Chemical Engineering Journal 488 (2024) 150954

Contents lists available at ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Review

Review on post-combustion CO_2 capture by amine blended solvents and aqueous ammonia

Jiaxing Du [a], Wu Yang [a], Linlin Xu [a], Lei Bei [a], Siyuan Lei [b], Wei Li [c], Haitao Liu [d], Ben Wang [a], Lushi Sun [a,*]

[a] State Key Laboratory of Coal Combustion, Huazhong University of Science and Technology, Wuhan 430074, China
[b] Xi'an Thermal Power Research Institute Co, Ltd, Suzhou 215153, China
[c] China Hubei Carbon Emission Exchange, Wuhan 430060, China
[d] Guangxi Huayu Energy Technology Co., Ltd, Nanning 530007, China

ARTICLE INFO

Keywords:
CO_2 capture
Amine blended solvents
Aqueous ammonia
Simultaneous removal
Industrial challenges

ABSTRACT

Absorption/regeneration systems based on chemical solutions are considered a more appropriate option for post-combustion CO_2 capture, with amine solvents being the most commonly utilized. First, this paper provides a systematic review of the mechanisms and performance of CO_2 capture by blended solvents of amine–amine, amine-organic solutions, amine-inorganic solutions, and amine-ionic liquids. Furthermore, some process modifications that can reduce energy consumption and amine degradation during CO_2 capture are discussed. As a promising and challenging absorbent, aqueous ammonia shows potential for simultaneous removal of CO_2/NOx/SO_2, producing valuable byproducts like ammonium sulphate and ammonium nitrate fertilizers. Therefore, the current development of ammonia scrubbing techniques for CO_2 capture and simultaneous removal of CO_2/NOx/SO_2 is subsequently reviewed in terms of reaction mechanisms, process modifications, and application challenges. Finally, specific directions have been proposed for the future development of amine and aqueous ammonia scrubbing techniques, which are expected to provide meaningful guidance for CO_2 capture by chemical absorption.

1. Introduction

The increasing global industrial and economic development has led to a rising demand for energy, predominantly supplied by fossil fuels [1–3]. However, the combustion of fossil fuels results in significant emissions of carbon dioxide (CO_2), a primary contributor to global warming, responsible for 58 % of all greenhouse gases (GHGs) [4,5]. The total global CO_2 emissions across various energy sectors and the annual average atmospheric CO_2 concentration since the beginning of the century are shown in Fig. 1. Notably, global CO_2 emissions have been steadily rising each year, primarily attributed to coal, oil, and natural gas. From 2000 to 2022, the average atmospheric CO_2 concentration increased from 370 ppm to 418 ppm [6,7]. To curb global CO_2 emissions and achieve the target of limiting the global average temperature rise to below 2 °C, many countries have proposed carbon emission reduction strategies like carbon neutrality, carbon trading, etc. [7]. The report

Abbreviations: GHGs, Greenhouse Gases; MEA, monoethanolamine; EDA, ethylenediamine; PZ, piperazine; DGA, 2-aminoethoxyethanol; MDEA, methyldiethanolamine; BDA, 1,4-Butanediamine; AEP, 1-(2-aminoethyl)piperazine; TEPA, tetraethylenepentamine; AMP, 2–amino–2–methyl–1–propanol; DEEA, N, N-diethylethanolamine; DEAB, 4-(diethylamine)-2- butanol; AEEA, (2-aminoethyl) ethanolamine; PMDETA, pentamethyldiethylenetriamine; DMA2P, 1-dimethylamino-2-propanol; DMAC, N,N-dimethylcyclohexylamine; 2ME, 2-methoxyethanol; 2EE, 2-ethoxyethanol; 3DMA1P, 3-(dimethylamino)propan-1-ol; DEGDME, diethylene glycol dimethyl ether; EGME, ethylene glycol monomethyl ether; HEEDA, N-(2-hydroxyethyl)-ethylenediamine; HEIA, 1-(2-hydroxyethyl)-2-imidazolidinone; FPZ, 1-formylpiperazine; OPZ, 2-oxopiperazine; DMOZD, 4,4-dimethyl-1,3-oxazolidin-2-one; SCR, selective catalytic reduction denitrification; FGD, flue gas desulphurization; NMR, Nuclear Magnetic Resonance; ILs, Ionic liquids; [BMIM][BF4], 1-butyl-3-methylimidazolium tetrafluoroborate; [N1111][Gly], tetramethylammonium glycinate; [HMIM][Tf2N], 1-hexyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide; [DETAH][Tz], diethylenetriamine triazole; [gua][FAP], guanidium tris(pentafluoroethyl)trifluorophosphate; [BMIM][Lys], 1-butyl-3-methylimidazolium l-lysine; CCS, Carbon Capture and Storage; CAP, Chilled Ammonia Process; DEA, diethanolamine; DETA, diethylenetriamine; TETA, triethylenetetramine; MPZ, methyl piperazine; MCA, methylcyclohexylamine; MAPA, 3-methylamino propylamine; HMDA, 1,6-hexamethyl diamine.

* Corresponding author.
E-mail address: sunlushi@mail.hust.edu.cn (L. Sun).

https://doi.org/10.1016/j.cej.2024.150954
Received 18 January 2024; Received in revised form 29 March 2024; Accepted 1 April 2024
Available online 2 April 2024