

COMMERCIALIZATION OF THE DOW GASIFICATION PROCESS

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Introduction

In 1979 The Dow Chemical Company authorized \$450 million of capital to be spent on the Gulf Coast Power Conversion Project, the largest single power project Dow had ever built. This capital was to be spent phasing out less efficient gas-fired boilers at the Texas and Louisiana Divisions and integrating 910 MW of new gas turbine generation capacity into these manufacturing locations. Fuel cost savings were projected to be \$200 million per year. Future plans involved utilization of Dow's extensive lignite holdings and then-developing gasification technology to provide our Gulf Coast manufacturing locations with low-cost energy on a long-term basis. Dow completed the installation of the gas turbine facilities in 1982.

Now, after Dow's largest single research and development project ever, a price guarantee from the Synthetic Fuels Corporation has provided the incentive to build our first commercial gasifier in Plaquemine, Louisiana, the Dow Syngas Project. Western coal will be transported by rail to the plant site and the product, medium Btu syngas, will be used to fuel existing gas turbines. The output of this facility will be equivalent to 155 MW of net power production.

Background

Dow's products are highly energy intensive. The primary demand for electrical energy is derived from electro-chemical processes and thermal (steam) demand comes from production of petrochemicals and plastics. Most of our manufacturing locations have a convenient balance between electrical energy and thermal energy, allowing the economical cogeneration of power and steam. Variations of combined cycle plants to match a particular site's requirements for power and steam now exist at all of Dow's major production locations. In the U.S. alone Dow has 1600 MW of gas turbine generation capacity and 800 MW of steam turbine capacity. Over \$500 million has been spent in the last decade on power generation facilities.

History of Dow Gasification Process

Dow's current energy program took form in the early 1970's. The prospect of future shortages of natural gas and resultant high prices launched a "war on Btu's". The outcome was an energy strategy based on:

1. Gas turbines as the most efficient power production technology.
2. Solid fuels as the most abundant low cost energy resource.

Coal gasification was the necessary link to insure the viability of our strategy.

We looked at commercially available processes and found none that met our criteria. We needed a process that was:

1. Reliable.
2. Energy efficient.
3. Environmentally clean.
4. Capable of handling all coals.

Shortcomings of these processes included:

1. High capital cost.
2. Need for coal feed drying.
3. Difficult heat recovery due to tars and oil in product gas.
4. Inability to acceptably process coal feeds containing fines.

Research continued and we found processes that were not commercially proven had some very promising attributes:

1. Reduced residence time in reactor.
2. Feed flexibility.
3. Molten slag removal.
4. Environmentally clean.

However, this technology was not efficient on low rank coals and did not meet Dow's acceptable reliability criteria.

Our development efforts were then greatly expanded and by 1979 we had in place at Plaquemine, Louisiana, an air-blown 400 ton per day demonstration gasifier and a 12 ton per day pilot plant. The pilot plant was used for advanced studies. In August of 1981 we achieved an event without precedent--the successful use of synthetic gas from a coal gasification unit to fuel a 15 MW commercial gas turbine generator.

During 1981 and 1982 a new reactor design and a novel energy recovery technique were developed at the pilot plant. The pilot plant was increased in size to 36 tons per day and converted from air to an oxygen blown process. In 1983 a new technology demonstration gasifier was completed. It incorporated all the technology developed at the pilot plant and has a 1600 ton per day capacity. The capacity of the Dow Syngas Project, our first commercial scale unit, on Western coal is approximately 24000 tons per day. Consequently, scaling up from our new technology demonstration gasifier is a relatively small increment.

Description of the Dow Gasification Process

The Dow gasification process utilizes a pressurized, entrained flow, slagging, slurry fed gasifier with a continuous slag removal system. The process includes a unique heat recovery system which provides high efficiency on low rank coals. The novel slurry feed technology and continuous slag removal technique eliminates high maintenance, problem-prone lockhoppers for introducing the coal to the gasifier or for removal of slag. The design completely prevents the combustion gases and raw product gases from escaping into the atmosphere during slurry feeding or slag removal.

The coal slurry is fed to the reactor and mixed with oxygen in the burner nozzles. The feed rate of oxygen is carefully controlled to maintain the reactor temperature above the ash fusion point to insure slag removal. Under these conditions, the coal is almost totally gasified by partial combustion to produce synthetic gas

consisting principally of hydrogen, carbon monoxide, carbon dioxide, and water. The sulfur is converted almost totally to hydrogen sulfide with small amounts of carbonyl sulfide. The gasifier system operates in such a manner that essentially no tars, oils, or phenols are produced. The Dow Gasification Process includes a unique heat recovery system which provides high efficiency on low rank coals. The ash is fused in the flame, direct quenched in a water bath and removed from the bottom of the reactor as a slurry through a special pressure reducing system. The slag is dewatered and stored.

The gas exiting the gasifier system is further cooled by a conventional heat recovery boiler to near its saturation. The high pressure superheated steam produced can be used for power generation via steam turbines or to drive the oxygen plant air compressor.

The raw synthetic gas goes through a cyclone separator where most of the entrained particles are removed. Final particulate removal is achieved by water scrubbing the partially cooled gas. All of the particulates removed by the cyclone and wet scrubber are recycled to the gasifier.

The scrubbed syngas is then cooled through a series of heat exchangers before entering the acid gas removal process. The amount of low level heat recovery is economically balanced with the heat requirements of both the gasifier and the acid gas removal process.

The acid gas removal from the syngas stream is an economic evaluation of the application of several known technologies with the environmental and process constraints of the location. The particulate-free syngas from the Dow gasifier is suitable feed for any of the known commercial processes.

The Dow Syngas Project gasifier satisfies its location requirements with a Gas/Spec ST-1 acid gas removal system and a Selectox sulfur conversion unit.

Commercial Application of the Dow Gasification Process

Synthetic gas produced from the Dow gasification process can be used as a substitute for coal, natural gas, fuel oil, and natural gas derived chemical feedstock. The synthetic gas can be used as fuel for gas turbines, industrial and utility boilers, furnaces, and process heaters. It also can be used to meet some chemical feedstock demands; methanol and ammonia are examples of products which could use this synthetic gas as feedstock.

The most promising market for this synthetic gas is as fuel for turbines to generate electricity.

The combined cycle gas turbine fired by medium Btu synthetic gas has capital advantages versus coal-fired steam boilers and steam turbines. Overall energy efficiency for the medium Btu synthetic gas/combined cycle turbine is projected to be better than a steam boiler/steam turbine fed by coal.

The Dow Gasification Process has been developed as a module with a gasifier output sufficient to fuel a nominal 100 MW gas turbine. The net output of power after subtracting the requirements of the oxygen plant and gasifier and considering the by-product steam from an associated heat recovery unit converted to power is about 160 MW. When referring to a replicable unit using the Dow Gasification Process, Dow believes this is representative. Dow expects to build about ten of these modules in its Gulf Coast plants to provide fuel for existing gas turbines combined cycle units.

License Availability

Dow is committed to license its gasification technology on reasonable commercial terms. Dow offers related services such as engineering, consultation services, project management and operations support, all of which enhance our technology by bringing Dow's owner/operator perspective to a project.

