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Seminarium Zakładu Energetyki Jądrowej i Analiz Środowiska (UZ3) Departament Badań Układów Złożonych (DUZ)

Wtorek: **11.05.2021**
11:30

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Optimization of the DC magnetohydrodynamic pump for the Dual Fluid Reactor

Abstract:

The Dual Fluid Reactor (DFR) is a new nuclear reactor concept which consists of two separate loops with liquid medium - coolant and fuel. It is an innovative design that is expected to have a high operating economy due to its high operating temperature. During the presentation, a magnetohydrodynamic pump for a dual fluid reactor in which both loops contain liquid metals will be discussed. Since the fuel loop of the reactor uses Uranium - Chromium (U-Cr) eutectic whose temperature can reach 1300 °C, a pump able to withstand high temperatures, corrosion and erosion must be used. Such a device is the magnetohydrodynamic pump, which forces the flow of liquid metal by means of a current and an electromagnetic field. The approach of modelling a direct current conduction magnetohydrodynamic pump using the analytical Equivalent Circuit Method (ECM) will be thoroughly described. This method was originally developed in a study of an experimental MHD pump to propose a model by which the pressure rise generated on the pump can be calculated. It is also possible to use the ECM method to calculate other parameters of the MHD pump at a given pressure drop, which has been done and will be presented.

Reference databases were used to validate the author's implementation of the ECM method and were used to provide information on an exemplary DFR reactor for which a MHD pump was designed. Moreover, the application of the metaheuristic method to optimize the above magnetohydrodynamic pumps for minimizing the magnitude of the feed current will be discussed. The key effects of current flux and pump length on the optimal pump geometry will also be presented. It was observed that for certain fluids there are critical values that can serve as design values for specific MHD pump applications. These values will be discussed during the presentation. Moreover, in order to propose more universal pump design models, a space of 1024 input points was generated based on reference values of the databases such as temperature, pressure drop, cross-section, fluid velocity, and magnetic induction. The results of the metaheuristic analysis performed to obtain a set of 1024 pumps with optimized geometries for minimum input current will be presented.

Finally, the application of the multiple regression method, which was used to obtain linear models allowing the estimation of the MHD pump dimensions based on the input parameters, will be discussed.

Serdecznie zapraszamy
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