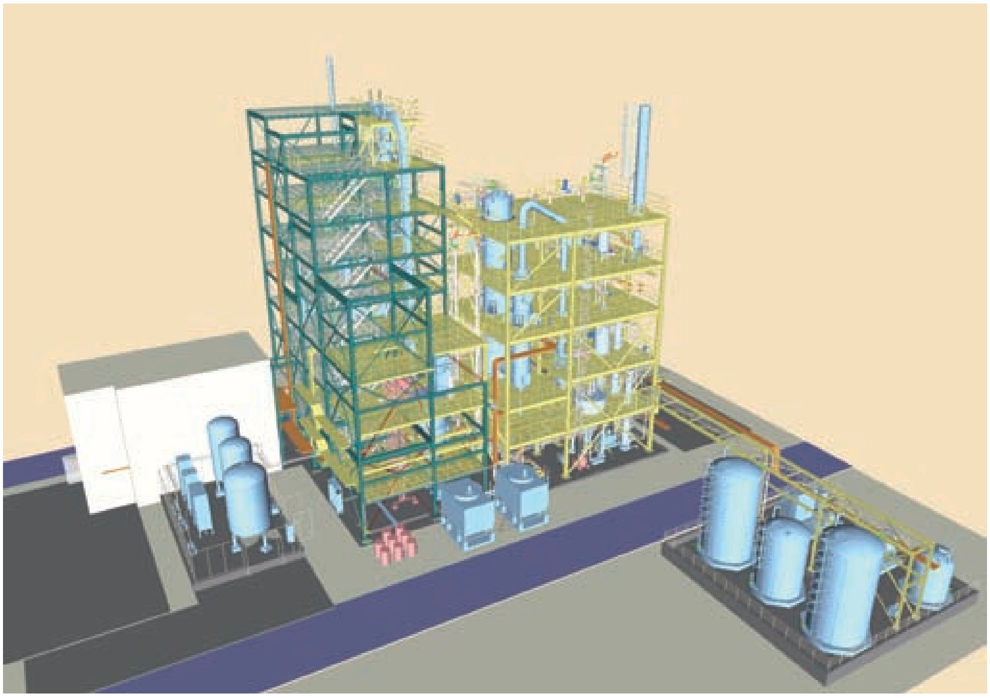
Turning a Poorly Utilized Fuel into a Useful Fuel

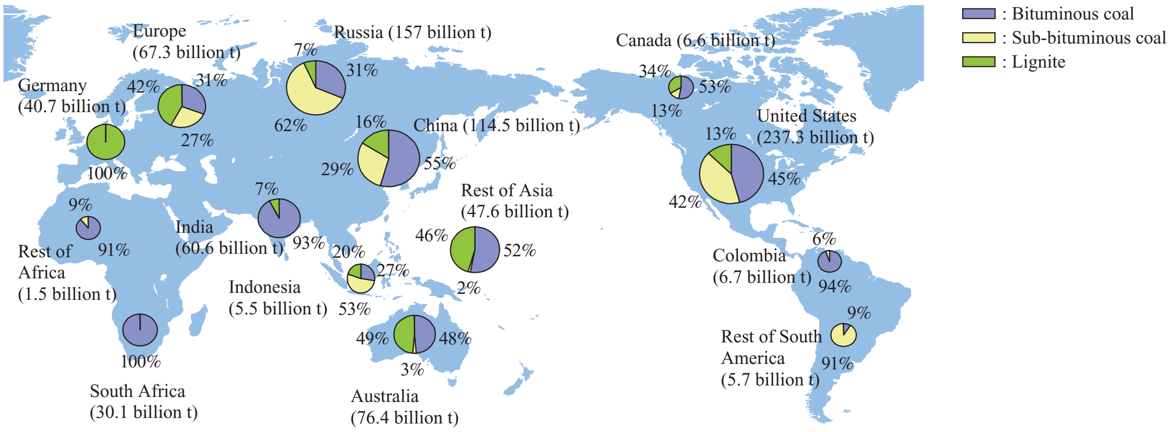
Twin IHI Gasifier (TIGAR®) can expand the application of lignite and biomass.

The Twin IHI Gasifier (TIGAR®) is a circulating fluidized bed-type gasifier that can be operated under milder conditions than other gasifiers. Based on proven fluidized bed and plant technologies, IHI can provide an economically attractive gasification process.

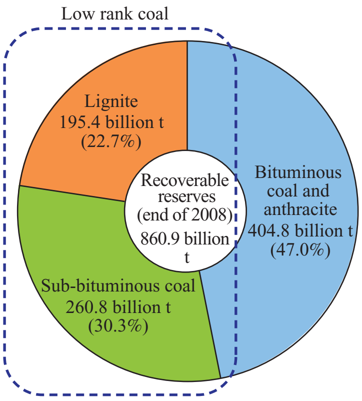


Twin IHI Gasifier (TIGAR®) pilot plant

Various types of energy sources are used in the world; they include fossil fuels such as oil, natural gas, and coal as well as nuclear power, hydropower, wind power, solar power, and biomass. Fossil fuels play a major role among these sources because of their high energy density, ease of transportation, and ease of use. Of these, oil is widely used as transportation fuel and chemical raw materials. However, oil reserves are predominantly in the Middle East and the price is unstable. Natural gas has no sulfur content and emits less CO_2 than other fossil fuels. This environmentally friendly property is encouraging growth in its consumption. Correspondingly, the price is expected to increase in the future. Meanwhile, coal reserves are the most abundant among the fossil fuels. It is distributed throughout many countries, and most importantly, among politically stable countries. Additionally, the price per calorific value is low and stable in comparison with oil and natural gas, which is the reason why coal is a key energy source in many countries. However, half of the coal reserves consist of so-called low rank coals such as lignite and sub-bituminous coal with high moisture and oxygen content, and thus, low calorific value (types of coals are described in the mini



World coal reserves
Based on data from WEC, "Survey of Energy Resources 2010"



Coal reserve by ranks

comment box). Lignite, moreover, requires careful handling due to the ease with which it ignites. For these reasons, low rank coals are generally not suitable for use as an energy source, despite their cheaper price. As low rank coals are unsuitable for long-distance transportation and storage, their utilization is limited to places such as coal fired power plants near coal mines.

By contrast, the synthetic gas from coal mainly contains H_2 and CO, these gases can be directly used for power generation such as in gas turbines or gas engines, or they can be converted into chemical raw materials or transportation fuel through chemical reactions.

Major substances derived by the chemical reactions are ammonia, dimethyl ether (DME), methanol, and methane. Methane can be applied as a Substitute Natural Gas (SNG) to processes where natural gas is usually used. Moreover, a liquid fuel called Coal-to-Liquid (CTL) can be obtained as a fuel-like oil and also as a chemical raw material. Therefore, economic and efficient gasification can convert low rank coal into various fuels with high calorific value and high value-added chemical raw materials, and ultimately make a great contribution to the economy and effective utilization of resources.

The gasification process used by TIGAR® is a suitable technology for many applications. TIGAR® can be applied to many kinds of feedstocks, from low rank coals including lignite, to biomass including wood chips, and produce fuels and chemicals having high added value.

The TIGAR® process is based on proven circulating fluidized bed technology with twin reactors, a gasifier and a combustor. In the gasifier, coal is introduced and volatile matter and part of the char of the coal is gasified with steam in fluidized bed. Since this gasification reaction is endothermic, external heat sources are required.

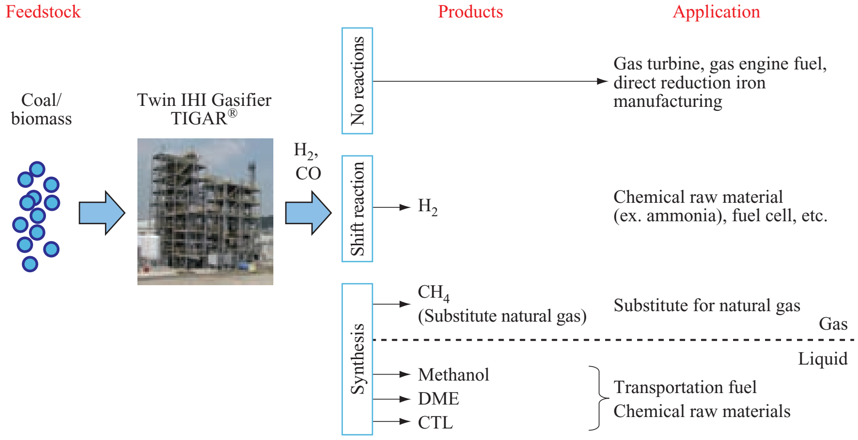
The combustor supplies the required heat for the gasification reaction as follows. The remaining char after gasification is introduced into the combustor with circulated bed material. In the combustor, the char is burned in air and the required heat is produced by the combustion of the char. Then hot circulating bed material heated by the combustion is carried to the gasifier after separation by the cyclone equipped at the combustor exit.

TIGAR® has the following features:

(1) Gasification under low temperature and atmospheric pressure

The entrained bed gasifier used for the Integrated Coal Gasification Combined Cycle (IGCC) which has already been commercialized, needs to operate under the high temperature and pressure of 1 500°C and 3 MPa as it involves a process to melt and recover ash (melting point is around 1 200°C to 1 500°C) in coal. In contrast, lignite coal contains highly volatile matter and can be easily gasified at temperatures below 1 000°C. It is considered inefficient to gasify at such a high temperature.

TIGAR® targets lignite as a feedstock and does not melt ash content. TIGAR® can be operated under the relatively low temperature range of 800°C to 900°C at atmospheric pressure. Therefore, in comparison with other high-temperature/pressure gasifiers, TIGAR® has the advantages of being an efficient gasification



Various use of syngas

process for lignite and having low initial, operation, and maintenance costs owing to the fact that expensive heat- and pressure-resistant mechanisms/components are not necessary.

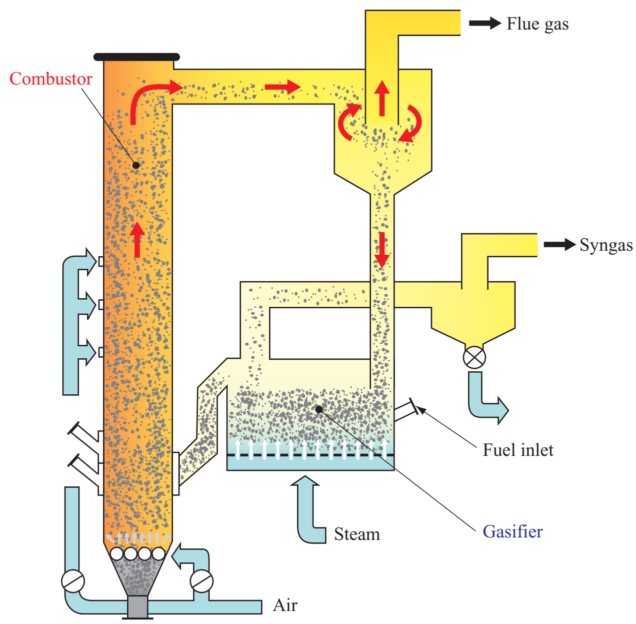
IHI has already reflected proven circulating fluidized bed technologies in the TIGAR® design.

(2) Syngas with high calorific value

Generally, as is the case with many other gasifiers, the heat required for the gasification process is supplied by the combustion of a part of the feedstock in the gasifier. For this purpose, oxygen generated by an expensive Air Separation Unit (ASU) is injected into the gasifier as a gasification agent. In contrast, TIGAR® uses heated sand circulating from the combustor to derive the required heat for gasification while steam is used as a gasification agent in the gasifier. Hence, oxygen is not necessary for the gasification reaction. Additionally, air is fed into the combustor in order to provide combustion heat. Since the combustor and gasifier are separated from each other and only heated sand circulates into the gasifier, flue gas does not mix with syngas. It is thus possible to obtain syngas with high calorific value, which is also suitable for chemical raw materials.

(3) Multi-fuel application

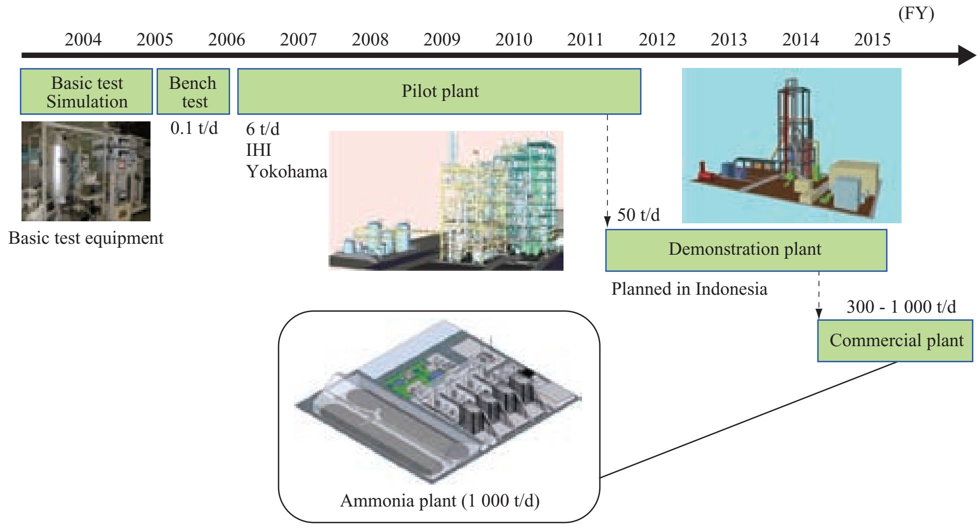
TIGAR® can also accept biomass as feedstock. Since the gasifier is a fluidized bed gasifier, it is sufficient to feed coarsely crushed feedstock for gasification. Coal and biomass can be utilized simultaneously. As a form of renewable energy, biomass gasification can contribute to CO_2 reduction.



Structure and principle of the Twin IHI Gasifier (TIGAR®)

This gasifier, with its many advantages, was called TIGAR® (Twin IHI Gasifier). IHI started its development in 2004. The Ministry of Economy, Trade and Industry has been supporting it since 2010. At present, TIGAR® will enter its next stage, from a pilot plant with a coal feeding rate of 6 t/d to a demonstration plant with a scale-up capacity of 50 t/d. IHI is planning to demonstrate a TIGAR® 50 t/d plant in Indonesia, where low rank coals are abundant and the development of technology for their utilization is actively supported. In this project, the feasibility of its scaled-up design will be confirmed and maintainability and durability will be verified through several thousand hours of operation.

In the commercialization phase following successful demonstration, the first aim is to replace natural gas as a raw material, which is used in an Indonesian fertilizer factory. The fertilizer company can save on plant operation costs if the cheap lignite abundantly available in Indonesia can be gasified to substitute for expensive natural gas. Natural gas can be shifted from domestic consumption to LNG export to acquire foreign currency. Further, the increase of LNG export from Indonesia is desirable for the energy security of Japan as an importer of a large amount of LNG.



Development schedule for the Twin IHI Gasifier (TIGAR®)

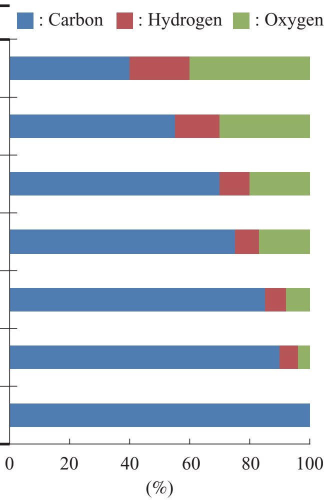
In the commercialization phase, our business targets are not limited to the fertilizer industry, but include other industries as well. IHI aims to expand TIGAR® business in several countries such as India and Australia where there are abundant reserves of lignite.

In addition to developed technology based on circulating fluidized bed boilers, IHI has experience in material handling systems, including coal handling, and Liquefied Natural Gas (LNG) plants. Based on much experience as a plant manufacturer, IHI aims to verify the advantages of TIGAR® as soon as possible in order to contribute to the effective utilization of resources.

Mini comment box

Various types of coals

Types	Characteristics
Plants	
Peat	Formed mainly in marshy areas when plant material is deposited and carbonized without fully decaying.
Lignite	Coal with carbon content of 70 - 78% and high water and oxygen content, distinctive of low coalification.
Sub-bituminous coal	Coal with carbon content of 78 - 83% and water content. Used as fuel for fine-powder coal boilers for power generation and industrial purposes because of its good ignition performance and high calorific value.
Bituminous coal	Relatively soft coal with carbon content of 83 - 90% containing bitumen. What is commonly referred to as coal is usually this bituminous coal.
Anthracite	Coal with the highest level of coalification. The carbon content is over 90%. It is characterized by the extremely small amount of smoke and smell during combustion.
Graphite Diamond	Examples of substances containing 100% carbon.



Since the Carboniferous period about 350 million years ago until the Neogene period about a few million years ago, plant materials deposited in the ground were decomposed by fungi and were compressed around their carbon content due to the pressure of crustal deformation under geothermal heat (coalification). The resultant coal also contains hydrogen, oxygen, and trace amounts of sulfur, nitrogen, silicon, aluminum, and calcium. Generally, the older the coal, the higher the proportion of carbon (higher level of coalification) and greater calorific value.

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