Pure oxygen circulation fluidized bed combustion-based energy conversion technology

Energy plant based on oxy-circulating fluidized bed combustion

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Patent title Pure oxygen circulation fluidized bed combustion device and exhaust gas recirculation method using same

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Authority status Registered

Technicality

Technology overview

- A pure oxygen circulation fluidized bed combustion technology is a combination of a circulation fluidized bed boiler and a pure oxygen combustion technology which enables source segregation of carbon dioxide (CO2). The pure oxygen circulation fluidized bed combustion technology is an energy conversion technology in which a combustion exhaust gas is recirculated to a boiler, and a mixture of pure oxygen and a part of an exhaust gas is used instead of air as an oxidizing agent, so that the carbon dioxide concentration is increased during combustion to separate, collect, and recycle the source of carbon dioxide and the processing capacity is significantly increased along with zero emission of an exhaust gas source.

Development background and problem to be solved

- Required is a waste-to-energy (Oxy-CFBC WtE) technology by which an exhaust gas including a greenhouse gas and an air pollutant can be reduced to solve the national waste crisis and eliminate pollutants and a waste treatment capacity in an existing air-using incineration facility can be increased.
- In a pure oxygen circulation fluidized bed combustion device, an outdoor air valve unit is provided between a recirculation unit and an exhaust gas valve unit, and is connected to a combustion furnace, a fuel supply unit, and a particle circulation unit. An outdoor fan is not included, and thus it is possible to reduce fan purchase costs and required site areas, thereby enabling a switch to an economical and stable pure oxygen combustion mode.

Excellence and discrimination of technology

▶ Excellence of technology

- A CO_2 source is separated by using, as an oxidizing agent, a material obtained by circulating and mixing a part of an exhaust gas with pure oxygen instead of air.
- Through an oxidant concentration control technology (O_2 content: 21-60%), a waste treatment capacity is tripled.
- The burden on downstream environmental facilities is reduced through exhaust gas recirculation combustion and furnace desulfurization/denitrification technologies.
- A hybrid exhaust gas control technology enables zero emission of air pollutants.
- A fluidized bed external heat exchange technology according to a change in throughput can be used to recover variable heat.

▶ Discrimination of technology

- The highest level of CO_2 separation efficiency and stability: high-concentration CO_2 source separation during an operation (90 vol.% or more)
- Reduction of air pollutants and fine dust: 80% or more reduction of an actually discharged exhaust gas amount
- Technology applicability is simple, and thus existing old facility retrofit can be easily performed.
- Operating capacity range flexibility is maximum 300% (a fuel handling capacity in the same facility increases three times or more.)

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Implementation method

According to the present invention,

- a pure oxygen circulation fluidized bed combustion device comprises a combustion cyclone, a particle circulation unit, a combustion unit (a fuel supply unit), a recirculation unit, an exhaust gas valve (recirculation control), and an external air valve.
- When the exhaust gas valve is closed at the initial stage of an operation of the combustion unit, the external air valve is opened to supply external air to the combustion unit. After the set time, an exhaust gas and pure oxygen are mixed and supplied to the combustion unit. Thus, the introduction of external air can be adjusted only by one external air valve without an external air fan.

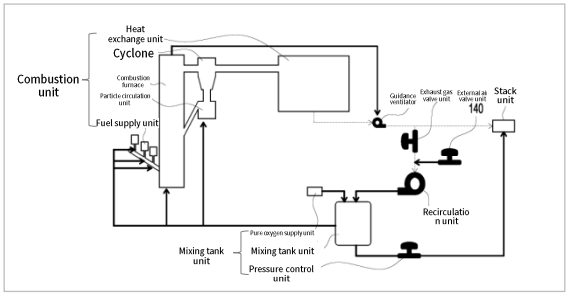

Figure 1 Composition of a pure oxygen circulation fluidized bed combustion device

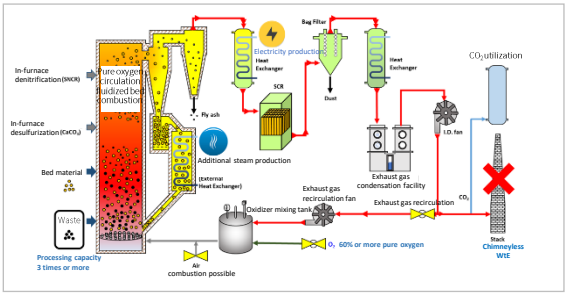

Figure 2 Chimneyless WtE cogeneration example

Degree of technology completion (TRL)

Degree of technology completion: TRL5 (implementation environment application experiment stage)

TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Technical principle presentation	Technology concept setting	Technology concept verification	Lab Scale prototype development	Implementation environment application experiment	Full Scale prototype development	Quasi-commercial product development	Commercial product development	Commercial product implementation

Utilization

Utilization field and applied product

Utilization field

· Fluidized bed-based power plant (industrial boiler or the like)

· Fluidized bed reactor process design and analysis (CO2 raw material industry - extinguishing agent, mineralization, or the like)

· Fluidized bed boiler and plant user operation education

Figure 1 Circulation fluidized bed combustion furnace facility

Applied product

· Solid residue fuel (SRF) circulation fluidized bed cogeneration power plant

· Unused biomass distributed cogeneration power plant

· Renovation of old power plant

· Reduction of pollutants in existing combustion facilities and evaluation of combustion obstacles

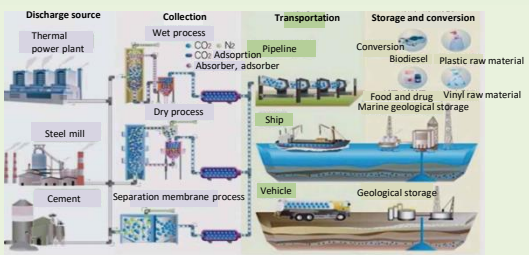

Figure 2 Carbon collection process and applied product

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Technology trend

- In addition to efforts to reduce carbon dioxide emissions to prevent global warming, direct reduction is being pursued through the collection, utilization, and storage of carbon dioxide as a technological alternative. The North American continent, including the United States and Canada, is already operating fourteen large-scale (CCS, Carbon Capture & Storage) facilities. (As of 2019, nineteen large-scale CCS projects worldwide are in operation, with an annual CO_2 capture amount of 40 million tons.)
- A pure oxygen combustion technology for domestic carbon dioxide collection has been studied mainly by the Korea Institute of Energy Research, Korea South-East Power Co., and KEPCO Research Institute. The Korea Institute of Energy Research built and performed a trial operation of a 2MWe-class demonstration plant to which a pure oxygen circulation fluidized bed combustion technology is applied for the first time in Korea. A joint R&D agreement (2020) with the US National Energy Technology Laboratory (NETL) has been signed, and the technology is being developed.

Family patent status

Application nation	Application No. (Application date) / Registration No.	Title of the invention
KOR	KR 10-2018-0052697 (2018.05.08) / 10-2051667 (2019.11.27)	Circulation fluidized bed reactor for stable material introduction including exhaust gas recirculation
KOR	KR 10-2019-0059845(2018.09.26)	Stable pure oxygen combustion operation method using heat recovery and exhaust gas moisture removal
KOR	KR 10-2020-0042709(2020.04.08)	Pure oxygen circulation fluidized bed boiler and energy circulation system using renewable energy

Market prospect

Target market size and prospect

- The size of the domestic waste treatment market is expected to grow from KRW 16.7 trillion in 2018 to KRW 23.7 trillion in 2025. During the same period, the total amount of waste in Korea is expected to increase by 16.9% from 157.2 million tons to 183.8 million tons.
- The global carbon dioxide collection and storage market is expected to reach USD 8,054.7 million by 2021, growing at a CAGR of 13.6% from USD 4,251.9 million in 2016.

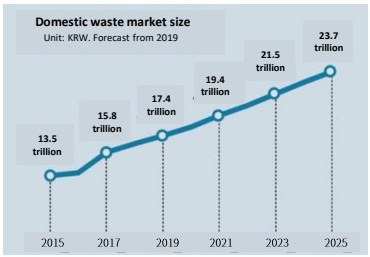

Figure 1 **Domestic waste market size**
<Data: Shinyoung Securities, Ministry of Environment, IMF>

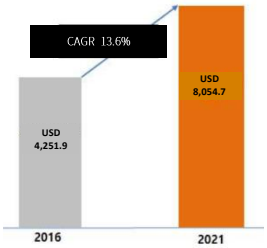

Figure 2 **Global carbon dioxide collection and storage market size**
<Data: Markets and markets>

Technology transfer query

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Technology transfer process