Summer Student Program
at the Joint Institute for Nuclear Research

Frank Laboratory of Neutron Physics

SELECTING A PERSPECTIVE MATERIAL FOR PELLETIZED COLD "CENTRAL DIRECTION" NEUTRON MODERATOR OF IBR-2 PULSED RESEARCH REACTOR.

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Dubna, 2016.

ANNOTATION

The following paper describes the research in the possible usage of aromatic hydrocarbon, triphenylmethane, as a material for "CM 201" "pelletized" cold neutron moderator at the central direction at IBR-2 pulsed research reactor. Possible production of solid beads from triphenylmethane, comparison of radiation resistance and cold neutron output in accordance with currently existing materials for cold moderator material: mixtures of aromatic hydrocarbons m-xylene and mesitylene are also examined in this work. As to the radiation resistance of triphenylmethane, even in the case of small loss in the flux of cold neutrons it has shown 10-fold result which is better than that of the mixture of metaxylene and mesitylene.

Content

Introduction

Project specification

Neutrons are perfect means for the research of various substances; the high efficiency of which is due to their unique properties.These are: large depth of penetration into substance, nondestructive testing of materials under different conditions, the presence of magnet, etc. Currently, the research in the field of condensed state of matter appear to be thoroughly significant, as well as one of the promising areas in science.In particular, the research in the field of slow neutrons scattering by the usage of impulse neutron sources are of great concern.

Slow neutrons of various powers are used in physical investigations of different materials. Thermal neutrons are used for the studies of substance structure the power of which is comparable with that of the thermal vibrations in atoms with in solid, and the wavelength λ_n - is comparable with the inter-atomic distance. Cold neutrons are used in studying slow diffusive movements of atoms and molecules in various environments as well as for the studies of complex structural formations. Generally, in order to receive thermal neutrons moderators are used on the basis of water at room temperature.No problems occur during the application of such moderators in addition, availability and low price can be attributed to the advantages of simple water as a moderator. In case of cold moderators situation is more complicated, basically, due to the problems of radiation resistance. The most essential radiation effects in solid hydrogenous substances during the irradiation at the temperature of 20-100 K are:

- Formation of radiolytic hydrogen. A huge amount of hydrogen outputis able to lead to the failure of moderator's chamber. [1, p. 95-102.], [2, p. 299-304].
- Accumulation of 'frozen' radicals.
-Self-sustaining reaction of recombination followed with unexpected fast heating of the moderator in the result of irradiation. [3, p. 358-360], [4, p. 222-232], [5, p. 315-319], [6, p. 16-20].
- Formation of high-molecular, high-boiling products of radiolysis, which need to merge from the moderator's chamber. [7, p. 131-153].
- Decrease of thermal conductivity of substance in moderator. [8, p. 1232-1235].

Frozen beads of mixture of mesitylene and metaxylene are used as a material for the first CM 202 pelletized cold neutron moderator at IBR-2 reactor. The main advantages are:

- Possibility to use in a wide range of temperature;
- The importance of neutron and physical parameters (high intensity of cold neutrons output).
- High radiation resistance in comparison with other hydrogenous materials for cold neutron moderators (except liquid hydrogen);
- Safety in use (explosion-proof and less flammable than hydrogen and methane) etc.

The disadvantage of such a moderator is the duration of the work, lasting 9 days, while the standard period of reactor cycle operationvaries from 11 to 14 days.

Therefore, it was necessary to increase the period of the operation on physical experiment by using another material for the project of the second "central" direction moderator (research beams No. 1, 4-6, 9 of IBR-2 reactor). [12, p. 131-134], [13, p. 230-235], [14, p. 283-286], [15, p. 115-123]. It is possible to do it by using new material: aromatic hydrocarbon - triphenylmethane (tritan). The preliminary analysis of the present literature has shown [16, p. 1-5] that triphenylmethane can be used as material for cold neutron moderators according to the neutron and physical characteristics. As for the radiation resistance of triphenylmethane, there are indications in literature [17, p. 368] that it is almost 10 times better than that of mesitylene. However, the data from literature are not enough to use triphenylmethane as a material for cold neutron moderators at IBR-2 reactor. It is necessary to conduct a number of experiments under conditions of IBR-2 real reactor cycle.

The aim of the work is the research on the possible usage of aromatic hydrocarbon, triphenylmethane, as a material for "CM 201" "pelletized" cold neutron moderator at central direction at IBR-2 pulsed research reactor and comparison in accordance with currently existing materials for cold moderator material: mixtures of aromatic hydrocarbons m-xylene and mesitylene.

The following tasks have to be solved in order to reach the aim:

1. Studying the possibility of receiving solid beads right form from triphenylmethane.
2. Experimentally, determining radiation resistance of triphenylmethane and comparing the data with a mixture of mesitylene and m-xylene at the IBR-2 reactor.
3. Conducting experiments in order to determine the output of cold neutrons from triphenylmethane by using the method of inelastic scattering DIN-2PI spectrometer and comparing the data with the mixture of mesitylene and m-xylene at the IBR-2 reactor.
4. Making preliminary conclusion on the possible usage of triphenylmethane on the basis of gained results, as a material for "CM 201" "pelletized" neutron cold moderator at the central direction of the IBR-2 pulsed research reactor.

1. Literature reviews

1.1. Cold moderator materials.

In present, water containing materials such as: simple water, liquid hydrogen [18, p. 279-280], [19, p. 559], [20, p. 644-652], liquid hydrocarbons of methane, [21, p. 144-155] [22, p. 209-221] [23, p. 111-115], of propane [24, p. 311-318], and of solid methane [25, p. 865] are used as moderators at impulse sources for short impulse support. In addition, it is possible to use ice water, polyethylene [26, p. 18-26], frozen mixtures of methane with unsaturated hydrocarbons or inert gas, methane in zeolites, methane hydrates, ammonia, aromatic hydrocarbons (in particular-mesitylene), [27. p. 222] etc.

The most technologically advanced and most frequently applied material for cold neutron moderator appears to be liquid hydrogen [24, c. 311-318]. Its advantages

include the absence of radiolysis and other radiation effects; however, the thermalization of neutrons in liquid hydrogen is not complete due to the lack of low-lying excitation levels of the hydrogen molecule. Liquid hydrogen is rarely used for pulsed reactors because of explosion hazards.Two cases of explosion of liquid-hydrogen moderator in stationary neutron sources are known [28, p.112-115], [29, p. 117-119]. A similar situation at the IBR-2 would lead to a serious nuclear accident, because pulsed neutron sources are 40 times more sensitive to the changes in their geometry, in comparison with stationary reactors.
Methane is less technological, but more effective for neutron coldmoderators, as the rotational level of methane molecule is about 1 MeV. The output of cold neutrons from solid methane at thetemperature of 20 K is 2-3 times higher than that of liquid hydrogen. The advantages of methane include a wide range of temperature, where it can be used; however, the disadvantage of methane is the low level of radiation resistance. In the operation process of methane moderator at the IBR-2 it was necessary to change temperature condition 2-3 times a day, (it was because highly explosive radiolytic hydrogen was being formed). Radiolytic hydrogen by heating methane creates high pressure on the camera housing of the moderator and eventually can damage the camera. The repeated change of temperature caused instability in the neutron spectrum. Besides, the formation of high-molecular-boiling products in the case of radiation by neutrons caused sharp decrease in the operation resource of such moderators. Cold moderator with solid methane being used at the temperature of 30-70 K acted on the reactor IBR-2. [21, p. 144-155] [22, p. 209-221] [23, p. 111-115].

The possibility of using ice water as well as polyethylene as moderating materials was considered [30, p. 4-9], [31, p. 315-319]. The idea of using the pelletized cold moderators for high intensity neutron sources originated in the mid-80s. It was supposed to use beads of solid methane in the first of published concepts for pelletized cold moderators. In those days such a proposal couldn't be realized because of the fundamental technical difficulties and lack of necessary experimental data. It was decided to select the mixture of aromatic hydrocarbon - mesytilene (1, 3, 5 - trimethylbenzoyl, aromatic hydrocarbons, C_9H_{12} benzene derivative) and m-xylene (working material for pelletized cold moderator CM-202 at present) as a material for pelletized cold moderator on the basis of research and foreign experiences.

1.2. Triphenylmethane as a material for pelletized cold moderators at IBR-2 reactor.

Finding ways to solve a problem by increasing operating time of pelletized cold moderator on the physical experiment is an actual task, as there are physical experiments requiring exposure times ofover 9 days. In case of pelletized cold neutron moderator, one of thesolutions to the problem appears to be the usage ofdifferent moderator material, which would have significantly bigger radiation resistance and at the same time, the output of cold neutron of this moderator should be comparable to that of mesitylene. An aromatic compound, triphenylmethane (tritan), can be a possible material. The chemical designation of triphenylmethane is $C_{19}H_{16}$ shown at figure 1. The idea of using an aromatic compound, triphenylmethane, as a material for cold moderator has never been investigated before.

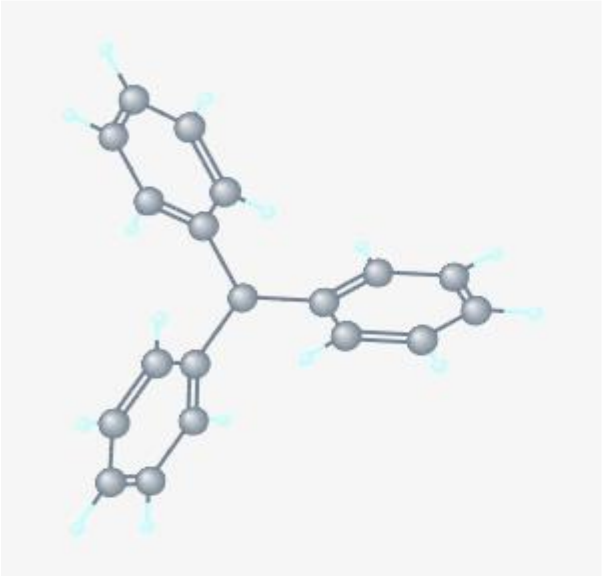


Figure 1 Molecule of triphenylmethane (White atoms – hydrogen, black - carbon)

At room temperature, triphenylmethane is beige finely granular powder. The melting temperature in the stable crystal modification is 365 - 367 C. The boiling point is 632 K.

Theoretically, triphenylmethane corresponds to the basic selection criteria as a substance for cold moderator:

- Unique structure: the three aromatic phenyl groups surrounding the Central carbon atom, which is subsequently capable of forming relatively stable radicals or even ions. Radicals are usually quite unstable, and therefore chemically aggressive environment is formed in which the polymerization process occurs. In the aromatic systems localized electron orbits of several neighboring atoms overlap to form one huge orbital length over all the atoms.
- At the same time axial rotation of phenyl rings around connection relative to the central atom provides low-energy excitation.

With the increasing number of aromatic rings in the molecule the stability of connection will be higher, because of this, we can assume, that triphenylmethane is much more stable than mesitylene. In general, aromatic hydrocarbon triphenylmethane can be used as material for a cold neutron moderator, but firstly, all hypotheses should be confirmed experimentally in a real physical experiment.

2. Studying the possibility of using triphenylmethane as a material for "pelletized" cold neutron moderator at IBR-2.

2.1 The possibility to receive a bead form from triphenylmethane.

The possibility to receive a bead form triphenylmethane is one of the key moments when choosing potential working material. Beads for moderating substances can:

- Avoid high-pressure radiolytic hydrogen while heating the substance before the next change of material [40, p. 111];

— Significantly reduce the temperature of the moderator and make it more uniform (the thermal conductivity of all hydrogen-containing compounds suitable for use in cryogenic neutron moderators is very low; mesitylene — 0.2 W/m/K at 20 K).

- Establish the continuous work of the moderator by periodically loading and unloading small portions of the beads.

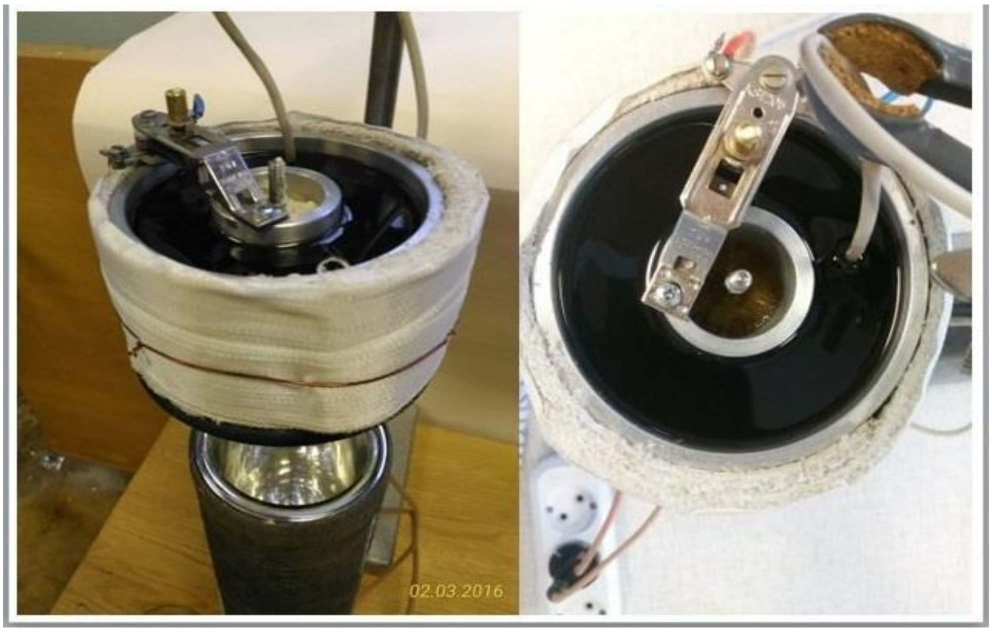


Figure 2. Facility for production of solid beads from triphenylmethane

Figure 2 presents the facility for production of solid beads from triphenylmethane. The powder of triphenylmethane is located at the top part with a heating element which maintains the temperature not exceeding 120°C. The die with about 1 mm diameter dropper is located at the bottom of the top part. The vessel with liquid nitrogen is located at the distance of 50 mm under die. Liquid triphenylmethane falls into a vessel filled with liquid nitrogen at periodicity of 20-30 seconds. In order to check the receipt of beads of correct form, alternatively liquid nitrogen and various liquids were used, particularly, water, distilled water, alcohol, mixture of water with alcohol, etc., but, in these cases, triphenylmethane didn't acquire a bead-shape, formed beads were crumbled. As a result, after calibration and sifting, solid beads of an appropriate shape with a diameter of about 4 mm are received. The illustration is given in figure 3.

Figure 3. Solid beads from triphenylmethane

The productivity of facility is 10 ml/hour. In contrast to beads from mixture of mesitylene and m-xylene, which melt at 228 K (temperature of adhesion of beads is 160 K), it is not necessary to store beads from triphenylmethane in liquid nitrogen permanently. Also there is no problem of loading beads in the portioning device which arises with beads from a mesitylene and m-xylene.

Thus, it became clear that getting a solid beads from triphenylmethane is entirely possible, and now the challenge here is to study the process of release of gaseous products in the radiolysis and output of radiolytic hydrogen from triphenylmethane (in a various condensed states) in a real physical experiment.

2.2. A study of radiolytic output of hydrogen from the mixture of mesitylene, m-xylene and triphenylmethane

Radiolytic hydrogen is directly generated in an intratrack reaction and partly the product of recombination of atomic hydrogen. At operating temperature of cold moderator, which is 30, hydrogen is inactive, and at temperature below the critical point (33 K) hydrogen is in a condensed state and therefore, the accumulation of radiolytic hydrogen in the process of irradiation does not cause swelling of the material of the cold moderator. At the end of the working cycle of the cold moderator, the temperature in the chamber rises, as a result of the expanding gas in the working material for cold moderator significantly increases, adverse consequences of which can damage the chamber of the moderator. The information about the rates of accumulation and the release of radiolytic hydrogen gives confidence in the usage of any material for cold moderators. The literature provides the evidence that the relative yields of gaseous products formed during the irradiation by fast electrons of aromatic hydrocarbons with energy of 170 keV from triphenylmethane are 10 times less than that from mesitylene, and this at least means that its radiation resistance is 10 times better.

The study of radiolytic accumulation and output of hydrogen from a mixture of mesitylene, m-xylene and triphenylmethane has been conducted on irradiation facility which is located in the third channel at IBR-2 and designed to test the radiation resistance of materials. 3 samples in an ampoule were located in the moderator during the standard reactor cycle time (12 days) at the distance of 300 mm from a surface of water. Figure 4 presents samples before irradiation.

Figure 4. Samples before irradiation (I – ampoule with a liquid mesitylene and m-xylene, II- ampoule with a powdery triphenylmethane , III – ampule with a beads fromtriphenylmethane)

There were 12 ml of liquid mixture from m-xylene and mesitylene (3: 1) in the first ampule; the second ampule contained 22 ml of amorphous state triphenylmethane (powdery) and 22 ml of crystalline state triphenylmethane (solid beads) were in the third ampule. The main objective of the experiment was to examine the output of radiolytic hydrogen of triphenylmethane and to compare it with the current working material, mixture of mesitylene and metaxylene.

It was possible to observe increase in pressure under intense irradiation by fast neutrons with the help of established model gauges. Figure 5 shows two types of manometres with different values of accuracy class. Accuracy class of manometre (I) with a mixture of mesitylene and m-xylene is 1.5. Exemplary manometres II and III have a higher accuracy class (0,15). The circular scale of manometres, has 400 conventional units. The graduation is 1 conventional unit.

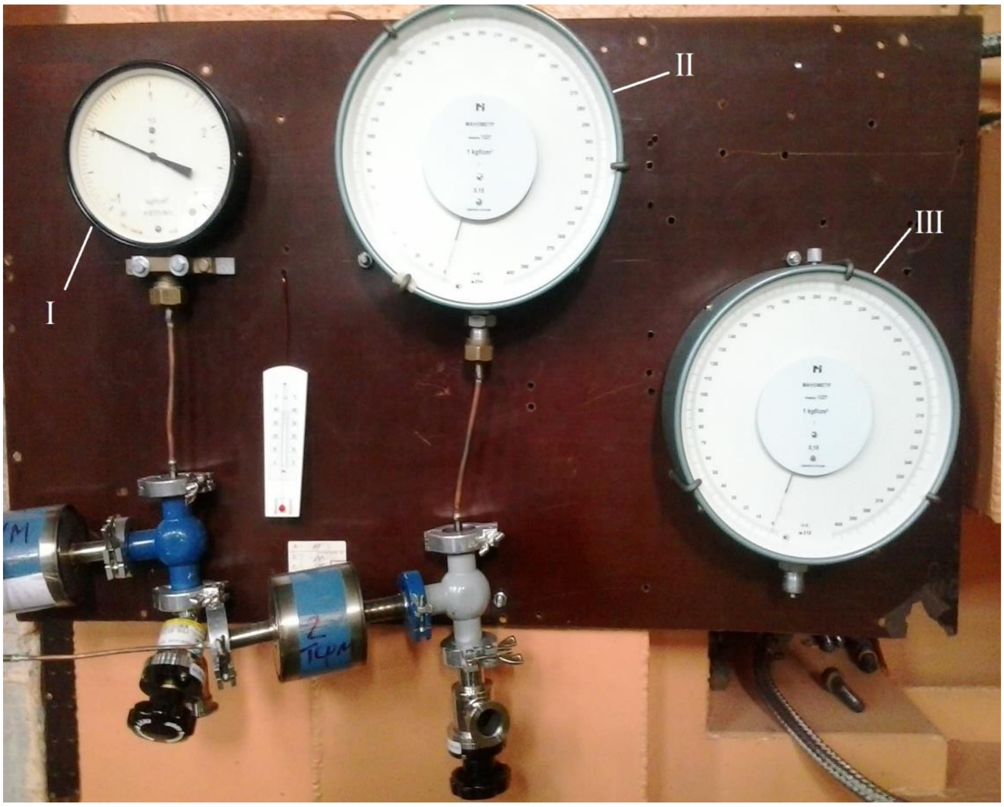


Figure 5. Pressure indications from manometers. (I - manometre with a mixture of mesitylene and m-xylene, II - manometre with powdery triphenylmethane, III - manometre with granular (pelletized) triphenylmethane)

Figure 6. Powdery triphenylmethane after irradiation

The fluency of neutrons with the energy of above 1MeV in the process of installing the sample at distance of 0.3 m from the moderator in the first vial was $7{,}5 \cdot 10^{17}$ n·cm^{-2} (flux density at $7{,}8 \cdot 10^{11}$ n/cm^{2}/s). The neutron fluency in the ampule with the powder and granular triphenylmethane was $5.9 \cdot 10^{17}$ n·cm^{-2}. The fast neutron flux density was - $6{,}1 \cdot 10^{11}$ n/cm^{2}/s and $6{,}2 \cdot 10^{11}$ n/cm^{2}/s respectively. Figure 7 provides a graph which compares the pressure read in the gauge within 12 days of exposure. These values were obtained by neutron activation analysis at FLNP.

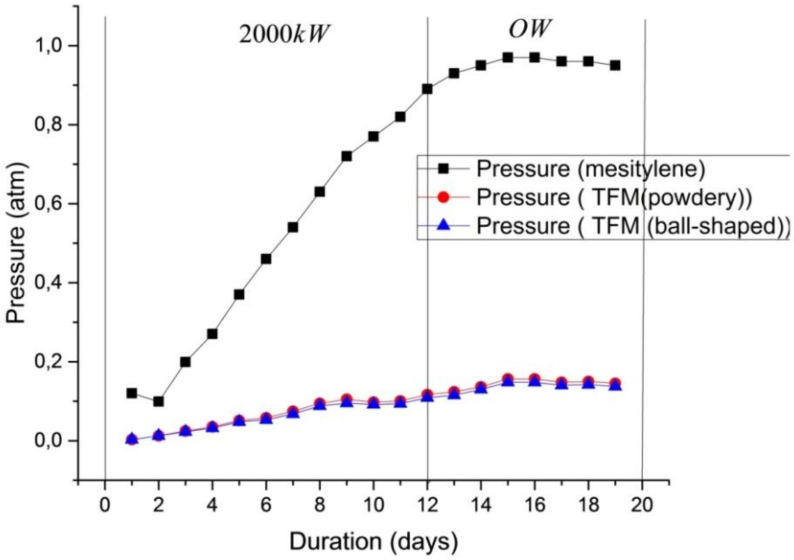


Figure 7. The study of radiolytic accumulation and output of hydrogen from the mixture of triphenylmethane, mesityleneand m-xylene during irradiation

According to thechart mentioned above we can say that the output of triphenylmethane gaseous fission products (in different condensed states) largely (about 10 times) exceeds mesitylene, which is confirmed and partially consistent with the theoretical data. This means that the aromatic hydrocarbon triphenylmethane (in both states) is more resistant to radiation exposure in comparison with the current working material, mixture of mesitylene and metaxylene.

2.3 The study of cold neutrons output both from frozen mixture of the mesitylene, m-xylene and powdery triphenylmethane

Neutron spectra emitted by a cassette, close in size to the moderator and filled with materials with different values of the effective thickness of the cassette, were measured on TOF spectrometer of inelastic neutron scattering DIN-2PI at different values of the temperature and energy of monochromatic neutrons of 10 meV. A general schematic illustration of the experiment is presented in figure 8.

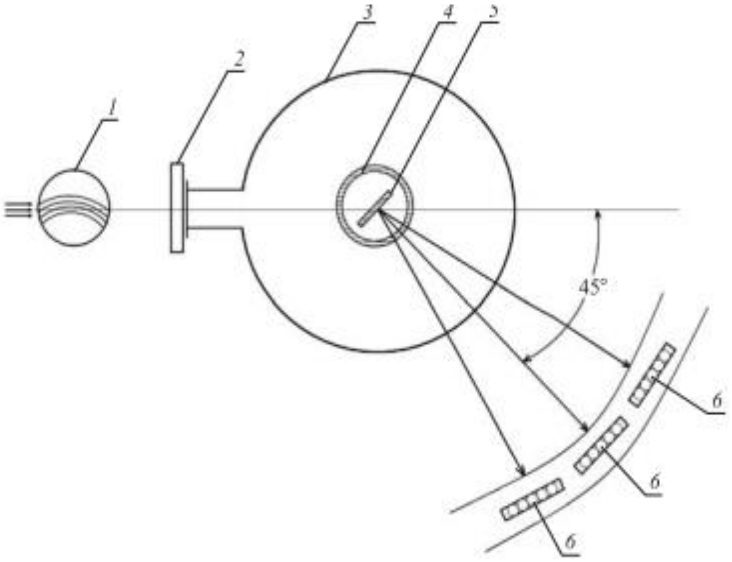


Figure 8. Experiment scheme: 1 – main chopper, 2 – monitoring chamber, 3 – vacuum sample chamber, 4 – cryogenic device, 5 – cassette with a substance, 6 – detector cassettes (total number of joined counters filled with 3He under the pressure of 10 atm is 20), in which neutron spectra emitted by the substance are registered

Each detector block contains 5-6 individual counters working as one big detector. Time-of-flight spectra were registered for each detector group; as a result, 20 time-of-flight spectra were received. Measurements show that the first four groups of detectors had a significant background level; consequently, they were not included in subsequent analysis of the results. Aluminum cassette (figure 9) was filled with the substance, which slowed neutrons down, and mounted on the cryogenic device (closed-cycle refrigerator) to reach low temperature (from 10K to 60K). Different values of moderator thickness were used. The thickness of the moderator for frozen mixture of mesitylene, meta-xylene and triphenylmethane powder was - 2 cm; for granular triphenylmethane - 4 cm.

Figure 9. Cassette with a different value of thickness of the moderator (left – 4 sm, right – 2sm)

CRYOMECH cryogenic device (figure 10) was placed in the center of the spectrometer directed towards the neutron beam axis at a 45^0 angle.

Figure 10. The view of cryogenic system on DIN-2PI TOF spectrometer

Neutron spectra emitted by a cassette, close in size to the moderator and filled with materials of different values of the effective thickness of the cassette, were measured on TOF spectrometer of inelastic neutron scattering DIN-2PI at different values of the temperature (10, 20, 30, 50, 60 K) and the energy of monochromatic neutrons of 10 meV. Neutron spectra for the mixture mesitylene and m-xylene are given in figure 11.

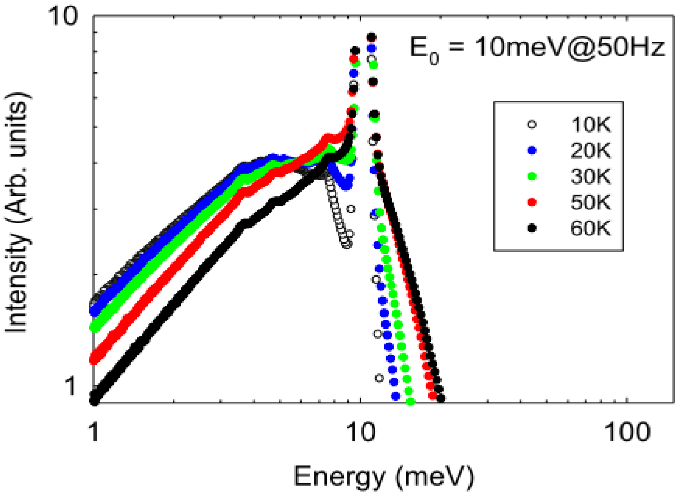


Figure 11. Neutron spectra with energy 10 meV from the mixture mesitylene and m-xylene (the thickness of the cassette 2 cm)

As it’s shown in figure 11, the mixture of mesitylene and m-xylene with decreasing temperature moderating efficiency is growing up. The optimum temperature range is 10 - 30 K. In these cases, the highest output of cold neutronsoccurs. Similar experiments were performed by using another material - powdery triphenylmethane, the thickness of cassette for the sample remained unchanged (2 sm). In Figure 12 we can see neutron spectra formed out of powdery triphenylmethane. In this case, along with lower-temperature the moderating efficiency for triphenylmethane starts reducing and accordingly the output intensity of cold neutrons is also reduced.

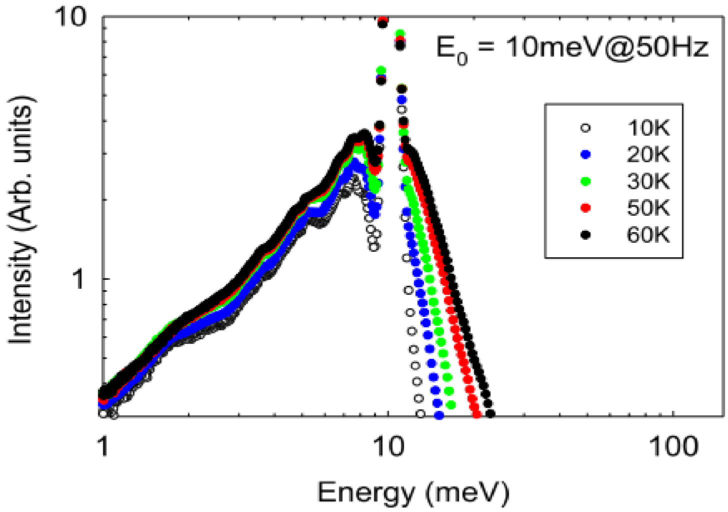
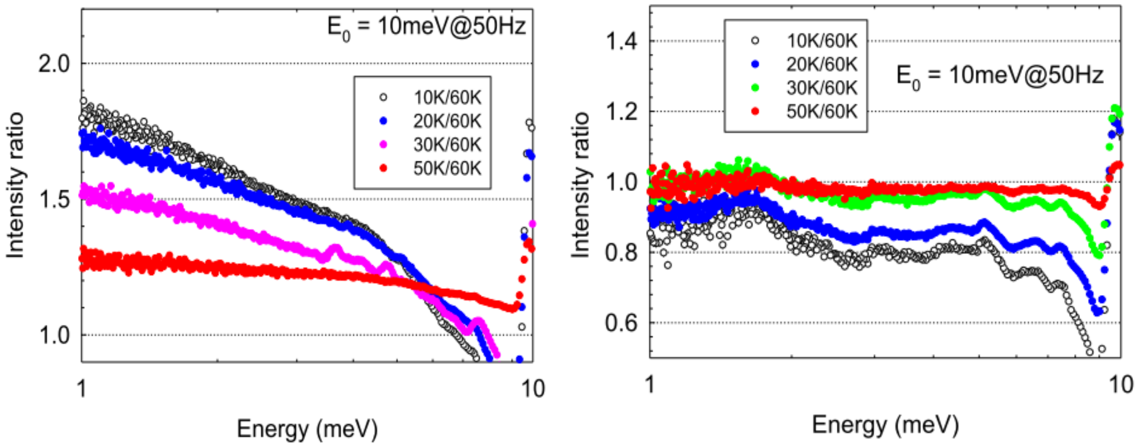


Figure 12. Neutron spectra emitted by powdery triphenylmethane

The gain factor presented in figure 12 was estimated like the relation of ranges at different values of temperature of 10, 20, 30, 50 K to a range of 60 K.



a) b)

Figure 12. Gain factor of cold neutron output for frozen mixture mesitylene (a) and powdery triphenylmethane (b)

According to the comparison of measurement results of mesitylene and powdery triphenylmethane shown in figure 12 the output of cold neutrons for mixture of mesitylene and metaxylene is twice higher than that for powdery triphenylmethane. Besides, the output of cold neutrons from a capsule surface in case of powdery triphenylmethane decreases with the fall of temperature. Firstly, such a result can be explained by wrong choice of thickness, which was 2 cm, and also by the physical condition of substance.

2.4. The study of cold neutrons output from triphenylmethane with 4 sm-effective thickness of the cassette

The output intensity cold neutron depends on several factors and primarily on the content of hydrogen atoms in a substance. Second important factor is the vibrational dynamics of the substance of the moderator and especially in its low-frequency part. The concentration of hydrogen atoms in a substance and its dynamics depends on atomic structure. There are two condensed states – crystalline and amorphous. Crystalline substances are characterized by periodic arrangement of molecules and ions, thereby forming a spatial lattice. The main feature of the amorphous state of matter is the lack of long-range order in the atomic or molecular lattice, i.e, three-dimensional periodic structure is shown only at short distances, which distinguishes it from crystalline state atomic structure. Hydrogen atoms number in substance determines the output of cold neutron moderator.

The usage of different forms of moderating substances allows to determine exactly in which of the substances the concentration of hydrogen atoms is more. The next step is directed to the comparison of powdery and granular triphenylmethane for pelletized cold neutron moderator at IBR-2. It should also be noted that the concentration of hydrogen atoms in powdery triphenylmethane may be more than that of granular triphenylmethane. Unlike the beads triphenylmethane may not have a vacancy in the powdery; the packing density can be significantly higher despite of beads. In order tocheck this assumption, in cassette (thickness 4 sm) solid beads were filled from triphenylmethane, at total volume of 320 ml. In a similar experiment, instead of triphenylmethane beads triphenylmethane powdery form was used.

As in the previous experiment, the value of initial neutron energy was used equal to 10 MeV, the temperature of sample - 10, 20, 30, 50, 60 K. Figure 13 shows neutron spectra for granular and powdery triphenylmethane.

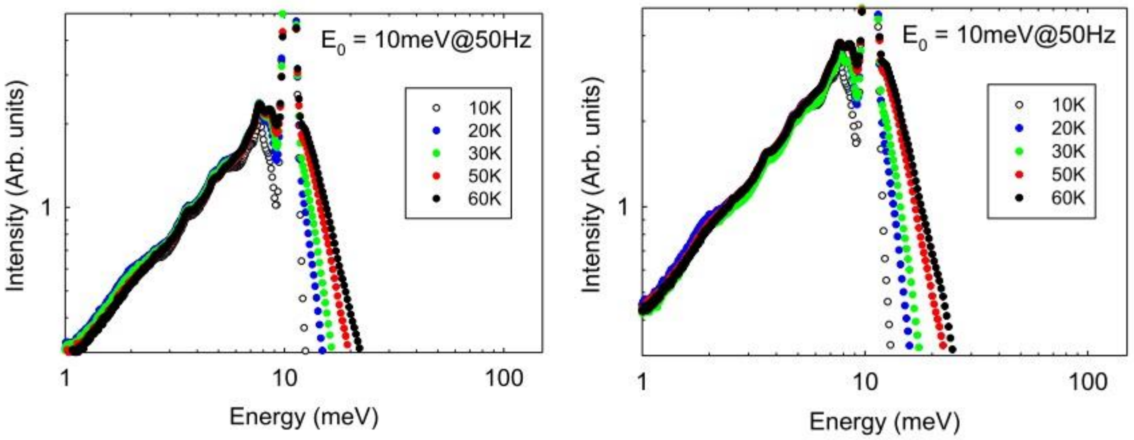


Figure 13. Spectra emitted by granular (left) and powdery triphenylmethane (right)

It is evident that the usage of powdery triphenylmethane gives little advantage in cold neutron output in comparison with a granular triphenylmethane.

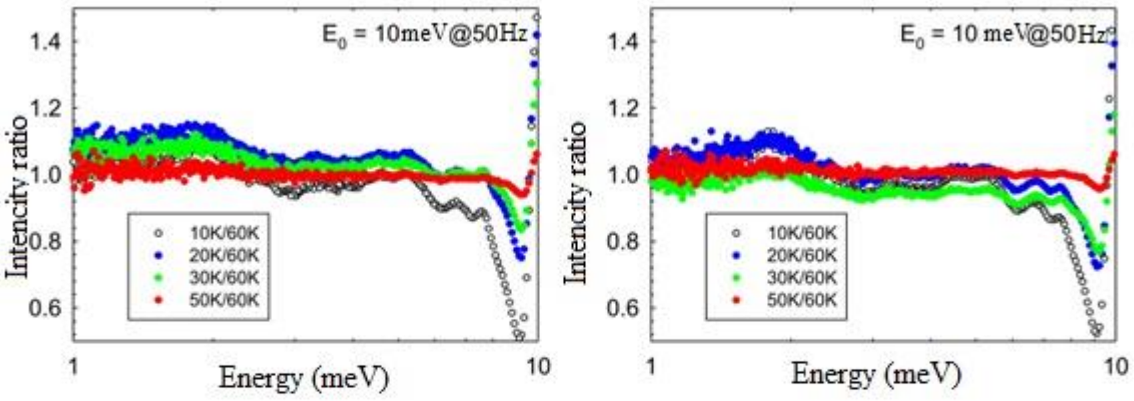


Figure 14. Gain factor of cold neutron output for granular (left) and powdery triphenylmethane (right)

The comparison of measurement results of granular and powdery triphenylmethane in figure 14 shows that the output of cold neutrons for powdery triphenylmethane is a little bit higher than that for powdery triphenylmethane. Figure 15 presents the comparison of usage powdery and granular triphenylmethane, with the same thickness of cassette (4 sm). The energy of the incident monochromatic neutrons at a temperature of 10 K was 10 meV.

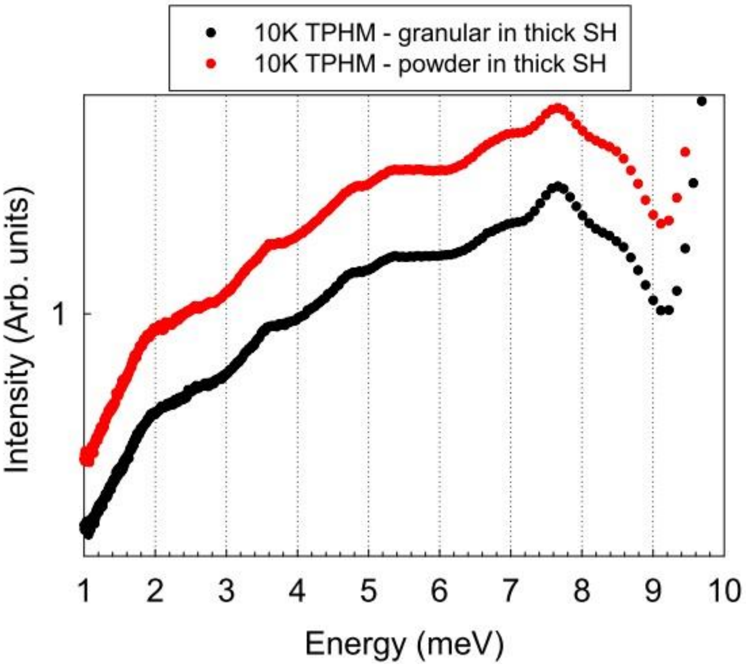


Figure 15. The comparison of obtained intensity spectra from triphenylmethane (red spectrum – powdery TFM, black - granular TFM)

The preliminary conclusion was based on the comparison of obtained intensity spectra from triphenylmethane different form, with the same values of cassette thickness. It’s obvious that the usage of powdery triphenylmethane gives a small gain (1.1-1.2 times) in intensity of cold neutron output. In figure 16 we can see the comparison of usage powdery triphenylmethane with the different thickness of cassette.

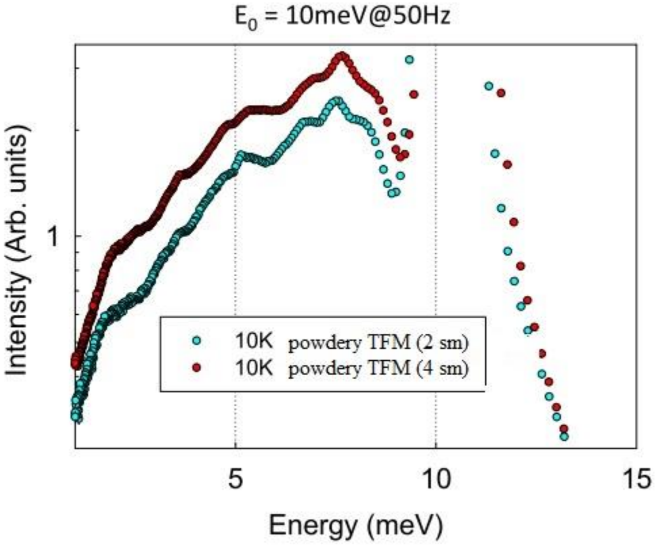
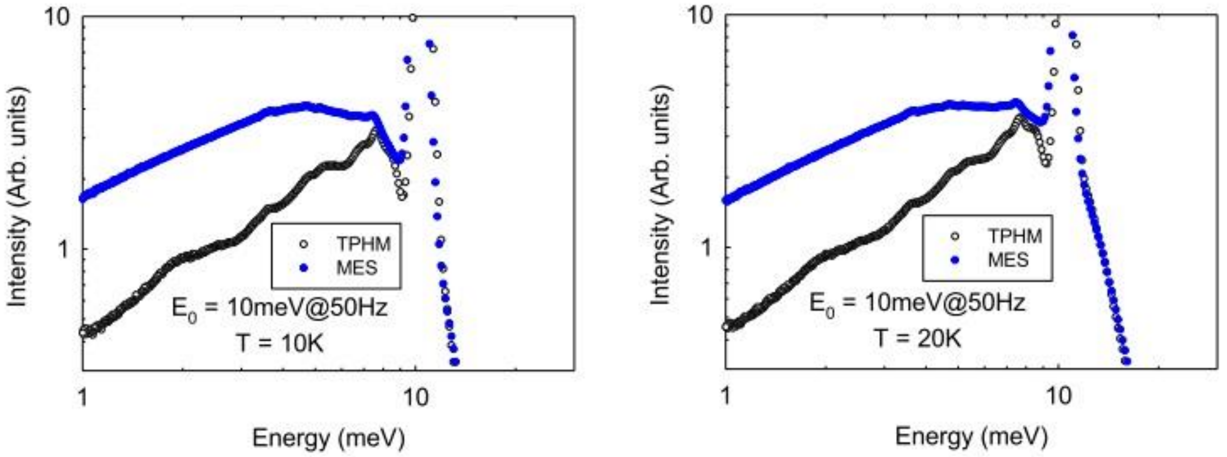


Figure 16. Comparison of the intensity spectra obtained from triphenylmethane (red spectrum - powdery TFM (2 sm), blue - granular TFM (4 sm))

As to figure 16, the usage of the cassette thickness equal to 4 cm is optimal for cold neutrons output. In the spectral picture the output of cold neutrons using powdery triphenylmethane, (effective thickness of cassette - 4 cm), gives small advantage compared with the usage of beads from triphenylmethane. Explanation to it is that in triphenylmethane of an amorphous state, concentration of atoms of hydrogen is more, than that in triphenylmethane of a crystalline state.

2.5. The comparison of measurement results of mesitylene and triphenylmethane for different physical condition of substance

The comparison of usage powdery triphenylmethane, with the optimum thickness value of cassette (4 sm) and mesitylene with the effective thickness of cassette (2 sm) is presented. In the previous experiment, too, the value of initial monochromatic neutron energy equal to 10 meV was used, the temperature of sample - 10, 20, 30, 50, 60 K. In figure 17 we see neutron spectra for mesitylene and m-xyelene mixture and powdery triphenylmethane.



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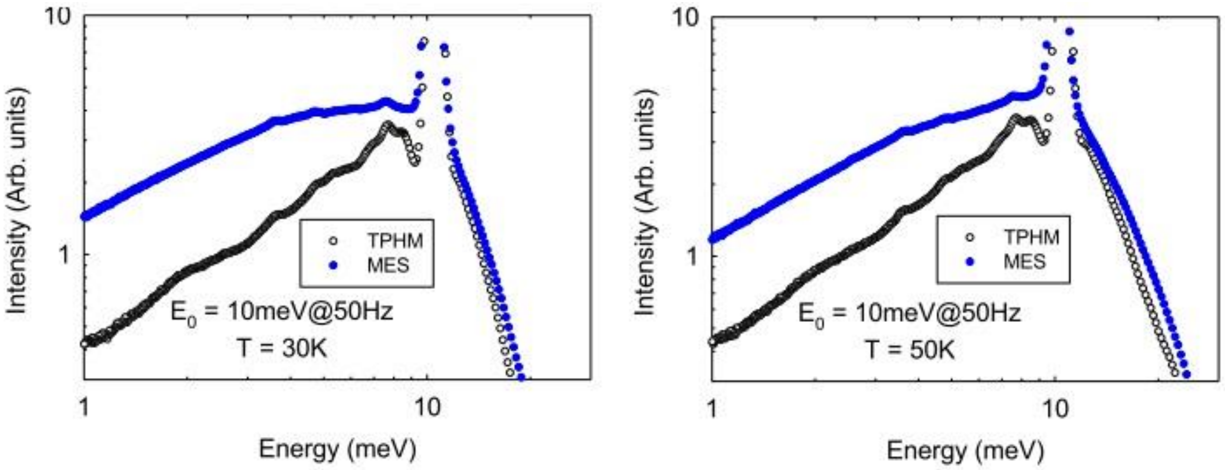
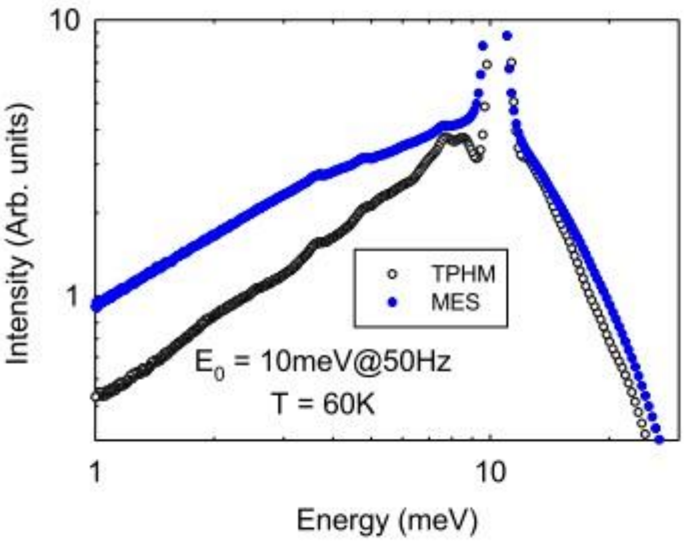


c) d)



e)

Figure 17. Neutron spectra emitted by a mesitylene (the effective thickness of the cassette 2 cm) and powdery triphenylmethane (thickness of the cassette 4 cm) with different values of temperature

As to the comparison of measurement results of mesitylene and powdery triphenylmethane in figure 17 it becomes obvious that the output of cold neutrons for mixture of a mesitylene and metaxylene is twice higher than that for powdery triphenylmethane. Besides, the output of cold neutrons from a capsule surface in case of a powdery triphenylmethane decreases with the fall of temperature; accordingly, the intensity also decreases.

Results:

1. The possibility of production of working material from triphenylmethane as a material for pelletized cold neutron moderator at IBR-2 has been proved.
2. The output of radiolytic hydrogen from a mixture of mesitylene, m-xylene and triphenylmethane in an amorphous and crystalline state has been studied. It has been shown that the output of gaseous fission products from triphenylmethane (in different condensed states) 10 times lower than that for mesitylene and m-xylene mixture.
3. Experiments on inelastic neutron scattering directed to determining cold neutron output from triphenylmethane and comparing it with mixtures of mesitylene and m-xylene:
   - It shows that the usage of powdery triphenylmethane gives a small gain (1.1-1.2 times) in intensity of cold neutron output.
   - The usage of the cassette thickness equal to 4 cm is optimal for cold neutrons output.
   - The cold neutron output from a powdery triphenylmethane with thickness of cassette equal to 4 sm, almost 1,8 times lower than that for frozen beads from mesitylene and m-xylene with an effective thickness of a cassette equal to 2 sm.
4. On the basis of received results we can make final conclusion that despite the loss in intensity of cold neutron output, due to radiation resistance, aromatic hydrocarbon – triphenylmethane can be used as a material for a pelletized cold "central" direction neutron moderator of IBR-2 pulsed research reactor.

Conclusion:

This paper describes the research of possible usage of aromatic hydrocarbon, triphenylmethane, as a material for "CM 201" "pelletized" cold neutron moderator at central direction at IBR-2 pulsed research reactor and comparison of radiation resistance and cold neutron output in accordance with currently existing materials for cold moderator material: mixtures of aromatic hydrocarbons m-xylene and mesitylene.On the basis of received results we can make the final conclusion that aromatic hydrocarbon – triphenylmethane can be used as a material for a pelletized cold "central" direction neutron moderator of IBR-2 pulsed research reactor. It is necessary to check the option to load solid beads from TFM into the chamber on the test bench of "CM 201" pelletized cold moderator at IBR-2 under the circumstances of real physical experiment.

Acknowledgement

Firstly, I want to be thankful to my advisor Maxim Bulavin for his continuous support in the summer students program. He showed me different ways to approach a research problem and the need to be persistent to accomplish any goal. He taught me how to write academic papers, made a good specialist of me, trusted me when I doubted myself, and brought out good ideas in me.

Besides my advisors, I would like to thank the rest of our "Cold moderator" group members: Alexander Yevgenievich, Yevgeniy Nikiforovich, Valeriy Vladimirovich and Gleb Germanovich who asked me good questions and who gave insightful comments and reviewed my work on a very short notice.

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