Gas Absorption In a Packed Tower

Overall Operation

Process water containing sodium carbonate (Na₂CO₃, or soda ash) flows countercurrent to the flow of the air-CO₂ mixture through the packed tower. A centrifugal pump takes water from a feed tank, and pumps it to the top of the tower. The valve on the outlet side of the pump should be closed when the pump is started. The outlet return line to the fluid tank should also be closed. This allows pressure to build up in the pump. Open the outlet valve to the rotameter for the desired flow rate.

The air to the bottom of the tower is provided by the house air system. The inlet pressure is determined by a regulator, which is set at 25 psig. The inlet valve to the rotameter controls the airflow rate to the packed tower. Pressure taps connected to the differential pressure gauges are located in the air stream at the top, middle, and bottom of the tower.

Carbon dioxide from a high-pressure tank is added to the air stream after the rotameter. Be sure that the heating tape is on to prevent freezing in the CO₂ feed line. To make sure that the CO₂ reaches ambient temperature before entering the tower, it passes through a “warming” coil. The amount of CO₂ added is regulated by its own rotameter.

A GC gas analyzer is provided to analyze the air-CO₂ streams. The air outlet holes at the top of the tower can be plugged to provide higher gas pressure if necessary. Before taking a sample, turn on the gas sample pump. Insert the needle of the syringe into the end of the gas sample tube and draw a gas sample into the syringe. Not more than 0.50 cc should be injected into the GC.

The Henry’s Law constant (atm/mole fraction) for CO₂ in water is given by the following equation:

\[ H_{CO₂} = \frac{p_{CO₂}}{x_{CO₂}} \]

Where \( p_{CO₂} \) is the partial pressure (atm) of CO₂ in the air, and \( x_{CO₂} \) is the mole fraction of CO₂ in water. At 0°C, \( H_{CO₂} = 728 \); at 10°C, \( H_{CO₂} = 1040 \); at 20°C, \( H_{CO₂} = 1420 \); at 30°C, \( H_{CO₂} = 1860 \); and at 40°C, \( H_{CO₂} = 2330 \). Assume that this system obeys Henry’s Law under the experimental conditions.
Equipment Specifications

Column:  6” ID Corning glass pipe – 2 six-foot sections with a liquid distributor plate at the top, a redistributor plate and support plate between the sections, and a support plate at the bottom of the vertical glass pipe.

Packing height: 5.5 feet per section

Packing: Top section – Flexipac type structured packing
          Bottom section – 5/8” polypropylene Flexirings dumped packing

Pump: Oberdorfer model 109 MB, 30 gpm at 30 ft of head (water)

Rotameters:  Air, model 10A3555, SCFM at 8.1 psig, 70°F
             CO2, model 10A3555S, SCFM at 14.7 psig, 70°F
             Water, model 10A3555, 100% = 21.6 gpm at specific gravity = 1.0