

feed gas neutralizes alkalinity of KMnO_4 solution which significantly retards oxidation rates and removal efficiencies. Contaminants such as H_2S , DMS COS, mercaptans impart objectionable taste and odor, even at very low concentrations. Therefore, inefficiencies in oxidative scrubbing are not acceptable.

Precipitation of manganese oxides fouls packing in absorption columns which reduces gas-liquid contacting surface area, thereby rendering the columns to be less efficient and not as cost-effective.

SUMMARY OF THE INVENTION

Accordingly, in a first aspect, the present invention provides an apparatus for removing contaminants from a gas stream. The apparatus includes a container having a reaction chamber therein for receiving the gas stream, a gas-liquid contact assembly disposed in the reaction chamber, and a sump disposed in the reaction chamber beneath the gas-liquid contact assembly. The sump contains a liquid scrubbing agent. A first inlet is in communication with the sump for providing a reactive species to the liquid scrubbing agent in the sump for producing an oxidizing solution. The first inlet is arranged to introduce the reactive species into a liquid phase in the sump. A second inlet is in communication with the reaction chamber for providing the gas stream to the reaction chamber between the gas-liquid contact assembly and the sump. A flow directing assembly is disposed in the sump to direct flow of the liquid scrubbing agent. A feed line having a first end in communication with the sump and a second end having an outlet in communication with the reaction chamber above the gas-liquid contact assembly is provided for

dispensing the oxidizing solution to contact the gas-liquid contact assembly, the gas stream in the reaction chamber and the oxidizing solution in the sump.

In a second aspect, the present invention provides a method for removing contaminants from a gas stream. The method includes (a) introducing the gas stream into a reaction chamber of a scrubber, (b) introducing reactive species into a liquid phase in a sump of the scrubber and oxidizing first contaminants in the liquid phase, (c) providing an oxidizing solution from the oxidizing in (b), (d) oxidizing second contaminants in a gas phase of the gas stream above the sump with excess reactive species disengaging from the oxidizing solution in the sump, and (e) oxidizing and scrubbing third contaminants in a gas-liquid contact assembly disposed above the gas stream. The steps (b) – (e) occur simultaneously.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present embodiments, reference may be had to the following drawing figures taken in conjunction with the description of the embodiments, of which:

FIG. 1 shows known stages of a CO₂ purification and production process for a CO₂ feed gas stream.

FIG. 2 shows known feed gas scrubbing in the pre-compression cleanup stage of FIG. 1.

FIG. 3 shows a feed gas scrubber column according to the present embodiments.

FIG. 4 shows a pre-compression cleanup stage including an ozone based scrubber of the present embodiments.