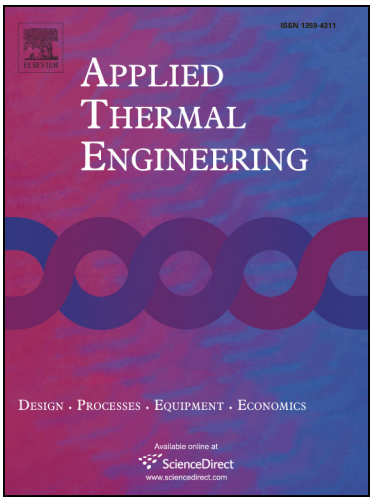

Development and experimental investigation of an oil-free twin-screw air compressor for fuel cell systems

Yongning He, Linfen Xing, Yeqiang Zhang, Jun Zhang, Feng Cao, Ziwen Xing

PII: S1359-4311(17)37747-5
DOI: https://doi.org/10.1016/j.applthermaleng.2018.09.064
Reference: ATE 12673

To appear in: *Applied Thermal Engineering*

Received Date: 6 December 2017
Revised Date: 6 August 2018
Accepted Date: 14 September 2018

Please cite this article as: Y. He, L. Xing, Y. Zhang, J. Zhang, F. Cao, Z. Xing, Development and experimental investigation of an oil-free twin-screw air compressor for fuel cell systems, *Applied Thermal Engineering* (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.09.064

Development and experimental investigation of an oil-free twin-screw air compressor for fuel cell systems

Yongning He [a], Linfen Xing [a,b,*], Yeqiang Zhang[a] , Jun Zhang [a] , Feng Cao[b], Ziwen Xing [b]

[a] School of Energy and Power Engineering, Zhengzhou university of light industrial, 5 Dongfeng Road, Zhengzhou 450002, China

[b] School of Energy and Power Engineering, Xi'an Jiaotong University, 28 Xianning West Road, Xi'an 710049, China

A B S T R A C T

Compressor in air supply circuit influences flow rate of oxygen in cathode of polymer electrolyte membrane (PEM) fuel cell systems. In this paper, an air-cooled dry oil-free twin-screw compressor for fuel cell systems was developed and adopted successfully in a type of truck with fuel cell system. Extensive experimental investigations including the recording of *p*-*V* indicator diagram were carried out to study the performance of the prototype compressor. Rotation speed of the female rotor varied from 5000 rpm to 10000 rpm, and discharge pressure from 0.14 MPa to 0.22 MPa. It was found that the volume flow rate decreases almost linearly with the reduction of rotation speed and this is beneficial to the fuel cell systems under part-load. Between speed of 7000 rpm and 10000 rpm at a given discharge pressure, the variations of isentropic efficiency and specific power are very limited. This indicates the twin-screw compressor can operate efficiently in a wide range of power output from the fuel cell systems. Under the design conditions with discharge pressure of 0.2MPa and female rotor rotation speed of 9000 rpm for a fuel cell output of 50kW, the volumetric efficiency and isentropic efficiency of the prototype compressor developed are 70% and 55% respectively. And the mechanical efficiency and the polytropic process index regarding to discharge temperature are 80% and 1.58. These values can be used in the design of other air-cooled dry oil-free twin-screw compressors for similar applications.

Key words: air supply, fuel cell system, oil-free, twin-screw compressor

1. Introduction

Fuel cell technologies have received much attention owing to their high efficiency and low emission. Its application in vehicle can decrease the usage of gasoline and control emission of greenhouse gas. PEM fuel cell systems have lower operation temperature, higher power density and easy scale-up. Those features make PEM fuel cell systems a promising power source for portable application, such as various kinds of vehicles [1].

For a typical PEM fuel cell system, hydrogen and oxygen is often used in anode and cathode respectively [2]. Hydrogen supply circuit and oxygen supply circuit are two key circuits of a fuel cell system. Air compressor is used to provide compressed air in the oxygen supply circuit. The compressor is driven by a motor which consumes the power of fuel cell system. So its power consumption and air flow rate have great effect on the performance of fuel cell system [3].

The main types of compressors used in PEM fuel cell systems include centrifugal compressors, scroll compressors, lobe compressors and twin-screw compressors. Centrifugal compressors have great advantages of compactness and low noise when compared with the positive displacement compressors. However, there are great challenges in their bearings and