

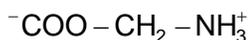
# The CONTACTOR™

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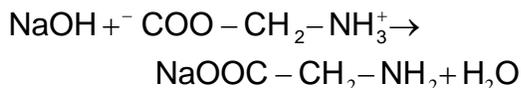
## Capturing CO<sub>2</sub> With Sodium Glycinate

The benchmark amine solvent for post-combustion CO<sub>2</sub> capture is high-strength MEA. It was probably the first amine to go through extensive semi-commercial scale testing for use in carbon capture. However, several other alkaline solvents have engendered interest, including aqueous ammonia and AMP (2-amino-2-methyl-1-propanol). Caustic-neutralized amino acids are another class of amine-type solvents. For example, the Alkazid® process developed by BASF uses the potassium salts of *N,N*-dimethylaminoacetic acid and *N*-methylalanine for treating refinery, coke-oven, and natural gases. It is noteworthy that refinery and especially coke-oven gases are two of the most aggressive treating services from contamination and solvent degradation standpoints. Since 1935 the process appears to have been most usually applied in Europe, especially in Germany, although there are instances of its use elsewhere.

Glycine is the simplest of the amino acids. In water solution, it exists as a zwitter<sup>†</sup> ion



Because the amino group is protonated, it is completely nonreactive towards CO<sub>2</sub>. However, when the acid group is titrated (neutralized) with NaOH or KOH the amino group deprotonates,



and produces what turns out to be a *highly-reactive* primary amine. Sodium glycinate (NaGly) exists in water as the fully-dissociated salt, which makes it completely non-volatile. Like the compounds used in the Alkazid process, NaGly is already partially oxidized, making it resistant to further oxidation by the excess oxygen in post-combustion gases.

Information available in the open literature indicates that dilute potassium glycinate reacts with CO<sub>2</sub> at about twice the rate of MEA, and at higher concentrations, at three times the rate. There is no reliable kinetic data for NaGly; however, it seems unlikely that substituting Na for K will make a huge difference to the kinetics of reaction of the amine group with CO<sub>2</sub>. Fast kinetics, lack of volatility, and oxidation resistance make NaGly very interesting. The main question remaining is its vapor-liquid equilibrium (VLE) behavior.

VLE data have been regressed to an activity coefficient model for use by the ProTreat™ simulator. Figure 1 is an example plot of CO<sub>2</sub> partial pressures above NaGly versus solution loading at 35°C compared with MEA and DEA at the same temperature. At low loading, NaGly has about twice

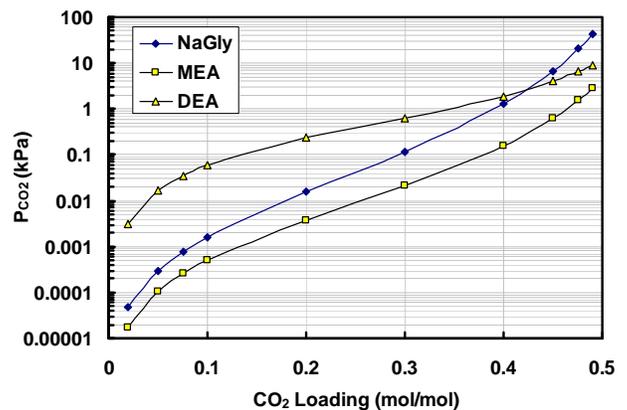


Figure 1 Equilibrium of CO<sub>2</sub> at 35°C and Equal Molar Amine Concentrations

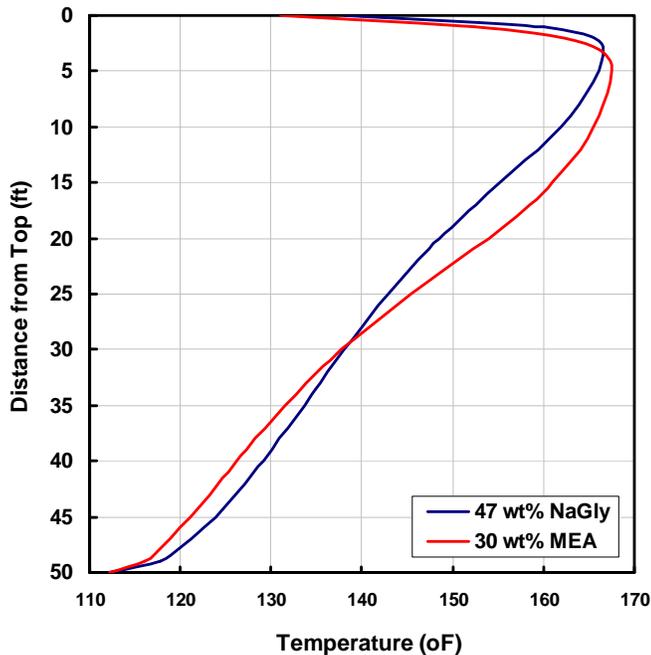
the CO<sub>2</sub> partial pressure as MEA but is well below DEA, making it a much better solvent than DEA. At high loadings, NaGly has even higher CO<sub>2</sub> partial pressures than over DEA. All of this suggests that NaGly may require less regeneration energy than the benchmark MEA. This is despite the fact that analysis of the VLE data indicates the heat of

<sup>†</sup> Zwitter is a German word meaning hybrid (hermaphrodite in biology)

absorption of CO<sub>2</sub> into NaGly is nearly the same as MEA (to be expected since NaGly and MEA are primary amines of similar size and structure).

ProTreat simulations were run on a 3,000 tonne/day CO<sub>2</sub> capture plant. Flue gas containing 13% CO<sub>2</sub> at 110°F and 27 in w.c. was boosted to 34 in w.c. before entering the absorber. The absorber contained a 50-ft deep bed of Mellapak-Plus™ 252.Y structured packing. Solvent rate was 1,750 gpm and solvents are compared on an equal molar concentration basis.

Figure 2 shows temperature profiles in the absorber for equal molarities of NaGly and MEA.

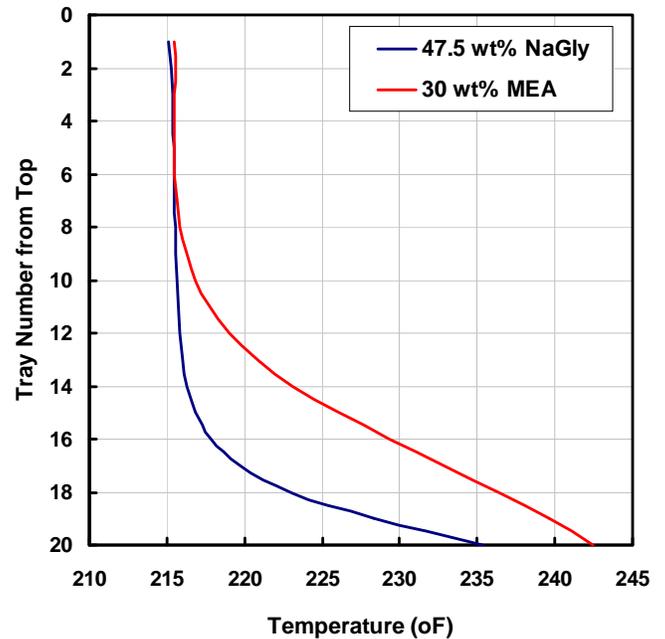


**Figure 2 Absorber Temperatures for NaGly and MEA Both at 90% CO<sub>2</sub> Recovery**

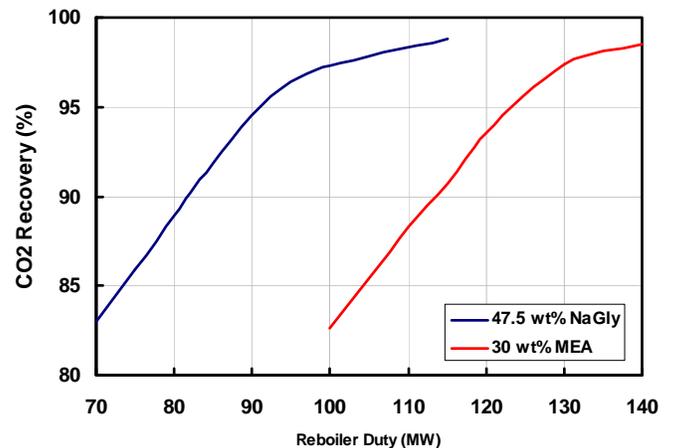
The temperature peaks differ by only about 1°F, with NaGly peaking slightly closer to the top of the bed because of the faster reaction kinetics.

Figure 3 compares NaGly and MEA, both at 90% CO<sub>2</sub> recovery. The bottom temperature with NaGly is lower than MEA simply because NaGly does not boil (it's non-volatile) so it doesn't act as the second (high-boiling) component in the mixture. All these temperature profiles would indicate completely unsatisfactory operation in conventional gas treating. In CO<sub>2</sub> recovery, however, they are perfectly normal. CO<sub>2</sub> absorption is purposely rich-end pinched to ensure minimum circulation and regenerators have collapsed temperature profiles

so that the absolute minimum reboiler duty is used to achieve a given CO<sub>2</sub> recovery. The low position of NaGly's temperature profile in Figure 3 suggests lower regeneration. This is borne out by Figure 4.



**Figure 3 Regenerator Temperatures**



**Figure 4 Reboiler Duties**

NaGly uses nearly 30% less reboiler energy than MEA. Considering that CO<sub>2</sub> capture accounts for about 30% of the power plant's output, this represents an energy savings of roughly 10% of the power plant's entire generating capacity.

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