AN EXPERIMENTAL STUDY OF FUEL ROD VIBRATIONS OF THE NEPTUNE REACTOR

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These days, a new research neutron source – a periodic pulse reactor with neptunium nuclear fuel, is being designed at the Frank Laboratory of Neutron Physics (JINR). Since it is necessary to produce the highest possible neutron flux, the reactor power must be about 10–15 MW [1]. It is known that periodic pulsed reactors can exhibit dynamic instability at high power, which is caused by thermoelastic deformations of the active zone and reactivity feedback [2]. A mathematical model of reactor dynamics that takes into account transverse vibrations of fuel rods contains parameters that need to be measured in an experiment with full-scale fuel rod simulators [3].

The work provides a description of the vibration diagnostics stand for model fuel rods of the NEPTUNE reactor, measuring equipment and the first measurement results. The model fuel rod is an exact copy of the fuel rod of the designed reactor with the replacement of fuel pellets with imitators made of tungsten alloy of identical mass. The test stand has replaceable mounting bushings, which allows studying different methods of fastening fuel rods, as well as a casing for measurements in liquid (fig. 1). At this stage, electromagnetic sensors with a sealed housing and allowing operation under water were chosen as motion sensors. The calibration of the equipment made it possible to measure the natural frequency of free vibrations of the fuel rod and the attenuation time. The results are consistent with numerical and analytical calculations using the added mass model. Since the fuel rod has many internal elements and allows for their mutual movement, additional verification of the calculation model is required. For this purpose, numerical calculations are carried out in full geometry, taking into account the interaction of internal elements.

For further experimental studies of transverse deformations of fuel rods, it is planned:

- measurements with different types of fuel rod fastening;
- study of the mechanical interaction of several fuel rods in a liquid;
- modernization of the test stand and measuring equipment (search for other types of sensors, development of a fuel rod excitation device, creating conditions for measurements at high temperatures, etc.).

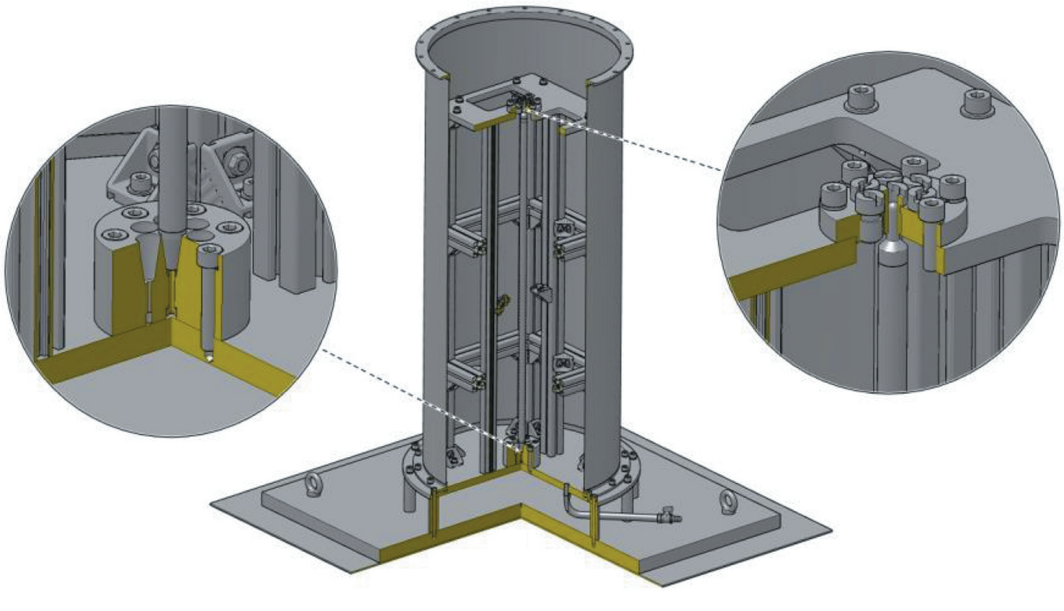

Fig. 1. Sketch of a test stand for vibration diagnostics of fuel rods

References

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