SUPERCRITICAL COAL FIRED POWER PLANT

Introduction – Energy, in general, and electricity in particular, plays a vital role in improving the standard of life everywhere. World has abundant proven reserves of coal and thus coal-based thermal power plants dominate almost everywhere. The development of coal fired supercritical power plant technology can be described as an evolutionary advancement towards greater power output per unit and higher efficiency. Energy conversion efficiency of steam turbine cycle can be improved by increasing the main steam pressure and temperature.

As name suggests, coal-fired supercritical power plants operate at very high temperature and pressure (580 degree centigrade temp. with a pressure of 23 MPa) resulting much higher heat efficiencies (46%), as compare to sub-critical coal-fired plants which operates at 455 degree centigrade temp., and efficiency of within 40%. Some of the benefits of advanced supercritical power plants include:

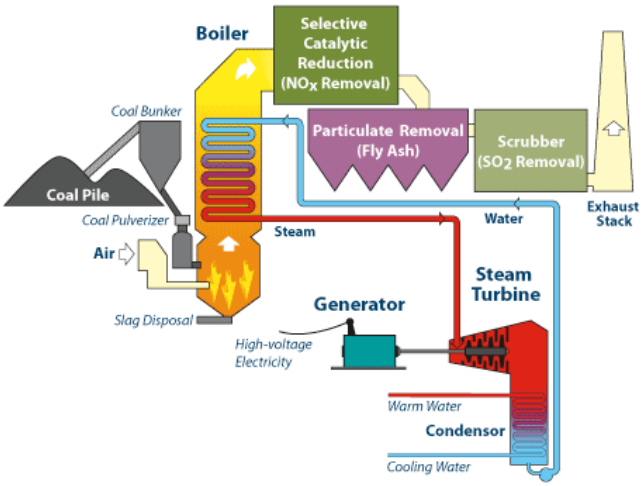
(a) Reduced fuel costs due to improved plant efficiency;

(b) Significant improvement of environment by reduction in CO2 emissions;

(c) Plant costs comparable with sub-critical technology and less than other clean coal technologies;

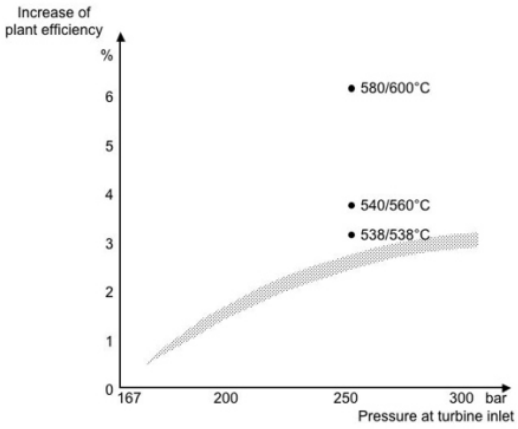
(d) Much reduced NOx, SOx and particulate emissions;

(e) Can be fully integrated with appropriate CO2 capture technology.



Supercritical technology and its advantages - In other words, supercritical power plants are highly efficient plants with best available pollution control technology, reduces existing pollution levels by burning less coal per megawatt-hour produced, capturing the vast majority of the pollutants. This increases the kWh produced per kg of coal burned, with fewer emissions.

Because of the above techno-economic benefits along with its environment-friendly cleaner technology; more and new power plants are coming-up with this state-of-the-art technology. As environment legislations are becoming more stringent, adopting this cleaner technology have benefited immensely in all respect. As LHV (lower heating value) is improved (from 40% to more than 45%); a one percent increase in efficiency reduces by two percent, specific emissions such as CO2, NOx, SOx and particulate matters.



"Supercritical" is a thermodynamic expression describing the state of a substance where there is no clear distinction between the liquid and the gaseous phase (i.e. they are a homogenous fluid). Water reaches this state at a pressure above 22.1 MPa. The efficiency of the thermodynamic process of a coal-

fired power describes how much of the energy that is fed into the cycle is converted into electrical energy. The greater the output of electrical energy for a given amount of energy input, the higher the efficiency. If the energy input to the cycle is kept constant, the output can be increased by selecting elevated pressures and temperatures for the water-steam cycle.

Increased thermal efficiency observed when the temperature and pressure of the steam is increased. By raising the temperature from 580 °C to 760 °C and the pressure out of the high pressure feed-water pump from 33 MPa to 42 MPa, the thermal efficiency improves by about 4% (Ultra-supercritical steam condition).

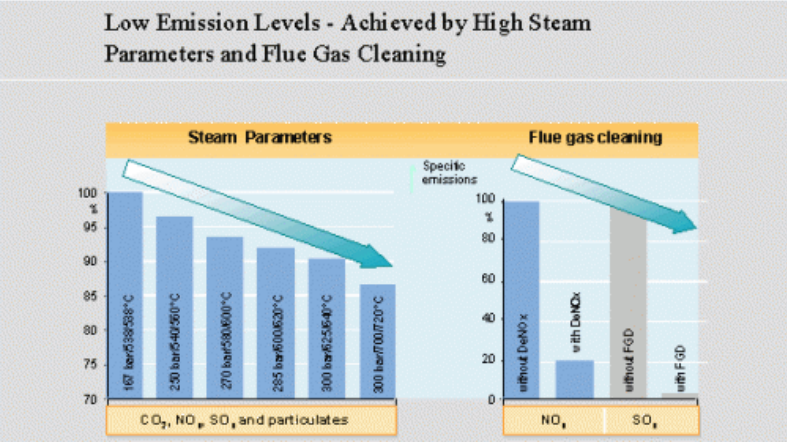
Moreover, there are various operational advantages in case of supercritical power plant. There are several turbine designs available for use in supercritical power plants. These designs need not fundamentally differ from designs used in sub-critical power plants. However, due to the fact that the steam pressure and temperature are more elevated in supercritical plants, the wall-thickness and the materials selected for the high-pressure turbine section need reconsideration. The supercritical plant needs 'once-through' boiler, where as 'drum' type boiler is required by sub-critical power plant. In fact, once-through boilers are better suited to frequent load variations than drum type boilers, since the drum is a component with a high wall thickness, requiring controlled heating.

The performance of supercritical plant depends on steam condition. Steam conditions up to 30 MPa/600°C/620°C are achieved using steels with 12 % chromium content. Up to 31.5 MPa/620°C/620°C is achieved using Austenite, which is a proven, but expensive, material. Nickel-based alloys, would permit 35 MPa/700°C/720°C, yielding efficiencies up to 48%. Lot R&D inputs and allying with suppliers are required to achieve higher performance.

Moreover, fuel flexibility is not compromised in Once-Through Boilers. A wide variety of fuels have already been implemented for once-through boilers. All types of coal as well as oil and gas have been used.

Conclusion – Thus, new pulverised coal combustion systems – utilising supercritical and ultra-supercritical technology – operate at increasingly higher temperatures and pressures and therefore achieve higher efficiencies than conventional sub-critical units with significant CO2 reductions. The objective of power plants within toady's market boundaries is more than ever to ensure high efficiency (to reduce the environmental impact as much as possible) while at the same time to increase their economics in competition to existing alternatives. The development of an economical and efficient concept needs to look at the steam turbine all other main components like boiler, flue gas cleaning equipment and the optimization of the water-steam-cycle as main parts for the optimization.

Current designs of supercritical plants have installation costs that are only 2% higher than those of sub-critical plants. Fuel costs are considerably lower due to the increased efficiency and operating costs are at the same level as sub-critical plants. Specific installation cost i.e. the cost per megawatt (MW) decreases with increased plant size. This plant concept fulfils the requirement to balance reliable power supply, sustainable use of existing resources and economic operation.



Today, supercritical steam turbine cycle is the leading "clean coal" technology in widespread application. Supercritical steam cycle technology has been used for decades and is becoming the system of choice for new commercial coal-fired plants in many countries. Because of the high performance, efficiency and preservation of much cleaner environments than sub-critical coal-fired power plants, more than 500 supercritical coal-fired power plants are operating in the developed countries like US, Europe, Russia and in Japan. Most of the new power plants coming up now-a-days are of supercritical coal-fired technology. Recent plant built in Europe and Asia use supercritical boiler-turbine technology and China has made this standard on all new plant 600MW and upwards.

In fact, Supercritical steam cycles are not just applicable to coal-fired plant; oil- and gas-fired plants are also well proven. Research and development is under way for ultra-supercritical units operating at even higher efficiencies, potentially up to around 50%. The introduction of ultra-supercritical technology has been driven over recent years in countries such as Denmark, Germany and Japan, in order to achieve improved plant efficiencies and reduce fuel costs. Research is focusing on the development of new steels for boiler tubes and on high alloy steels that minimise corrosion.

Source : http://saferenvironment.wordpress.com/2008/12/29/%E2%80%98supercritical-coal-fired-power-plant%E2%80%99-necessary-to-promote-advanced-technology-in-power-generation-for-achieving-better-efficiency-cleaner-and-safer-environment/