JREE: Vol. 4, No. 2&3, (Spring & Summer 2017) 56-67

Journal of Renewable Energy and Environment

Journal Homepage: www.jree.ir

Research Article

Solar Heat Utilization in Separation Column Reboilers Case Study: Amine Regenerator in South Pars Gas Complex, Assalouyeh

Morteza Keshavarz, Behnam Mostajeran Goortani*

Department of Renewable Energy Engineering, University of Isfahan, Isfahan, Iran.

P A P E R I N F O

Paper history:
Received 15 Jun 2018
Accepted in revised form 9 September 2018

Keywords:
Non-equilibrium Model
Amine Regenerator
Concentrated Solar heat
Heat Storage
Angstrom Model

A B S T R A C T

The amine regenerator of acid removal unit in South Pars Gas Complex, Assalouyeh, Iran was modeled. This model was fitted to assess the large scale columns and allow application of solar thermal energy for production of low pressure steam. Heat transfer fluids including Therminol oil, sulfur, or salt melt could be applied to yield thermal energy from a solar collector and to store and transfer it to the reboiler of columns. The Angstrom model was adopted here to simulate solar irradiance. Solar irradiance data for the city of Assalouyeh, during the years of 2009-2014, were collected and applied. The results indicated that based on a reboiler duty of around 21.8 MW, a solar collector area of 148,000 m^2 was required with a mass of heat transfer and storage medium of 1247255 kg oil, 1787732 kg salt melt and 3803686 kg sulfur, respectively. This model was applied as an analytical tool to explore and describe the following two problems encountered during real plant operation: fouling in the amine heat exchangers and increasing regenerator pressure.

1. INTRODUCTION

Although high volume of solar thermal energy is available in the most parts of the earth, fossil fuels are still the major energy for providing the requirements of different industries. A possible explanation of this drawback is that most industries were born with burning fossil fuels. The increasing in knowledge of researchers in this field regarding renewable sources of heat such as solar may be a solution towards resolution of this drawback. Meanwhile, distillation and regeneration columns consume about 40% of the total energy of these industries [1].

It is necessary to develop methods for energy reduction and move towards sustainable processes. Solar thermal energy is harvested and concentrated through collectors to produce hot water or low pressure steam, the major type of heating source consumed by aforementioned separation processes. Tora et al. studied the integration of solar heat into industrial processes where, hot water tanks are applied to handle the dynamic nature of solar heat and determine the optimal mix of energy types (solar versus fossil) [2]. Integration of parabolic trough solar collectors for production of low pressure steam applied in different industries had been assessed in [3].

*Corresponding Author's Email: b.mostajeran@ast.ui.ac.ir (B. Mostajeran)

Pendaya presented a non-equilibrium model for absorption columns by assuming ideal liquid and vapor phases [4]. Pacheco and Rochell) considered a variable with temperature kinetics for CO_2 absorption inside packed columns [5]. Bolhar et al. assumed two film resistances in the absorption columns [6]. Gabrielsen et al. presented a non-equilibrium model for packed-bed absorption columns assuming equilibrium reactions [7]. Godini and Mowla combined experimental and theoretical studies for examining the absorption of H_2S and CO_2 gasses. They found that although CO_2 is a weak competitor against H_2S, liquid-vapor flow rate ratios are involved in absorption selectivity [8].

Mostajeran et al. presented a flexible three-phase non-equilibrium model for energy efficient reactive distillation columns applied in oil and gas industry [9]. Khan et al. experimentally studied four aqueous amine solvents including MEA, AMP, MDEA, and PZ, as an absorbent for post-combustion CO_2 capture through chemical absorption processes, in a packed column [10]. Yu et al. studied CO_2 absorption process by consuming NH_3/PZ blended solutions in a packed column, and developed and validated a rate-based model for NH_3–PZ–CO_2–H_2O system [11]. Spek et al. developed a model in Procedé Process Software (PPS) environment to study CO_2 capture with a blend of AMP and PZ. This model was a rigorous process simulation model, where the gamma-phi approach was applied to describe vapor-liquid equilibrium (VLE), and the two-film model to