comprises: a pyrolysis gasification furnace and feeder disposed above the pyrolysis gasification furnace, the feeder is configured to feed pre-treated municipal solid waste into the pyrolysis gasification furnace for pyrolysis to generate pyrolysis gas and slag; wherein the feeder comprises a main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state.

S906, Removing chlorine-containing compounds and sulfur-containing compounds from the pyrolysis gas, and cooling the pyrolysis gas to separate macromolecular organic substance from small-molecule combustible gas, the macromolecular organic substance is recycled to pyrolysis gasification furnace for further pyrolysis, the small-molecule combustible gas is collected into an external storage device.

S908, Separating the slag into metal, incompletely pyrolyzed organic matter and ash residue; and recycling the incompletely pyrolyzed organic matter to the pyrolysis gasification furnace for further pyrolysis.

With reference to Fig. 10, a feeding method for a pyrolysis gasification furnace is also provided according to an embodiment of the present invention, which comprising:

S1002, Providing a main chamber body for feeding comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state.

That is to say, the pyrolysis gasification furnace comprises three gates from top to bottom, namely: the feed gate, the isolation gate, and the discharge gate, which separate the main chamber body into the upper chamber and the lower chamber.

S1004, Opening the feed gate and closing the isolation gate to seal the lower chamber, allowing material to enter the upper chamber through the feed gate, then closing the feed gate after completion of feeding.

In the first mode, the upper chamber is opened and the lower chamber is closed,

S1006, Opening the isolation gate to transfer material from the upper chamber into the lower chamber, then closing the isolation gate to seal the upper chamber after completion of transfer.

S1008, Opening the discharge gate to transfer material into the pyrolysis gasification furnace.

The working process of the municipal solid waste treatment system of this invention is as follows:

Crush the municipal solid waste, the crushed municipal solid waste is then mixed with the microbial consortia and placed in the drying chamber for 14 days, the dehydrated and dried municipal solid waste is sorted after 14 days to remove obvious or large inorganic impurity and metal.

Grab the crushed municipal solid waste by hydraulic grab and discharge it into the feed hopper 25 of the feeder, the feeder discharges the municipal solid waste into the pyrolysis gasification furnace in a sealed state to produce pyrolysis gas and slag through pyrolyzing.

Separate the macromolecular organic substance from the small-molecule combustible gases through the pyrolysis gas purification device 30, wherein the macromolecular organic substance are sent back to the pyrolysis gasification furnace for secondary pyrolysis, the small-molecule combustible gases are collected for using.

The metal, incompletely pyrolyzed organic matter and ash residue are sorted by the slag sorting device 40, the sorted metal can be sold directly, the incompletely pyrolyzed organic matter are sent back to the pyrolysis gasification furnace for secondary pyrolysis, the ash residue can be used for resource utilization.

Specifically, the feeder includes the vertical feeder and the horizontal feeder, the working process of the vertical feeder is as follows:

Send an open instruction to the power mechanism 221 by a controller, the feed gate 22 is driven to open, meanwhile, a close instruction is sent to the power mechanism 242 and the power mechanism 233, the isolation gate 24 and the discharge gate 23 are closed, the feeder is in the first mode, the upper chamber 211 of the feeder can be fed through the feed hopper 25;

After the upper chamber 211 is filled with material, a close instruction is sent to the power mechanism 221 by the controller, the feed gate 22 is closed, then, an open instruction is sent to the power mechanism 242, the isolation gate 24 is opened, the feeder is in the second mode, the material in the upper chamber 211 falls into the lower chamber 212;

After the material falls into the lower chamber 212, a close instruction is sent to the power mechanism 242 by the controller, the isolation gate 24 in the middle is closed; then an open instruction is sent to the power mechanism 233, the discharge gate 23 is opened, the feeder is in the third mode and complete feeding into the furnace.

In conclusion, during feeding process, the isolation gate 24 on both sides in the middle and the discharge gate 23 on the bottom of the main chamber body 21 are completed closed to form a seal state and prevent air from entering the pyrolysis gasification furnace, then the feed gate 22 on the top is opened, the waste material is discharged into the upper chamber 211. The feed gate 22 on the top is closed, the upper chamber is in sealed state, the opening at the upper end and the lower end of the main chamber body 21 are closed. Then open the isolation gate 24 in the middle, after the waste material falls into the lower chamber 212 under the action of gravity, close the isolation gate 24 in the middle, at this time, both the upper and the lower chamber are in sealed state, the upper opening of the upper chamber 211 can continue to feed, the lower opening of the lower chamber 212 can feed material into the furnace, which realize the functions of sealing, preventing air from entering the furnace, and continuous feeding.

When discharging the material, open the discharge gate 23 at the bottom, and the material enters the pyrolysis gasification furnace under the action of gravity, close the discharge gate 23 and the lower chamber 212 is resealed. During the discharge process, the controller regulates the sequential operation and status of the discharge gate 23 on both sides to modify the material

distribution pattern within the furnace: when two discharge gates 23 are opened simultaneously, the waste material falls directly below the feeder; when only the left discharge gate 23 is opened, the amount of material distributed to the left increases under the action of gravity and inertia, significantly exceeding 50% of the total amount of material. Similarly, when only the right discharge gate 23 is opened, the amount of material distributed to the right increases, significantly exceeding 50% of the total amount of material. When both two discharge gates 23 are opened, all material enters the pyrolysis gasification furnace; when the discharge gate 23 is partially opened, only a portion of the material can enter the pyrolysis gasification furnace.

The first mode, the second mode and the feeding process of the horizontal feeder are the same as those of the vertical feeder, which will not be repeated here, the following text only describes the different working processes of the horizontal feeder and the vertical feeder:

After the material falls into the lower chamber 212, a close instruction is sent to the power mechanism of the isolation gate 24 by the controller, the isolation gate 24 in the middle is closed; then an open instruction is sent to the power mechanism of the discharge gate 23 and the pusher 26, after the discharge gate 23 is opened, the pusher 26 begins to reciprocate, the feeder is in the third mode, the pusher 26 pushes the material that has fallen into the lower chamber 212 into the pyrolysis gasification furnace through the discharge gate 23. The waste gradually falls down during the reciprocating process of the pusher 26, effectively dispersing material and increasing the gaps between waste blocks, greatly improving the efficiency of subsequent pyrolysis processes. Due to the uniform placement of the horizontal feeders above the four sidewalls of the pyrolysis gasification furnace in the embodiments of this application, each horizontal feeder completes a uniform distribution of 25% of the cross-sectional area of the

pyrolysis gasification furnace, effectively solving the problem of uneven feeding and improving pyrolysis efficiency.

According to the embodiments of this application, the feed gate 22 at the top of the feeder can effectively seal the inlet of the chamber, the lower part of the chamber can be effectively sealed when the isolation gates 24 symmetrically located on both sides at the middle of chamber 21 are closed and the feed gate at the top is opened; When the discharge gate at the bottom of the feeder chamber is sealed and closed, it can effectively seal the lower opening of the chamber. By coordinating the opening or closing of the upper, middle and lower gates inside the chamber, the continuous feeding function under sealed conditions can be reliably achieved. Due to the fact that each opening and closing of each gate takes only a few seconds and does not require continuous power, the comprehensive energy consumption for completing the same amount of feeding is much lower than that of a screw feeder that requires continuous operation, resulting in significant energy-saving effects.

	Screw feeder type	Feeder for coal block and others	This application
Flexible materials	Suitable, compression sealing	Not suitable, stuffing and jamming	Suitable, excellent sealing
Hard materials	Not usable, air leakage and seizure	Suitable	Suitable
Soft hard mixed materials	Not usable, air leakage and seizure	Not usable, jamming	Suitable
Power requirement	Continuous	Intermittent	Intermittent
Energy Consumption	High and continuous	Low	Low

Strip (rope) like materials	Not usable, entanglement	Not usable, clogging and jamming	Convenient and suitable
Large sheet/block materials	Not usable, feeding failure	Not usable, feeding failure	Convenient and suitable

The differences between the feeder in this invention and existing feeders are shown in the following table:

The feeder in this invention has a scientifically reasonable design, simple structure, stable performance, and low energy consumption, it can be applied to various forms and sizes of waste and combustible solid waste such as hard and soft materials, and can meet continuous feeding under the premise of sealing and air isolation, and provides a cost-effective, reliable, and energy-saving supporting equipment for the application of the new technology of pyrolysis gasification furnace equipment for processing municipal solid waste. The specific advantages are as follows:

1. Be able to satisfy the feeding function of different types of waste material, including hard and soft material.
2. Be able to satisfy the feeding requirements of large volume material.

For example, if the waste packaging foam block, waste plastic mesh, large sponge block, etc. are broken into small pieces, the cost will increase significantly, and the gains cannot make up for losses. The characteristics of these materials are that they shrink immediately when heated, the volume of the whole piece immediately shrinks extremely when it enters the pyrolysis gasification furnace, and within seconds, the volume is reduced to a level where the impact on production can be ignored, therefore, using the feeder of this invention can completely feed these materials into the pyrolysis gasification furnace, and this kind of waste can be quickly and effectively processed through the heat inside the furnace, without the need for crushing,

which can greatly reduce the energy consumption required for crushing, logistics cost and other operating cost.

3. The feeding process is realized through gravity, the feeder is mounted on the top of the furnace, both horizontal feeding and vertical feeding utilize gravity to allow material to naturally fall into the furnace, with fast feeding speed and no need for additional power to push material. Meanwhile, the discharge gate of the feeder provides reliable sealing when closed, significantly reducing power consumption for equivalent feeding capacity, resulting in notable energy savings.

4. Increase the feeding area, the material can be sent to different zones through separately opening the flip discharge gate at the bottom of the vertical feeder, alternatively, the material can be evenly distributed to the pyrolysis gasification furnace by setting up horizontal feeders at multiple points, the area where material is discharged into the furnace is increased, and the increasing area is beneficial for uniform distribution of the material inside the furnace.

5. Reliable sealing, the feeder achieves sealing through its integrated gate mechanism, with automated opening and closing operations controlled by the controller, which has enough automaticity and is stable and reliable; Unlike material extrusion-based sealing methods (which may vary in effectiveness depending on material properties), the feeder in this application delivers superior and consistent sealing performance.

This invention provides a complete municipal solid waste treatment system that achieves full pyrolysis of municipal solid waste and reuses the resources generated from pyrolysis process, significantly improving the utilization efficiency of both energy and materials derived from the pyrolysis process. The specific advantages are as follows:

1. By providing horizontal feeder or vertical feeder usable for various shapes and sizes of material, the cost of further crushing and granulation of material during pre-treating process is reduced.

2. Realize uniform feeding through multi condition control, comprising: positioning the feeder above the pyrolysis furnace, allowing material to fall vertically into the pyrolysis furnace, the impact upon landing enhances material dispersion and increases inter-particle gaps of the material; Multiple horizontal feeders are positioned at multiple points, vertical feeder controls the number and/or angle of opening of the discharge gate, due to the increased dispersibility of the material, the influence of particle size of the material on pyrolysis efficiency can be basically ignored, therefore the cost of further crushing and granulation of material during pre-treating process can be further reduced.

3. Multi condition control minimizes slag clumping, comprising: sorting and removing the inorganic soil in municipal solid waste through pre-treating process prior to pyrolysis; Maintaining furnace temperature at 800-900°C during pyrolysis process, which satisfies the pyrolysis requirements without reaching the temperature required for slag clumping (greater than 900°C); Sorting the slag to elect incompletely combusted organic matter such as charcoal, and add the incompletely combusted organic matter to material for secondary pyrolysis, which not only increases the calorific value but also achieves full utilization of the material.

4. The pyrolysis gasification furnace uses refractory materials and insulation materials to reduce heat loss, without adding any other fuel or energy, the pyrolysis gasification furnace maintains continuous and stable operation of pyrolysis only relying on the energy of household materials themselves.

5. Multiple measures are taken to improve the overall efficiency of the waste treatment system, comprising: increasing the calorific value of materials through drying and dehydration; Sorting materials to reduce the content of inorganic slag and metal in the waste entering the furnace, and reduce pyrolysis heat loss; Distributing the materials evenly in the pyrolysis gasification furnace and increasing the gaps between the materials to improve pyrolysis efficiency; The pyrolysis gasification furnace uses insulation materials and refractory materials, further reducing heat loss.

6. The complete resource utilization of municipal solid waste has been achieved, not only all products can be reused, among the products also includes small molecule combustible gas that can replace natural gas, which improves the utilization rates of both energy and resources.

While the present disclosure has been described in detail with reference to specific embodiments thereof, those skilled in the art will understand that various alterations and modifications may be made without departing from the spirit and scope of the embodiments. Accordingly, the disclosure is intended to cover modifications and variations of this disclosure, and any modifications, equivalents substitutions, improvements, etc. made within the spirit and principles of the present invention shall be included within the scope of the claims and their equivalents of this disclosure.

Furthermore, limitations disclosed in the above description, claims, or drawings, expressed in their specific form or according to the method or process for performing the disclosed functions or obtaining the disclosed results, may be used alone or in any combination of these limitations to implement the present invention in their different forms, as appropriate. Specifically, one or more limitations of any embodiment described herein may be combined with one or more limitations of any other embodiment described herein.

It is also possible to seek protection for any limitations disclosed in any one or more public documents that are combined with this disclosure and/or merged by reference.

CLAIMS

What is claimed is:

1. A municipal solid waste treatment system, wherein the system comprises:

A pretreatment device configured to perform a pre-treating process to the municipal solid waste, the pre-treating process comprising: dehydrating and drying, sorting and crushing;

A pyrolysis device comprising: a pyrolysis gasification furnace and feeder disposed above the pyrolysis gasification furnace, the feeder is configured to feed pre-treated municipal solid waste into the pyrolysis gasification furnace for pyrolysis to generate pyrolysis gas and slag; wherein the feeder comprises a main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state;

A pyrolysis gas purification device configured to remove chlorine-containing compounds and sulfur-containing compounds from the pyrolysis gas, and cool the pyrolysis gas to separate macromolecular organic substance from small-molecule combustible gas, the macromolecular organic substance is recycled to pyrolysis gasification furnace for further pyrolysis, the small-molecule combustible gas is collected into an external storage device;

A slag sorting device configured to separate the slag into metal, incompletely pyrolyzed organic matter and ash residue; and recycle the incompletely pyrolyzed organic matter to the pyrolysis gasification furnace for further pyrolysis.

2. The municipal solid waste treatment system according to claim 1, wherein the pyrolysis gas purification device further comprises a spray washing structure configured to reduce temperature of the pyrolysis gas, thereby converting the macromolecular organic substance from a gaseous state into a liquid state, a solid-liquid mixed state, or a solid state to separate the macromolecular organic substance from the small-molecule combustible gas in the pyrolysis gas.

3. The municipal solid waste treatment system according to claim 1, wherein the feeder comprises three modes:

A first mode wherein the feed gate is in an open state while the isolation gate and the discharge gate are in a closed state;

A second mode wherein the feed gate is in an open state, the isolation gate is in an open state, while the discharge gate is in a closed state;

A third mode wherein the feed gate and the isolation gate are in a closed state, while the discharge gate is in an open state.

4. The municipal solid waste treatment system according to claim 1, wherein the feeder is configured as a vertical feeder or a horizontal feeder, a discharge gate of the vertical feeder is arranged along a horizontal direction, and a discharge gate of the horizontal feeder is arranged along a vertical direction.

5. The municipal solid waste treatment system according to claim 4, wherein the horizontal feeder further comprises a pusher disposed opposite to the discharge gate, the pusher is configured to horizontally push the municipal solid waste falling from the upper chamber into

the lower chamber, thereby causing the municipal solid waste to be fed into the pyrolysis gasification furnace.

6. The municipal solid waste treatment system according to claim 4, wherein at least two horizontal feeders are uniformly arranged above feed inlets of sidewalls of the pyrolysis gasification furnace.

7. The municipal solid waste treatment system according to claim 4, wherein the vertical feeder is arranged centrally above a feed inlet of the pyrolysis gasification furnace.

8. The municipal solid waste treatment system according to claim 1, wherein the feed gate is configured as a horizontally or downwardly inclined single-side sliding structure.

9. The municipal solid waste treatment system according to claim 1, wherein the volume of the lower chamber is greater than the volume of the upper chamber.

10. The municipal solid waste treatment system according to claim 1, wherein the small-molecule combustible gas comprises: carbon monoxide, hydrogen, methane, and small-molecule hydrocarbons.

11. A municipal solid waste treatment method, wherein the method comprises:

Performing a pre-treating process to the municipal solid waste, the pre-treating process comprising: dehydrating and drying, sorting, and crushing;

Pyrolyzing the municipal solid waste through a pyrolysis device, wherein the pyrolysis device comprises: a pyrolysis gasification furnace and feeder disposed above the pyrolysis gasification furnace, the feeder is configured to feed pre-treated municipal solid waste into the pyrolysis gasification furnace for pyrolysis to generate pyrolysis gas and slag; wherein the feeder comprises a main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state;

Removing chlorine-containing compounds and sulfur-containing compounds from the pyrolysis gas, and cooling the pyrolysis gas to separate macromolecular organic substance from small-molecule combustible gas, the macromolecular organic substance is recycled to pyrolysis gasification furnace for further pyrolysis, the small-molecule combustible gas is collected into an external storage device;

Separating the slag into metal, incompletely pyrolyzed organic matter and ash residue; and recycling the incompletely pyrolyzed organic matter to the pyrolysis gasification furnace for further pyrolysis.

12. The municipal solid waste treatment method according to claim 11, wherein the pyrolysis gas purification device further comprises a spray washing structure configured to reduce temperature of the pyrolysis gas, thereby converting the macromolecular organic substance from a gaseous state into a liquid state, a solid-liquid mixed state, or a solid state to separate the macromolecular organic substance from the small-molecule combustible gas in the pyrolysis gas.

13. The municipal solid waste treatment method according to claim 11, wherein the feeder comprises three modes:

A first mode wherein the feed gate is in an open state while the isolation gate and the discharge gate are in a closed state;

A second mode wherein the feed gate is in an open state, the isolation gate is in an open state, while the discharge gate is in a closed state;

A third mode wherein the feed gate and the isolation gate are in a closed state, while the discharge gate is in an open state.

14. The municipal solid waste treatment method according to claim 11, wherein the feeder is configured as a vertical feeder or a horizontal feeder, a discharge gate of the vertical feeder is arranged along a horizontal direction, and a discharge gate of the horizontal feeder is arranged along a vertical direction.

15. The municipal solid waste treatment method according to claim 14, wherein the horizontal feeder further comprises a pusher disposed opposite to the discharge gate, the pusher is configured to horizontally push the municipal solid waste falling from the upper chamber into the lower chamber, thereby causing the municipal solid waste to be fed into the pyrolysis gasification furnace.

16. The municipal solid waste treatment method according to claim 14, wherein at least two horizontal feeders are uniformly arranged above feed inlets of sidewalls of the pyrolysis gasification furnace.

17. The municipal solid waste treatment method according to claim 14, wherein the vertical feeder is arranged centrally above a feed inlet of the pyrolysis gasification furnace.

18. The municipal solid waste treatment method according to claim 11, wherein the feed gate is configured as a horizontally or downwardly inclined single-side sliding structure.

19. A feeder for a pyrolysis gasification furnace of a municipal solid waste treatment system, wherein the feeder comprises:

A main chamber body comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state;

The feeder comprises three modes:

A first mode wherein the feed gate is in an open state while the isolation gate and the discharge gate are in a closed state;

A second mode wherein the feed gate is in an open state, the isolation gate is in an open state, while the discharge gate is in a closed state;

A third mode wherein the feed gate and the isolation gate are in a closed state, while the discharge gate is in an open state.

20. A feeding method for a pyrolysis gasification furnace of a municipal solid waste treatment system, wherein the feeding method comprises:

Providing a main chamber body for feeding comprising: a feed gate disposed at an upper end, a discharge gate disposed at a lower end, and an isolation gate disposed between the feed gate and the discharge gate at a middle portion; wherein the main chamber body is divided into a hermetically sealed upper chamber and a hermetically sealed lower chamber when the feed gate, the isolation gate and the discharge gate are simultaneously in a closed state;

Opening the feed gate and closing the isolation gate to seal the lower chamber, allowing material to enter the upper chamber through the feed gate, then closing the feed gate after completion of feeding;

Opening the isolation gate to transfer material from the upper chamber into the lower chamber, then closing the isolation gate to seal the upper chamber after completion of transfer;

Opening the discharge gate to transfer material into the pyrolysis gasification furnace.