

Post Combustion Carbon Capture & Sequestration Plant – A Feasibility Study towards Reduction of Energy Penalty in Regeneration of Solvent

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Abstract

India is rich in coal and is third largest coal producer in the world with estimated coal reserves of the order of 257 billion tons. Coal continues to be the dominating energy source and meets nearly 58% of total requirement of commercial energy, but accounts for over 50% of the gross emissions. Out of total annual emission of about 1800 Million Tons per annum (MTPA), CO₂ emitted by the Coal based thermal power plants of capacity over 180 GW amounts to about 900 MTPA.

Government of India has declared its policy on Carbon Dioxide (CO₂) abatement by the announcement and adoption of the 'National Action Plan on Climate Change'. It has also made voluntary commitment at the UNFCCs Paris Summit COP-21 that the country shall decrease its Carbon Intensity by 30-33% by 2030. The path chosen makes it imperative that the CO₂ which forms 95% of the GHG emissions be reduced. The reduction of 33% intensity as promised by India at COP-21: Paris; would translate to a decrease of CO₂ emissions from our Coal Plants from 0.9 kg/kWh to a level of 0.58 kg/kWh by 2030. This decrease is possible by a combination of adaptation and mitigation measures like acceleration of present pace of Low Carbon Technologies (LCT) such as Renewable and Clean Coal Technologies (CCT) and setting up of Carbon Capture & Sequestration (CCS) plants primarily for Post combustion carbon capture on our Fossil Fuel based Sub and Supercritical thermal power plants.

The augmentation of low carbon technologies is being pursued in mission mode by the Ministry of New & Renewable Energy (MNRE) through accelerated pace of setting up of 100 GW Solar plants, mainly PV, by 2022. On the Clean Coal Technology front the setting up of Supercritical Plants will follow lower carbon options in coal sector like retrofitting of Integrated Gasification Combined Cycle (IGCC) plants on selected combined cycle units in the country by 2022.

However, as regards post combustion CCS plants on coal fired units, the CO₂ capture by an amine system of 30% CO₂ capture would mean an energy penalty of about 25% including a minimum of 10% for compression and pumping to deep reserves like mineral rocks, gas hydrates and ocean. In any case, the energy penalty in Indian context, when our power planners are targeting at no-storage options for CCS like Carbon sequestration for conversion to multi-purpose fuels rather than CO₂ storage, the energy penalty still remains at level of 15 -25%. This can be further reduced to a level of 5-10 % if solar thermal device is used for production of steam for solvent regeneration and stripping of CO₂. An establishment of pilot plant of CO₂ Capture and Sequestration plant integrated with Concentrated Solar Power (CSP) for carrying out system optimization studies, having variable fluid dynamic configuration would be needed.

With this aim a feasibility study of installation of CCS on a 500MW unit together with integration of solar concentrator for steam generation for reducing energy penalty in regeneration has been presented in this paper. The paper also provide test results of Post Combustion Carbon Capture & Sequestration Pilot Plant installed at the State Technical University, RGPV, Bhopal in Central India, for CO₂ capture and conversion into fuel molecules like H₂ and CH₄ from associated Oil fired Boiler and a Biomass gasifier. Test results of Solar Thermal pilot plant for Steam production with thermal storage, using solid pathway is given which may pave way for development of the technology of Post Combustion Carbon Capture with least energy penalty in regeneration of solvents used in the process.

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