Commercial Operation
of the Puertollano IGCC Plant

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Introduction

The IGCC power plant in Puertollano / Spain has reached reasonable operating hours.

The paper describes the status of the plant including the last two years of successful operation.

The PRENFLO gasification process was selected by ELCOGAS for gasifying the main fuel, a mixture of raw coal and petroleum coke. Various mixtures of raw coal and petroleum coke were gasified in 2000.

With a capacity of 300 MWe (net) the IGCC plant in Puertollano (Figure 1) is the largest unit world-wide based on solid fuels.

Figure 1 : The IGCC plant in Puertollano/Spain

The IGCC plant

Figure 2 shows the Block diagram of the IGCC plant (highly integrated combined cycle system) consisting of the main sections :

air separation, gas island and power block.

The gas island includes the following plant units :

- coal preparation
- PRENFLO gasification
- desulphurisation
- Claus unit.

The raw fuel consisting of 50% raw coal and 50% petroleum coke is first mixed and then milled and dried in the coal preparation unit.

Figure 3 shows the Flow diagram of the PRENFLO process. The produced fuel dust is gasified together with oxygen (purity 85 vol.%) in the PRENFLO gasification unit at a pressure of approx. 25 bar. PRENFLO is an entrained-flow gasification system with dry fuel dust feeding. This system is able to gasify a wide variety of solid fuels (hard coal, lignite, anthracite, refinery residues, etc.).

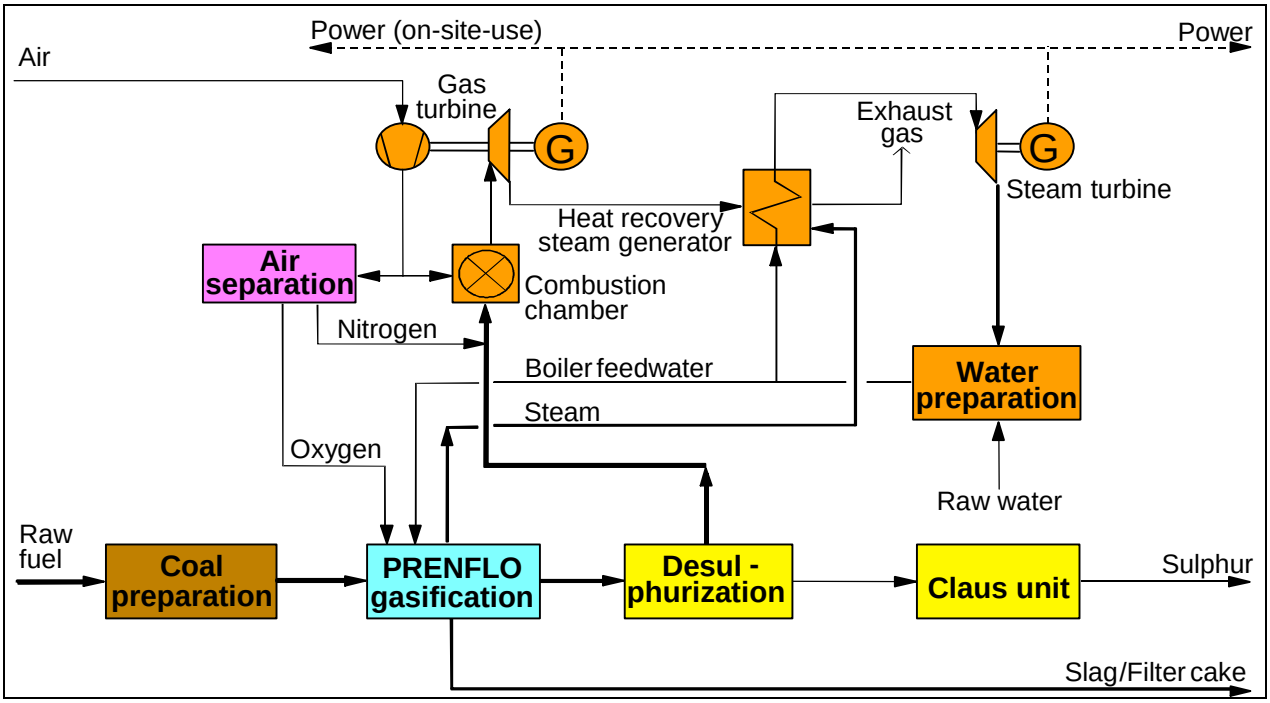

Figure 2 : Block diagram of IGCC plant

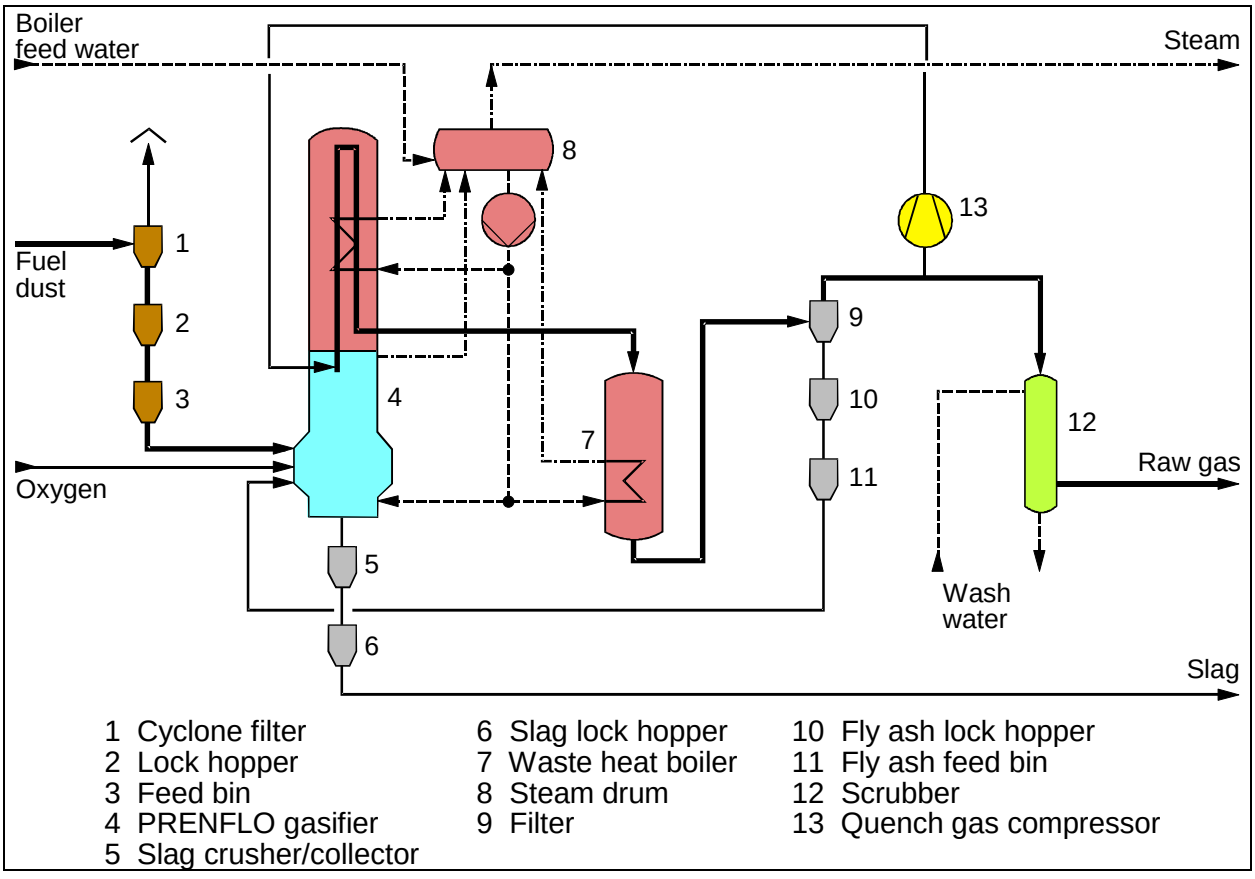

Figure 3 : Flow diagram of PRENFLO process

High-pressure steam and medium-pressure steam is generated in the waste heat boiler system and in the PRENFLO gasifier.

In the desulphurisation unit (MDEA process) the raw gas from the gasification is cleaned and preheated. After saturation the clean gas is sent to the Siemens V 94.3 gas turbine, Figure 4, with dual sources (natural gas and synthetic gas).

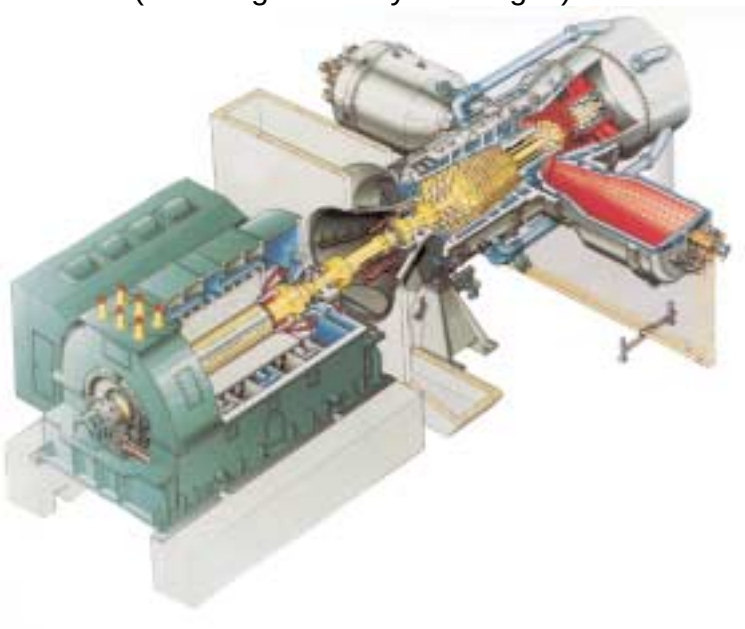

Figure 4 : Siemens V 94.3 gas turbine

The Claus gas (H_2S-fraction) from the desulphurisation unit is treated in the Claus unit. The produced liquid elemental sulphur is finally available in solid form.

The IGCC plant is fully automated and operated from the central control room. A large screen (approx. 7x1.8 m), Figure 5, can be divided in 12 smaller screens and is able to show simplified P&I diagrams, operating values and trends, statistical values or e.g. the picture of burner flames in the combustion chambers of the gas turbine.

Figure 5 : Control room

Results

The main events as well as the gas production hours are included in Table 1. Up to the end of 2002 more than 11,400 gas production hours could be collected.

19.12.1997	First coal gas production
19.03.1998	First coal gas to gas turbine
13.11.1998	Power generation with coal gas : 311 MWe at approx. 92% load
20.12.1998	48 h-run of PRENFLO gasification
1998	**426** hours gas production
30.07.1999	First 100 h-run of PRENFLO gasification
1999	**1,827** hours gas production, longest run = 244 h
12.01.2000	**Power generation =331 MWe; gas turbine =198 MWe**
2000	**3,771** hours gas production; longest run = 688 h; longest run gas turbine = 327 h
2001	**5,408** hours gas production; longest run = 561 h; longest run gas turbine = 514 h

Table 1 : Main events and gas production hours

In 2000 different mixtures of raw coal and petroleum coke were gasified with raw coal in the range of 39-58 wt % and petroleum coke in the range of 42-61 wt %, accordingly. The range of the produced fuel dust is included in Table 2.

C	wt %	60.66 -68.8
H	wt %	3.15 - 3.68
N	wt %	1.27 - 1.52
O	wt %	1.89 - 3.68
S	wt %	3.0 - 3.82
Ash	wt %	20.67 -28.21
HHV	**MJ/kg(mf)**	**23.61- 26.89**

Table 2 : Fuel dust data

Highest carbon conversion was achieved with the highest raw coal portion in the mixture, while highest cold gas efficiency is obtained with the highest petroleum coke portion.

The main gas components in the clean gas were in the range of :

CO	60.36 -62.06 vol % (mf)
H_2	19.80 -21.17 vol % (mf)
CO_2	1.43 - 3.05 vol % (mf)

The anticipated slag/ash split based on the results from the PRENFLO demonstration plant in Fürstenhausen could be clearly shown during the test period. With increasing ash content in the fuel, slag production is over-proportional higher.

A more detailed summary of gas production hours for the years 1999-2001 is given in Figure 6.

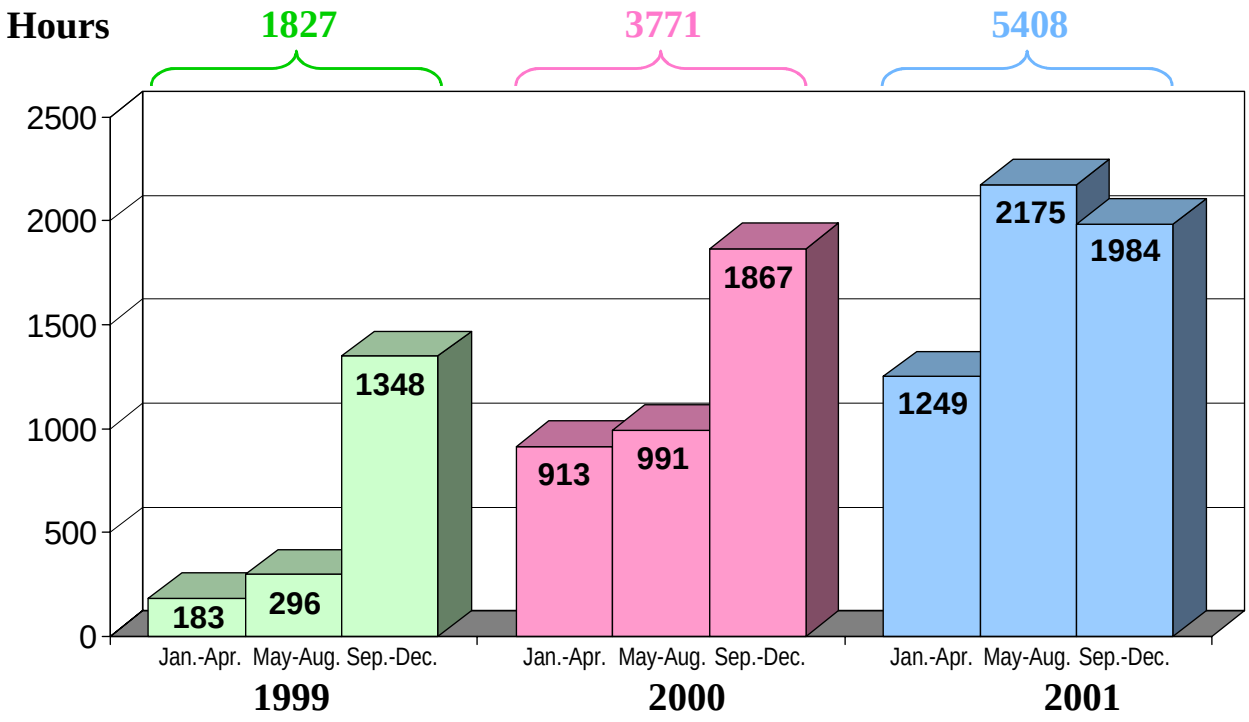

Figure 6 : Gas production hours

In addition to the variation of coal/coke mixtures also MBM (Meat and Bone Meal), a risk material, was gasified together with the mixture. It could be demonstrated that entrained-flow gasification can use this material as fuel without any environmental impact and without increasing emissions. Table 3 shows a brief summary of the main parameters and the results of the MBM tests.

Figure 7 includes power generation data for the generation from natural gas and the coal/coke mixture. Figure 8 includes the data for the IGCC plant only.

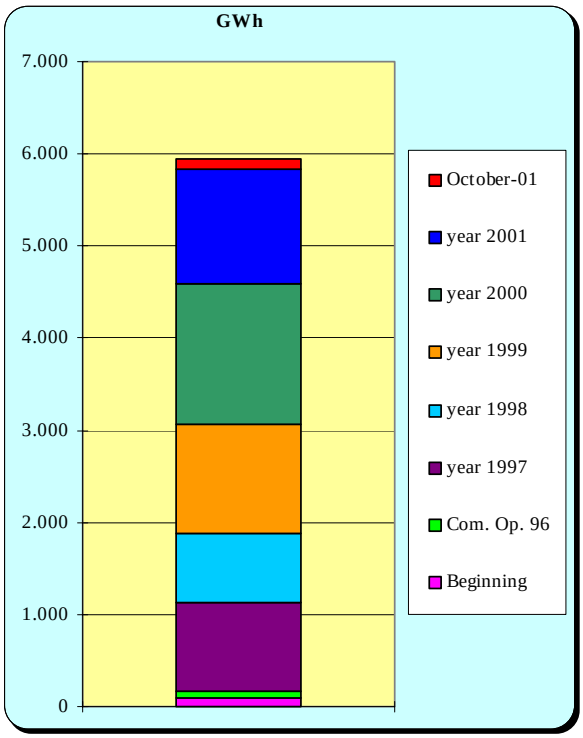

Figure 7 : Total gross generation

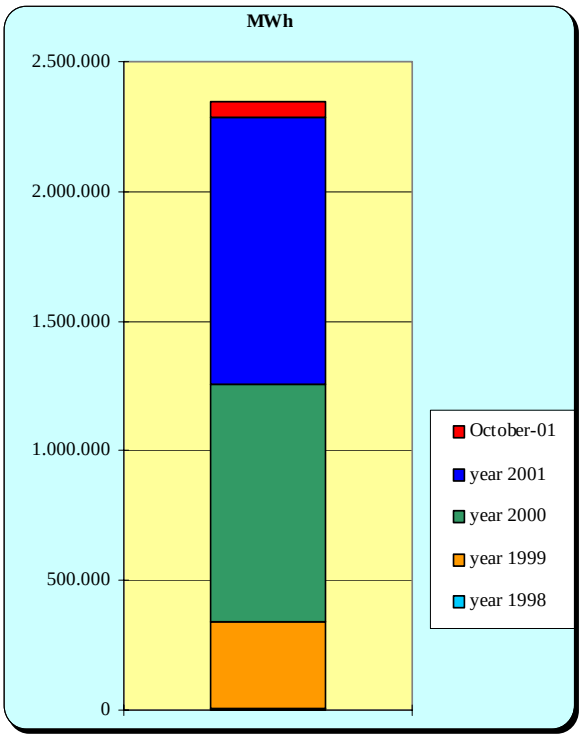

Figure 8 : Gross generation as IGCC

MBM (Meat and Bone Meal) Cogasification in Elcogas IGCC Plant

Tests characterisation

MBM types

- SRM (Specific Risk Material), composed of spinal marrow, bones, intestines, spleen or brain.
- HRM (High Risk Material), obtained from the rest of the animal parts that are not included in the SRM.
- BS (Blood Stuff), composed exclusively of dried animal blood.

Two tests were carried out: 1% (20/03/01 4:00 - 13:00), and 4.5% (4/04/01 11:00 - 16:00). 93.3 tons were used.

MBM was introduced in the gasification process as a mixture with limestone

	Raw material			Fuel mixture		
Parameter	**HRM**	**BS**	**SRM**	**1% test**	**4.5% test**	**Regular fuel**
Weight loss at 100ºC (%)	5.03	14.96	2.54			
HHV (kJ/kg)	18,918	23,265	20,089	25,284	25,096	24,921
Volatile (%)	63.7	93.82	65.27	17.98	19.2	17.5
Ash (%)	25.54	1.45	26.13	24.1	24.7	24.4
Cl (mg/kg)	2,560	6,500	3,420	390	460	420
CaCO3	-	-	-	3.1	2.8	2.6

Conclusions

- ✓ Technical viability of MBM co-gasification has been demonstrated
- ✓ There are no differences in the behaviour of fuel preparation and sluicing systems.
- ✓ In the gasifier, there is no effect in the 1% test. In the 4.5% test, there is an appreciable drop in the fouling values, which is coincident with a limestone reduction.
- ✓ In the wet scrubber system, only in the 4.5% test, a progressive increase in chlorate compounds is observed.
- ✓ There is also no effect on slag discharge system. The expected behaviour of MBM as fusion agent (due to its high Ca composition) was not observed.
- ✓ There are no changes in hazardous emissions.

Table 3 : Data of MBM tests

The environmental friendly generation of electric power in the Puertollano plant could be shown during the last years. Table 4 includes a comparison of emission data (SO_2,NO_x and dust) in the flue gas including the official emission limits of the European Union, data from modern conventional power plants and data from Puertollano.

	SO_2	**NO_x**	**Particles**
	mg/m^{3}n based on 6 vol % oxygen in flue gas		
EU emission levels (old)	400	650	50
EU emission levels (future) for conventional power plants	200	200	30
Puertollano IGCC (design)	25	150	7.5
Puertollano IGCC (actual)	< 20	< 100	< 2

Table 4 : Emission data from power plants

Outlook

Most problems of the last years could be solved and the ELCOGAS IGCC plant has now reached commercial status.

The following years will show more than 6,000/6,500 operating hours.

With the addition of risk-, waste- or biomass-materials to the normal fuel (raw coal/petroleum coke) the power generation costs can be reduced. These materials have no negative impact to the environment.