

Amine for the Solvent Based Capture of Carbon Dioxide from a Gas Stream

Amine treatment has been used on refineries in gas processing since the 1930. Reactive absorption with an aqueous solution of amines with an absorber/ stripper loop is a mature, but still developing, technology for post combustion carbon dioxide capture.

Other technologies exist, including other absorption processes, physical adsorption, membrane separation, microbial and algal systems and cryogenics. This article looks at the use of amine treatment (absorption) for the removal of Carbon Dioxide

Introduction and History. Girbotol Process – history. Has been in use for gas sweetening since 1930's.

Amine Treatments

Several different amines are used in ccs

MEA	Monoethanol Amine
DEA	Diethanol Amine
MDEA	Methyldiethanol amine
DIPA or ADIP	Di propanol amine
DGA	Di glycol amine

The most common is MEA but MDEA is also used extensively.

Proprietary Amine Based Treatments

DOW, BASF, SHELL

There are many proprietary amine based solvent available offering a range of features

- Final CO₂ concentration
- CO₂ transport and transfer capacity
- Resistance to degradation
- Benign degradation products

There are several proprietary solvent products available with a range of benefits including enhanced solvent loading, enhanced carbon dioxide removal (high specification on the scrubbed gas), slow degradation and benign degradation products, but perhaps of greatest interest is reducing the huge energy requirement for regeneration of the solvent in the stripper.

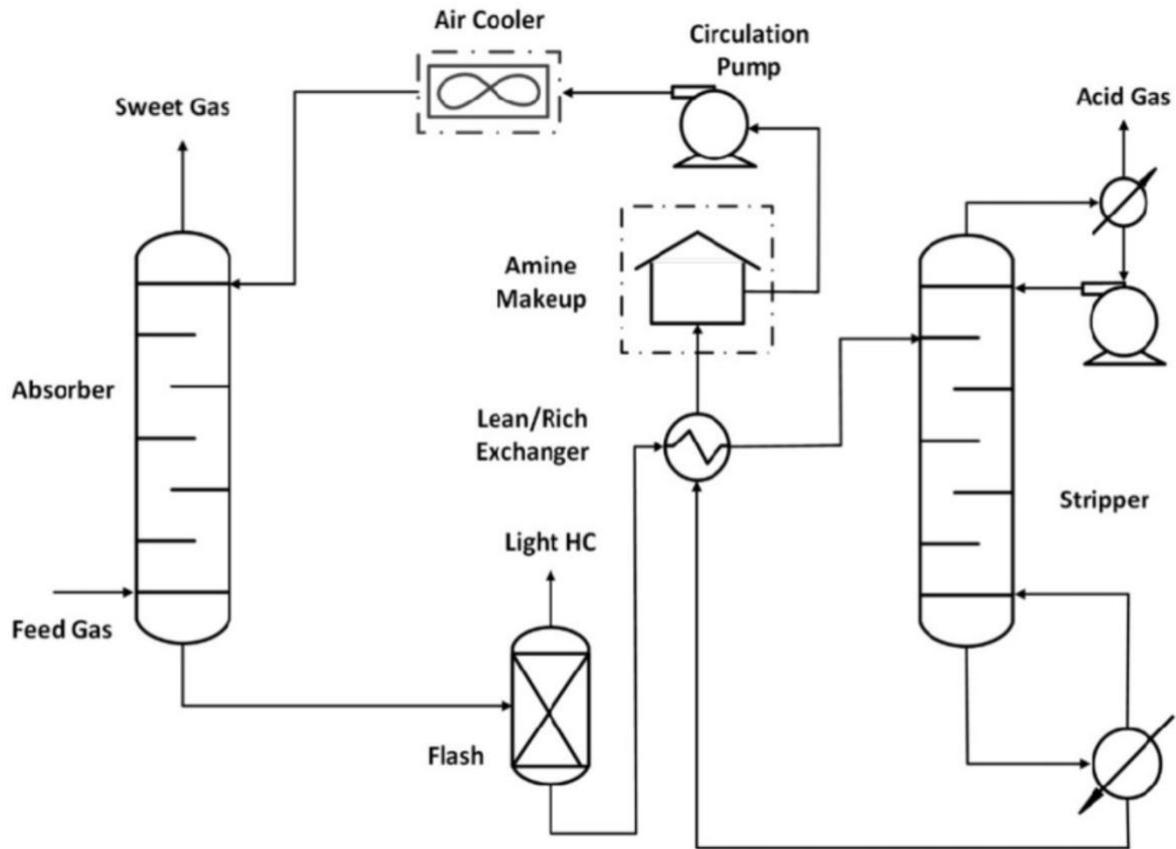
There is a rule of thumb that says the steam to the reboiler should be 1.2 kg/ l of recirculating amine.

- 1- MDEA is a game-changer in the Amine industry, renowned for its exceptional selectivity and high CO₂ slip performance. But it has higher hydrocarbon solubility.
- 2- By switching from MEA or DEA to MDEA, refineries can significantly reduce energy consumption in their Amine systems. MDEA's efficient regeneration process requires less energy, resulting in cost savings and environmental sustainability. Moreover, it boasts minimal CO₂ degradation.
- 3- MDEA shines in LNG facilities, where its blending capability with piperazine allows for effective CO₂ removal. This is crucial in preventing gas hydrate formation, ensuring CO₂ levels remain below 50 ppm.
- 4- Temperature bulge monitoring in Amine absorbers and regenerators plays a vital role in evaluating system performance and troubleshooting. It provides valuable insights for optimizing operations.
- 5- Thermal imaging of Amine absorbers and regenerators offers a powerful tool for detecting hot spots, fouling, and maldistribution. This enables optimization and troubleshooting, ultimately enhancing system efficiency.
- 6- Promax simulation, with accurate input data, generates reliable results for temperature profiles, loading distributions in Amine absorbers and regenerators, as well as Sour Water stripper columns. Leverage this tool for effective process design and performance analysis.
- 7- Keeping some Heat Stable Salts in the Amine promotes rich Amine regeneration, ensuring low levels of lean loading.
- 5- Over-stripping of Amine poses no risk of corrosion, offering better operating conditions without compromising system integrity.

Typical Amine Treatment Flowsheet

Scaling up Existing Technologies

Amine based CO₂ removal facilities were built were used at various sites with the intention of using the CO₂ for enhanced oil recovery (EOR), urea production and in the food and beverage industry. Capacities varied from 700 to 365,000 tonnes per year, by comparison, a single 550 MW net output coal fired power station capturing 90 % of the emitted CO₂ will need to separate approximately 5 million tonnes of CO₂ per year. Scaling up the existing processes represents a significant technical challenge



A basic amine sweetening process flow diagram [13].

1.1 HISTORY OF SOLVENT-BASED CO₂ CAPTURE

The removal of CO₂ from industrial gas streams is not a new process. Gas absorption processes using chemical solvents to separate CO₂ from other gases have been in use since the 1930s in the natural gas industry. However, concentrations of CO₂ in natural gas are typically much higher than those found in gases resulting from the combustion process, which simplifies separation. The CO₂ partial pressures encountered in flue gas applications (≈ 2 psia [≈ 13 – 14 kPa]) CO₂ in feed flue gas, ≈ 0.26 psia [≈ 1.8 kPa] in treated flue gas) necessitated the use of amine-based processes (see Figure 1-1).

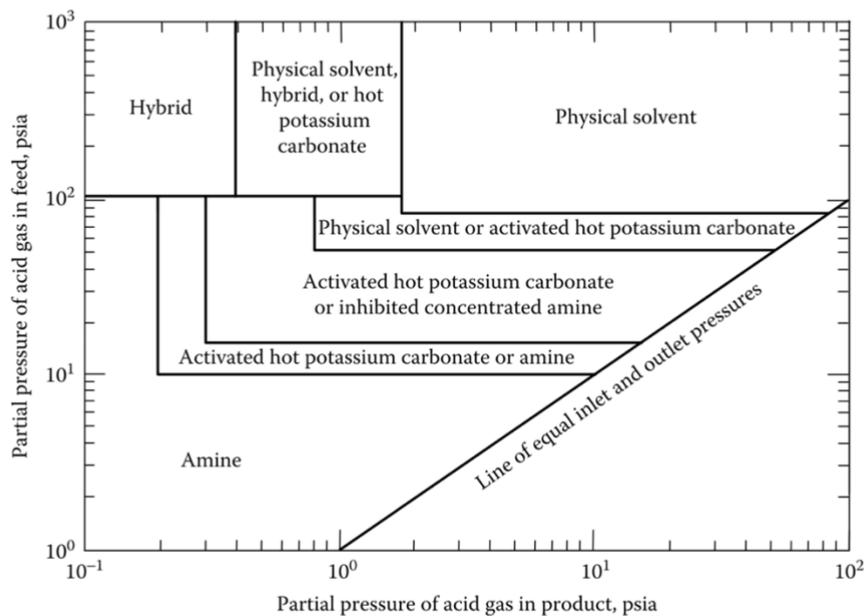


Figure 1-1. Chart for Selecting CO₂ Removal Technologies Available Commercially Before the inception of the DOE/NETL Post-Combustion CO₂ Capture Program. Source: Kidnay and Parrish. ¹ Note that the 'product' in the figure refers to treated flue gas.