Cryogenics 102 (2019) 85–104

Contents lists available at ScienceDirect

Cryogenics

journal homepage: www.elsevier.com/locate/cryogenics

Review article

Thermodynamic data for cryogenic carbon dioxide capture from natural gas: A review

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ARTICLE INFO

Keywords:
Natural gas
Cryogenic technology
CO_2 removal
Phase equilibria
Hydrocarbons

ABSTRACT

The increasing global energy demand has compelled the researchers to utilize the undeveloped contaminated natural gas (N.G) reservoirs. However, due to the emissions standards established by environmental regulatory authorities, N.G treatment has become more crucial. Amongst the established CO_2 separation strategies, the cryogenic CO_2 removal techniques are promising due to environmentally friendliness, high N.G purification, low footprint values, no chemical reaction involved and capable of handling N.G with high CO_2 content. Design and operation of a cryogenic process require accurate thermodynamic knowledge along with the understanding of the phase behavior of CO_2 with light alkanes to make the process cost–effective. Furthermore, the study of frosting and liquefaction behavior of CO_2 or CO_2–alkanes mixture is significant for the energy minimization and smooth operation of the cryogenic CO_2 removal from N.G. This paper provides a critical review of the available experimental and predicted thermodynamic data for CO_2–alkanes mixtures at different conditions. The significance of pressure–temperature (PT), pressure–composition (P–xy), and temperature–composition (T–xy) phase diagrams for CO_2–alkane mixtures are discussed in this paper. This paper also describes the use of the equation of states (EoS) for predicting the thermodynamic phase behavior of the CO_2 mixtures. This review will help the researchers in designing more efficient, economical, and sustainable cryogenic CO_2 capture processes.

1. Introduction

From the last few decades, the world is fastly becoming a global village due to the increasing energy requirement across the world. The energy and its related services are significant to satisfy human social and economic developments. Currently, CO_2 emission from the energy sources and environmental issues have attracted global concern. Nowadays, renewable energy sources are becoming the most significant energy wellsprings. However, as these technologies are still in the nascent stages, therefore are unable to fulfill the high energy requirement of the 21st century. Hence, for the next few decades, fossil–based fuels will be dominant over the other energy sources of the world [1-3]. Among the fossil fuels, natural gas (N.G) is considered as the cleanest fossil fuel and has become one of the primary global energy sources [4-6]. The projected average annual rise in N.G consumption from 2002 to 2030 is around 3.4% [7]. Although N.G is considered as an environmentally friendly fuel, still, its quality strongly depends upon the geological conditions, deposit type, and the well–depth [8]. N.G primarily consists of Methane along with some higher hydrocarbons (H.C), and contaminants like CO_2, N_2, H_2S, and He [9]. CO_2 is one of the major greenhouse gases in N.G, and its concentration may vary from 5% to 90% [10-15]. Malaysia alone has about 13 trillion standard cubic feet (136.11 cubic kilometers) of unexplored high CO_2 content (87 mol %) N.G reservoirs [16]. The acceptable standard specification for CO_2 in N.G is usually less than 2% to avoid pipelines corrosion and other environmental problems [17-21]. Fig. 1 presents the standard U.S pipeline specifications for N.G delivery. Therefore, the removal of CO_2 from the N.G is vital for improving the N.G quality and production of

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https://doi.org/10.1016/j.cryogenics.2019.07.004
Received 25 March 2019; Received in revised form 29 June 2019; Accepted 17 July 2019
Available online 17 July 2019
0011-2275/