

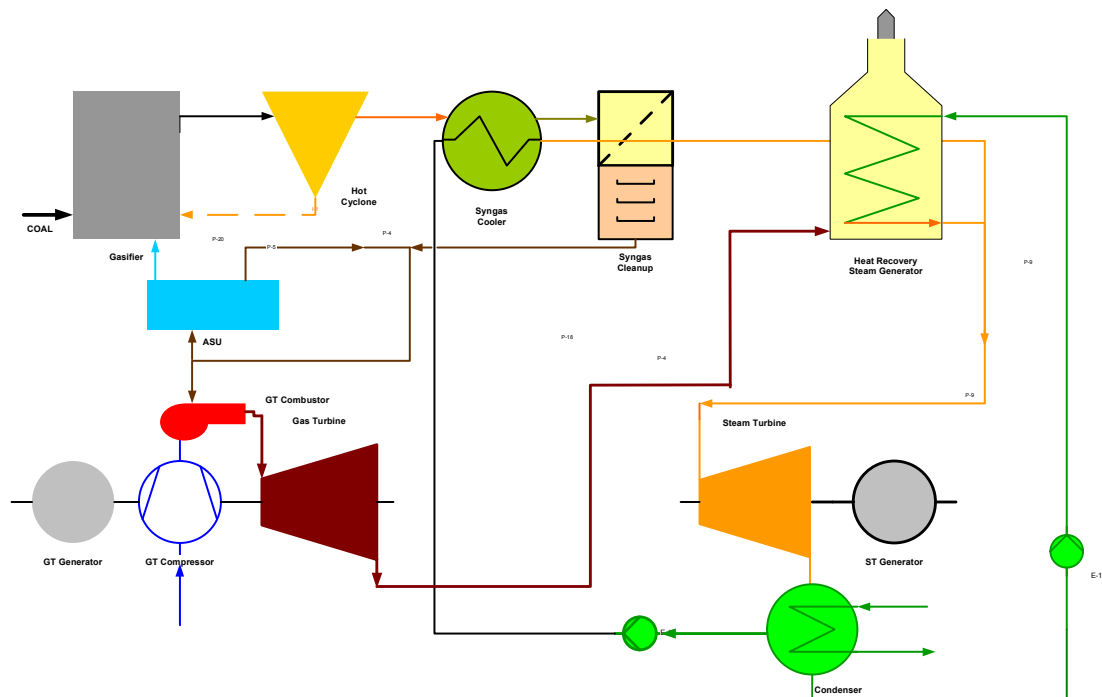
EFFICIENT & CLEAN COAL BASED POWER GENERATION

A range of advanced technologies has been developed and continues to be enhanced to make further reductions in the emissions of pollutants and to improve coal-fired power plant efficiencies.

- ✚ INTEGRATED GASIFICATION COMBINED CYCLE (IGCC)
- ✚ SUPERCRITICAL & ULTRA-SUPERCRITICAL CYCLE (SCC & USCC)
- ✚ FLUIDIZED BED COMBUSTION (FBC)
- ✚ PRESSURIZED PULVERIZED COAL COMBUSTION (PPCC)

INTEGRATED GASIFICATION COMBINED CYCLE

In this system coal is not burnt directly, but is reacted with oxygen and steam to form a 'syngas' composed mainly of hydrogen and carbon monoxide, which is cleaned and then burned in a gas turbine (GT) to generate electricity, the waste heat energy from GT is utilized in heat recovery steam generator (HRSG) for steam production. High pressure, high temperature steam drives a steam turbine which also produce electricity.



SIMPLIFIED IGCC FLOW DIAGRAM

IGCC offers efficiencies up to 50%, with the prospect of 56% in the future – and so significantly improves the environmental performance of coal.

IGCC technology may be the way towards an ultra-low emissions future, if combined with carbon capture and storage, and as part of a future hydrogen economy.

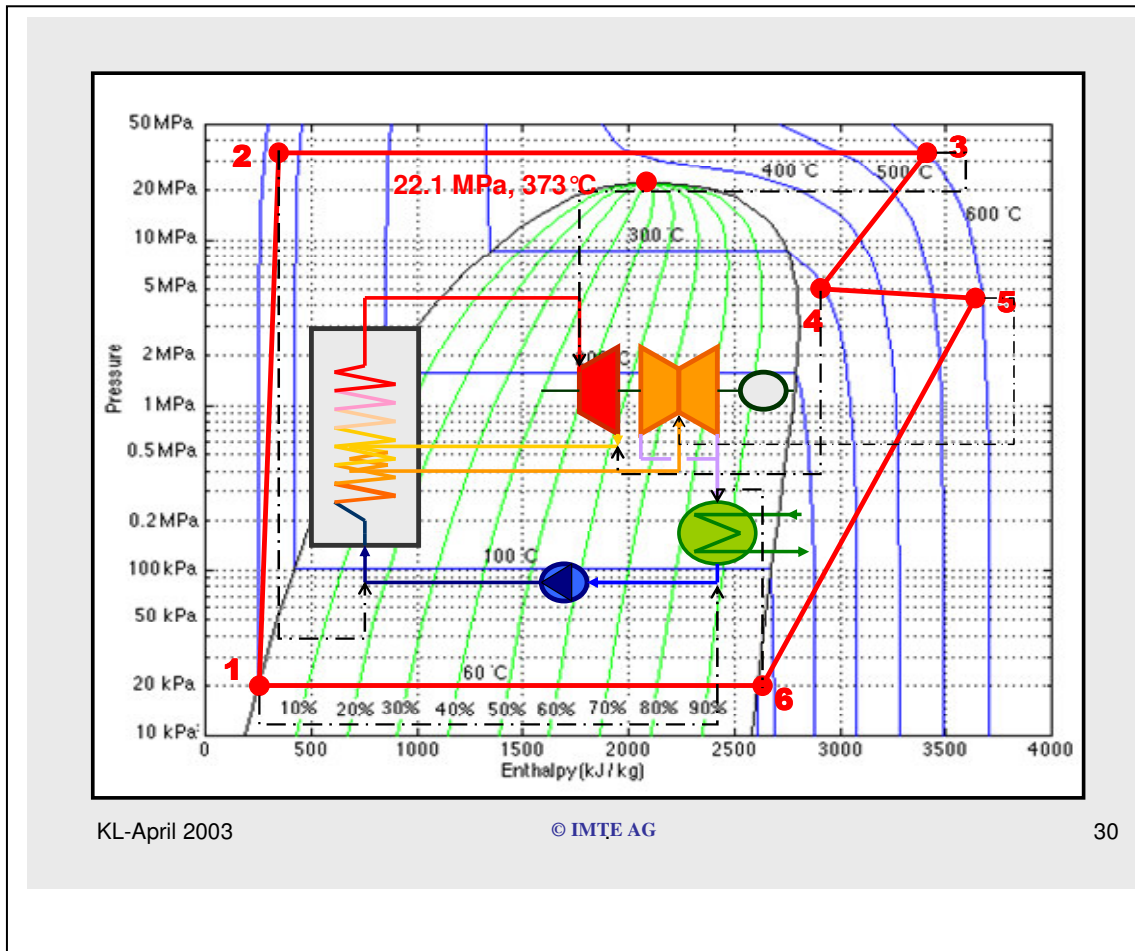
Further development to improve reliability and reduce the price is ongoing.

SUPERCRITICAL & ULTRA-SUPERCRITICAL

SC & USC power plants operate at higher temperatures and pressures (above the critical point of water; >22.1 MPa, 373°C) than conventional power plants, resulting in higher specific power output and efficiencies – and thus lower emissions, including CO₂.

More than 400 SC & USC power plants are in operation worldwide and for example China is now installing SC power plants as standard.

Supercritical is a thermodynamic expression describing the state of a substance where there is no clear distinction between the liquid and the gaseous phase.



SC & USC CYCLE

The cycle medium is a single phase fluid with homogeneous properties and there is no need to separate steam from water.

Once-through boilers are therefore used in supercritical cycles. Supercritical plant offer higher efficiencies than conventional, sub-critical plant.

USC power plants operate at advanced temperatures and pressures (>27.0 MPa, 600°C) and have the potential to offer efficiencies of over 50%.

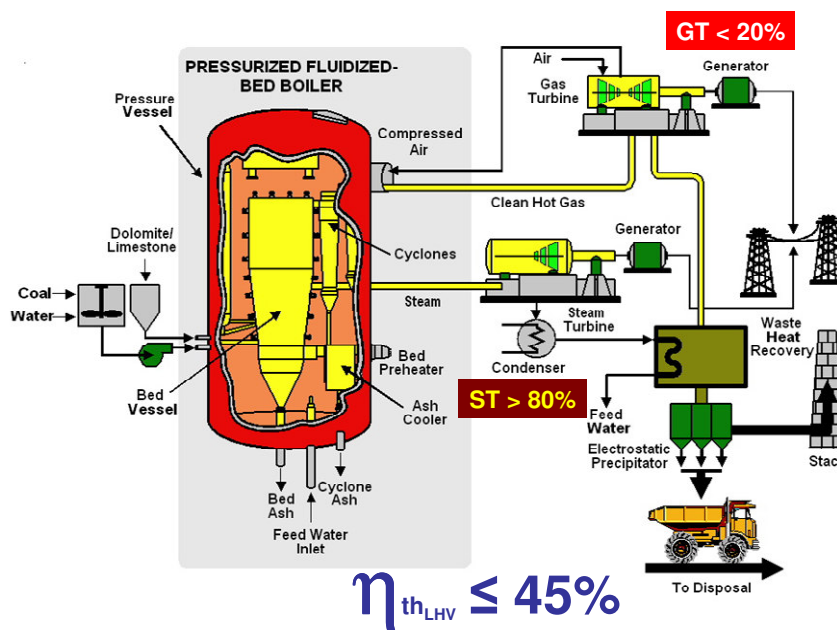
FLUIDIZED BED COMBUSTION

FBC can reduce SOx and NOx by 90% or more. FBC is very flexible fuel utilization technology capable to burn, environmentally friendly, almost any combustible material.

In the USA for example, FBC systems are increasingly used for abandoned coal waste, utilizing low grade coal for power generation.

In FBC, coal is burned in a reactor comprised of a bed through which gas is fed to keep the fuel in a turbulent state. This improves combustion, heat transfer and recovery of waste products.

The higher heat exchanger efficiencies and better mixing of FBC systems allows them to operate at lower firing temperatures than conventional (pulverized) coal-burning systems.



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PFBC

By elevating pressures within a combustion bed, a high-pressure gas can be used to drive a gas turbine-generator.

Fluidized bed combustion technologies includes:-

- Atmospheric Pressure Fluidized Bed Combustion (APFBC) in bubbling (BFBC) or circulating (CFBC) beds.
- Pressurized Fluidized Bed Combustion (PFBC).
- Pressurized Circulating Fluidized Bed Combustion (PCFBC).

CFBC technology, which has been most widely applied, has the most extensive operating history.

CFBC uses the same thermodynamic cycle as PCC and therefore its power generation efficiency is in the same range, which is normally between 38% and 40%.

PFBC is based on the combustion of coal under pressure in a deep bubbling fluidized bed at 850 °C.

BFBC is a lower velocity and CFBC is a higher velocity system.

PRESSURIZED PULVERIZED COAL COMBUSTION

Pressurized pulverized combustion of coal (PPCC) is a technology currently under development, mainly in Germany.

Similar to conventional pulverized coal combustion, in that it is based on the combustion of a finely ground cloud of coal particles, the heat released from combustion generates high pressure, high temperature steam, which is used in steam turbine-generators to produce electricity.

The pressurized flue gases exit the boiler and are expanded through a gas turbine to generate further electricity; hence this is a form of combined cycle power generation.