# Feasibility analysis of activated carbon as a pre-combustion technology for carbon capture and storage

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Summary:As one of the cheapest $CO_2$ absorbing materials, activated carbon adsorption $CO_2$ technology has become one of the most promising technologies. This article analyses the feasibility of activated carbons technology for pre-combustion from the perspective of adsorbent technology, and compares the advantages and disadvantages of activated carbons technology and other technologies.

Key words: CCS; AC; carbon capture and storage; MEA; monoethanolamine; activated carbon

## Introduction

The CCS (Carbon capture and storage) is one of the most successful solution to capture $CO_2$and then stored or utilized. There are three main ways for $CO_2$ capture: pre-combustion, post-combustion and oxyfuel combustion $CO_2$ separation decarbonization from flue gases.

Compare with Pre-combustion and oxyfuel combustion the post-combustion is easier to renovate the factory that can help reduce cost and increasing feasibility.

The aim of this article is to Critically evaluate a pre-combustion technology for $CO_2$ capture compared to a post-combustion technology, it discusses the pre-combustion and post-combustion conditions from the perspective of economic cost, CCS efficiency and future development feasibility. The purpose of this paper is to compare AC with traditional monoethanolamine (MEA) methods and analyze the feasibility of using AC for CCS.

## Discussion

Before comparing pre-combustion with post-combustion, it is necessary to elaborate the various technical differences of pre-combustion and post-combustion and the applicable conditions. This is enabled as to understand the various comparison processes such as efficiency, cost and technical requirements.

Pre-combustion is applicable for gasification system including the integrated gasification combined cycle power plants (IGCC). In this process, a solid, liquid or gaseous fuel is converted to a mixture of hydrogen and $CO_2$ by a process of gasification or reforming. The $CO_2$ is then separated and collected using physical or chemical adsorption methods. Compared to the post-combustion, the pre-combustion can capture and collect $CO_2$ before the fuel is burned, and the pre-combustion $CO_2$ is collected to a higher degree than the post-combustion. It is possible to absorb $CO_2$ from special materials due to the high concentration of pre-combustion $CO_2$, which can greatly increase the capture efficiency of $CO_2$. Therefore, from the adsorption technology review, usually, whether the use of physical technology for adsorption is the main difference between pre-combustion and post-combustion.

## Efficiency and technology

The efficiency of CCS is the key whether to continue the development this technology.

In post-combustion, the $CO_2$ is captured from the excluded waste. The most mature technology is the use of a liquid system such as MEA. Experiments have shown that when the simulated $CO_2$ gas velocity fluctuates between 3.4 mol/s and 4.6 mol/s, the MEA has a minimum adsorption rate of 83% for $CO_2$ and a maximum of 99% (Abdul Manaf et al. 2016). In fact, the current $CO_2$ capture technology used in a large number of $CO_2$-emitting plants such as power plants has a theoretical $CO_2$ adsorption capacity of around 90%, which include pre-combustion and post-combustion (Chen et al. 2013).

However, those technologies that using chemical adsorbent also has some great drawbacks. This technology can lead to the boil-off and corrosion, and this technology requires much energy before $CO_2$ capture because this chemical reaction requires high temperature and high-pressure conditions, which consumes about 30% of the energy produced by a power plant (Lu et al. 2012). This increases the cost of capture lead to the rise of electricity price.

Compared with MEA in post-combustion, the biggest advantage of AC is the low cost. Experiments from Hirst et al. (2018) showed that biomass can be converted to activated carbon with strong $CO_2$ adsorption capacity at very low cost, and the adsorption degree can be as high as 8.3mmol/g.

Compared with other technologies, AC technology has great advantages in technical requirements. First, the environment required for adsorption of activated carbon is easier to reach. Kacem et al. (2015) proved that activated carbon has a good performance for adsorbing $CO_2$ at 25℃ and above 3.5 bar. Compared to traditional post-combustion techniques such as MEA, the reaction conditions of activated carbon are easier to achieve. In addition, CCS requires equipment support from IGCC, and the low cost of AC reduces the total cost of power plant equipment to a certain extent.

## Conclusion

After comparison of efficiency, technology and cost, it can be concluded that AC can not only reduce the technical requirements of current power plants, but also because of other solutions in terms of cost and efficiency, so the application of AC for CCS technology has great prospects.

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