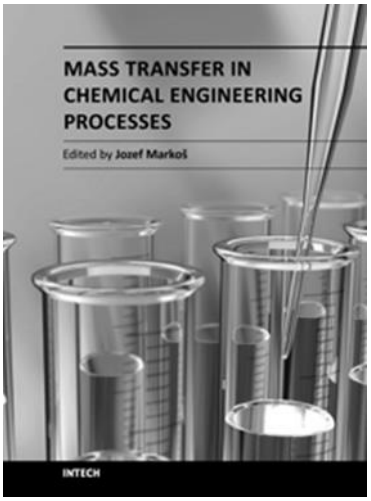
Reseñas Bibliográficas / Book Reviews

Mass Transfer in Chemical Engeering Processes



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Chapter 7 - Removal of H_2S and CO_2 from Biogas by Amine Absorption

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Due to strategic and environmental reasons, currently, there is an increasing interest in biofuels as alternative energy source. Bio-alcohols and biodiesel are the alternatives been considered for auto-motion while biomass and biogas are the alternatives been considered for electrical power generation. Biogas is a medium-energy content fuel derived from the organic material decomposition under anaerobic conditions. It can be obtained from landfills or from bio-digesters that transform manure and biomass into natural fertilizer in farms after 25-45 days of residence time. Due to its gaseous nature and the impossibility of producing it intensively, it is not attractive for large scale power generation. However, recently, a new approach for electric power generation has been emerging. It consists of inter-connecting thousands of small and medium scale electrical plants powered by renewable energy sources to the national or regional electrical grids. It is considered to interconnect the hundreds of the existing small aero generators and solar panels. Even though, there are still several technical issues to be resolved, this alternative of distributed electrical power generation is being considered as the best alternative to bring electricity to the rural communities located far away from the large urban centers.

In this case, the use of the biogas generated in the thousands of existing farms and landfills, as fuel for internal combustion engines connected to an electric generator becomes a very attractive alternative for electric power generation because of its very low cost, high benefit-cost ratio and very high positive impact on the environment. Biogas is made up mainly of methane (CH_4) and carbon dioxide (CO_2). It also contains traces of hydrogen sulfide (H_2S). Its composition varies depending on the type of biomass. To be used as fuel for internal combustion engines, it has been recommended a CH_4 concentration greater than 90%. However CO_2 has a typical concentration of ~ 40%. This high CO_2 concentration reduces the engine power output proportionally to its concentration, limiting the use of biogas in electrical power plants driven by internal combustion engines. The high content of H2S (~3500 ppm) causes corrosion in the metallic parts at the interior of the engine. The H2S is an inorganic acid that attacks the surface of metals when they are placed in direct contact. Sulfur stress cracking (SSC) is the most common corrosive mechanism that appears when the metal makes contact with H_2S. Sulfides of iron and atomic hydrogen are formed in this process.

Typically, small scale power plants based on biogas range from 0.1 to 1 MW. This implies a volumetric biogas flows between 60 and 600 m3/hr. For this small scale application an additional practical consideration arise. Out of the bio-digester or landfill, the biogas gauge pressure is negligible, and due to economical considerations the use of any device to increase pressure should be avoided. Engine suction is the only driving force available to make the biogas to flow from the bio-digester or landfill to the engine. Therefore, the pressure drop across the biogas treatment system should be the least possible. To address this need, the chapter describes the design, manufacturing and testing of a system to reduce H_2S and CO_2 content to less than 100 ppm and 10%, respectively, from 60 to 600 m^3/hr biogas streams, with minimum pressure drop, for applications in small scale power plants (0.1 to 1 MW) based on internal combustion engines fueled with biogas.

Initially, this document describes and compares the existing alternatives to trap H_2S and CO_2 from gaseous streams. From this analysis it is concluded that amines treatment is the most appropriate for this application. Since there is no reported data for the H2S and CO_2 absorbing capacity of these substances, a method is proposed to measure it by means of a bubbler. This information is used in the design process of biogas treatment system. Details of the manufacturing process are also included. Then, results of the experimental work are reported, and finally, an economical analysis on the use of this type of systems is presented.

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