WATER AND COLD MODERATOR FOR NEW RESEARCH REACTOR NEPTUN

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At present, neutrons are widely used in different experiments to investigate interactions, structure and properties of nuclei, condensed matter including solid states, liquids, polymers, biological systems and chemical reactions. Neutrons are produced in high intensity mainly by reactors (steady state or pulsed) and spallation sources. Thermal and cold neutron spectrum can be controlled by interest through optimizing the thermal and cold moderator. Pulsed mode of neutron source and high-intensity sources are prospects for increasing the accuracy of experiments that use cold neutrons as neutron diffraction, reflection and small angle neutron scattering.

Ultra-cooled neutrons were discovered by F.L.Shapiro's group in 1968 at FLNP in Dubna, Russia. Cooled neutrons are these neutrons which have energy within the range (10-7 to 10-3 eV) or wavelengths between (930 to 10 Å) Which has great advantages in most modern experiments at the present time. Neutrons having wavelengths greater than 4 Å are useful for scattering experiments. The ratio of these neutrons in extracted neutron beams from research reactors are very small according to Maxwellian distribution. To increase the cooled neutrons ratio, a complex of thermal and cooled moderators must be used. Cooled moderators are moderators having a very cooled temperature (≈ 20 K) like mesitylene, methane, beryllium ortho and para hydrogen and deuterium and ice water [1, 2]. At these low temperatures only hydrogen or deuterium can be in liquid phase, other possible moderators like ice or mesitylene will be solids. In high neutron flux these solid materials will suffer from many problems like heat removal, radiation damage and decomposition only liquid materials at low temperatures can be more reliable. For these reasons hydrogen can be the best moderator because of good heat removal properties, most economical in size, but of its relatively large absorption cross section, an increase in volume above optimum will not give any increasing in cooled neutron flux. On the other hand, deuterium has a low absorption cross sections and also low scattering cross sections so in the case of using deuterium a huge volume must be used to get the optimum neutron flux [3].

FLNP at Dubna, Russia has overcome problems of solid moderators and used solid methane to enhance the cold neutron flux ($\lambda > 6$ Å) by a factor of 20. And concluded that solid methane cold moderator can increase the flux 2 to 3 times that of liquid hydrogen [4]. This was confirmed the results from America and Japan [4-6]. In 2012 in Dubna cold neutrons were generated for the first time with the unique cold moderator on the basis of pelletized mesitylene carried by helium gas at 25 K [7-9].

This work is aims to optimize the thermal and cold moderators for the fourth-generation neutron source in Dubna (reactor NEPTUN) to get the higher possible thermal and cold neutron fluxes in extracted neutron beams.

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