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HETEROGENEOUS CATALYTIC CO_2-MEA ABSORPTION WITH ALKALINE EARTH METAL CARBONATES;

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OUTLINE OF THE WORK:

- 1. Background
- 2. Experimental process and chemicals
- 3. Results: Solid chemicals catalysis:
  - 1. 1.0 M MEA solutions. With 0-25g $CaCO_3$, $MgCO_3$, $BaCO_3$.
  - 2. 3.0 M MEA solutions. With 0-25g $CaCO_3$, $MgCO_3$, $BaCO_3$.
- 4. Conclusion

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- Background:

- Three types of solid alkaline catalysts were selected for CO_2 absorption with MEA solvent. The classic mechanism of "catalytic carbamate formation" was confirmed here, in terms of heterogeneous catalysis. Similar to the aqueous hydroxide [OH^-] can serve homogeneous catalyst of carbamate formation, several solid alkaline can serve as heterogeneous catalysts/promotors implemented for CO_2 absorption in the amine scrubbing process. The solid catalysts, $CaCO_3$, $MgCO_3$ and $BaCO_3$, can accelerate the CO_2 absorption in MEA solvent properly. These solid alkaline are proved to be good candidates for heterogeneous catalytic CO_2 amine absorption.

EXPERIMENTS AND MATERIALS

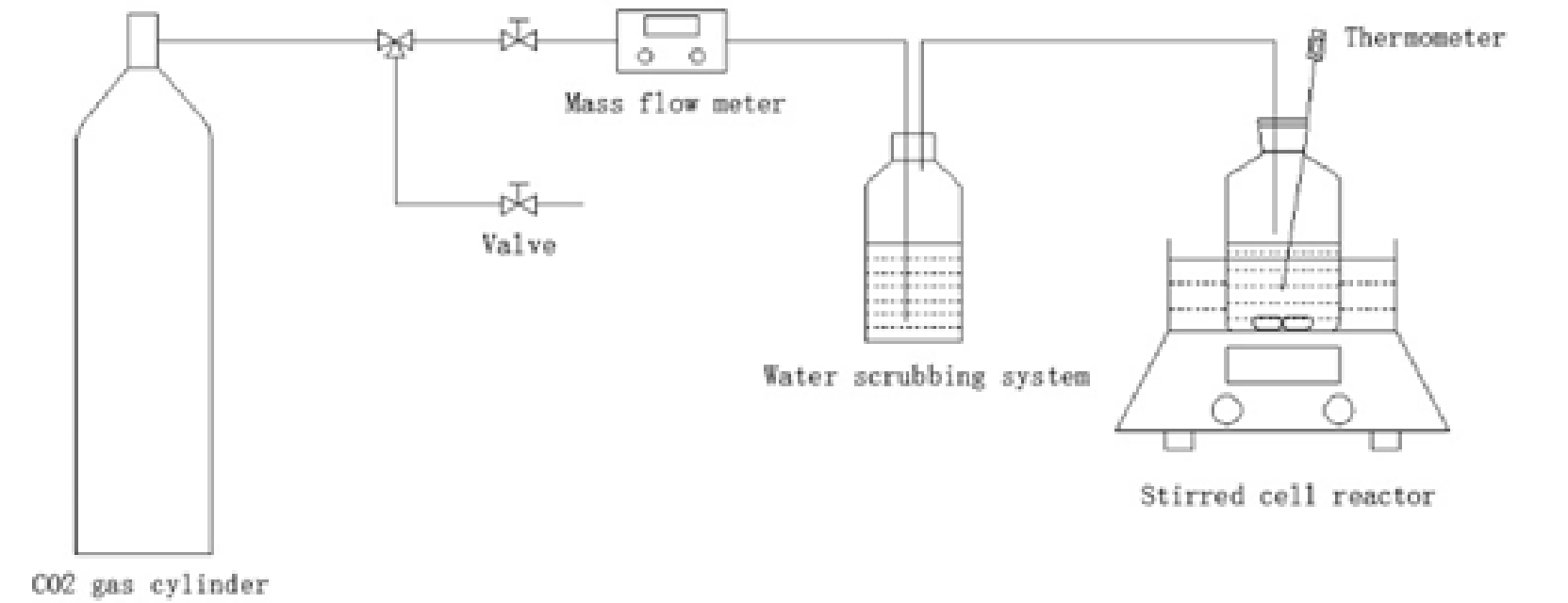
- Chemicals and CO_2 loading tests
  - Chemicals, MEA, HCl, CO_2 are commercially available.
  - The solid chemicals were purchased from HuiShan Chemical Ltd; they are magnesium carbonate (MgCO3), and magnesium carbonate hydroxide (Mg(OH)2(MgCO3)4˙5H2O). The CO2 gas was purchased from Tansool Chemical Ltd, and the chemicals MEA, HCl and methyl orange were commercial available from Guoyao Chemical Ltd.

- Major Reference

- Idem, R., Shi, H., Gelowitz, D., Tontiwachwuthikul, P., 2013. Catalytic method and apparatus for separating a gaseous component from an incoming gas stream. US Patent, 2013/0108532 A1.
- Idem, R., Supap, T., Shi, H., Gelowitz, D., Ball, M.; Campbell, C., Tontiwachwuthikul, P., 2015. Practical experience in post-combustion CO2 capture using reactive solvents in large pilot and demonstration plants. Int. J. of Greenhouse gas control. 40, 6-25.

EXPERIMENTS AND PROCESS

- Figure 1. Stirred Cell Reactors with suspended fine chemicals:



- From Fig.1 , 0-25 g of pelletized catalysts were wrapped in a net and hang up to the cock during the catalytic reaction. We selected 3 concentrations of MEA, 1, 3, 5 mol/L, with 3 types of solid chemicals $CaCO_3$, $MgCO_3$ and $BaCO_3$ to conduct the catalytic CO_2-absorption.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- 1. CO_2 absorption with 1.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $[Mg(OH)_2(MgCO_3)_4 \cdot 5H_2O]$

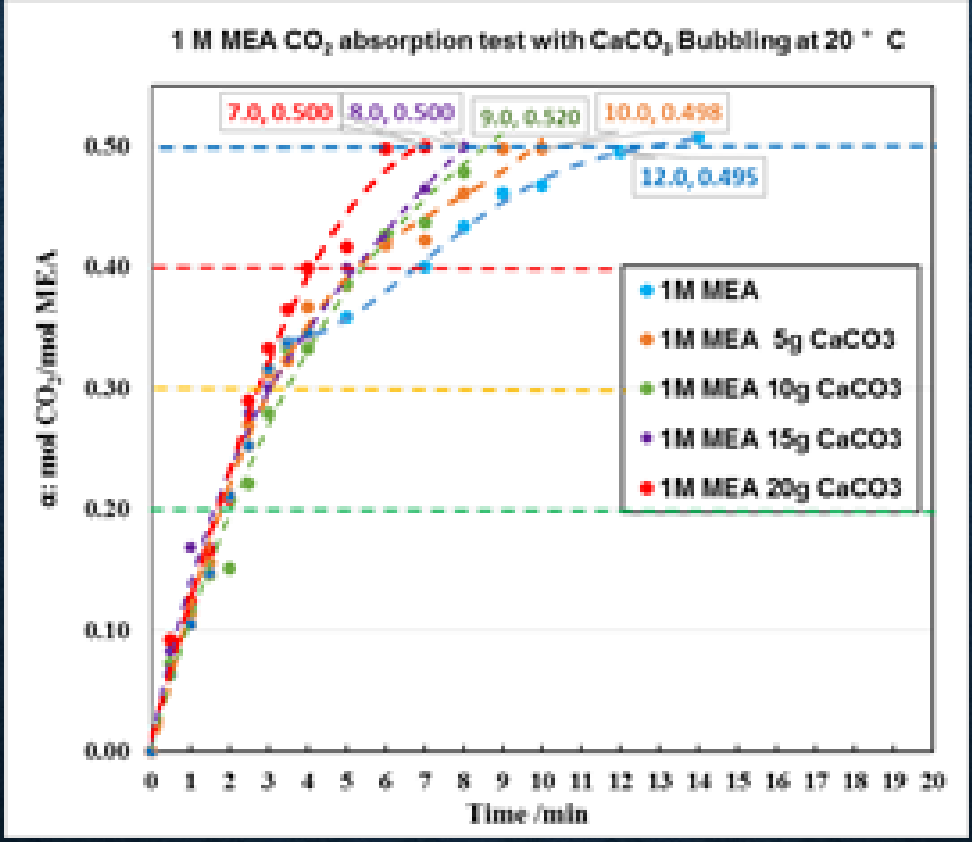


Fig 2. 1 Catalytic CO_2 absorption of MEA with aid of 5-20g $CaCO_3$ at 20°C.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- CO_2 absorption with 1.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $[Mg(OH)_2(MgCO_3)_4 \cdot 5H_2O]$

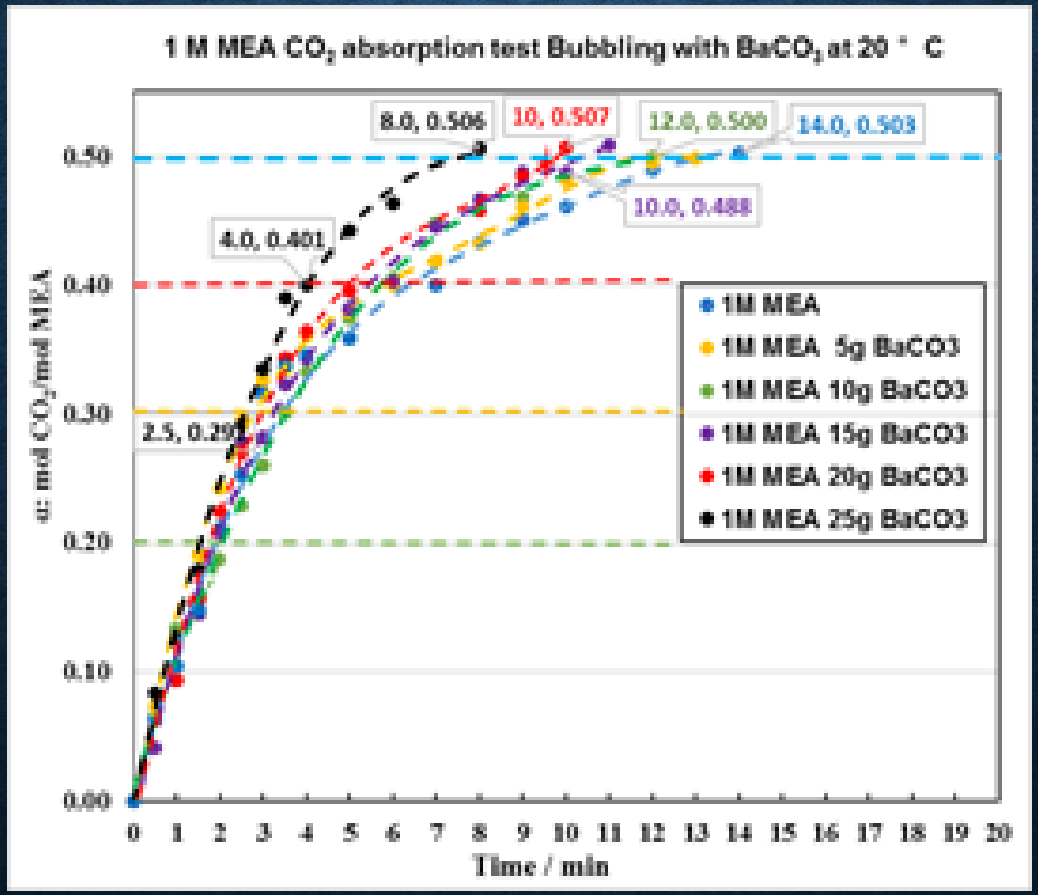


Fig 2. 2 Catalytic CO_2 absorption of MEA with aid of 5-20g $BaCO_3$ at 20°C.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- CO_2 absorption with 1.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $[Mg(OH)_2(MgCO_3)_4 \cdot 5H_2O]$

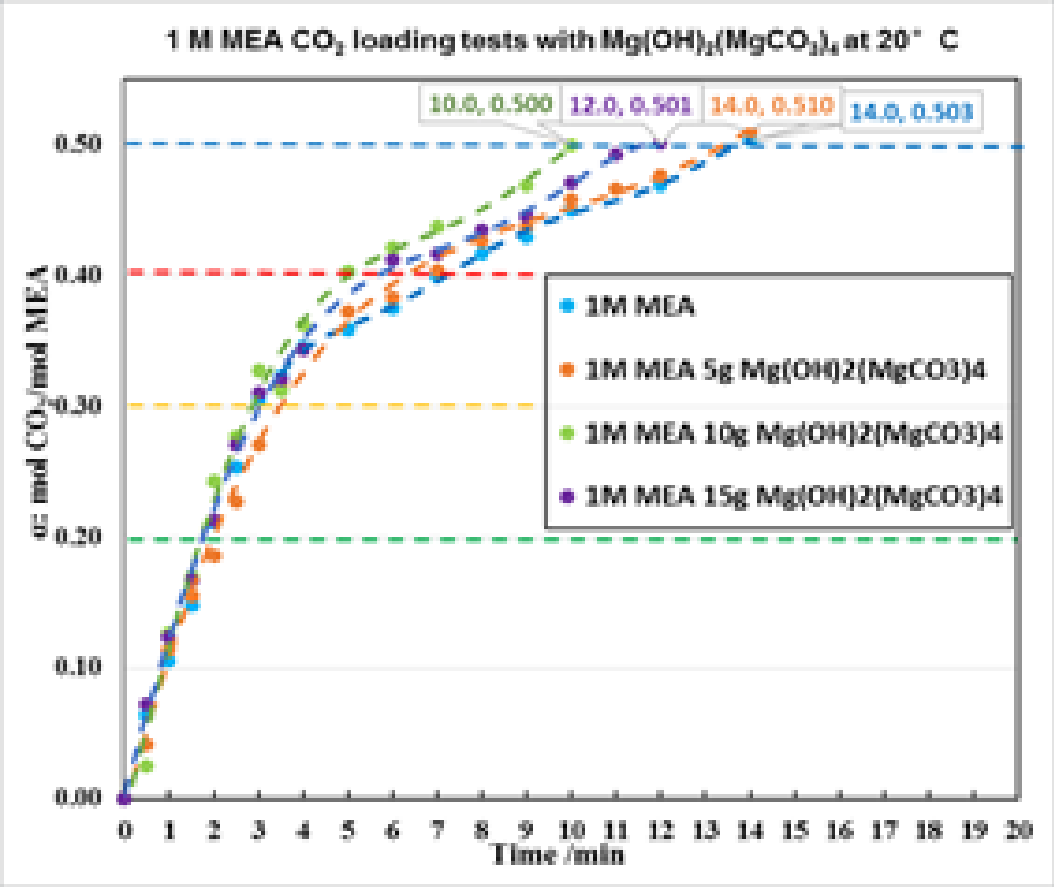


Fig 2. 3 Catalytic CO_2 absorption of MEA with aid of 5-20g $[Mg(OH)_2(MgCO_3)_4 \cdot 5H_2O]$ at 20°C.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- 2. CO_2 absorption with 3.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $MgCO_3$

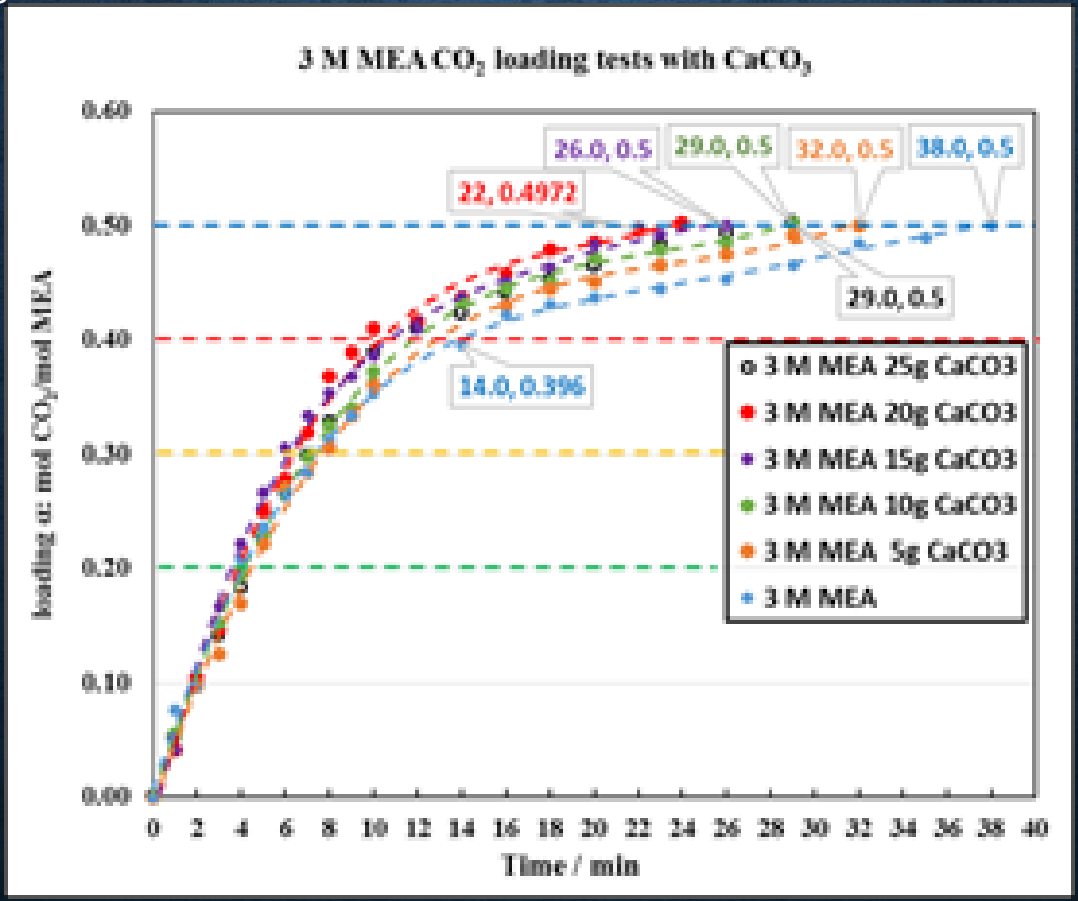


Fig 3. 1 Catalytic CO_2 absorption of MEA with aid of 5-20g $CaCO_3$ at 20°C.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- 2. CO_2 absorption with 3.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $MgCO_3$

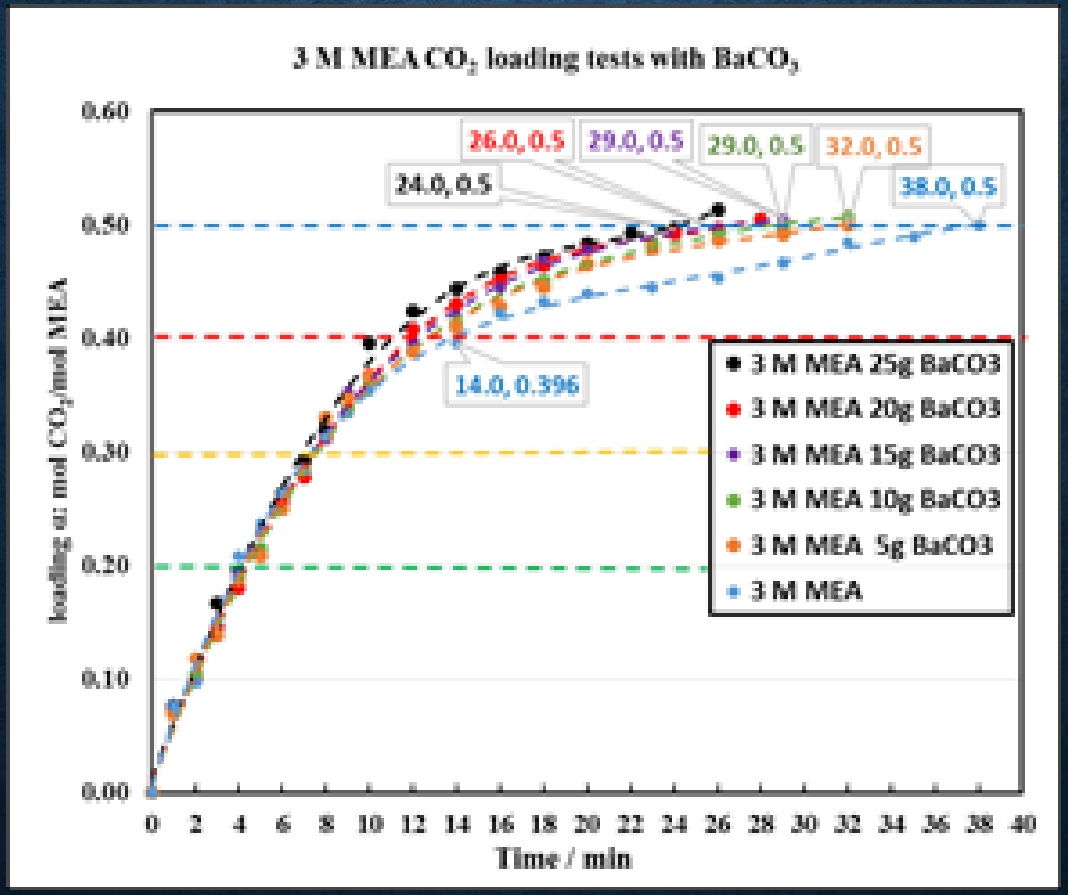


Fig 3. 2 Catalytic CO_2 absorption of MEA with aid of 5-25g $BaCO_3$ at 20°C.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- 2. CO_2 absorption with 3.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $MgCO_3$.

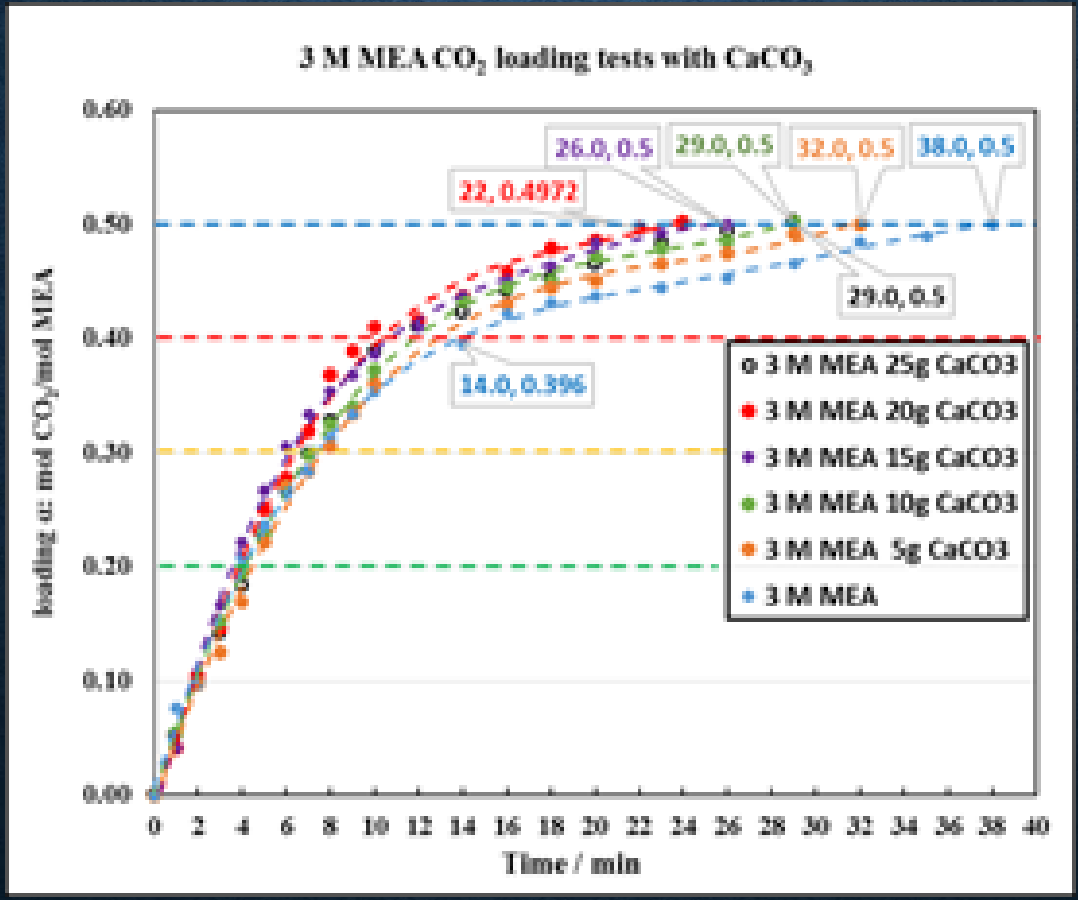


Fig 3. 1 Catalytic CO_2 absorption of MEA with aid of 5-20g $CaCO_3$ at 20°C.

RESULTS. CATALYTIC ABSORPTION WITH SOLID ALKALINE

- 2. CO_2 absorption with 3.0 mol/L MEA solutions with $CaCO_3$, $BaCO_3$ and $MgCO_3$.

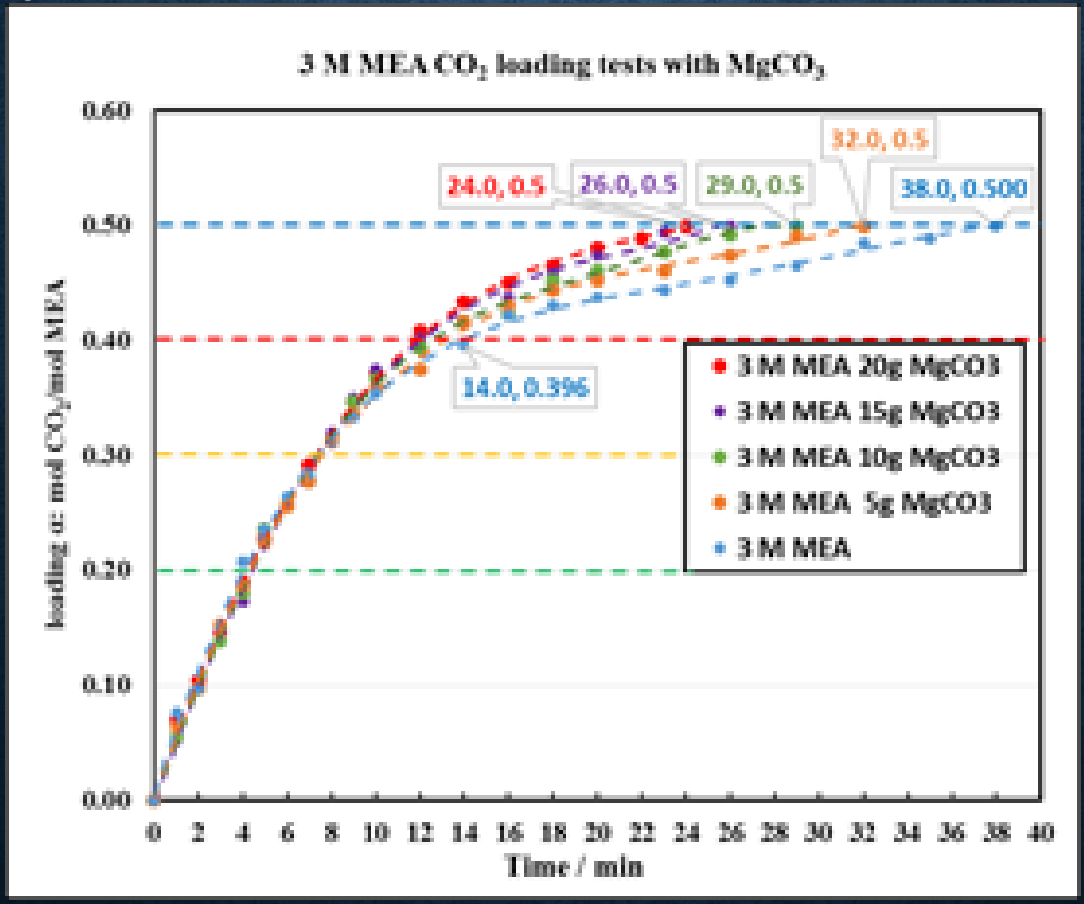


Fig 3. 3 Catalytic CO_2 absorption of MEA with aid of 5-20g $MgCO_3$ at 20°C.

CONCLUSIONS:

- The catalytic effect of solid alkaline onto CO_2-MEA interactions:

- 1 The idea was validated experimentally that pelletized "alkaline earth metal carbonate" can serve as good-performance catalysts for CO_2-MEA absorption. These catalysts were heterogeneous, which are only effective as being placed in the gas-liquid interface with bubbling.

- 2 Three types of solid chemicals were adopted as catalysts for CO_2 absorption with MEA solutions, and 5-20g of $MgCO_3$ / $[Mg(OH)_2(MgCO_3)_4 \cdot 5H_2O]$, $CaCO_3$, and 5-25g $BaCO_3$ were tested onto MEA solutions under 1, 3 and 5 M concentrations at 20°C.

ACKNOWLEDGEMENT

- This financial supports are provided by Youth Teachers Support Program (ZZsl15042) and Young Eastern Scholar (QD 2016011) with Supporting Funding (10-17-307-005-11). The National Natural Science Foundation of China (NSFC Nos. 21606150) are gratefully acknowledged. Natural Sciences and Engineering Research Council of Canada (Canada) are also acknowledged.