125 MM SODIUM LOOP FOR SCALED DOWN 4-TH GENERATION NUCLEAR REACTOR THERMO-HYDRAULIC EQUIPMENT TESTING

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Abstract: In the context of the 4th generation nuclear reactors development a considerable interest exists on the stability of the sodium Electro-Magnetic Induction Pumps (EMIP). The MHD instability, which is known already since 70ies may occur in EMIPs with highly conductive materials, like sodium. This instability leads to formation of contra verse flow, pressure losses and limited usage of EMIP. Experimental investigations of this instability are planned in newly installed 125 mm sodium loop.

1. Introduction

Large scale induction electromagnetic pumps are foreseen to be used in ASTRID (Advanced Sodium Technological Reactor for Industrial Demonstration) protoype [1]. A model facility is being built in CEA Cadarache, called PEMDYN to support theoretical developments in EMIP design.

There are many investigations devoted to the development of large scale annular linear induction pumps (ALIP). The instability criterion has been theoretically derived in [2], the boundary between flow stability and instability has been determined experimentally in [3], experimental and numerical results are compared in [4, 5]. While qualitative agreement between theoretical predictions and experiment can be observed, a more detailed analytical study [6] and experiment with controlled velocity/magnetic field perturbation implementation is necessary to deepen the understanding of the instability mechanisms in EMIP.

2. Description of the experiment

To investigate the stability of the EMIP a 125 mm sodium loop has been built at the Institute of Physics of the University of Latvia (IPUL). The principal scheme of the measuring and control system of the loop DN – 125 is shown in fig 1.

The loop is equipped with two electromagnetic switchable induction pumps providing a liquid metal flow rate up to 150 l/s^{-1} at discharge pressure of 4.4 bars. Two flow meters - of the induction types and a Venturi tube are installed on the loop. The working temperature of the loop is 200° C - 500° C. To control the temperature of the loop, it is equipped with three component (LM-Oil-H_2O) heat exchanger with maximum cooling power 120 kW. The cooling power is controlled by the oil level in the ring-like channel. The control range is 2-120 kW at sodium temperature of 300° C.

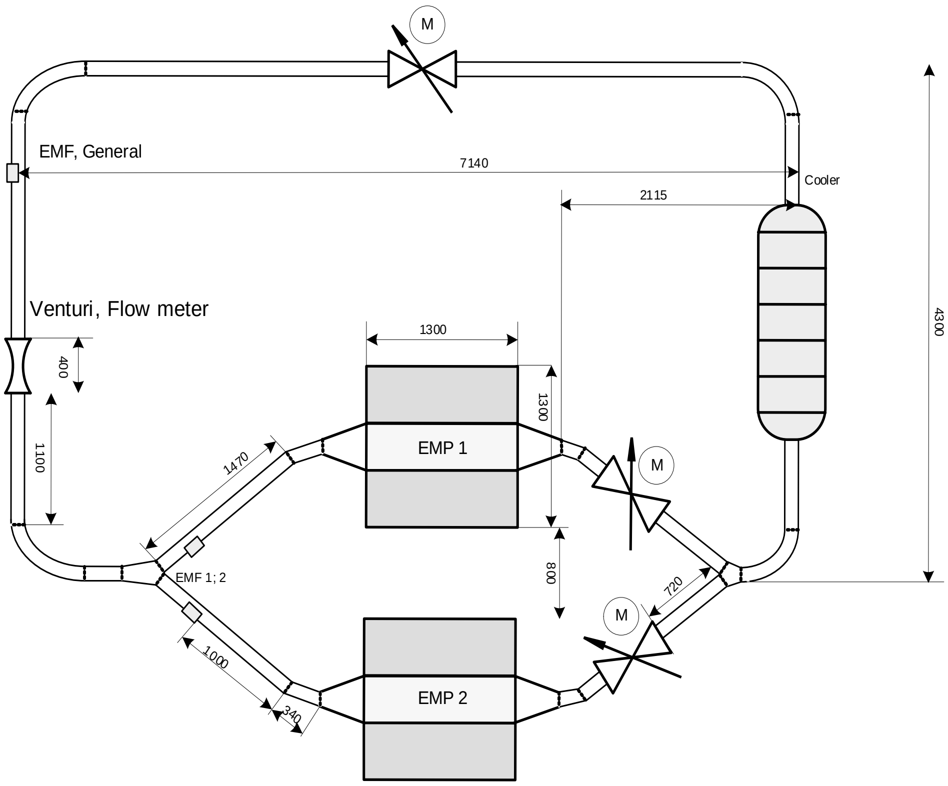

Figure 1: Principal scheme of the measuring and control system of the loop DN – 125.

The overall view of the sodium loop DN – 125 with one installed electromagnetic pump is shown in fig 2.

Figure 2: View of the sodium loop DN – 125.

The channel of the EMIP is equipped with magnetic field, potential and temperature sensors for determination of the distributions of these fields (fig 3.). Up to 144 magnetic coils are foreseen to determine the distribution of the magnetic field. These distributions are to be compared with analytical and numerical results of the stability analysis of EMIP [6].
The inlet zone of the channel serves as a perturbation forming region for controlled velocity distribution. This will allow more detailed comparison of experimental data with predictions of theoretical models.

Three experimental measurement sessions are planned in 2014.-2015.

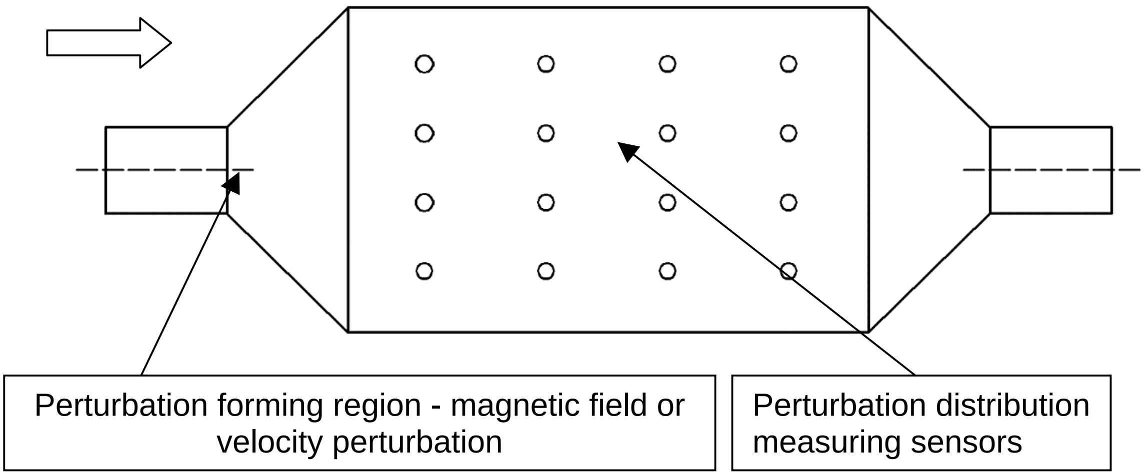

Figure 3: Channel inlet zone and sensor location.

3. Conclusion

A 125 mm sodium loop has been built at the Institute of Physics of the University of Latvia (IPUL) with controlled velocity/magnetic field perturbation implementation in the channel inlet zone and a large number of sensors in the channel zone for detailed comparison of analytical [6] and experiment results to deepen the understanding of the instability mechanisms in EMIP.

4. References

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