Article

Development of CO_2 Absorption Using Blended Alkanolamine Absorbents for Multicycle Integrated Absorption–Mineralization

Chanakarn Thamsiriprideeporn * and Suekane Tetsuya

Department of Mechanical Engineering, School of Energy Science and Technology, Tokyo Institute of Technology 2 Chome-12-1 Ookayama, Tokyo 152-8550, Japan
* Correspondence: chanakarn.tham@gmail.com

Table S1. Composite index of blended alkanolamine absorbent in multicycle IAM.

$$\begin{aligned}\text{Appropriate blened absorbent} = (W_1 \times CO_2 \text{ absorption factor}) + \\ (W_2 \times \text{Conversion factor}) + (W_3 \times \text{Degration factor}) \\ +(W_4 \times \text{Toxic factor}) + (W_5 \times \text{Cost factor})\end{aligned} \quad (9)$$

	CO_2 absorption factor	Degradation factor	Conversion factor	Toxic factor	Cost factor	Index
5wt.%MEA	0.668	0.922	0.594	0.014	0.713	0.463
5wt.%DEA + 5wt.%MEA	0.326	0.789	0.725	0.014	0.68	0.477
10wt.%DEA + 5wt.%MEA	0.226	0.778	0.742	0.013	0.669	0.466
15wt.%DEA + 5wt.%MEA	0.226	0.752	0.759	0.013	0.663	0.48
5wt.%TEA + 5wt.%MEA	0.361	0.763	0.614	0.017	0.856	0.44
10wt.%TEA + 5wt.%MEA	0.191	0.675	0.706	0.018	0.904	0.455
15wt.%TEA + 5wt.%MEA	0.15	0.702	0.805	0.019	0.928	0.466
5wt.%AMP + 5wt.%MEA	0.351	0.382	0.659	0.015	0.756	0.576
10wt.%AMP + 5wt.%MEA	0.224	0.431	0.799	0.015	0.77	0.577
15wt.%AMP + 5wt.%MEA	0.201	0.451	0.871	0.016	0.778	0.587

where:

(1) The CO_2 absorption factor represents the fraction of the blended alkanolamine absorbent's experimental CO_2 absorption capacity to its nominal CO_2 absorption capacity. The nominal CO_2 absorption capacity is 720 g·CO_2/kg.absorbent at very low concentrations [48].

2. The degradation factor accounts for the degradation of the blended alkanolamine solution over time due to the fact of chemical reactions and impurities [52–54] and can be estimated using Equation (7).

3. The conversion factor represents the fraction of CO_2 that is converted into a stable carbonate after absorption [51] and can be estimated using Equation (8).

4. The toxic factor indicates the environmental impact of the amine solution during production and disposal, which is measured by the lethal dose 50 (LD50). The LD50 value is the dose of a substance or material that would cause the death of 50% of the exposed population within a specifictime period. For instance, the acute oral LD50 values for MEA, DEA, TEA, and AMP are 2.74, 1.82, 2.34, and 2.15 g/kg, respectively [59,60].

5. Cost factor represents the economic feasibility of using the amine solution. The cost factor is calculated based on the market price of the amine components, which include MEA, DEA, TEA, and AMP. The current market prices of these amine components are reported as 0.71, 0.65, 1, and 0.8 USD/kg [61–63], respectively. By considering the cost factor in the decision-making process, it is possible

to choose the most economically viable amine blend for CO_2 capture applications.

6. W_1, W_2, W_3, W_4, and W_5 are weights assigned to each variable according to their importance in developing multicycle IAM. The conversion and degradation factors are the most important components (W_2 = 0.3 and W_3 = 0.3), followed by the CO_2 absorption factor (W_1 = 0.2) and then the toxic and cost factors (W_4 = 0.1 and W_5 =0.1), in that order.

These factors range from 0 to 1, with 0 indicating no effect and 1 indicating the greatest effect.