CO₂ CAPTURE IN FORM OF CLATHRATE HYDRATE – PROBLEM AND PRACTICE

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ABSTRACT

CO₂ capture by hydrate formation is a novel gas separation technology, by which CO₂ is selectively engaged in the cages of hydrate and is separated with other gases, based on differences of phase equilibrium for CO₂ and other gases, for example CO₂ is easier than N₂ to form hydrate with water. Hydrate-based capture of CO₂ is a growth technology of CO₂ capture for the next 10-15 years, which cost can be reduced by 40% to 50%. However, rigorous temperature and pressure, low separation efficiency and high energy cost dragged the development of the CO₂ capture by hydrate formation. In this paper, we analyzing the key problems in CO₂ capture from flue gas and natural gas, and proposed the answer for how to improve the CO₂ separation efficiency. In a practice of CO₂ separation, we added the phase equilibrium data of CO₂, CO₂/N₂ mixture hydrate with TBAB and TBAF, and designed a process to realize the rapid CO₂ separation from CO₂/N₂ mixture gas at room-temperature surroundings through adding accelerator. The results showed that the maximum of CO₂ separation factor was 9.65 with TBAB and 36.98 with TBAF, respectively. CO₂ could be enriched from 16.60 mol% to 90.40 mol% under the low feed pressure only by two stages hydrate formation process with TBAF. The process of CO₂ capture via hydrate formation could be carried out at ambient temperature (20.1 °C) by increasing the TBAF aqueous concentration. The economic analysis of capture of CO₂ from flue gas via two stages TBAF hydrate formation displayed that for 1000 MW power plant the energy consumption of capture of CO₂ via hydrate was 0.57 kW·h/kg-CO₂ or 2.05 MJ/kg-CO₂. The energy consumption of capture of CO₂ was mainly caused by the compression process that was 66.3% of entire process.

In the case of CO₂/CH₄ system, the bottleneck is how to selective increase the CO₂ hydrate kinetic rate. It is not obtained satisfactory solution. In our study, we found in order to separate the CH₄/CO₂ mixture gas, the operating pressure should far away from the boundary line of methane, and the gas-water ratio should keep small.

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