

A novel heat exchanger including hydrogen and water for heat capturing and combating water scarcity

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Abstract— In today's world, people have been facing different unpleasant phenomena like global warming, water shortage and thermal pollution. Power plants for electricity generation are from the main sources of greenhouse gases and thermal pollution in aquatic ecosystem. On the other hand, these power plants consume high amount of freshwater for cooling purposes. Water scarcity is a detrimental crisis that the whole world is struggling with it. To combat the thermal pollution, various wet cooling and dry cooling technologies have been introduced and reviewed till today. While wet cooling systems use lots of water, dry cooling ones are not suitable options in warm weather and climates. Here, the need for an alternative element is felt more than ever. So far, water and air have been the main coolants in power generation units. According to specific heat capacities in different substances, hydrogen, by far has the highest amount. So, an novel heat exchanger containing hydrogen and water could be a promising solution for the mentioned issues. This paper focuses on advantages of this heat exchanger from different points of view, however, some assumptions, considerations and calculations should be carried out to have the best performance for this idea. Temperature control is such an important process that should be done in heat exchangers. Hence, a review on a control method has been carried out in this paper. The simulation results have been taken by MATLAB/SIMULINK software.

I. INTRODUCTION

The Earth has faced a rise in human population and an increasing demand on Earth's natural resources is being occurred. The possibility of begetting a human settlement on other planets is far-fetched in our universe. Hence, the key goals for our society are protecting the environment for next generations and identifying opportunities for transition to global sustainability. Currently, we are dealing with climate change, which causes damage to the environment and human health. Our burden is the reduction of climate change and

providing the clean environment again for next generations [1].

In the last few years, the connection between water energy and electricity production has drawn lots of attention. In a period of 60 years until the end of 2010, water use by the power industry has increased 18-fold globally because the power capacity has been extended rapidly. So the efficiency improvement of the water used in power generation has become an instantaneous issue in some countries suffering from water scarcity [2], [3].

While electricity generation is accountable for a fourth of the world's greenhouse gas emissions, lots of freshwater is consumed by these power plants. According to statistics, it is expected that the required water for power generation will be gradually increasing in the future [4].

Among fossil fuel options, Coal is the main source of energy for power generation around the world [2]. Coal-fired power generation consumes nearly 6 out of 10 of all water use in the electricity sector. On the other hand, Considering the statistics, power generation from coal-fired power plants (CPP) has the share of roughly 50% of global electricity generation (International Energy Agency, 2016). It is predicted that there will be a conflict between coal-fired power generation and other substantial water consumers in the near future [2]. Some studies show an increase of 18% in water consumption during 2 decades from 2010 to the end of 2030. [5]. Water scarcity would be a significant concern in the future [6] and water footprint analysis on power system is a significant indicator for its sustainability [7].

The amount of water consumption for electricity generation is intensively related to the cooling technologies in power plants [2], [8]. Some specific factors like affluence, geographic location, and water availability are essentially impressive in the selection of cooling technologies. For instance, it is difficult to use seawater cooling in inland areas [9]. As the economy and population grow, whether or not, demand for