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Experience with Integrated Gasification Combined Cycle Power Projects (IGCC)

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IMIA Paper

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1 Executive Summary

Experts see several driving forces which will bring forward the gasification technology and especially the technology of integrated gasification combined cycle power projects (IGCC).

On the one hand they see the move towards ultra - clean and efficient use of the world's fossil fuel resources, on the other hand they expect an enormous growth of demand of gas for clean electricity production.

Refineries will have to cope with the latest and very strict demands of fuel regulations in Europe and other countries (and eventually even worldwide in due course) which are limiting the sulphur content in their products (liquid fuels) to 50 ppm (parts per million or even 10 ppm in comparison to 350 ppm today.

Gasification provides the advantage that "dirty fuel", e.g. residues from refineries like asphalt or bitumen which are difficult to sell and often have to be disposed off at high costs, can be used to produce clean gas (syngas) for generating electrical energy in an integrated combined cycle power plant. Thus the extremely low limits for sulphur-oxide emissions of refineries may be met and a considerable amount of electricity can be produced.

The technology of gasification has been in commercial use for more than fifty years and remains an important process in chemical and refining industry. Starting in the 1980's Shell, Texaco and Lurgi scaled up the size of gasifiers to produce the quantities of gas needed for recently developed large gas turbines. Thus gasification became of interest also for the power industry. During the 1990's, world gasification capacity grew by almost fifty percent.

In 1999 a World Gasification Survey was conducted to gather information on 160 commercial gasification plants in operation, under construction, or in planning and design stages in twenty-eight countries in North and South America, Europe, Asia, Africa and Australia. [4]

In conclusion, IGCC technology is expected to remain a realistic alternative to the technical development of conventional power stations.

The complexity and versatility of this type of plant and the loss experience during the recent years led to the need to investigate more in detail the technology and to reflect about the risks to insure construction and operation of IGCC plants.

2 Introduction

This paper describes the typical technologies applied for IGCC plants as well as special technical features of gasifiers for tar and coal. Furthermore the specially adapted technology of gas turbines necessary to work with syngas will be described below. The experience of Reinsurers with this type of plant and a summary of losses shall help to evaluate the insurance risks involved.

The following table lists some examples of IGCC plants:

Wabash River, USA, 1995	262 MWe	Destec gasifier for coal and pet-coke gas turbine GE 7001 FA
Tampa, Florida, USA, 1996 at Polk Power Station	250 MWe	Texaco gasifier for coal gasification gas turbine GE 7 FA
Buggenum, Netherlands, 1997	253 MWe	Shell coal gasification gas turbine Siemens V94.2
Shell Pernis, Netherlands, 1997	2 x 43 MWe	Shell Oil Gasification 2 gas turbines GE6B
Puertollano, Spain, 1998	320 MWe	Prenflo gasifier, gas turbine Siemens V94.3
API Energia, Italy, 2000	280 MWe	Texaco gasifiers gas turbine ABB 13E2
ISAB, Italy, 2000	512 MWe	Texaco gasifiers, asphalt gasification gas turbine Siemens V94.2
Motiva/Dalaware, USA, 2000	551 MWe	Texaco gasifiers 2 gas turbines GE 6FA
Sarlux, Italy, 2001	554 MWe	Texaco gasifiers, tar gasification gas turbine GE 9EC

There are also several new projects of IGCC plants which became known, a list of such projects is taken from the publication "Gas Turbine World - September/October 2001"

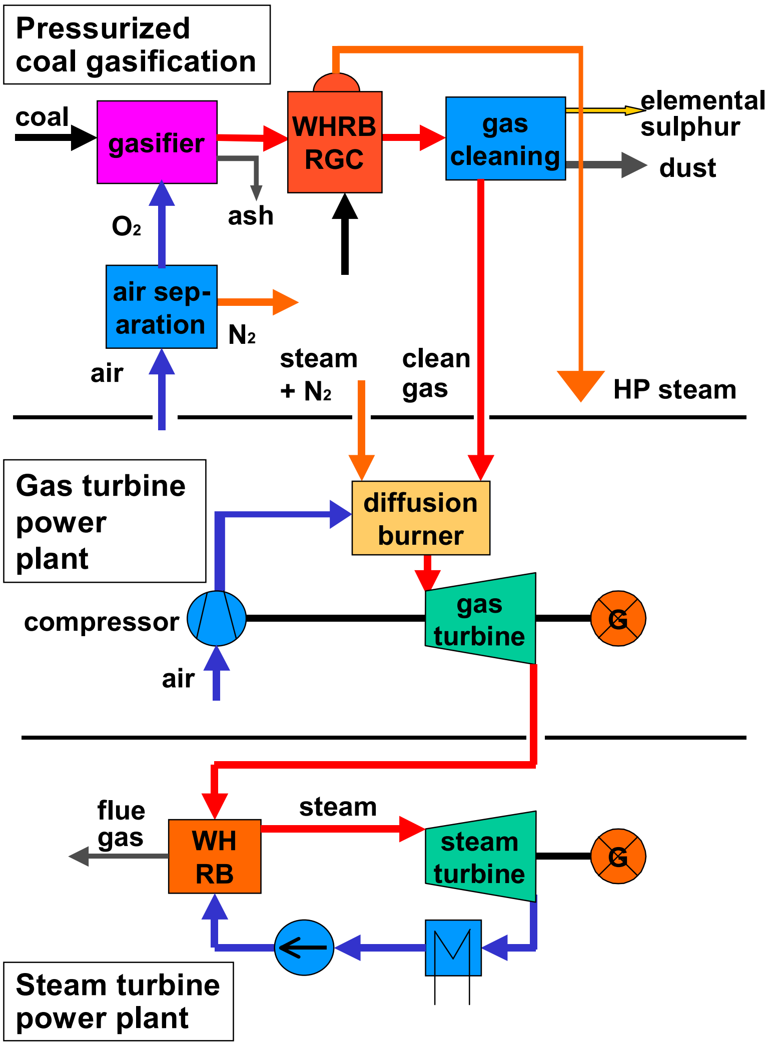
Citgo, USA	680 MW pet-coke project at Lake Charles refinery	partnership between Tampa Electric Company Power Services and Chevron Texaco Power & Gasification
Global Energy, USA Kentucky Pioneer project	540 MW plant in Kentucky	coal and refuse-derived fuel pellets
Global Energy, USA Liberty Commons Brownfield site	540 MW plant in Lima, Ohio	coal and refuse-derived fuel pellets
Sannazzaro, Italy	1000 MW IGCC for AGIP refinery,	Shell gasification for oil
Piemsa, Bilbao, Spain	800 MW IGCC adjacent to Petronor refinery	gasification of refinery heavy stocks

3 Technology of IGCC

Gasification is a very versatile process to convert a variety of carbon-containing feed stocks like coal, petroleum coke, lignite, oil distillates and residues into synthesis gas.

As large IGCC plants based on coal gasification already have gained operational experience since the last years and as the technology of tar gasification and coal gasification is quite similar we will describe in the following the coal gasification process more in detail.

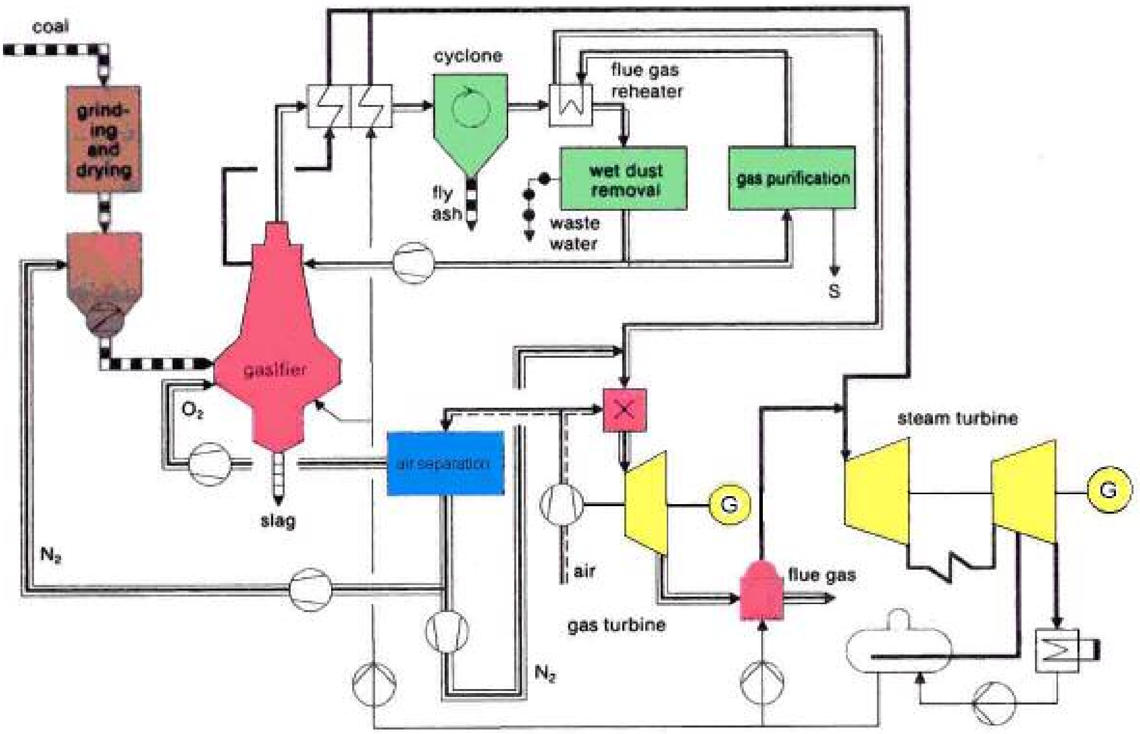
Figure 1 shows the set-up for an entire IGCC plant based on coal gasification. Coal is fed into the gasifier and burnt either with air or with pure oxygen coming from the air separation unit. Ashes are withdrawn from the gasifier and the raw gas is cleaned in the gas cleaning system where elemental sulphur and dust is removed from the gas. The clean gas obtained is used as fuel in the gas turbine which generates electrical energy. The hot gases leaving the gas turbine are generating steam in the waste heat recovery boiler which in turn is driving a conventional steam turbine to generate additional electrical energy.



Simplified flow sheet of IGCC Power Plant

The gas turbine, the steam turbine and the waste heat recovery steam boiler form a combined cycle power station and the gasifier, the air separation unit and the gas cleaning system together form the gas generation plant.

The flow sheet of the Prenflo IGCC power plant, as used for example in Puertollano, shows already how complicated the set-up of the IGCC plant can get and gives a hint about the interactions within the overall plant.

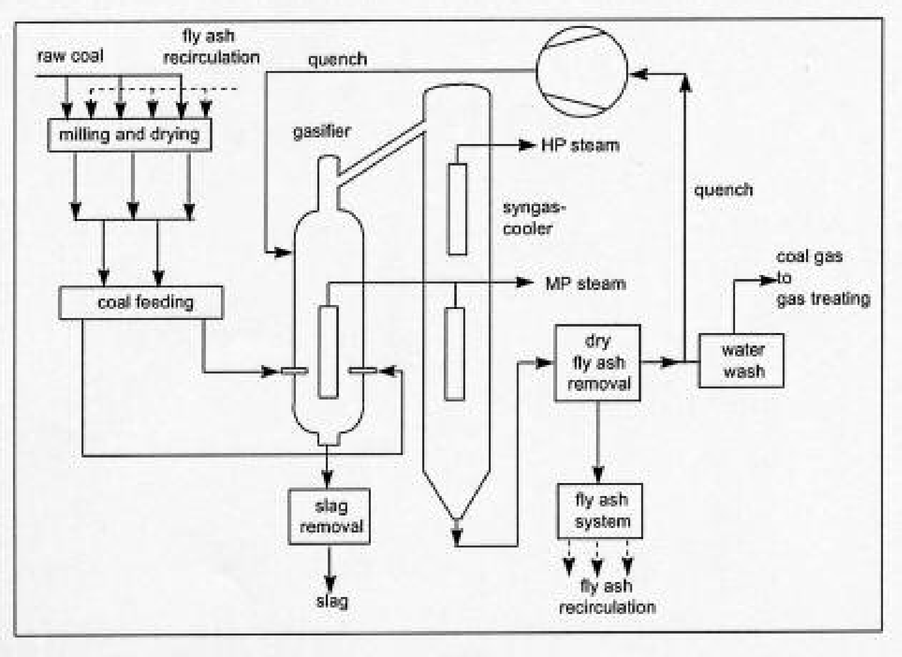


IGCC (PRENFLO) Power Plant

The first plant shown (figure 1) is comparatively straight forward but the set-up can be much more sophisticated (see figure 2) where the compressed air of the gas turbine is not only used for combustion of the gases in the combustion chamber of the gas turbine but also in the air separation unit which feeds the gasifier with oxygen.

3.1 Shell Coal Gasification Process (SCGP)

One of the main gasification processes used for gasification is the Shell Coal Gasification Process.



A typical line-up of an SCGP Gasification plant

Coal is the most abundant and widely distributed fossil fuel in the world (280 years availability proven reserve) but coal's future commercial development depends critically on its environmental acceptability and in particular on the success of the power generation industries in reducing the sulphurous and other pollution emission.
The SCGP process converts coal into clean syngas and produces high-pressure steam at the same time both are ideally suited for use in an IGCC plant.

The SCGP process offers following advantages:

- 43% thermal efficiency with the potential to approach 50% as gas technology is further developed.
- Usage of wide variety of coal types including high sulphur coal lignites and even petroleum coke. In addition the coal types can be switched easily.
- Optimum unit size from MW 1430 to MW 400 modular
- Environmental impact is low because 99% sulphur in coal will be recovered, 50% less water is required, no limestone is required, all of which helps to reduce the carbon dioxide emission of 10-25%.

Process Details:

The SCGP Process uses an oxygen-blown entrained flow, slagging gasifier incorporating a dry coal feed. The gasifier plant includes a slag removal system and gas cooler, together with an associated gas cleaning and sulphur removal plant, as well as water purification equipment.

The raw coal is pulverised and dried before being transported pneumatically in nitrogen to a storage vessel. Oxygen needed for gasification and any steam that may be needed are also routed to the gasifier. Nitrogen and oxygen are both produced in a conventional air separation plant.

The controlled combination of coal, oxygen and variable steam keeps the gasifier operating in the °C 1400 to °C 1700 range. The coal reacts with oxygen and steam to produce syngas, a mixture of carbon monoxide and hydrogen. The ash in the coal melts and runs down the refractory lined walls into a water tank where it is quenched and forms small glass-like beads. The mixture of beads and water is depressurised and exits. The hot gas produced in the gasifier is partially cooled by quenching with recycled clean cool gas. The partly cooled gas then enters a heat recovery steam generator to produce superheated steam, simultaneously cooling the gas still further. Small quantities of slag which contains the carbon (1% of original) that has not been converted to gas is separated from the gas stream, via a cyclone with fabric filters.

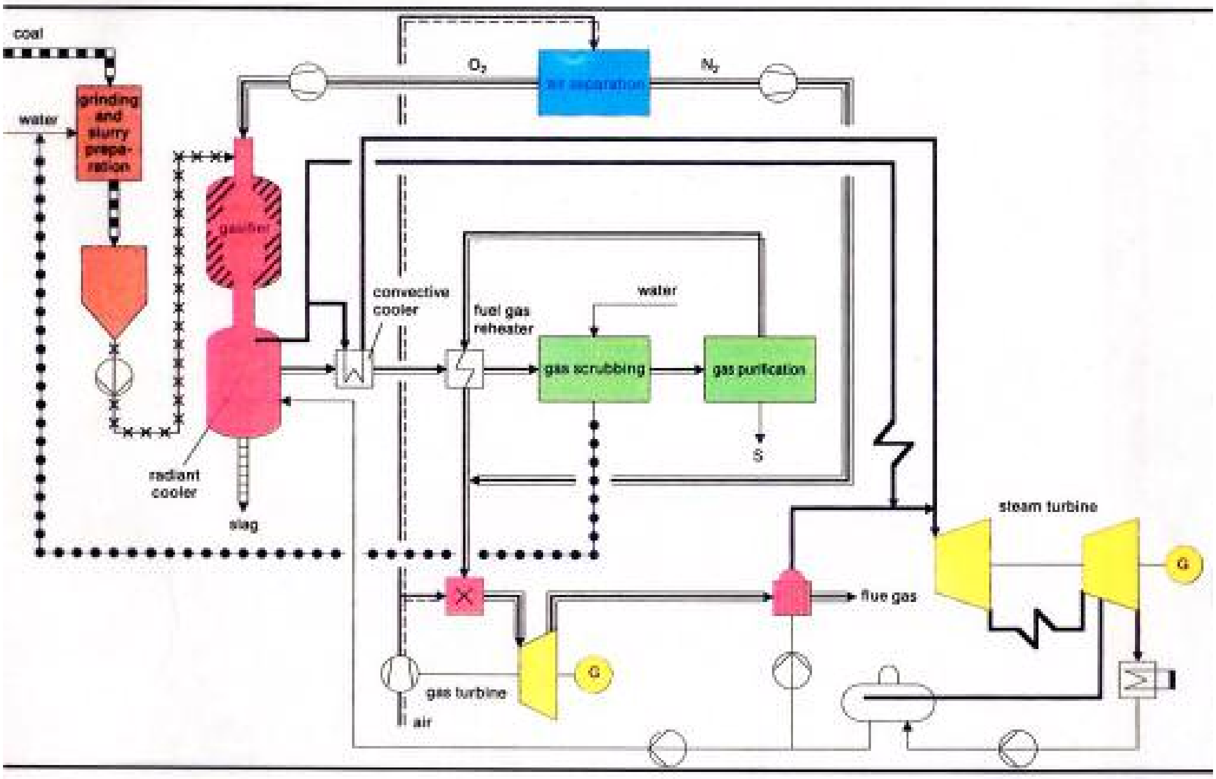
The gas leaving the gasifier contains 80-83% of the energy of the original coal, the superheated steam 16-18%. The gas stream leaving the gasifier is substantially free of particulate matter. Ammonia, hydrogen cyanide and chlorides are removed by scrubbing with water in a scrubber. About 95% of the sulphur is removed from the scrubber gas and converted into elementary sulphur in a Clauss Plant. Complete 99% removal of the sulphur can be achieved in an Offgas Treatment Plant.

Because of this low sulphur content in the gas burned in the gas turbine it is possible to recover the heat from the exhaust gas down to an exit temperature of 85°C without encountering acid dew problems.

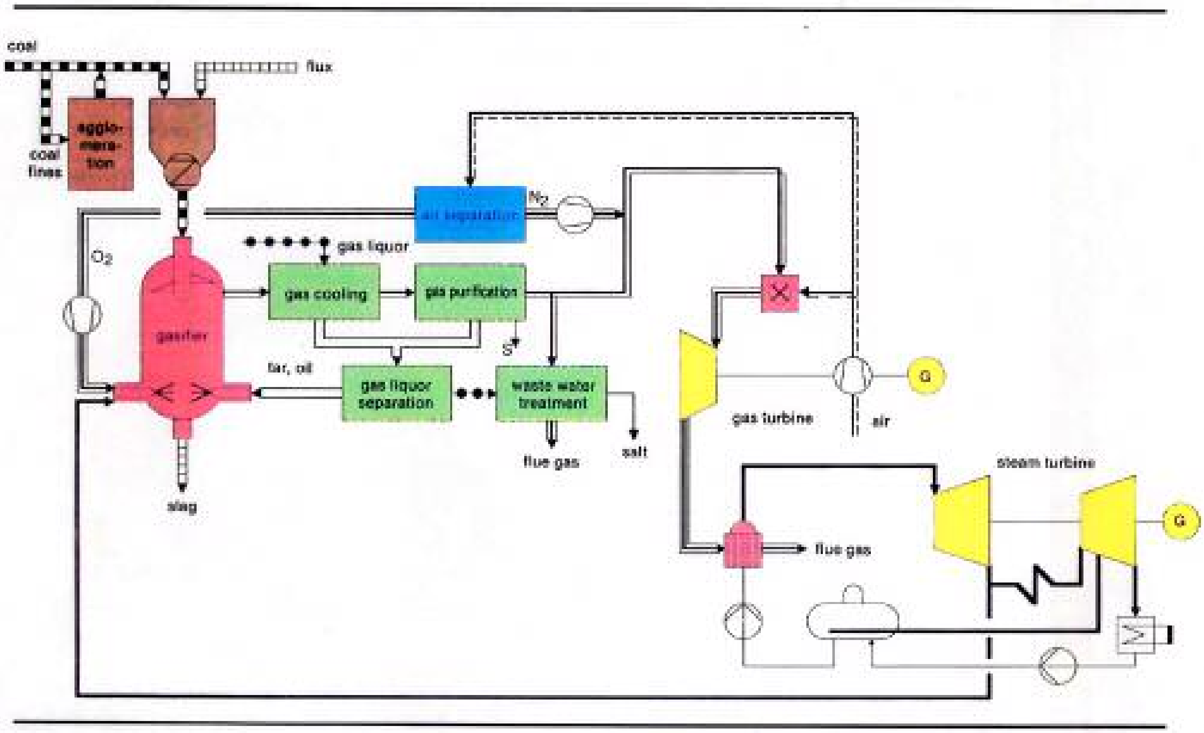
Particulate matter, insoluble compounds, undesired material in solution are removed in the water purification unit. All gas and water purification techniques used are well established.

This process can also be used for tar gasification with very minor changes in regard to the different feedstock. A technically very similar process is the Texaco gasification process used mainly for tar gasification.

Further examples are the Texaco IGCC Power Plant (figure 3) and the BGC/Lurgi IGCC Power Plant (figure 4) which show variations of integrated gasification combined cycle processes.



Flow sheet of IGCC (Texaco) Power Plant



Flow sheet of IGCC (BGC/Lurgi) Power Plant

Residual tar from the refinery as used in the Texaco process is of varying composition and requires a number of cleaning processes before it is useable. It ultimately dictates the configuration of the gasifier namely refractory and burner nozzles.

On its journey from the delivery point at the end of the refinery to the gasifier the product needs to be heated and kept in fluid condition at temperatures above 200 °C. Shut down and re-start up operations are difficult since intermediate products have to be used to „warm“ up the gasifier to produce a syngas that can be used in the gas turbines.

3.2 Gas turbine

The gas turbines which are applied in the highly integrated process of the IGCC have to fulfil different requirements compared to the standard gas turbines applied in a large number of industrial power stations.

The type of gas turbine used in IGCC plants is usually derived from a standard product developed for power plants in single cycle or combined cycle operation. As only a small number of gas turbines has so far been needed for IGCC applications the original equipment manufacturers just modified the relevant components to match the special criteria for IGCC application.

One of the major differences is the caloric value of the fuel: The gasification gas has a lower heating value. The range is from 1/8 (air blown gasification) up to one third (oxygen blown gasification) of the heating value of natural gas (Hu = MJ/m3). This must be dealt with by

a) a reduced compressor mass flow or
b) a larger throat area of the first stage turbine nozzles.

Option a) requires a compressor with partly closed guide vanes of the first 3 to 5 rows or a different (smaller) compressor.
Option b) results due to the higher turbine mass flow (more low caloric fuel is required to produce the same heat) in a higher power output. This could affect the whole turbine blading and many other items.

The modifications of the combustion system are handled in a separate chapter below. However it should be noted here that combustion pulsations can and did cause damage to combustors, turbine and compressor.

The compressor is, due to lack of experience, more exposed to stall and stall related damage.
Also the turbine blading may have to cope with higher mechanical loads. Depending on the cleanness of the fuel, also the exposure to corrosion and oxidation could be higher. Losses related to higher load or different chemistry have however not become evident yet.

To sum up, the applied gas turbines generally have major modifications compared to standard machines. Due to the comparably small number of applications the experience made is limited and therefore the loss exposure is not yet known well.

3.3 Combustion of Syngas in the gas turbine

Depending on the gasification process, the type of feedstock and the gas treatment, the syngas composition varies within a very wide range. Hydrogen varies from 7 to 65 %, CO from 15 to 50%, while inert gases such as N_2 and CO_2 vary from 1 to 30 % [6]. Therefore the combustion process of the gas turbine as well as the fuel flow within the gas turbine have to be analysed individually for each project.

The very high H_2 concentration of a typical syngas reduces the auto-ignition temperature and increases flame speed dramatically compared to natural gas. As a result reaction-kinetics, thermo-acoustics and heat-transfer will be totally different for IGCC gas turbine as it is for natural gas fired gas turbines. In principle the H_2 leads to increased production of thermal NO_x, higher material temperatures and modified flame stability. Burners and combustion chambers have to be modified accordingly to secure safe combustion within the guaranteed performance data. The NO_x production can in most cases be reduced easily by diluting the primary gas from the reactor with inert gases such as N_2 from the air separation and/or steam from the HRSG. Material temperatures can be maintained within the normal range by reduction of the firing temperature while flame stability is handled by modifications of the burner and operational concept, optimisations of fuel-air mixing or additional passive or active damping devices.

Since syngas with 4000 - 6000 KJ/kg has a very low heating value compared to natural gas (48000 kJ/kg), the fuel gas flow is approximately eight times higher for syngas as it is for natural gas using the identical gas turbine model. This makes flow path modifications of the supply lines and the gas injection and mixing areas unavoidable. Because of the propensity for hydrogen to migrate through the smallest possible openings special seals have to be fitted or seals have to be avoided by the introduction of welded instead of flange connections. Because of the H_2-content of the syngas, electrical devices used in the fuel gas and turbine compartments have to be classified higher, ventilation has to be increased and special purge cycles have to be incorporated into the starting and shut down sequence of the gas turbine [7].

To increase the availability of the power plant and, due to the relatively long time required to start up and stabilise the gasification process, in most cases, a secondary fuel is used for start-up and stop of the gas turbine and as a back up (diesel oil).

The technical solutions for syngas combustors of gas turbines are derived from existing standard burners. GE uses a multi nozzle combustor with integrated air extraction, a variation of their standard diffusion type combustor, while Siemens and Alstom modified their lean premix systems, the Hybrid- and the EV-burners to burn syngases. Both principles have their pros and cons, i.e. stability and fuel flexibility speak for the diffusion type of burners while the better NO_x -control give advantage to the lean premix principle.

The testing and operational risk of IGCC gas turbine combustion can easily be derived from the special physical, chemical and flame reaction properties of the syngas as described above. Typical problems are the overheating of burners and combustors due to pre-ignition and high cycle fatigue cracking of combustor, foreign object damage in the turbine or compressor incidents due to flame instabilities (pulsations). Up to now these prototype-problems could always be resolved. Nevertheless in several cases the time needed to do so, took very long (months or even years) and has led to high risk of damage and severe delays in the start-up of commercial operation. Reasons for that observation are the complexity of the combustion process in modern gas turbines, the individual character of each "single" IGCC power plant and the complex interaction with the fuel production plant. Before covering BI for an IGCC plant the individual character of the combustion process has to be properly assessed. Spare parts availability might be lower; respectively manufacturing lead times might be longer for a syngas combustion system than for the standard combustion system of a gas turbine.

4 Experience with IGCC plants, technical problems encountered and losses known to reinsurers

Below follows some information on the experience of typical IGCC plants, mostly resumed from literature available.

4.1 Coal gasification plants

Today there are more than 12 integrated gasification combined cycle plants in operation based on coal gasification. The largest one is operated in Puertollano/Spain. The efficiency is 45 % using standard coal. [1] Incorporating the most modern technical features in design and material would allow efficiencies of 51.5 % for a new plant according to a study "Advanced Cycle Technologies" [2]

4.1.1 IGCC at Puertollano, Spain - ELCOGAS

The Puertollano plant is a 317,7 MW IGCC plant in commercial operation as Natural Gas Combined Cycle (NGCC) since 1996 and as IGCC since 1998. The Puertollano IGCC plant uses the pressurized entrained flow gasification technology. The syngas obtained is cleaned and burnt as fuel in a combined cycle plant. The syngas is a result of the reaction between a mix of coal and petroleum coke with oxygen at high temperatures of up to 1600 °C. The oxygen required for the gasification process is produced in an integrated air separation unit, which also produces nitrogen for drying the pulverised coke, for fuel transportation and for the safety inertisation of the different circuits.

IGCC at Puertollano

The gasifiers are fed with 2600 t/d of pulverised coal and produce an output of 180.000 m3/h of raw gas, 230 t/h high pressure steam and 23 t/h medium pressure steam. The process is carried out at a pressure of 25 bar and at a temperature of 1200 -1600 °C in a cylindrical chamber of 5,6 m diameter. Most of the ash produced is removed from the bottom of the gasifier in liquid form. A small part is entrained by the gas (fly ash).

The gas turbine at Puertollano is a V94.3 Siemens model. This turbine has two external combustion chambers, which can burn natural gas or coal gas, individually maintaining high performance level in terms of rate, efficiency and pollution.

Before combustion takes place in the gas turbine, the clean coal gas is subjected to a process of water saturation in order to reduce nitrogen oxides (NOx) formation during combustion. The gas is subsequently heated to a temperature of 260 °C by water from the high pressure boiler and is finally mixed with residual nitrogen from the air separation unit. N_2 acts as an inert dilutant with the aim of reducing NOx formation further during combustion. As a result of these two operations (saturation and dilution), together with the use of low NOx burners, contamination levels of less than 60 mg/Nm3 (15 % O2) is obtained.

Until now the plant gained operational experience both on natural gas and on syngas. The variable production costs and efficiencies are shown below:

Fuel mode	Variable production cost $/MWh	Gross Efficiency	Net Efficiency
Natural Gas	39,50	54,0	52,4
Coal & Petcoke	12,50	47,2	42,0

Already the costs show that it is important to operate the plant with coal gas. Puertollano has gained lots of experience and improvements have been suggested by ELCOGAS S.A. We may cite the closing sentence of an article published by Elcogas S.A.: "The consideration of those improvements, together with the installation of a power island (combined cycle) of following to current level of power (400 to 500 MWe), would lead to competitive project costs. Obviously with the current environmental laws, because of the use of IGCC technology would be adequately economically supported by legal differentiation with other less clean technologies, it would be competitive in actual status of technology." [3]

In the beginning some technical problems within this plant have occurred at a 20 MW motor of the air separation plant and the gas turbine burners needed to be exchanged. Furthermore during a routine inspection metal pieces have been detected in the hot gas path of the turbine which have caused damage to the turbine blading. Furthermore we are aware of increased wear and tear of the gas turbine combustion chamber coating which requires increased maintenance.

According to our files the operation of the IGCC plant continues without major incidences. It occurred to us that the efficiency of the gas turbine is still an unsolved issue which until May 2002 hindered the plant from its final take over.

4.1.2 Tampa Electric Company; Polk Power Station, Florida

In the US, the US Department of Energy supported two demonstration plants, one in Tampa, Florida (Polk Power Station) and the other at Wabash River, Indiana. Good results have been experienced over the past two years. Both Polk and Wabash River have shown that with the right management team, the technology offers a very reliable way to generate power. This has been achieved in just four years. [5]

The Polk power IGCC plant went in operation in September 1996. The plant uses around 2.200 t/d of coal to be gasified in one gasifier of Texaco design, one GE frame 7 gas turbine and one steam turbine. The cogeneration process can also be operated on fuel oil in case syngas is not available.

Main difficulties within the 1st year of operation were reported from a gas/gas heat exchanger. Due to tube leaks the clean syngas was mixed with particulate laden raw syngas. This resulted in a 3 months outage of the gasifier and turbine damage due to ash deposits on the gas turbine blades. Ultimately, internal corrosion as well as plugging of tubes with raw gas particulates led to these tube leaks.

Further, syngas reactor outages were caused by an improper seal inside the syngas cooler as well by the need to replace the refractory liner inside the gasifier already after half a year.

4.1.3 Wabash River Coal Gasification Repowering Project

The Wabash River Project, located in Terre Haute, Indiana is an IGCC demonstration plant, owned and operated by Global Energy Inc. and PSI Energy - a part of Cinergy Group.

The plant is equipped with a Destec air separation unit, gasifier and one GE7FA gas turbine. The project was completed in July 1995 and went into commercial operation in September 1995. Overall availability reached 75 % in the second year.

We wish to mention briefly problems encountered during the first two years of operation:

- breakage of ceramic filters in particulate removal system
- poisoning of COS hydrolysis catalyst with chlorides
- cracks inside the combustion liner of the gas turbine, which was solved by a change of the combustion nozzles.

Recently the following highlights of 2001 have been published by Wabash River Energy Ltd: [9]

- Wabash is the cleanest coal coke fired power plant
- Syngas supply factor is 98.3 %
- Gasifier reliability is 99,5 %
- Multiyear availability above 80 %

4.1.4 IGCC at Buggenum, NL

The IGCC plant at Buggenum is owned by Demkolec and supported by the Dutch Government. This demonstration plant at Buggenum is the cleanest coal-based power plant in Europe. Its performance has been very good in the past two years. The teething troubles related more to the combustors on the Siemens turbines V94.2 of 156 MW than to the gasifier itself. [5]

The plant was run in "demonstration mode" for 1997 and went into commercial operation in 1998.

A ceramic filter fracture and problems with the slag fines handling caused an outage of 6 weeks in addition to a scheduled shutdown of 4 weeks in summer of 1997.

Gas turbine humming/vibration were solved by design changes in the burner. Nevertheless, a 75 % availability was achieved within the 1st year and the longest consecutive runs on syngas were 609 hours and 447 hours respectively.

4.2 Tar gasification plants

The three big IGCC plants with tar gasification in Italy are the first bigger plants which came into operation only recently. Time until now was too short to obtain sound operational experience. Below follows a report on difficulties encountered during their erection period.

Here we will inform about some technical problems encountered and report from several interesting losses which occurred at some plants which we reinsured during their erection periods.

4.2.1 ISAB, Italy

ISAB Energy is located in Priolo Gargallo (Siracusa) in Italy. The initial start-up of the IGCC plant was on 17.7.1999 and the Guarantee Test run was completed on 4.4.2000. The plant is now in full commercial operation. [8]

The ISAB plant is operating above the designed output even without a still problematic expansion turbine which was meant to benefit from the pressure drop at the point where the gas expands.

During its construction and subsequent testing period the plant suffered from 17.7.1996 to 18.4.2000 a total of 27 claims. Two of the major claims require substantial amounts to be paid under both Material Damage and Advanced Loss of Profit. One loss refers to the gasifier and another one to an expansion turbine.

A fire damage resulted after the refractory lining of one of two gasifiers failed due to continuous impingement by the burner flames from a wrongly designed nozzle. The lining collapsed starting at the top end. Heat and pressure load onto the now unprotected steel vessel weakened the top flange and lifted it, leading to external fire of the insulation, wiring and piping. Both refractories (the damaged and the undamaged one) were replaced with a different special lining and burner nozzles were repeatedly reshaped before successful re-commissioning.

An emergency shut down resulted in solidified asphalt in the piping on the way from the de-asphalting plant to the affected units.

The design of the lining in the nose brick area was not satisfactory and a check of the same area of the second gasifier revealed similar problems to the lining and a further fire loss was prevented on time. It may well be, that also technical problems of the burner contributed to the rapid damage to the lining as the burner was modified several times during commissioning. (It is not possible to calculate the correct form and length of the burner nozzle, during commissioning the best design has to be found by trial and error. In case of a burner nozzle being too long, damage is unavoidable, but hot spots may be localized by temperature sensors. These hot spots have been detected at ISAB and have been fought by cooling devices, which led to a more or less satisfactory solution).

Another fire loss occurred to the expander turbine. Condensate of the syngas entered the turbine and impurities of the condensate damaged the high temperature sealing and allowed leakage of syngas. High vibrations of the turbine, which runs at about 6000 rpm, may have contributed to the leakage with its subsequent fire damage.

4.2.2 Sarlux IGCC Project, Italy

The Sarlux IGCC Project is located in Sarroch near Cagliari on the Sardinia Island, Italy. The initial start-up of the IGCC plant was on 24.4.2000 and the reliability test run was completed on 28.3.2001. At the time of writing the plant is in full commercial operation. [8]

Almost at the end of the policy period an enormous concrete water reservoir, a part of the surrounding refinery and not part of the plant insured, collapsed and one of the walls fell on an existing pipe bridge which carried pipes and cables of the refinery and of the new gasification plant. The pipe bridge was widely damaged by the collapsing wall and by the water quantities which flooded the area. The pipe bridge carried also one syngas pipe which directs the gas to the flare during start up of the plant. Fortunately no leakage occurred to this pipe as a starting fire could have hit the entire refinery complex.

It was possible to shut down the IGCC plant in a controlled mode and a catastrophe was avoided. Reconstruction of the pipe bridge took several months, thus this damage caused a significant ALOP loss.

Loss adjustment became very complicated by the fact that insured and non-insured items were damaged. Additionally the Insured claimed costs for lengthy shut down and start up periods.

A further damage occurred in the soot separation system. A measuring device of the control and monitoring system failed and allowed a high concentration of soot into the equipment.

Other technical problems to this plant, which became known to reinsurers, are:

- cracks in spool pieces (feed pipes to the turbines), their probable cause was unsuitable material
- damage to membrane cartages of the gasifier (separation equipment to produce hydrogen from the crack gas of the gasifier), obviously faulty design
- cracks in gasifier burners ignition casings, obviously due to cooling problems / insufficient feeding with water steam

4.2.3 API Energia, Italy

API Energia is located in Falconara in Italy. Initial start-up was on 12.2.2000 and the guarantee test run was completed on 21.2.2001. At the time of writing the plant is in full commercial operation. [8] The acceptance date for PAC is 26.4.2001.

API had three series of losses which became known to Insurers, unfortunately with only little information until now.

There was for example a failure of compressor motor of the air separation unit and we know of a leakage to the cold box of the air separation unit.

We became aware of 120 loss events of which 17 losses were potentially relevant for ALOP losses. Amongst others of various damage was reported to

a heat exchanger,
a soot water tank,
a two inch oxygen vent valve and
a ten inch butterfly valve.

Failure of a series of valves which, due to unsatisfactory material, had to be exchanged was extremely time consuming. Although we consider this not as relevant for an insurance claim, the insured nevertheless claimed indemnity.

4.2.4 Dalaware City Repowering Project, Motiva

A catastrophic loss occurred in May 2000. The plant is designed to burn refinery by-products by pure oxygen at high pressure. During testing of the air separation unit (ASU) operators were starting to bring the system on line. They attempted to remotely activate a valve which would allow oxygen to the gasifier but the valve did not open because a smaller control valve was closed. One operator tried to operate the valve manually when an explosion occurred followed by a brief fire ball that appears to have originated in the immediate vicinity of the valve. Heat from the oxygen accelerated fire, caused considerable damage and actually melted the steel piping. One plant operator suffered second degree burns on 19 % of his skin.

Another event happened only within two months when the explosion had occurred.
During "first fire" test of the gasifier 1 pressurized oxygen from the air separation unit was supplied downstream to the gasifier. After 40 minutes the plant tripped due to a dramatic decrease of the water level. A partial meltdown to the refractory bricks had occurred. Cause of loss was the faulty calibration of the oxygen flow transmitters.

5 Risk Transfer

Both, erection and operation can be insured by standard policies and may be extended by either Advanced Loss of Profit (DSU) or by Business Interruption covers.

The scope of cover shall reflect the fact that IGCC plants feature characteristics of petrochemical plants as well as power plants. It is recommended to Underwriters to consider thoroughly the application of "hydrocarbon" endorsements and "catalyst" endorsements as well as the scope of manufacturers risk to be granted. The application of a "time schedule" endorsement is fundamental. Furthermore the near vicinity of existing plant and equipment needs to be studied in detail and the cover of surrounding property should be evaluated accordingly.

In case of DSU or BI covers being required the interaction with existing plants, the gasification and the power plant and installations needs to be analysed and rated accordingly and adequate sums insured have to be set and entered in the policy schedule.

A complex and expensive technology of IGCC plants is demanding the application of significant deductibles, for testing, specially if manufacturers risk is covered, and equally for operational cover. A proper time excess for any BI cover granted has to be applied.

Loss experience during erection of several insured IGCC plants has shown that a close monitoring of the erection is necessary as many events, insured or not, are relevant to significant delays. In case of such losses loss adjusters experienced in DSU have to be contracted to allow efficient and proper loss handling.

6 Conclusion for the underwriting of IGCC plants

When several years ago IGCC plants needed to be insured for their erection, underwriters interest focussed on the gas turbines and on the gasifiers and due to the scaling up of dimensions and technological modifications of the gasifiers and gas turbines the overall process often was considered as prototypical. Now, after having accompanied the erection all risk covers and some operational covers of IGCC plants it is interesting to note that most of the plants had losses and significant delays in erection relevant for ALOP covers, which were less related to the special technology but more to a great variety of general defects in design, material or manufacture or workmanship quality, i.e. losses of plant and machinery which could happen in any other project of special lay-out. Many of the losses occurred to components which constitute as such not unproven technology.

An important fact is that IGCC plants are complex and integrated industrial plants with a high risk exposure. They are designed individually to process a certain fuel which is often "dirty" and difficult to treat. Technology is advancing quickly to obtain higher efficiencies and a higher output. Furthermore the investment costs still have to be reduced to allow these types of plants to be competitive with conventional thermal or CC power stations. All these factors are calling for cautious and appropriate underwriting to all sections of covers requested. Special focus has to be drawn on Loss of profits insurance and the necessity of a high quality of claims handling for this demanding cover.

Furthermore underwriters have to consider that IGCC plants may be installed on a narrow space within existing refineries and interferences with the surrounding property have to be considered both for material damage and for possible maximum loss evaluations. Third party liability exposure also is an essential issue for underwriting these risks.

Experience has shown that most of these plants have had to cope with a wide variety of complex technical problems involving considerable delays to plant completion.

As only recently the big tar gasification plants have been completed not much can be said regarding their operational experience which might become relevant for underwriting in future. The behaviour of these plants has to be observed closely and a careful approach is recommended to Insurers.

7 References

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