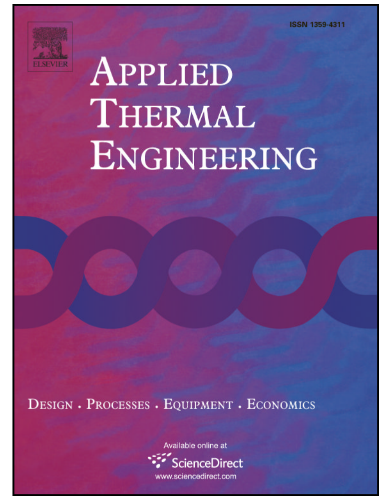
Accepted Manuscript



Entropy Generation Minimisation of Shell-and-Tube Heat Exchanger in Crude Oil Preheat Train using Firefly Algorithm

Moses Omolayo Petinrin, Tunde Bello-Ochende, Ademola Adebukola Dare, Miracle Olanrewaju Oyewola

PII: S1359-4311(18)32615-2
DOI: https://doi.org/10.1016/j.applthermaleng.2018.09.045
Reference: ATE 12654

To appear in: *Applied Thermal Engineering*

Received Date: 30 April 2018
Revised Date: 23 July 2018
Accepted Date: 8 September 2018

Entropy Generation Minimisation of Shell-and-Tube Heat Exchanger in Crude Oil Preheat Train using Firefly Algorithm

Moses Omolayo Petinrin[a,b], Tunde Bello-Ochende[a,*], Ademola Adebukola Dare[b] and Miracle Olanrewaju Oyewola[b]
[a]Department of Mechanical Engineering, University of Cape Town, Cape Town, South Africa
[b]Department of Mechanical Engineering, University of Ibadan, Ibadan, Nigeria

[*]Corresponding author: tunde.bello-ochende@uct.ac.za

Abstract
This paper presents the entropy generation analysis and optimisation of typical shell-and-tube heat exchanger in the preheat train of crude oil distillation unit. The implication of entropy minimisation on energy consumption associated with design of heat exchanger was studied. The developed optimisation model was solved by employing the firefly algorithm. A number of constraints were applied with thirteen decision variables. The ε-NTU method and Delaware method were used for the heat exchanger design. Four cases were considered for each of two selected samples and were categorised under two studies. Total entropy generation rates for all the four cases considered were almost the same, and the dominant irreversibility distribution is by heat transfer. However, the sharp decrease in entropy generation due to fluid friction caused a great reduction in pumping power in the range of 51.4 to 82.1% and 54.8 to 92.2% for the two studies, respectively. The results of sensitivity study on the decision variables showed sharp reduction in entropy generation rate and increased pumping power as the mass flow rate increases for all the variables. Also, the choices of the tube diameter and tube number had greater impact on the changes in entropy generation rate and pumping power.

Keywords: shell-and-tube heat exchanger, preheat train, entropy generation rate, firefly algorithm, pumping power

1. Introduction

Crude oil is one of the most exploited global energy resources and is refined into different forms of consumer products, such as fuels and other petrochemical products for human use. The crude oil, which is normally preheated in a network of heat exchangers, is separated into its fractions of lower hydrocarbons in refineries from the crude oil distillation unit (CDU) [1]. It is recorded that about 5-6% of the refinery fuel is consumed for refining purposes while nearly