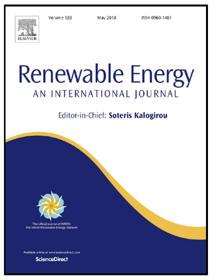
Accepted Manuscript



Air-Cooled fuel cells: keys to design and build the oxidant/cooling system

A. De las Heras, F.J. Vivas, F. Segura, M.J. Redondo, J.M. Andújar

PII:	S0960-1481(18)30221-0
DOI:	10.1016/j.renene.2018.02.077
Reference:	RENE 9808
To appear in:	*Renewable Energy*
Received Date:	06 June 2017
Revised Date:	07 November 2017
Accepted Date:	17 February 2018

Please cite this article as: A. De las Heras, F.J. Vivas, F. Segura, M.J. Redondo, J.M. Andújar, Air-Cooled fuel cells: keys to design and build the oxidant/cooling system, *Renewable Energy* (2018), doi: 10.1016/j.renene.2018.02.077

AIR-COOLED FUEL CELLS: KEYS TO DESIGN AND BUILD THE OXIDANT/COOLING SYSTEM

A. De las Heras, F.J. Vivas, F. Segura, M. J. Redondo, J.M. Andújar.
Grupo de Investigación de Control y Robótica TEP-192,
Departamento de Ingeniería Electrónica, de Sistemas Informáticos y Automática,
Escuela Técnica Superior de Ingeniería, Universidad de Huelva.
Carretera Huelva - Palos de la Frontera. 21819. La Rábida - Palos de la Frontera. Huelva, Spain

Abstract – **In the field of energy, hydrogen as an energetic vector is becoming increasingly important. Specifically, fuel cells powered by hydrogen are becoming an alternative in automotive and other fields because of their ability to produce electricity without any pollution. Therefore, at this time there is a very active research field. A fuel cell can be described as a scale down industrial plant that consists of different subsystems whose purpose is to make the stack works properly. Air Cooled Polymer Electrolyte Fuel Cells (AC-PEFC) are receiving special attention due to their potential to integrate the oxidant and cooling subsystems into one, which in term gives the fuel cells their capability to reduce its weight, volume, cost and control complexity. In these ~~kind of~~ fuel cells, the Oxidant/Cooling subsystem is of crucial importance and along with three others (*Fuel*, *Electrical* and *Control* subsystems) make up the Balance of Plant (BoP), which together with the stack comprise the full fuel cell system. The aim of this paper is to present a comprehensive experimental study of an AC-PEFC paying particular attention to the Oxidant/Cooling subsystem configuration. According to the scientific literature, this subsystem has not received the same attention as other subsystems like the *Fuel* and *Control* subsystems. However, a suitable design and size is critical for the proper functioning of the stack. The analysis carried out in this paper tries to solve some problems that can appear if the design of the Oxidant/Cooling subsystem has not been optimized. These problems are related to important aspects such as the performance and the efficiency of the whole system and temperature distribution over the stack.**

Keywords: Air Cooled Polymer Electrolyte Fuel Cell, BoP configurations, Oxidant/Cooling subsystem design, Experimental study, Performance improvement.

1. INTRODUCTION

Polymer Electrolyte Fuel Cells (PEFCs) **are** a promising technology to produce electricity from hydrogen for stationary power generation due to its operational strength such as high power density, low operating temperature, low corrosion, quiet operation, stack design simplification, relatively quick start up and shut down and especially by its zero emission capability [1]–[4]. In the past decades, there has been a huge progress in the PEFC field but researchers are still focused on new cell designs, cost reduction and performance improvement. PEFC technology is having more and more importance because it is suitable for a wide range of applications, including portable, stationary and automotive power delivery [5]–[8] and lately it is being more used in backup systems for emergency situations (e.g. earthquakes, terrorist attacks). Configuration or hybridization of generation systems around the PEFC can be miscellaneous [6], [7], [9] as well as its control modes [10].

For the configuration of a PEFC system, apart from the stack it is necessary to include additional subsystems for the proper system operation. Generally these systems can be divided into five main groups which form the Balance of Plant (BoP): 1- Oxidant subsystem: it supplies air/oxygen at the appropriate conditions for the oxidant reaction, 2-Fuel subsystem: it supplies hydrogen at the appropriate conditions for the reduction reaction, 3-Cooling subsystem: it removes the heat produced in the stack and keeps it at the temperature recommended by the manufacturer and removes the water produced, 4-Electrical subsystem: it connects the stack to electric load, and 5-Control subsystem: it processes information from sensors so as to control the actuators, Figure 1 [11]–[13].

When it comes to develop a PEFC system, researchers conclude that an appropriate design of the BoP is essential to the proper PEFC stack operation and influences on the performance of the whole system. Therefore, according to the BoP design, it is important to optimize the main subsystems avoiding an oversized BoP configuration which usually results in an increase of parasitic losses, system volume, weight and noise level [14].