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Review Article

A review on CO_2 capture with chilled ammonia and CO_2 utilization in urea plant

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ABSTRACT

During the past 30 years, the development of technology following the industrial revolution caused an intense increase in energy demand and consequently the concentration of CO_2 and greenhouse gases worldwide. Therefore, implementing efficient solutions to reduce emissions of these gases has become one of the most critical challenges of various industries. Many industries, including the petrochemical industry, consider using technology such as Carbon Dioxide Capture and Utilization (CCU) as a potential option to reduce CO_2 emissions. Nonetheless, the high cost of CO_2 recovery, which is inextricably linked to energy consumption, is one of the most significant challenges of implementing these technologies. This article investigates the possibility of using the new Chilled Ammonia Process (CAP) technology as a promising solution and alternative to traditional methods to recover CO_2 from ammonia plant flue gases and reutilize in a urea plant. The advantages of integrating this technology into ammonia and urea plants can be mentioned as capturing SO_X and NO_X pollutants and CO_2 and converting them into high value-added chemical fertilizers, reducing energy consumption and corrosion rate in equipment. But the key benefit that distinguishes this from other CO_2 capture technologies is the elimination of the CO_2 desorption section due to the formation of ammonium carbamate during the CO_2 absorption process. The elimination of the CO_2 desorption section can significantly reduce costs and energy consumption.

1. Introduction

As the population rises, the use of technologies has also increased, which in turn has increased the consumption of fossil fuels significantly. One of the consequences of increasing energy consumption is increasing greenhouse gas emissions, especially carbon dioxide (CO_2), and global warming, one of the most important environmental challenges today. According to the Emission Database for Global Atmospheric Research, global CO_2 emissions in 2011 were equal to 33.4 billion tons [1]. From the middle of 1800 to 2014, the CO_2 concentration increased by about 40%, with an average of 2 PPM per year [2]. According to the Intergovernmental Panel on Climate Change (IPCC) reports, the amount of CO_2 in the atmosphere will increase up to 750 PPM until 2100. This will lead to an increase in the average earth's temperature by about 1.9 °C and the average sea level by about 3.8 m [3]. Coal and natural gas, some of the most significant energy sources, still have the largest share in various industries as sources of energy production and raw materials in chemical processes due to their low cost and availability. Chemical and petrochemical industries consume approximately 30% of global energy and emit 16% of direct CO_2 [3–5]. Therefore, one of the ongoing and prospective challenges would be implementing appropriate methods to minimize greenhouse gas emissions.

Since the CO_2 emissions from power plants and chemical industries are the primary sources of CO_2 emissions in the world, in recent years many studies have been conducted on Carbon Dioxide Capture and Storage (CCS) technology as an efficient way to reduce CO_2 emissions. Based on these studies reducing 47% of Europe's total CO_2 emissions would be achievable by 2030 using this method [6]. CCS technology consists of three parts. In the first stage, CO_2 is taken from the flue gases of fossil fuels combustion. In the next stage, CO_2 is separated from the absorbent and transferred to the last stage, in which it is compressed and stored in underground or sub-ocean reservoirs or might be reused as a feed of chemical industries and petrochemicals (CCU) [1,2,6]. Both coal and natural gas are the most common fossil fuels used in power plants and other industries. Carbon is consumed primarily in the combustion of coal, while carbon and hydrogen are burned simultaneously in the combustion of natural gas. Therefore, for a power plant with equal capacity, the amount of CO_2 from coal combustion is much higher than the CO_2 produced from natural gas combustion. Table 1 shows the typical

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