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Advances in CO_2 utilization technology: A patent landscape review

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ABSTRACT

There is rising concern on the increasing trend of global warming due to anthropogenic CO_2 emission which steers progress of carbon capture and storage (CCS) projects worldwide. However, due to high cost and uncertainties in long term geological storage, there is a growing inclination to include utilization, which re-use the CO_2, hence carbon capture utilization and storage (CCUS). Additionally, it is expected to generate income to offset the initial costs. This study methodically review patents on CO_2 utilization technologies for CCUS application published between year 1980–2017. It was conducted using the Derwent Innovation patent database and more than 3000 number of patents was identified. The patents identified are in the field of enhanced oil recovery (EOR) and enhanced coal-bed methane (ECBM), chemical and fuel, mineral carbonation, biological algae cultivation and enhanced geothermal system (EGS). Over 60% of these patents were published since the last 10 years, and a sharp increase in patents were seen in the last 5 years (~38%). The top major patent types are patents granted in the United States (US), China (CN) and Canada (CA) which makes of 3/5 of the overall patent type found. Recent patents published include enhancements to the state-of-the-art technologies and hybrid concepts such as in photo-bioreactor in algae cultivation, chemical reaction and EGS. From this study, it was found that further research for the best CO_2 utilization method which fulfil the need of an economic, safe, non-location dependent and environmentally friendly whilst efficiently mitigate the worldwide global warming issue is much needed.

1. Introduction

Limiting the increase of anthropogenic carbon dioxide (CO_2) emissions in the environment is a major challenge facing the world today. Hence, there is a vital need to assess the growing worldwide concern about global climate change. CO_2 generally originated from flue gas from fossil fuel combustion, biogas from anaerobic digestion, product of coal gasification and natural gas streams [1–4]. According to BP energy statistics, in the year 2016 there were 33,432.04MT of CO_2 emission worldwide [5]. An assessment conducted by The Intergovernmental Panel of Climate Change (IPCC), concluded that the CO_2 emissions should be decreased by at least 50% to limit the escalation of the global average temperature to 2 °C by 2050. International Energy Agency (IEA) presented models of technology mix which are essential to meet the 2 °C scenario. The model shows that in order to achieve the targeted scenario, CCUS will need to contribute at least one-sixth of global CO_2 emission reductions by 2050, as well as 14% of the cumulative emissions reductions from 2015 to 2050 as compared to a business-as-usual [6].

CCUS is a methodology to separate CO_2, then utilize CO_2 to produce valuable products and techniques to store produced CO_2, commonly from power generation, industrial processes and even high CO_2 gas fields. The IPCC report stated that without CCUS implementation, the overall cost required to mitigate global climate change may increase up to 138% and there is great challenge to achieve the targeted 2 °C scenario [7]. Various international agreements have been established to ensure that CCUS will play an important role for an economically sustainable route for CO_2 emissions cut required to limit the global climate change rise [8]. More recently, the Paris Agreement of 2016 was established to further accelerate the worldwide response to the threat of climate change by keeping a global temperature rise this century by limiting the temperature rise even further to 1.5 °C [9]. This effort requires even more effective actions to combat climate change, especially on the mitigation for CO_2 emission reduction worldwide. Therefore, new technologies are needed to be developed as one of the critical methods to mitigate the global warming issue [10]. Apart from international agreements, a global competition was introduced to combat CO_2 emission. NRG Canada's Oil Sands Innovation Alliance (COSIA)

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