A NOVEL APPROACH TO PRODUCTION OF HYDRATE SLURRIES AT HIGH PROCESS INTENSITY AND CONCEPTUAL APPLICATIONS

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ABSTRACT

Gas hydrates are typically thought of as a flow assurance/drilling hazard and sometimes as a potential energy resource. However, hydrates can be of great industrial use in stable water continuous slurries. Hydrates slurries can be used for gas separation, where CO₂ is captured from gasification processes that produce hydrogen. This separation method can also be used in the upgrading of “sub-quality” high-CO₂ natural gas or “bio-gas” from anaerobic digestion of biomass. Hydrate slurries can be used in a gas storage/peak shaving scenario; here produced natural gas is stored during off peak times and utilized when demand and prices are high. Additionally, the latent heat of these hydrate slurries can be used to chill turbine inlet air, to maximize the load capacity or can also be used for off-peak energy management for residential/commercial cooling systems. Finally, hydrate slurries produced from natural gas may play a role in the development of remote gas fields or the capture of gas flared in association with remote oil production.

The use of hydrate slurries in industrial applications is not new. However, most hydrate slurry studies have utilized lab scale equipments (i.e. scraped tanks) that are not easily scalable to industrial sizes. Marathon Oil Corporation has developed a fluidized-bed heat-exchange gas hydrate reactor and constructed a nominal tonne/day capacity pilot plant, which can be readily scaled to greater than 1500 tonne/day.

In the Marathon pilot plant, hydrate slurries have been generated from pure methane and simulated natural gas mixtures and tested for extended periods (72+ hrs) over a range of formation conditions. Hydrate slurries have been generated with a variety of concentrations greater than 10 wt%. The viscosities of these slurries have been measured as a function of shear rate and were found to be non-Newtonian. Additionally, the Marathon pilot plant has been also used to separate CO₂ from methane. To further this study, various binary methane-CO₂ mixtures were tested over a range of conditions and gas and hydrate phase compositions were measured.

Keywords: gas hydrates, fluidized-bed heat exchanger, rheology, methane-CO₂ separation

INTRODUCTION

Gas hydrates (particularly hydrates in stable water continuous slurries) have many possible applications for industrial use. Some examples of these applications include gas storage and transportation, cooling, and separation.

Gas hydrates are known to store as much as 180 times their volume at standard temperature and pressure [1]. For this reason it has been proposed that gas hydrates could be used for storage of gas.