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Yanin Volodymyr

Independent researcher, Ukraine

e-mail: volodymyrianin@gmail.com

<https://orcid.org/0000-0002-6299-8924>

**Engineer of the communication lines Mykola Pavlovych Petrov (1836–1920):
factors for his scientific views' formation**

***Abstract.** The article reviews the factors of the scientific views' formation of Mykola Pavlovych Petrov – formidable Russian scientist and engineer in relation to his administrative efforts of development of the native scientific and technical community XIX–XX. The special focus was made on the biographical component, especially his study in Petersburg institutions. The crucial impact on the scientific destiny of M. P. Petrov was made by his studying in the Engineer Academy. In that time the intellectual basement for the future activities was formed. As a matter of fact, later M.P. Petrov became the formidable engineer and scientist. M. P. Petrov was the student of the formidable mathematician, academician of the Petersburg Academy of Science Mykhailo Vasylovych Ostrohradskyi (1801–1862). M. P. Petrov gained a lot of useful skills and knowledge from his teacher. Among those the following: high mathematical culture, abstract thinking, knowledge of the theoretical and practical problems in various areas of science, especially the ones that were related to railway transport. Work as the lecturer in the Technological Institute, communication with I. A. Vyshniehradskyi, A. P. Borodin and other scientists and specialists played a role of some kind of push for M. P. Petrov to study applied disciplines, mainly related to the friction of lubricated materials. Among the teachers of M. P. Petrov in the Academy was Herman Yehorovych Pauker (1822–1889). M. P. Petrov always recalled him as the wonderful engineer and teacher, who was the creator of the school for the engineers-teachers. The main goal of the school was the harmonious connection between engineer work and science. In the Academy M. P. Petrov met the lecturer of mechanics of the Institute of the communication paths engineer corps Stanislav Valerianovych Kerbedz. During the studying in the Academy M. P. Petrov was formed as the future scientist and specialist, who had the character which helped him to communicate easily with people. He had humane views and always acted alone and fairly. These features of his character in conjunction with his great mind helped him to achieve all his goals while solving the complicated engineer and administrative tasks. Aspiration to knowledge, original and brave thinking were among the main features of M. P. Petrov`s nature.*



Keywords: *scientist; engineer; hydrodynamic theory of lubrication; building mechanics; teacher; railway worker*

Introduction

Nowadays, historians of science and technology more often focus their attention on the issues related to the period of the foundation and development of the railway transport during the second half of the XIX century – beginning of the XX century. They included to the scientific founds and analysed a lot of new facts due to the archive researches. However, despite it, there are considerable amount of issues that are not investigated by the researchers. Among such issues, there is one that relates to the activities of the formidable scientists and engineers, who were the pioneers of the scientific, technical, engineer, and teaching thoughts and ideas, when the questions related to the promotion of the development of the different industries arose. In addition, those persons paid a lot of attention to the teaching and sharing their knowledge with the wide people masses.

That is why there is a great need of observing the scientific and educational activities of the different scientists in Ukraine because of their hard work in the scientific field remains unknown for the native history. Professor M. P. Petrov was among those scientists and engineers.

Methods of the research

This study was based on the historical method. Thanks to this method of research it was possible to analyze the sources related to the life and work of M. P. Petrov, namely the literature that characterizes the factors to shape his scientific worldview. The use of the historical method allowed a deeper study of the early period of life and work of M. P. Petrov, which has not yet been done in scientific and popular literature (Yanin, 2018).

Analysis of the researches and publications

Activities of M. P. Petrov, the formidable Russian scientist, who worked a lot on the territory of the modern Ukraine, was observed in works of O. S. Akhmietov, O. G. Burhvyts, M. O. Zenzinov, S. M. Petrov, S. M. Tretiakov. However, a lot of issues related to his scientific and educational activities are mostly not researched. In the available sources we are able to find only some pieces of information related to the formation of his views as the scientist and teacher considering the period of the development of the science in Russian Empire of the second half of the XIX century – beginning of the XX century (Burhvyts, 1984).

Results and discussion

Petrov Mykola Pavlovyh – formidable Russian scientist and engineer, honourable member of the emperor`s Academy of science in Petersburg (since 1894), follower of the formidable Ukrainian mathematician M. V. Ostrohradskyi, professor

of the Technological institute and Mykolaivska Engineer Academy, Engineer – general, head of the state railway council (1882–1892), head of the Engineer Council of the communicational path Ministry of Russian Empire (1893–1900), head of the Russian technical fellowship (1896–1905), Member of the State Council, founder of the hydrodynamic theory of lubrication, awardee of the Lomonosov prize of the Petersburg Academy of science (1884), author of the scientific works related to the calculation of the rail strength, theory of the interaction between rail and rolling stock, head of the council of the communication paths Ministry, head of the special railway research council (1908–1912), head of the Russian technical fellowship council, cavalier of the various native and foreign orders, honourable member of the technical institutions and scientific fellowships (Zenzinov & Ryzhak, 1978).

Mykola Pavlovych Petrov was born 13 of May 1836 in Trubchevsk of the Orlovskaya region in the military family (see fig.1). There were seven children in the Petrov's family – three boys and four girls. As it was common in not so rich noble families, children were taught at home, and Mykola Petrov till 13 was living in his father's house where he gained his primary education (Akhmietov, 1965, pp. 240-246). There was a tradition for noble boys to gain education in military institutions. However, it was possible to start the engineer's career without breaking the traditions. This possibility was found in the Institute of Railway Engineers in Petersburg. Although, the specialists taught in the Institute were for the civil needs, in addition to the common courses there were also military disciplines and the institution was of the closed format, only for the nobles. It was not the ordinary military institute, it was more like cadets corps. According to the rules only boys from 11 to 13 were able to enter the institution and after graduating there became cadets (Petrov, 1925).



Figure 1. Mykola Pavlovych Petrov (1836–1920) (https://biblioclub.ru/index.php?page=author_red&id=13118&contrast=1)

During that period the railway Petersburg – Moscow was on the final stage of construction, which was the brilliant example of the Russian engineering. That is why studying in the Institute of the Corps of the communicational path engineers was considered as a prestigious one and 13 years old boys choose it not because of their skills but because of the will of their parents.

While studying at home Mykola showed some engineering skills and when he was 13 in 1849 his father brought him in Petersburg to enter the Cadets Corps. However, due to yet unknown for us reasons Mykola was not able to enter the Cadets Corps and was forced to enter the “Noble regiment” – military institution alike the Cadets corps. According to the feedbacks of the graduates the studying process in the following institution was quite average, however, during the engineer`s courses among the disciplines, there were Algebra, analytics Geometry, Physics, Architecture, Engineer Drawing, and Art of building. Everyone who finished the engineer`s courses met the requirements to enter the Engineer Academy which was found in 1819 and was situated in Engineer Palace in Petersburg. Among those who graduated the Noble regiment 11th of June 1855 and entered the Mykolaivska Engineer Academy was young M. P. Petrov (Tretiakov, 1948).

Studying in the academy had a considerable influence on the scientific fate of M. P. Petrov. During that period was formed his intellectual “basement” which in the future transformed into the formidable engineer and scientist. In the academy he was taught by the formidable mathematician, academician of the Petersburg Academy of science, Ukrainian born in Poltava, Mykhailo Vasyliovych Ostrohradskyi (1881–1862) (see fig.2).



Figure 2. Mykhailo Vasyliovych Ostrohradskyi (1881–1862)
(https://ru.wikipedia.org/wiki/Остроградский_Михаил_Васильевич)

Since August 1830 M. V. Ostrohradskyi was the professor of mechanics and astronomy and has been working in the Institute of the Corps of communicational paths engineers for almost 25 years. Almost any mechanics or mathematics courses, no matter civil or military, were taught under the mentorship of M. V. Ostrohradskyi. Moreover, he was working with the researches related to the hydrostatics, hydrodynamics, resilience theory, caloric theory, which had a considerable impact on the activities of the communicational paths engineers and also on the other sciences related to the mathematics.

Communication with this scientist made a huge impact on the whole life of Mykola Pavlovych. Even during his last days, M. P. Petrov remembered his teacher: “he was a formidable scientist and in addition was able to explain in the fantastic manner, abstract mathematics principals. This ability helped him to teach a lot of great mathematicians. Right now I remember those happy hours when due to his teaching manner some kind of magic force drew in my mind new knowledge. As everything powerful has a force of gravity, the science also attracted us, forcing to learn it deeper and serve to it, with the only reward, understanding the high honor to be servant of science. Here are the consequences of being a student of Ostrohradskyi” (Petrov, 1883, p. 84). From his teacher M. P. Petrov learnt not only mathematics culture and abstract thinking but also the knowledge in theoretical and practical issues of other sciences, especially related to the transport.

Excellent knowledge in mathematics in solving practical issues placed M. P. Petrov among the formidable scientists. In Academy M. P. Petrov got to know the lecturer of the building and mechanics course of the Institute of Corps communicational paths engineers Stanislav Valerianovych Kerbedz (1800–1899). Their communication prompt the interest of Mykola Pavlovych to the disciplines that were taught in the Institute and contacts with the scientists made it possible for him to gain the latest knowledge for that time.

After graduating from the Engineer Academy in 1858 M. P. Petrov left in the academy where he started to work under the mentorship of M. V. Ostrohradskyi i. At the same time he visited mathematics and mechanics lectures in the Petersburg practical institute, founded in 1828. Those lectures were held by scientist and engineer Ivan Oleksiiiovych Vyshnehradskyi (1832–1895). The relation between the theory and practical tasks, independence from the foreign schools were among the key issues of I. O. Vyshnehradskyi (see fig.3) as an innovator in mechanics. Work under his mentorship granted vast possibilities for the development of M. P. Petrov`s skills.

After the death of M. V. Ostrohradskyi in 1862 M. P. Petrov began to lead the mathematics course in Engineer Academy and also mechanics in Practical institute from 1866. Being a teacher in the institute and communication with I. O. Vyshnehradskyi, O. P. Borodyn and other scientists and specialists prompt M. P. Petrov to focus his attention on the issues related to the friction.

Among the teachers of M. P. Petrov in the Academy was Herman Yehorovych Pauker (1822–1889) (see fig.4). M. P. Petrov always remembered him as a wonderful

engineer and teacher, who created the school of teachers – engineers. Their main goal was to gain the harmonic connection between the exact sciences and engineering art. Later, in 1888–1889 H. Y. Pauker, as the minister of the communicational paths of the Russian Empire, who made a considerable impact on the M. P. Petrov`s career.



Figure 3. Ivan Oleksiiiovych Vyshnehradskyi (https://uk.wikipedia.org/wiki/Вишнеградський_Іван_Олексійович)



Figure 4. Herman Yehorovych Pauker (1822–1889) (https://ru.wikipedia.org/wiki/Паукер,_Герман_Егорович)

H. Y. Pauker was a well-known specialist among the Russian engineers (Strelko, 2016; Pylypchuk & Strelko, 2018). He was teaching not only during the lectures, also he practised the private discussions in the lecturer's room, speaking to the young teachers about various engineer issues. M. P. Petrov learnt from him to love engineering and to understand the ways of its development. In the Academy was found the school of the Russian military – engineering art.

During the studying in the Academy M. P. Petrov was formed as a future specialist and scientist, who had the character that made it easy for him to communicate with others. He was independent, truthful, and humane. In addition to his formidable mind it helped him to achieve all his goals, solve the hardest engineer task, and managerial tasks. The main feature of his nature was to be original and brave in thinking, and to seek learning.

Influence of the various dominating scientific schools and views on the further works of M. P. Petrov is quite hard to evaluate nowadays. The reason for it is that all his works are quite individual and original, but mostly they relate to the French school with its priority inaccurate mathematical analysis of the technical issues.

When M. P. Petrov came back after the foreign business trip he started to teach mechanics in Engineer academy and Technological institute in Petersburg. Soon, the first scientific researches appeared. In 1873 he started to work on the railways as an auditor of the Main Russian railways' fellowship. The same year M. P. Petrov founded the new discipline in Technological institute – “Railway rolling stock”, and he made the first step that had a huge impact on the development of the railway transport of the Russian empire.

In the first edition of this course some absolutely new ideas of the author and plans for the further work could be found. Among those for the first time the theoretical base for the formula of the train resistance while moving on the rails (Petrov, 1889). The founder of the discussion of this issue was English designer and inventor, founder of the development of the steam railway transport G. Stephenson. Later on, all European experimental areas were held the experiments and a lot of empirical formulas of the rolling stock resistance on the railway calculations were offered.

However, M. P. Petrov thought that the results of those experiments could not be considered scientific or technical because the researchers did not differentiate the separate elements of the whole issue. As the matter of fact, the general conclusion of those experiments could not be made that is why it was possible that the conditions and results for one railway could be quite opposite for other railways. So, the results of the experiments were quite different and were leading to different conclusions. M. P. Petrov did not choose the way of using the empirical formulas while solving the train resistance issue. The scientific way that he had chosen was complicated and required a lot of time for completion. However, that method in the future solved the crucial issue about the train movement resistance – friction impact on train movement. Solving this issue was extra important for science.

Even in the first his works related to this issue, he countered the theory that “coefficient of the friction in bearings does not depend on velocity, pressure and temperature”. Based on the works of N. Kirhgofer, S. Bokelberg, D. Velkner and his own works on the Warsaw railway he showed that the factors like velocity, pressure and temperature had a considerable impact.

The views of M. P. Petrov on the problem of train movement resistance hundred years ago were complex and considered all the elements of this resistance: “From the very beginning of the train movement resistance research the scientists mentioned that it consists of separate parts that do not relate one with another. Some of those aspects were researched and some appeared unknown or less known. For the research of the last ones, scientists made various experiments that gave us new knowledge. To determine the elements of the train movement resistance it should be mentioned that keeping the same velocity of two same trains on the rails of the same construction two different powers needed if the rails are placed on the surface with the different angle. The power that needed for the elevated surface differs and the difference is equal to the projection of the power of train`s gravity that is moving, which was taken in the direction parallel to rails. While moving up this power is adding to other resistances that are present while moving on the horizontal surface, and while moving down it should be subtracted from the total resistance”.

All the elements that included to the total resistance of the train while moving on the horizontal surface are easy to determine. They are:

- Air resistance;
- Friction between wheels and rails resistance;
- Axis friction resistance caused by the friction of lubricated solids;
- Resistance made by the hits between wheels and rails caused by the unevenness of the surfaces, rails or wheels, or caused by the third-party solids.
- Rolling resistance of wheels on the rails.
- During the acceleration of the train to the total resistance should be added to the resistances that depend on the powers of the inertia.

On the non-horizontal rails, but the straight ones, the resistance of the power of gravity should be also added.

Also, the curves of the rails are increasing the total resistance. The reason for it is that it increases the friction of solids. For the research of the train movement resistance, it is mandatory to evaluate all the elements of the total resistance.

In the works of M. P. Petrov that were published, we may find a lot of researches that solve not only the resistance issue but also the methods of the determining the main dimensions of the train, calculation of the wheels and so on. It is obvious, that further improvements and separate conclusions made by M. P. Petrov were justified, later they were changed by the more modern ones, however, the methods that were found while solving the issue are the same even nowadays.

Rolling stock course made it possible for M. P. Petrov to organize the professors` cathedra in 1873. He taught this course improving it till 1892. 1892 was

the last year of his lecturer's activities in the Technological Institute. The same year he was promoted to the position of the vice Minister of the communicational paths of the Russian empire and at the same time till 1900, he taught the steam mechanics course in Engineer Academy in Petersburg.

As a professor, M. P. Petrov treated well the students that had some lack of knowledge in the technical details, but he demanded from them accurate knowledge in differential calculations and mechanics basics. Those demands made him a reputation of a sharp examiner. On the other hand, everyone knew that he demanded the knowledge of the issue basics, not the additional details.

Conclusions

The period of the formation of the scientific views of M. P. Petrov had a couple of stages: 1849–1855) – studying in “Noble regiment”; (1855–1858) – studying in Mykolaiv Engineer Academy and Technical Institute in Petersburg. The considerable influence on the scientific views of M. P. Petrov was made by O. P. Borodin, I. O. Vyshnehradskyi, S. V. Kerbedz, H. Y Pauker, M. V Ostrohradskyi and others.

We determined that M. P. Petrov developed the learning about the hydrodynamic theory of lubrication. He found the main systematic parameters of the hydrodynamic lubrication that caused the foundation of his concepts in the development of the railway transport. His communication with the formidable scientists and engineers of that time could be considered as the most important factor of the formation of M. P. Petrov as a scientist, engineer and lecturer.

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Янін Володимир

Незалежний дослідник, Україна

Інженер шляхів сполучення Микола Павлович Петров (1836–1920): чинники формування наукового світогляду

Анотація. У статті розглянуто чинники формування наукового світогляду Миколи Павловича Петрова – видатного російського вченого та інженера на тлі його ініціативно-організаційних зусиль розбудови вітчизняного науково-технічного простору кінця XIX – початку XX століть. На особливу увагу заслуговує його біографічна компонента, навчання у вузах Санкт-Петербурга. На творчу долю М. П. Петрова вирішальний вплив мало навчання в Інженерній Академі. В цей час було закладено його інтелектуальний

фундамент, на якому пізніше він сформувався як видатний інженер і вчений. Там він навчався у видатного математика академіка Сакт-Петербурзької Академії наук, уродженця м. Полтави, Михайла Васильовича Остроградського (1801–1862). Від свого вчителя М. П. Петров сприйняв не тільки високу математичну культуру і глибину абстрактного мислення, а й знайомство з теоретичними і практичними проблемами в інших науках, в тому числі належних до транспорту. Викладацька робота в Технологічному інституті, спілкування з І. О. Вишнеградським, О. П. Бородіним, іншими вченими і спеціалістами послужили поштовхом до вивчення прикладних дисциплін, в першу чергу пов'язаних з тертям в умовах змащування. Одним з учителів М. П. Петрова в Академії був Герман Єгорович Паукер (1822–1889), про якого він завжди згадував з особливою теплотою як про чудового інженера і педагога, який створив школу інженерів-викладачів, яка прагнула до гармонійного зв'язку між точними науками та інженерним мистецтвом. В Академії М. П. Петров близько познайомився з викладачем курсів побудов і прикладної механіки Інституту Корпусу інженерів шляхів сполучення Станіславом Валеріановичем Кербедзом. Під час навчання в Академії М. П. Петров сформувався як майбутній вчений і спеціаліст, який володів такими рисами характеру, які сприяли звичайним і невимушеним відносинам його з людьми. Він володів жвавим характером і гуманними поглядами, діяв завжди самостійно і справедливо. Ці риси характеру у поєднанні з особливим розумом допомагали йому досягати мети і при вирішенні дуже складних не тільки інженерних завдань, а й у його адміністративно-організаторській діяльності. Головним в його натурі було стремління до знань, оригінальність і сміливість мислення.

Ключові слова: вчений; інженер; гідродинамічна теорія змащування; будівельна механіка; педагог; залізничник

Янин Владимир

Независимый исследователь, Украина

Инженер путей сообщения Николай Павлович Петров (18936–1920): факторы формирования научного мировоззрения

Аннотация. В статье рассмотрены факторы формирования научного мировоззрения Николая Павловича Петрова – выдающегося русского ученого и инженера на фоне его инициативно-организационных усилий развития отечественного научно-технического пространства конца XIX – начала XX веков. На особенное внимание заслуживает его биографическая компонента, учеба в вузах Санкт-Петербурга. На творческую судьбу М. П. Петрова решающее влияние имела учеба в Инженерной Академии. В это время было заложено его интеллектуальный фундамент, на котором позже он

сформировался как выдающийся инженер и ученый. Там он учился у выдающегося математика академика Санкт-Петербургской Академии наук, уроженца г. Полтавы, Михаила Васильевича Остроградского (1801–1862). От своего учителя М. П. Петров воспринял не только высокую математическую культуру и глубину абстрактного мышления, но и знакомство с теоретическими и практическими проблемами в других науках, в том числе относящихся к транспорту. Преподавательская работа в Технологическом институте, общение из И. А. Вишнеградским, А. П. Бородиным, другими учеными и специалистами послужили толчком к изучению прикладных дисциплин, в первую очередь связанных с трением в условиях смазки. Одним из учителей М. П. Петрова в Академии был Герман Егорович Паукер (1822-1889), о котором он всегда вспоминал с особенной теплотой как о чудесном инженере и педагоге, который создал школу инженеров-преподавателей, которая стремилась к гармоничной связи между точными науками и инженерным искусством. В Академии М. П. Петров близко познакомился с преподавателем курсов построений и прикладной механики Института Корпуса инженеров путей сообщения Станиславом Валериановичем Кербедзом. Во время учебы в Академии М. П. Петров сформировался как будущий ученый и специалист, который владел такими чертами характера, которые способствовали обычным и непринужденным отношениям его с людьми. Он владел оживленным характером и гуманными взглядами, действовал всегда самостоятельно и справедливо. Эти черты характера в сочетании с особенным умом помогали ему достигать цели и при решении очень сложных не только инженерных заданий, но и в его административно-организаторской деятельности. Главным в его натуре было стремление к знаниям, оригинальность и смелость мышления.

Ключевые слова: ученый; инженер; гидродинамическая теория смазки; строительная механика; педагог; железнодорожник

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