

Generator engine technology using low calorific value syngas

Low Calorific Syngas Engine Technology for Generator



Patent title	Power generation system utilizing coal gasification and FT reaction off-gas	Inventor	Korea Institute of Machinery & Materials / Oh Seung-mook, Kim Chang-up, Yi Yong-gyu, Kang Geon-yong
Patent application No.	KR 10-2018-0054218 (2018.05.11) / 10-2051849 (2019.11.28)	Authority status	Registered

Technicality

Technology overview

The technology is a technology which uses an electric ignition gas generator to generate a syngas produced through gasification of coals, waste, biomass, etc. or an off-gas discarded in an FT reaction liquefaction process. Since this syngas or off-gas fuel includes a large amount of inert gases (CO₂, N₂), the calorific value is very low. Also, this syngas or off-gas fuel has a low level of pressure of about atmospheric pressure. Thus, in order to optimally burn this fuel in an engine, it is necessary to apply a precision fuel supply technology suitable for an engine combustion chamber and an ultra-low pressure fuel, which are different from the existing ones. In addition, in order to obtain a clean exhaust gas after combustion, an active control algorithm which uses exhaust gas post-treatment catalysts and sensors and efficiently controls the same was developed.

Development background and problem to be solved

- A coal gasification combined cycle power generation technology was developed to solve this problem and develop the efficiency of thermal power generation as the amount of waste by-products such as harmful exhaust gases generated by coal power generation has a large impact on the atmospheric environment.
- Unused gases that are not converted into fuels in a coal gasification process are thrown away due to the low calorific value. For the environment and energy generation efficiency, a technology of increasing the calorific value of an off-gas with a low calorific value and utilizing the same for energy production is needed.

Excellence and discrimination of technology

Excellence of technology

- By producing electrical energy from a syngas (off-gas), which has been discarded or difficult to utilize, an increase in overall system efficiency and improvement in the economic feasibility of renewable energy have been led.
- Since a syngas (off-gas) can be stably burned alone without using a diesel fuel for dual fuel combustion, which has been used so far to burn a syngas (off-gas) fuel with a low calorific value, it is possible to improve power generation efficiency and improve economic feasibility due to reduction in energy production costs.
- Although a low-pressure fuel at about atmospheric pressure is used compared to a high-pressure fuel supply device for a general automobile engine, zero emission of CO and HC is achieved and NOx emissions are reduced by 1/4 of the environment regulation standards by using precision control, post-processing sensors, and active control algorithms.
- It is possible to reduce and utilize an off-gas emitted from low-grade coals, and economic feasibility is ensured through reduction in energy production costs.

Discrimination of technology

- A syngas produced through gasification (oxygen or air) or an off-gas discarded after an FT reaction is applied to a power generation unit.
- As high-efficiency utilization of a low-calorie gas (1,000 kcal/m³) and a medium-calorie gas (3,000 kcal/m³) is possible, it is possible to utilize not only a syngas (an off-gas) from coal gasification, but also a syngas with a low-medium calorific value from various sources. At this time, energy efficiency is obtained up to 42%.
- The energy efficiency of an off-gas, which has a calorific value of 1/5 or 1/10 compared to conventional diesel or gas fuels, increases by 37%.
- Carbon monoxide and nitrogen oxide emissions in an exhaust gas are reduced by applying a three-way catalyst technology which precisely controls air and gas fuels.

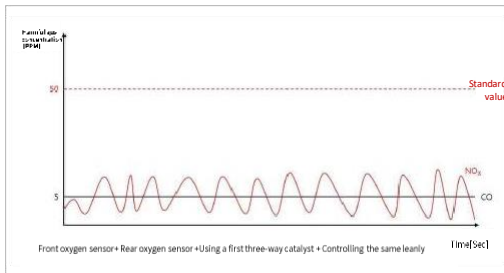
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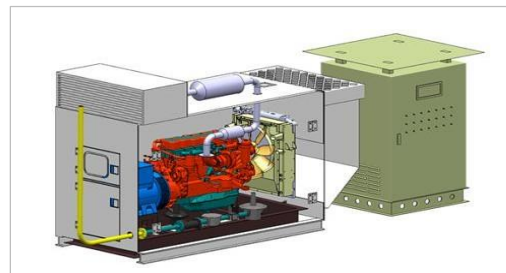
Implementation method

According to the present invention,

- A coal is gasified in a coal pre-processing unit and sent to the FT reaction to obtain crude oil such as gasoline and diesel through a liquefaction process. At this time, an off-gas that is discarded without participating in the FT reaction is supplied to a power generation unit to generate electricity through total combustion.
- By using precise control of fuels and catalysts or sensors for post-treatment, and by using an active control algorithm which efficiently controls the same, a harmful emission gas is purified to a zero level.



Picture 1 Effect of controlling harmful gas emissions in an exhaust gas



Picture 2 Off-gas utilization generator engine 3D model

Degree of technology completion (TRL)

Degree of technology completion: TRL4 (Lab Scale prototype development)

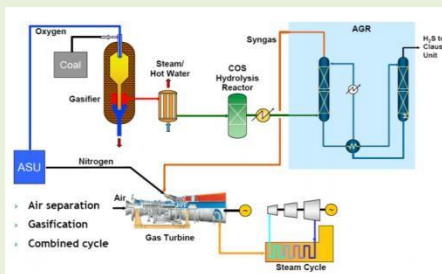
TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Technical principle presentation	Technology concept setting	Technology concept verification	Lab Scale prototype development	Implementation environment application experiment	Full Scale prototype development	Quasi-commercial product development	Commercial product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

Utilization

Utilization field and applied product

Utilization field

- Syngas power generation
- Island power generation
- Waste plastic power generation
- Industrial engine



Picture 1 Coal liquefaction gasification technology

Applied product

- Coal gasification power generator
- Ultra-low-emission gas power generator
- Low calorific value power generator
- Industrial engine



Picture 2 Waste plastic generator

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Technology trend

- The coal gasification technology is attracting attention due to a decrease in coal prices, a decrease in thermal power plants due to environmental regulations, and interests in eco-friendly energy.
- In the field of the coal gasification technology over the past 10 years, national research institutes such as Korea Institute of Energy Research and Korea Advanced Institute of Science and Technology, and Hyundai Heavy Industries and Doosan Heavy Industries & Construction among private companies are leading the technology development.
- Overseas, China, which uses a lot of coals, is leading the development of the coal gasification technology, and East China University of Technology has developed a technology of gasifying 1,150 tons of coals per day. In Japan, in 2018, Mitsubishi constructed a 540 MW direct liquefaction-type IGCC using high temperature and high pressure in Fukushima and started the operation in September 2020.

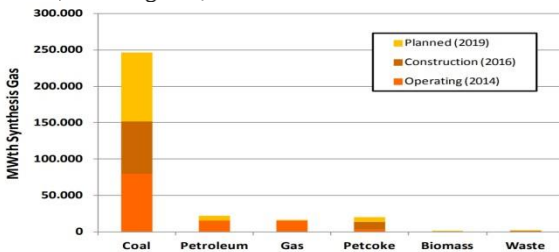
Family patent status

Application nation	Application No. (Application date) / Registration No.	Title of the invention
KOR	KR 10-2018-0054218 (2018.05.11) / 10-2051849 (2019.11.28)	Power generation system using coal gasification and FT reaction off-gas
KOR	KR 10-2018-0108270 (2018.09.11) / 10-2168472 (2020.10.15)	Power generation system utilizing coal gasification syngas and FT reaction off-gasification
KOR	KR 10-2018-0144577 (2018.11.21)	Power generation system utilizing FT reaction off-gas in coal gasification process

Market prospect

Target market size and prospect

The size of a global syngas market is highly volatile depending on gas prices, and thus the market size is inferred on the basis of the amount of energy produced. The global energy production scale was 245,557 MWth in 2020, and is expected to be 406,860 MWth in 2025, with a CAGR of about 10.6% until 2025. Environmental regulations are the main driving force for growth. Gas production from coal gasification is expected to be higher than syngas production from oil, natural gases, and waste.



Plants	Location	Technology	Gasifiers ⁽¹⁾	MW _{th} Syngas	Start year	Feedstocks / Products
Pearl GTL	Qatar	Shell	18 + 0	10,936	2011	Natural Gas / FT Liquids
Sinopec Changji SNG	China	Unspecified	20 + 2	10,000	2017 ⁽²⁾	Coal / SNG
Sinopec Urumqi SNG	China	Unspecified	24 + 4	10,000	2017 ⁽²⁾	Coal / SNG
Yinchuan CTL	China	Siemens	22 + 2	9,300	2016 ⁽²⁾	Coal / FT Liquids
Jamnagar Gasification Phase I	India	E-Gas	10 + 0	8,893	2015 ⁽²⁾	Petcoke / Electricity-SNG-CO-Acetic acid
CPI Yili SNG Phase II	China	Unspecified	20 + 2	7,500	2016 ⁽²⁾	Coal / SNG
Huadian Changji SNG	China	Unspecified	20 + 2	7,500	2017 ⁽²⁾	Coal / SNG
Datang Ningxia SNG	China	SEDM	45 + 3	7,125	2015 ⁽²⁾	Lignite / SNG
Sasol Synfuels West	South Africa	Large FBDB	40 + 0	7,048	1977	Subbit. coal / FT liquids
Sasol Synfuels East	South Africa	Large FBDB	40 + 0	7,048	1982	Subbit. coal / FT liquids

Table Syngas production, energy amount index, and syngas production business

<Data: Worldwide Gasification Database>

Technology transfer query

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Technology transfer process

Explore promising technologies → Contract consultation → Apply for technology transfer → Negotiate and sign contracts → Follow-up support