Training Reactor of the Budapest University of Technology and Economics

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OVERVIEW

LAYOUT

FLUX DENSITY and DOSE-RATE DATA

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OVERVIEW

The training reactor of the Budapest University of Technology and Economics is a swimming pool type reactor located at the university campus.

The training reactor was designed and built between 1969 and 1971, by Hungarian nuclear and technical experts. It first went critical on May 20, 1971. The maximum power was originally 10 kW. After upgrading, which involved modifications of the control system and insertion of one more fuel assembly into the core, the power was increased to 100 kW in 1980.

The main purpose of the reactor is to support education in nuclear engineering and physics; however, extensive research work is carried out as well. Neutron irradiation can be performed using 20 vertical irradiation channels, 5 horizontal beam tubes, two pneumatic rabbit systems and a large irradiation tunnel.

The reactor core is made up of 24 EK-10 type fuel assemblies, which altogether contain 369 fuel rods. The fuel is 10%-enriched uranium dioxide in magnesium matrix. The pellets are filled into aluminium cladding at a length of 50 cm. The total mass of uranium in the core is approximately 29.5 kg. The horizontal reflector is made of graphite and water, while in vertical direction water plays the role of reflector. The highest thermal neutron flux is 2.7×10^{12} n/cm^{2}s, measured in one of the vertical channels.

Seven measuring chains are applied for reactivity control and power regulation. The detectors are ex-core ionization chambers, two of which operate in pulse mode in the startup range, four operate in current mode and one is a wide range detector. In all power ranges doubling time and level signals can invoke automatic scram operations.

The reactor is operated when required for a student laboratory exercise or a research experiment. Accordingly, operation at 100 kW power for many hours is quite rare; on the average, it occurs once a week. As a fortunate consequence, burnup is very low: only 0.56% of the ^{235}U has been used up and 3.4 g ^{239}Pu and 12.3 g fission products have accumulated. Therefore, there has been no need to replace any of the fuel assemblies since 1971.

The reactor is used, among others, in the following fields:

- activation analysis for radiochemistry and archeological research
- analysis of environmental samples
- determination of uranium content of rock samples
- biomedical applications (BNCT)
- nuclear instrument development and testing
- experiments in reactor physics and thermohydraulics
- development and testing of neutron tomographic methods for safeguards purposes
- development of noise diagnostic methods, isotope production and investigation of radiation damage to instruments/equipment

Currently not available

Fig. 10. Vertical Cross-section of the Reactor

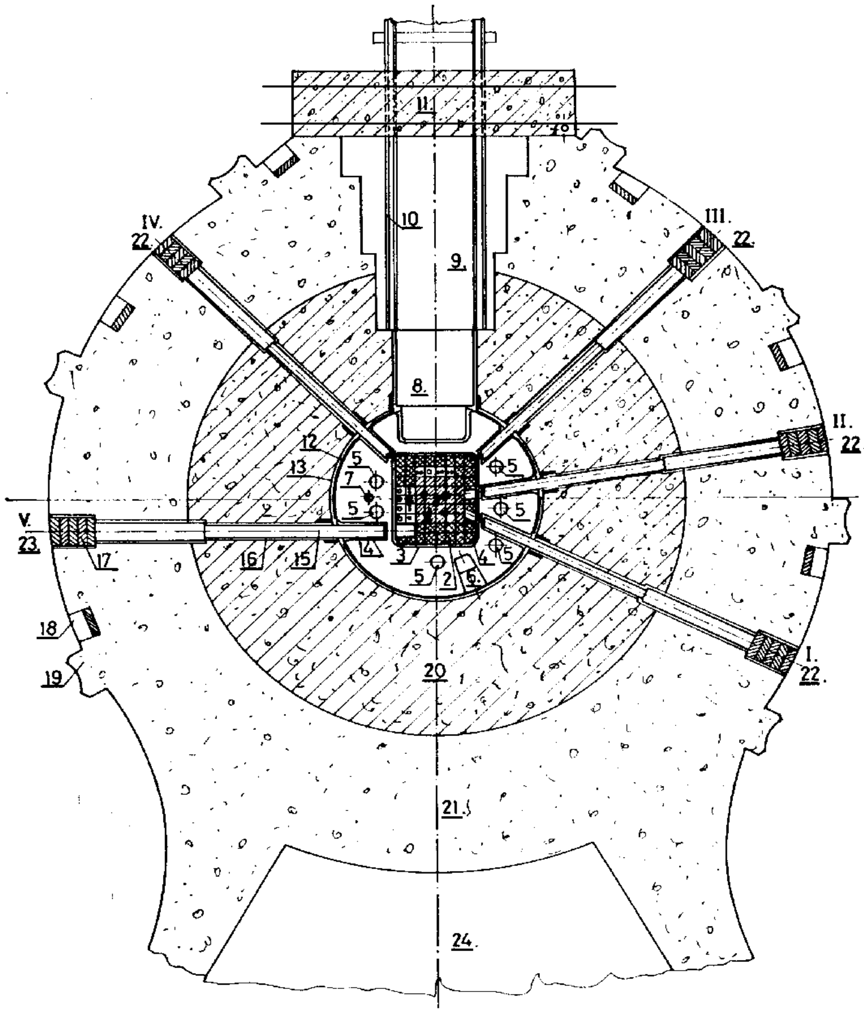

Fig. 11. Horizontal Cross-section of the Reactor

1- Fuel assemblies 2- Graphite reflectors 3- Core vessel … 5- Detector tubes …
7- Cooling water inlet 8- Inner irradiation space 9- Irradiation tunnel …
11- Heavy concrete door 12- Reactor vessel 13- Protective cylinder 14 Horizontal channel protective jacket 15 Horizontal water lock 16- Protective tube 17- Iron plug … 20- Heavy concrete 21- Normal concrete 22- Radial horizontal channels I., II., III. and IV 23- tangential channel V. 24 – Hot cell service area

Neutron flux-densities and γ dose-rates at 100 kW power

Irradiation position	**$\varphi^*_{th(E<0.5\,MeV)}$ ($cm^{-2}\,s^{-1}$)**	**$\varphi_{f(E>1\,MeV)}$ ($cm^{-2}\,s^{-1}$)**	**D_γ (Gy/h)**
D5 core pos. Vert. channel.	2.7E12 ± 1.08 E11 (±4 %)	1.82E12 ±1.82E11 (±10 %)	
G5 core pos. Vert. channel.	2.50E12 ± 1.00 E11 (± 4 %)	5.54E11 ± 5.54 E10 (±10 %)	
D9 core pos. Vert. channel.	1.07E12 ± 4.28 E10 (± 4 %)		
H4 core pos. Vert. channel.	1.16E12 ± 4.64 E10 (± 4 %)		
No. 1.hor. chan.	2.47E7 ± 3.71 E6 (±15 %)	1.36E7 ± 4.76 E6 (±35 %)	
No. 2.hor. chan.	2.79E7 ± 4.18 E6 (±15 %)	1.72E7 ± 2.58 E6 (±15 %)	
No. 4.hor. chan.	6.10E6 ± 9.15 E5 (±15 %)	3.06E6 ± 1.07 E6 (±35 %)	
No. 5.hor. chan.	3.17E7 ± 3.17 E6 (±10 %)	6.4E6 ± 2.24 E6 (±35 %)	
No. 5.hor. chan. with 103 mm Bi plug	1.50E7 ± 9.00 E5 (± 6 %)	2.24E6 ± 2.25 E5 (±10 %)	0.312 ±0.047 (±15 %)
Empty irrad. tunnel (inner surface)	5.54E10** ± 3.32 E9 (± 6 %)	3.99E9 ± 2.39 E8 (±6 %)	3300 ±660 (±20 %)
Irrad. tunnel (behind filter)	1.24E9** ± 6.20 E7 (±5 %)	7.03E6 ±3.51 E5 (±5 %)	1.300 ±0.195 (±15 %)

Notes

1) * Calculated value (using cross-section pertaining to the M-B distribution)
2) ** Calculated value (area under the Maxwell curve below 0.5 eV).
3) Flux densities at horizontal channels are valid at the outer surface of the physical shielding