Karlsruher Institut für Technologie

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Bachelorarbeit

Gas flow balancing for the DEMO inner fuel cycle

In Europe, a lot of efforts are ongoing to develop fusion power plants. Major goal of these developments is the generation of electricity for the grid by 2050. This requires the start of the detailed engineering phase of all machine systems by around 2020. One important system that is currently under development at KIT is the inner fuel cycle. The whole fuel cycle comprises a large number of sub-systems like vacuum pumps, fuel storage systems and a gas process facility.

Tools that helps engineers in the development of the power plants are so-called system codes. In these codes, simple equations are used for size- and performance calculations of all systems. For example, the knowledge of the flow rates and the gas composition between the fuel cycle sub-systems is essential for a proper design of the machine. Though system codes are extensively used in the fusion community, the fuel cycle is not yet included probably in any available code. This gap shall now be closed.

In a first step in this work, an assessment of the DEMO fuel cycle shall be done. The fuel cycle must then be described using balancing equations and simple descriptions of all major sub-systems. In the end, a well-documented set of equations shall be elaborated that can easily be implemented into a system code for the calculation of the desired output information.

Tab. 1 shows a list of the most important input- and output information that shall be used for this work. All equations must be implemented in e.g. an Excel-File and fed with some realistic default values to demonstrate the feasibility of the developed calculation procedure. This file can then be used for parametric studies.

Tab. 1: Summary of the most important input- and output parameters.

Input parameters	Output parameters
• Required fusion power and dwell time.	
• Engineering information (e.g. processing times for all gas species in the sub-systems, separating performances, vacuum pump performances, system volumes and surface areas).	• Required pumping speed, number of pumps and -ports.
• Physics information (gas composition in core and divertor, fuelling efficiency, bypass in the scrape-off layer and divertor, gas required for plasma control).	• Gas flow rates and -compositions between the fuel cycle sub-systems.
• Vacuum system information (e.g. outgassing rates, transmission probabilities, pump-down information).	• Tritium- and deuterium inventories in all sub-systems.

The work will be done at campus north and has to be written in English. An office, a computer and a model of the fuel cycle will be provided.

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