Abstract

Process Economics Report 216
ACID GAS TREATMENT AND SULFUR RECOVERY
(October 1997)

This report addresses the technology and economics of removing acid gases—H2S, CO2, COS, CS2, and mercaptans—from gaseous process streams and the subsequent conversion of H2S to S for sale or disposal. This topic is especially important now to the process industries because environmental regulations governing the atmospheric discharge of sulfurous gases are becoming increasingly stringent. In another respect, recovered S from petroleum refining and natural gas and mineral processing is now the major source of S for fertilizer production and other industrial applications. In addition to an extensive review of technological developments and process selection guidelines, the report discusses market issues concerning the world supply/demand of S and the prospects for recovered S. These data are valuable to process developers, market researchers, and plant operators.

To illustrate the process economics of acid gas removal and S recovery, we selected the following four representative new or improved process chains for treating four different sour gas streams:

- Refinery gas desulfurization by methyldiethanoamine absorption-Claus S recovery-Hydrosulffreen® tailgas treatment
- Natural gas desulfurization by Sulfinol absorption-Claus S recovery-Super SCOT tailgas treatment
- Synthesis gas desulfurization by Benfield absorption-Selectox S recovery-CBA tailgas treatment
- Natural gas desulfurization by diethanolamine absorption-LO-CAT II® direct H2S oxidation.

We selected these process chains because each has unique features that offer improved acid gas removal efficiency and/or reduction in energy consumption.

Our study findings indicate that a high flowrate sour gas stream containing small amounts of S compounds results in a high S recovery cost on an S weight basis, but a low treatment cost in terms of the sour gas volume treated. In contrast, a low flowrate sour gas stream containing high concentrations of S compounds results in a low S recovery cost on an S weight basis, but a high treatment cost in terms of the unit volume of the treated sour gas. Overall, at today’s depressed market prices for recovered S, the sales value of recovered S is unlikely to be high enough to offset the recovery cost, except perhaps for very large or fully depreciated recovery plants. The shortfall can be considered as an environmental control cost.
## Glossary

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<th>Term</th>
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<tbody>
<tr>
<td>ADA</td>
<td>Anthraquinone-disulfonic acid</td>
</tr>
<tr>
<td>BSR</td>
<td>Beavon sulfur removal</td>
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<tr>
<td>CBA</td>
<td>Cold bed adsorption</td>
</tr>
<tr>
<td>CRU</td>
<td>Claus recovery unit</td>
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<tr>
<td>DEA</td>
<td>Diethanolamine</td>
</tr>
<tr>
<td>DGA</td>
<td>Diglycolamine</td>
</tr>
<tr>
<td>DIPA</td>
<td>Diisopropanolamine</td>
</tr>
<tr>
<td>DMPEG</td>
<td>Dimethyl polyethylene glycol</td>
</tr>
<tr>
<td>EDTA</td>
<td>Ethylenediaminetetraacetic acid</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
</tr>
<tr>
<td>GRI</td>
<td>Gas Research Institute</td>
</tr>
<tr>
<td>G-V</td>
<td>Giammarco Vetrocoke®</td>
</tr>
<tr>
<td>HEDTA</td>
<td>Hydroethylenediaminetetraacetic acid</td>
</tr>
<tr>
<td>IFP</td>
<td>Institut Français du Pétrole</td>
</tr>
<tr>
<td>LPG</td>
<td>Liquefied petroleum gas</td>
</tr>
<tr>
<td>lt</td>
<td>Long ton = 1.016 metric tons = 2240 pounds</td>
</tr>
<tr>
<td>MCA</td>
<td>Methylcyanoacetate</td>
</tr>
<tr>
<td>MDEA</td>
<td>Methyldiethanolamine</td>
</tr>
<tr>
<td>MEA</td>
<td>Monoethanolamine</td>
</tr>
<tr>
<td>MPE</td>
<td>Methyl isopropyl ether</td>
</tr>
<tr>
<td>NMP</td>
<td>N-methyl-pyrrolidone</td>
</tr>
<tr>
<td>NTA</td>
<td>Nitrilotriacetic acid</td>
</tr>
<tr>
<td>PC</td>
<td>Propylene carbonate</td>
</tr>
<tr>
<td>Redox</td>
<td>Reduction-oxidation</td>
</tr>
<tr>
<td>S</td>
<td>Sulfur</td>
</tr>
<tr>
<td>SCOT</td>
<td>Shell Oil’s Claus Off-gas Treatment</td>
</tr>
<tr>
<td>SRU</td>
<td>Sulfur recovery unit</td>
</tr>
<tr>
<td>TBP</td>
<td>Tri-n-butyl phosphate</td>
</tr>
<tr>
<td>TEA</td>
<td>Triethanolamine</td>
</tr>
<tr>
<td>TMP</td>
<td>Tri-n-butyl phosphate</td>
</tr>
<tr>
<td>USBOM</td>
<td>U.S. Bureau of Mines</td>
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