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Mikhail Ziegler, the First Professor of Metallurgy at Warsaw Polytechnic, and His Contribution for Developing our Knowledge about Steels

Abstract

The article presents results of research on the origin and development of scientific schools in the field of metallurgy in Eastern Europe at the turn of the 19th–20th centuries, associated with the scientific and pedagogical activities of the famous scientist Professor Mikhail Karlovich Ziegler in the higher technical educational institutions of Warsaw (Warsaw Polytechnic Institute of Emperor Nicholas II), Kharkiv (Kharkov Technological Institute of Emperor Alexander III), St. Petersburg (Petrograd Polytechnic Institute) and Moscow (Moscow Mining Academy).

The main facts of the biography of this scientist and educator are given. The stages of formation of M.K. Ziegler as a personality and a scientist against the backdrop of occurring historical processes are shown. The Soviet period of his activity was considered separately.

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The scientific achievements of Professor Ziegler in the field of steel metallurgy, in particular, in determining the strength of steels depending on the conditions of their crystallization, studying the diffusion of impurities in steels, which became the foundation for the development of continuous casting technology, i.e. one of the most important world inventions of the 20th century, are systematized and analyzed.

His organizational and educating contribution for the training of scientific and engineering personnel for the metallurgical industry is also estimated.

The article includes interesting forgotten and little-known facts from the history of metallurgical science and the training of the higher engineering and technical personnel in educational institutions located on the territory of modern Ukraine and Poland.

Keywords: *Mikhail Ziegler, Warsaw Polytechnic, metallurgical science, history of metallurgy, technical education*

Wkład pierwszego profesora metalurgii Politechniki Warszawskiej Michała Zieglera w rozwój wiedzy o stalach

Abstrakt

W artykule przedstawiono wyniki badań nad genezą i rozwojem szkół naukowych w dziedzinie metalurgii w Europie Wschodniej na przełomie XIX i XX wieku, związanych z działalnością naukową i pedagogiczną słynnego uczonego profesora Michała Karłowicza Zieglera w wyższych uczelniach technicznych Warszawy (Instytucie Politechniki Warszawskiej im. Cesarza Mikołaja II), Charkowa (Instytucie Techniki im. Cesarza Aleksandra III w Charkowie), Petersburga (Instytucie Politechniki Piotrogrodzkiej) i Moskwy (Moskiewskiej Akademii Górniczej).

Podano główne fakty z biografii tego naukowca i pedagoga. Ukazano etapy powstawania M.K. Zieglera jako osobowości i naukowca na tle zachodzących procesów historycznych. Odrębnie rozpatrywano sowiecki okres jego działalności.

Usystematyzowano i przeanalizowano dorobek naukowy profesora Zieglera w dziedzinie hutnictwa stali, w szczególności w określaniu wytrzymałości stali w zależności od warunków ich krystalizacji, badaniu dyfuzji zanieczyszczeń w stalach, co stało się podstawą rozwoju technologii odlewania ciągłego, jednego z najważniejszych światowych wynalazków XX wieku.

Oceniono także jego wkład organizacyjny i dydaktyczny w kształcenie kadr naukowo-inżynierskich dla przemysłu metalurgicznego.

Artykuł zawiera ciekawe zapomniane i mało znane fakty z historii metalurgii i kształcenia kadr z wyższym wykształceniem inżyniersko-technicznym w placówkach oświatowych znajdujących się na terytorium współczesnej Ukrainy i Polski.

Słowa kluczowe: *Michał Ziegler, Politechnika Warszawska, metalurgia, historia hutnictwa, wykształcenie techniczne*

1. Introduction

Scientific researches in the field of metallurgy in Ukraine started at the end of the 19th century. Developing of scientific knowledge in the metallurgy and mining industry was associated with the activities of outstanding Ukrainian scientists, whose achievements have been recognized throughout the world. Among them, the special place belongs to Prof. Mikhail Karlovich Ziegler.

Mikhail Ziegler, the talented representative of the scientific school that was formed in Kharkiv at the end of the 19th century, was student of the first educator of metallurgy at the Kharkov Practical Technological Institute Apollon Fedorovich Mevius. Thanks to the persistent and tenacious work of Ziegler, metallurgical science was significantly expanded in promising areas, primarily in the production of steel and in improving its quality. He managed to make the significant contribution to the training of scientific and engineering personnel in metallurgy.

His students, whom he taught in Kharkov, Warsaw, Nizhny Novgorod, and Moscow, formed a golden fund of scientists and practitioners of metallurgy and founded new scientific directions and research institutes. Studying the history of Ukrainian metallurgy requires the integrated approach, that is, identifying key events, in-depth study of scientific schools and biographies of famous metallurgists. In this work, its authors used the following methods: content analysis, historiographical analysis, chronology, historical and comparative analysis, biographical methods, and critical analysis based on historicism and objectivity. The scientific and educational activities of Mikhail Ziegler formed the extremely important page in the history of world metallurgy and needs to be studied in detail. In addition, the personality and professional activities of Mikhail Ziegler have not yet been studied. Brief information about the scientist and pedagogue was presented in numerous studies on the history of the National Technical University “Kharkov Polytechnic Institute” (NTU “KhPI”) and the Moscow Mining Academy. However, these works had certain inaccuracies, did not reflect the contribution of the scientist and pedagogue to the history of world metallurgy, there is no comprehensive study of the life and work of Mikhail Ziegler.

The sources of this study were the materials of the State archive of the Kharkiv region, the State archive of the Nizhny Novgorod region and the archive of NTU “KhPI”.

This article makes an attempt to perform a historical and scientific analysis of the life and scientific work of Professor Mikhail Karlovich Ziegler, and evaluate his contribution to the theory of metallurgical processes.

2. Biographical information

Mikhail Karlovich Ziegler was born on June 19, 1864¹ in St. Petersburg in the family of the nobles Matilda-Eleonora Egorovna (in girlhood – Stukkey) and academician of architecture Karl Karlovich Ziegler.² His father was the architect of the court of Grand Duke Mikhail Nikolayevich and one of the restorers of the building of the Old Hermitage.³ Four children were born in the family. The older ones – Matilda Karlovna (born March 19, 1857), who married Viktor Lvovich Kirpichev in 1876 and brother – Emily Karlovich (born September 18, 1859), as well as the younger sister Nina Karlovna (born April 26, 1866).⁴ (Hereinafter, the dates are given in the old style.)

The godfather of the baby was Grand Duke Mikhail Nikolaevich, the godparents were Dr. Eduard Stukkey and the widow of the Finnish provincial architect Amalia Ziegler.⁵

It would seem that everything in the family is good: fast career father, prosperity in the house. But suddenly, in December 1867 mother Matilda-Eleonora Yegorovna Ziegler died.⁶ Father married second time Francis-Emilia (Fanny) Ivanovna Snow. Children are born in the father's new family: son – Maximilian Karlovich (born January 31, 1870) and Olga Karlovna (born July 15, 1875).⁷

Since 1891 the family name “Ziegler von Schaffhausen” was returned to the Ziegler family. By that time, father had the title of the real state councilor, which corresponded to army rank of major general and gave the right to hereditary nobility.

However, Mikhail Karlovich never signed either such surname or middle name – his birth certificate indicates his name according to the Evangelical Lutheran religion: Mikhail-Eduard

¹ SAKhR, f. 770, desc. 2, case 2120, p. 2.

² *Ibid.*, p. 5.

³ Blokh, Lebedev, Tarbeev 2018, p. 406.

⁴ SAKhR, f. 770, desc. 2, case 2120, p. 12.

⁵ *Ibid.*, p. 6.

⁶ Blokh, Lebedev, Tarbeev 2018, p. 29.

⁷ SAKhR, f. 770, desc. 2, case 2120, p. 13.

(obviously, he was named after his godfather, Grand Duke Mikhail Nikolaevich and uncle, Eduard Stuckey).⁸ Only the name Ziegler appears in his diplomas, passports, and his articles. Either Mikhail Karlovich did not want to change all his documents, or he did not want to use his father's new surname, being offended by him or his stepmother, perhaps he did not want to use the same surname with children born in his father's second marriage...



Fig. 1. Coat of arms of Ziegler von Schaffhausen noble family. *Source*: Anonymous₂ 1895.

In 1876 Mikhail entered St. Petersburg first real school, which he graduated from in June 1883. The young man's favorite subject was chemistry, knowledge of this subject was rated excellent. It is not surprising that in June 1884 he graduated from additional class in the chemical-technical department of the St. Petersburg first real school, which gave him the right to enter higher technical educational institutions.

Analyzing the grades of Mikhail Karlovich, we can assume that there could not have been without his older sister and her husband influence on the young man. The main course of the St. Petersburg first real school Mikhail finishes with average grades. His knowledge was rated 5 points in chemistry and history, 4 points in God's law, physics, drawing and mechanics, and 3 points in the remaining 10 subjects.⁹ Grades in the additional class in the chemical-technical department of the same school were significantly higher: his knowledge of the God's law, physics, chemistry, mechanics and laboratory work was rated 5 points, his knowledge of history, general building art and accounting was 4 points. And only knowledge of mathematics was rated with 3 points¹⁰. And Mikhail Karlovich subsequently graduated from higher educational institution with the title of process engineer, that is, with honors!

He successfully entered the St. Petersburg Technological Institute in 1886, and then transferred to the Kharkov Practical Technological Institute (KhPTI).¹¹

It would seem, why does young man move to Kharkiv, which in many respects was clearly inferior to the capital at that time? In the capital there is father's house, friends live, there are many attractive places for young man – a theater, a park, many museums, balls and gala evenings are held. Most likely, he did not have relationship with his stepmother and he decided to leave to study in another city. Moreover, his older sister, Matilda Karlovna, lived in Kharkiv, who was married the first director of the Kharkov Practical Technological Institute Viktor Lvovich Kirpichev. Moving from the capital was difficult test for Matilda Karlovna: she had four children in her care, the eldest of whom, Vera, was 8 years old, and the youngest, Nina,

⁸ *Ibid.*, p. 5.

⁹ SAKhR, f. 770, desc. 2, case 2120, p. 3.

¹⁰ *Ibid.*, p. 4.

¹¹ *Ibid.*, p. 1.

was not even 4 years old.¹² There was no hope for her husband's help: he has been out for all days at work, went on numerous business trips, worked hard for the successful opening of the institute. And yet, the first summer in Kharkiv brought a lot of joy to the Kirpichev family. The change from the humid and cold seaside climate of St. Petersburg to the temperate continental climate of Kharkiv had the positive impact on the health of both parents and children. The abundance of fruits, vegetables, dairy products, which Kharkiv fairs have always been famous for, has led to the fact that children in the Kirpichev family fell ill much less often. It should be noted that Matilda Karlovna was also a good mother. She devoted all her free time to children and almost did not participate in various events that she could attend, as the wife of the director of the institute.

Arriving in Kharkiv, Mikhail Karlovich plunges headlong into his studies.

Sometimes he visited his four nephews: Vera, Evgenia, Nina and Mikhail. The elder sister, as she could, supported her younger brother, realizing that he had to rely only on himself.

In the Kirpichev family, two future academicians bore the name Mikhail – Mikhail Viktorovich Kirpichev and Mikhail Alexandrovich Leontovich, the son of Vera Viktorovna Kirpicheva (married Leontovich). Most likely, the nephew, Mikhail Viktorovich, was named after Mikhail Ziegler: Matilda Karlovna loved her younger brother very much and tried to help him as much as she could. But in whose honor Mikhail Alexandrovich was named, it is impossible to determine. He could be named both in honor of his uncle, Mikhail Viktorovich, as well as in honor of his great-uncle, Mikhail Ziegler.

Mikhail Karlovich met his sister's expectations, graduating from the institute among the best graduates. The members of his group and the educational graduation of 1891 (the second graduation of the Kharkov Practical Technological Institute) was strong one: in the mechanical department 20 students received the title of process engineer and 8 received the title of technician and in the chemical department 23 students received the title of process engineer and 12 received title of technician.



Fig. 2. Mikhail Karlovich Ziegler (1864–1922). Photo from the album of KhTI graduates of 1891 is in Public Domain.

In other words, 43 people graduated with honors and 20 without ones. In the same graduation with Mikhail Karlovich were: Nikolai Ivanovich Kartashev – classic of locomotive building, Grigory Fedotov Burakov – future professor and rector of the KhTI, Duke Alexei Akakievich Tsereteli – well-known opera entrepreneur in the future, Joseph Abramovich

¹² SAKhR, f. R-1682, desc. 2, case 14, p. 35.

Zektser– Kyiv architect, Mikhail Konstantinovich Chekurul-Kush – city Chisinau architect and other lesser-known graduates.¹³

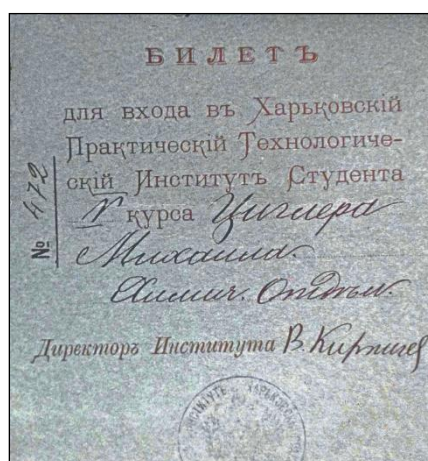


Fig. 3. Student card of Mikhail Ziegler. *Source:* SAKhR, f. 770, desc. 2, case 2120, p. 26.

3. Beginning of metallurgical research in Ukraine

The beginning of scientific research in metallurgy in Ukraine was made by Apollon Fedorovich Mevius, one of the most educated mining engineers of his time, the former head of the Lugansk Mining District, and then educator of metallurgy at the Kharkov Practical Technological Institute, who enriched domestic technical literature with fundamental works on foundry and ferrous metallurgy. For example, the printed course of iron metallurgy and many other scientific works of mining topics.¹⁴ A. F. Mevius is the author of about 100 printed works, including the first textbook on metalworking in Russian – “The cast iron foundry course” (for this work, published in 1859, the Russian Academy of Sciences awarded him the Demidov Prize 2 -th degree), “The future of mining in the South of Russia” (1867), “Training course on metallurgy of cast iron, iron and steel” (1894) – the first textbook on metallurgy published in Ukraine, “Technical French-Russian Dictionary” for 64 thousand words (1898), on which Mevius worked for the last 28 years of his life, and many others.



Fig. 4. Mining engineer, Acting State Councilor Apollon Fedorovich Mevius (1820–1898).
Source: A.G. Zhurilo, D.Yu. Zhurylo 2013, p. 8.

¹³ SAKhR, f. 45, desc. 1, case 989, pp. 2–3.

¹⁴ D.Yu. Zhurylo 2020, p. 170.

After analyzing the transport conditions, labor and water resources of the Donbass from the point of view of the building of metallurgical plants, Mevius not only outlined the basic principles and features of the design of metallurgical plants in the Donbass, but also specifically identified 11 points where it would be economically profitable to start building large iron and steel plants. It should be noted that subsequently, after 25–30 years, metallurgical plants were actually founded at number of these points (Yuzovsky, Makeevsky, Druzhkovsky, Olkhovsky and others).¹⁵ It was thanks to his activities that it became possible to carry out large-scale railway building in Russia, the boom of which coincided with the end of the 19th century.

A.F. Mevius from July 16, 1887 became the educator of metallurgy at the Kharkov Practical Technological Institute.¹⁶ In addition to lecturing on metallurgy, he supervised fifth year student graduation projects on the building of metallurgical plants and their equipment, and also supervised the manufacturing practice of students at metallurgical plants and edited the “Gornozavodskoy Listok magazine” published in Kharkiv.¹⁷

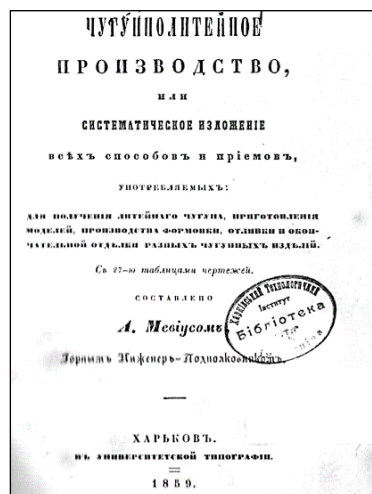


Fig. 5. Cover of the Mevius’s book “Iron foundry”.
Source: D.Yu. Zhurylo 2020, p. 178.

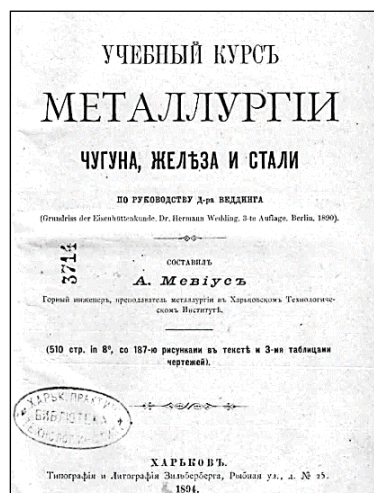


Fig. 6. Cover of Mevius’s book “Training course on cast iron, iron and steel”.
Source: D.Yu. Zhurylo 2020, p. 180.

¹⁵ A.G. Zhurilo, D.Yu. Zhurylo 2013, p. 12.

¹⁶ SAKhR, f. R-1682, desc. 2, case 202, p. 2.

¹⁷ *Ibid.*, p. 8.

The outstanding Russian scientist and mining engineer, the founder of mining mechanics, Ivan Avgustovich Time wrote:

A.F. Mevius is one of the most educated mining engineers, who was the head of the Lugansk mining district and then professor of metallurgy at the Kharkov Technological Institute, who enriched Russian technical literature with fundamental works on foundry. He also published the printed course on iron metallurgy and the lots of other scientific works on mining topics.¹⁸

In parallel with teaching, Mevius supervised the building of the metallurgical plant in Alchevsk. Due to the heavy workload of factory affairs, Mevius was forced in 1895 to refuse to work at the institute.¹⁹ Despite the fact that Mevius left teaching, he did not leave work in the field of technical education – he served as vice president of the Kharkov branch of the Imperial Russian Technical Society (the president was the director of KhPTI V. L. Kirpichev). The technical society was located in house number 18–20 on Sumskaya Street, where the Congress of Miners of the South of Russia was also located. In the last years of his life A. F. Mevius was honorary member of the Kharkov branch of the Russian Technical Society. Until the death of A. F. Mevius the South Russian Society of Technologists was headed by V. L. Kirpichev.

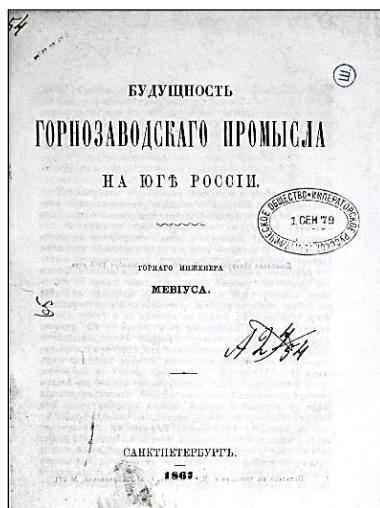


Fig. 7. Cover of Mevius's book "The Future of mining in the South of Russia".
Source: D.Yu. Zhurylo 2020, p. 182.

Mikhail Ziegler was also one of the members of the South Russian Society of Technologists, located at number 18–20 on Sumskaya Street. Naturally, he could not pass by personal acquaintance with such outstanding specialist, especially with extraordinary educator of his higher educational institution. In addition, Apollon Fedorovich was exceptionally charming, modest and benevolent person. Even at his celebration on the 50th anniversary of his mining career, he modestly noted that "his merits are too insignificant and he, to the best of his ability, tried only to fulfill his duties".²⁰

¹⁸ A.G. Zhurilo, D.Yu. Zhurylo 2013, p. 16.

¹⁹ SAKhR, f. R-1682, desc. 2, case 202, p. 6.

²⁰ Anonymous₁ 1890, p. 189.

4. Professional activity of Mikhail Ziegler

After graduating from the Kharkov Technological Institute, the young engineer begins to work for the Ministry of Finance – an assistant factory inspector in the Kharkov province. At the beginning of 1893, order No. 12 for the Ministry was issued, appointing him to the post.²¹

The system of factory inspectors in the Russian Empire was quite interesting. In each province, senior factory inspector was appointed, often with the rank of state councilor, to whom several district factory inspectors and assistant factory inspectors of various ranks and with various educations – from home to university one, were subordinate. Factory inspectors were engaged in “supervision of the classes and training of young workers working in factories, plants and manufactories”²², with the exception of injuries, for what today is called the parameters of the microclimate – temperature, humidity, illumination in the workplace. In fact, it was labor protection service. After the reform of 1861, a lot of former peasants moved to the city, where they worked in variety of factories and plants. Sometimes, 3 workers worked at the “factory”, sometimes more than one hundred ones. There were enough violations of the law, and factory inspectors often closed enterprises until the violations were completely corrected. For example, due to the lack of permission, the factory inspectorate closed the forge²³, denied the opening of the dyed fabric²⁴, the tobacco factory with 5 workers was closed due to dampness in Petrovsky lane of Kharkiv²⁵, denied permission to arrange a bathhouse in Gymnastic Waterfront Street²⁶. The decisions of the factory inspection were awaited, like the well-known merchant in Kharkiv Vasily Pashchenkov-Tryapkin, asking for permission to install locomobile for lighting at his factory in Klochkovskaya Street²⁷ and Nikolai Grebenshchikov, little-known in Kharkiv, who wanted to make soap in Voskresenskaya square²⁸. All managers of enterprises were required to allow factory inspectors and assistant factory inspectors to enter the enterprises, to assist them and comply with their legal requirements. The inspector could come to the enterprise with verification at any time of the day.

Considering that the enterprises were located in different counties of the province, and there were not so many inspectors, the work involved not only knowledge of the basics of various crafts, but also multiple trips. The main requirement for factory inspectors was higher education. Technical education was appreciated above university one. The specialized higher chemical education of Mikhail Karlovich was in demand, and his single life allowed him to be on business trips for a long time.

Already in September 1893 Mikhail Karlovich received the rank of collegiate secretary,²⁹ and in May 1894 he became the factory inspector in the Kharkov province. In March 1895 he was promoted to titular councilor.³⁰ It was possible to stay in the service further, receiving new ranks with the prospect of becoming a senior factory inspector, receiving the rank of state councilor or even a real state councilor...

In 1896 Ziegler started working in the KhTI as a laboratory assistant at the chemical laboratory.³¹ His former superiors did not see any obstacles in the transition of Mikhail Karlovich to the new place of service, realizing that his income is low, and the demands, like

²¹ SAKhR, f. R-1682, desc. 2, case 356, p. 45.

²² *Ibid.*, p. 62.

²³ SAKhR, f. 45, desc. 1, case 1097, p. 54.

²⁴ SAKhR, f. 45, desc. 1, case 769, p. 42.

²⁵ SAKhR, f. 45, desc. 1, case 989, p. 29.

²⁶ SAKhR, f. 45, desc. 1, case 1097, p. 36.

²⁷ SAKhR, f. 45, desc. 1, case 9903, p. 162.

²⁸ *Ibid.*, p. 111.

²⁹ SAKhR, f. R-1682, desc. 2, case 356, p. 73.

³⁰ *Ibid.*, p. 74.

³¹ *Ibid.*, p. 2.

most young people, are high. Ziegler was paid only 800 rubles of annual salary, to which were added 600 rubles for housing and 600 rubles for canteens.³² Of course, when traveling around the province, the inspector was also paid travel money, but their amounts were small. At the same time, the consolidation of factory districts took place and, for example, from 1897 on the basis of the Law of June 3, 1886 the number of senior factory inspectors for the entire Russian Empire was set at 26, and factory inspectors – 125 people.³³

On May 26, 1896 the director of the institute sent the letter to Mikhail Karlovich announcing his acceptance to the position of a laboratory assistant with a payment of 800 rubles per year.³⁴ He settled not far from the place of working on Theater square, near the Lutheran church, in house number 10.

In 1898 Ziegler received the rank of collegiate assessor.³⁵ In August 1898 he took part in the Tenth Congress of Russian Naturalists and Physicians, which took place in Kyiv from August 20 to September 1, 1898.³⁶

After leaving the service as a laboratory assistant of the laboratory of mineral substances Dmitry Turbaba, Professor Valery Gemilian insists that Ziegler take a vacant position and from June 1, 1899 Mikhail Karlovich is a laboratory assistant of the laboratory of mineral substances.³⁷

On April 21, 1900 at the Society of Physical and Chemical Sciences at the Imperial Kharkov University, Mikhail Ziegler reports his first scientific work on the recovery of metals by the Goldschmidt method.³⁸ Professor Valery Alexandrovich Gemelian provided him with serious assistance in conducting research. He also insisted on Ziegler's business trip abroad in June 1900.³⁹

In February 1901 Mikhail Karlovich received permission from his superiors to marry,⁴⁰ and in April 1901 he marries the daughter of a hereditary nobleman of the Tauride province (from Melitopol) Claudia Alexandrovna Rykova, the younger sister of his colleague, graduate of the KhTIYanuariy Alexandrovich Rykov. Yanuariy Alexandrovich graduated from the mechanical department of the institute a year earlier than Ziegler, in the first graduation of engineers with the title of technician.⁴¹ The authors⁴² indicate that subsequently, two children were born in the Ziegler family. According to,⁴³ the birth of children in the Ziegler family is not indicated.

Where Ziegler met his future wife is unknown. It can be assumed that he spent one of his vacations (in 1894⁴⁴ or in 1896⁴⁵) in the Crimea, visiting his friend Yanuariy Rykov, who was engaged in construction of churches and other buildings in the Tauride province. In Ziegler's passport there is a note about his residence in the Crimea in the summer of 1896.⁴⁶ There he

³² *Ibid.*, p. 5.

³³ Anonymous, 1900, p. 17.

³⁴ SAKhR, f. R-1682, desc. 2, case 356, p. 9.

³⁵ *Ibid.*, p. 17.

³⁶ *Ibid.*, p. 80.

³⁷ *Ibid.*, p. 37.

³⁸ SAKhR, f. R-1682, desc. 2, case 356, p. 25.

³⁹ *Ibid.*, p. 22.

⁴⁰ *Ibid.*, p. 32.

⁴¹ SAKhR, f. R-1682, desc. 4, case 480, p. 1.

⁴² Blokh, Lebedev, Tarbeev 2018, p. 30.

⁴³ CANNR, f. 2082, desc. 2, case 321, p. 160.

⁴⁴ SAKhR, f. R-1682, desc. 2, case 356, p. 5.

⁴⁵ *Ibid.*, p. 16.

⁴⁶ *Ibid.*, p. 94.

could meet his friend's sister. Ziegler's friendship with Rykov continued until the death of Mikhail Karlovich.

In June 1901 the Ministry of Public Education sent Mikhail Karlovich on a business trip abroad. In 1895 the metallurgy educator Apollon Fedorovich Mevius resigned from the institute, and another educator, Nikolai Petrovich Klobukov, died on October 27, 1900⁴⁷ and there was no full-time educator of this subject. It was decided to prepare Ziegler for a professorial rank. He was awarded a scholarship from the Ministry of Public Education in the amount of 2,000 rubles per a year from January 1, 1901 to July 1, 1902.⁴⁸ Later, the scholarship was extended until January 1, 1903.⁴⁹

During the business trip, it was planned to visit the Freiberg Mining Academy, to study iron metallurgy under the guidance of Professor Karl Ledebur⁵⁰. It was planned to study mineralogy and crystallography with Professor Julius Weisbach, geology and microscopic studies of minerals – with Professor Friedrich Beck, electrometallurgy – with Professor Wilhelm Borchers.⁵¹ It was noted that it was desirable to have the practice of performing thin sections with Professor Adolf Martens, and refractory production – with Professor Herman Seger.⁵² The preparation was planned to be very serious, affecting all aspects of the ferrous metallurgy of that time – from theory to practice, from determining the quality of ores to chemical and metallographic studies of the melted metal.

Letters of recommendation were written in French and German with the request to assist scholarship holder of the Ministry of National Education Mikhail Ziegler. Interestingly, in the German certificate Ziegler's position (laboratory assistant) is indicated as “assistant”, but crossed out and “associate professor” is written on top.⁵³

Letters were sent to the number of domestic factories, for example, to Yuzovsky and Dneprovsky, which indicated the need for laboratory assistant Ziegler to visit laboratories, production shops of “our best factories” and asked management for assistance.⁵⁴

Unfortunately, there is no report on the trip abroad in Ziegler's personal file. But the main milestones of the training of Mikhail Karlovich can be restored from his printed works. One of them was co-authored with the classic of metallurgy Henri Le Chatelier (inventor of the pyrometer, metallographic microscope and author of the famous Le Chatelier thermodynamic principle). The article was called: “Iron sulfide, its properties and state in molten iron”.⁵⁵ And it was also translated into English.⁵⁶ It is interesting that the future metallurgist Ziegler, while still studying at the fifth year of KhPTI, specialized not in metallurgy, but in sugar beet production.⁵⁷ This is not the only case. For example, the world's first doctor of science in the field of aviation, who defended his thesis at the Sorbonne, George Botezat, being a student at the Kharkov Technological Institute, defended his diploma in the design of power plants.⁵⁸ This once again testifies to the exceptionally high engineering training of specialists who were taught in higher technical educational institutions in the Russian Empire in the late 19th and early 20th centuries.

⁴⁷ SAKhR, f. R-1682, desc. 2, case 145, p.116.

⁴⁸ SAKhR, f. R-1682, desc. 2, case 356, p. 30.

⁴⁹ *Ibid.*, p. 87.

⁵⁰ *Ibid.*, p. 26.

⁵¹ SAKhR, f. R-1682, desc. 2, case 356, p. 27.

⁵² SAKhR, f. R-1682, desc. 2, case 356, p. 27.

⁵³ *Ibid.*, p. 36.

⁵⁴ *Ibid.*, p. 28.

⁵⁵ Le Chatelier, Ziegler 1902.

⁵⁶ Le Chatelier, Ziegler 1903.

⁵⁷ SAKhR, f. 770, desc. 2, case 2120, p. 28.

⁵⁸ D.Yu. Zhurilo 2022, p. 74.

In 1902 Ziegler was promoted to court councilor.⁵⁹

Returning to Kharkiv, M.K. Ziegler from January 1903 began to educate metallurgy and conduct practical classes in chemical technology at his native institute with the year salary of 1600 rubles.⁶⁰ He was given the state-owned apartment on the territory of the institute. Using his advice after the trip abroad, the Institute purchased a Curie analytical balance at the cost of 500 francs; installations and devices for electrolysis at the price of 340 francs; Siemens and Buchersarc furnaces at the price of 270 rubles; electric drilling machine at the price of 147 rubles, rheostats and measuring instruments at the price of 168 rubles. An electric current was conducted to the laboratory of mineral substances and installations for electrolysis and electric furnaces were made.⁶¹ And the total expenses for the laboratory in 1903 amounted to 1500 rubles.⁶² Using this equipment, classes were held with students in metallurgy under the guidance of Ziegler. Thus, Mikhail Ziegler can be considered one of the first researchers of electric melting of metals in Ukraine.

From February 20 to February 28, 1903 Mikhail Karlovich was on vacation in St. Petersburg,⁶³ where, thanks to the connections of his older brother Emil Karlovich, he determines his future.⁶⁴ The Kharkov Technological Institute of Emperor Alexander III did not have a department of metallurgy. And it was impossible to get a professorship or an associate professorship. On the advice of his brother, Mikhail Karlovich writes a petition addressed to the director of the Warsaw Polytechnic Institute, Emperor Nicholas II Alexander Evgenievich Lagorio with a request to accept him “to one of the existing chairs of metallurgy at the Mining Department”.⁶⁵ The Warsaw Polytechnic Institute of Emperor Nicholas II at that time was in its infancy. At the time of opening on September 3, 1898 it had three departments: mechanical, chemical, and civil engineering. The Institute was temporarily located in a building donated by the prominent Warsaw manufacturer Jan Bloch.⁶⁶

And in 1902 the mining department was also opened.⁶⁷ The Warsaw Polytechnic Institute received beautiful buildings built in two years according to the design of academicians of architecture Stepan Feofilovich Schiller and Bronislav Stanislavovich Roguysky. It is interesting that in 1915 B.S. Roguysky repeated the project of institute buildings for the Don Polytechnic Institute in Novocherkassk, which appeared as the heir to the Warsaw Polytechnic.⁶⁸

The Warsaw Polytechnic Institute had the plot of land, almost 5 hectares, including a city park, in the area of Polna, Koszykowa and Nowowiejska (Polnaya, Koshikova and Novoveyskaya) Streets. There the buildings of the main pavilion, chemical and mechanical pavilions were located. As conceived by the architects, the single complex of buildings in the plan formed “cross inscribed in a rhombus”. In the center of the plan was the house church. The free space was covered with glass lantern, on which there were promenade the galleries and the pavilion for exhibiting diploma projects. Nearby, two residential buildings with 24 apartments for the administration and professors were built, providing the staff with state-owned apartments according to the standards of that time.⁶⁹

⁵⁹ SAKhR, f. R-1682, desc. 2, case 356, p. 57.

⁶⁰ *Ibid.*, p. 54.

⁶¹ Anonymous, 1904, p. 54.

⁶² SAKhR, f. R-1682, desc. 2, case 356, p. 61.

⁶³ *Ibid.*, p. 56.

⁶⁴ Blokh, Lebedev, Tarbeev 2018, p. 30.

⁶⁵ CANNR, f. 2082, desc. 2, case 321, p. 1.

⁶⁶ Blokh, Lebedev, Tarbeev 2018, p. 12.

⁶⁷ *Ibid.*, p. 13.

⁶⁸ Rybiev, Polyanskaya 2007, p. 16.

⁶⁹ *Ibid.*, p. 15.

In January 1904 the director of the Warsaw Polytechnic Institute of Emperor Nicholas II, Alexander Evgenievich Lagorio, sent the secret letter to the director of the Kharkov Technological Institute of Emperor Alexander III Nikolai Nikolaevich Schiller, asking him to clarify Ziegler's "moral and service qualities", to report that there were no obstacles to Mikhail Karlovich's transfer to new position service and, in their absence send copy of the service record to M.K. Ziegler.⁷⁰



Fig. 8. The main building of the Warsaw Polytechnic. *Source:* Anonymous⁴ 1901, p. 12.

The Warsaw Polytechnic Institute of Emperor Nicholas II belonged to the Ministry of Finance of the Russian Empire, and not to the Ministry of Public Education, like the Kharkov Technological Institute of Emperor Alexander III. Therefore, the transition from one higher educational institution to another was, in fact, transition to another ministry and required time for various bureaucratic delays.



Fig.9. Corner stamps of institutes. The affiliation to the ministries (finance and public education) is indicated at the top. *Source:* SAKhR, f. R-1682, desc. 2, case 356, pp. 37 and 59.

Director of the Kharkiv Technological Institute of Emperor Alexander III Nikolai Schiller in the response letter indicated that "process engineer Ziegler has good moral and service qualities".⁷¹ The Professor Schiller's only condition was that Ziegler's transfer should take place no earlier than June 1904. On July 1, 1904 Mikhail Ziegler was transferred to the Warsaw Polytechnic Institute of Emperor Nicholas II to the post of educator of metallurgy with the duties of an extraordinary professor.⁷²

As soon as he moved to Warsaw, Mikhail Ziegler filled out the application for supplying equipment for metallurgical laboratory at the Warsaw Polytechnic Institute of Emperor

⁷⁰ SAKhR, f. R-1682, desc. 2, case 356, p. 59.

⁷¹ SAKhR, f. R-1682, desc. 2, case 356, p. 60.

⁷² *Ibid.*, p. 65.

Nicholas II.⁷³ Not knowing the new address of the educator, the supplier T. Plevinsky sent the letter in February 1905 to the office of the Kharkov Technological Institute of Emperor Alexander III with request to indicate the address of residence of Mikhail Ziegler.⁷⁴ He was told that Ziegler's address was unknown to them.⁷⁵

Since moving to Warsaw, Ziegler has been actively working, self-educating, supervising coursework and graduation projects. The Warsaw Polytechnic is also developing. Already in the 1904/05 academic year, the number of students exceeded 1,000. In this academic year, 14 professors and 32 educators taught at the institute, some of whom were part-time.⁷⁶

The Warsaw Polytechnic Institute of Emperor Nicholas II did not belong to the Ministry of Public Education, therefore, the names of its employees, their positions, marital status, awards received and salaries were not published in the relevant proceedings. The Warsaw Polytechnic Institute belonged first to the Ministry of Finance, and then to the Ministry of Trade and Industry. However, in the proceedings of "All Warsaw" for various years we could find some data about its educators and staff. For example, in the proceeding for 1905 it is noted that the acting process engineer court adviser Mikhail Karlovich Ziegler was the acting extraordinary professor of metallurgy.⁷⁷

But in 1905 revolutionary events came and the Institute was transferred to Novocherkassk. Mikhail Karlovich, having procured the vacation,⁷⁸ continued his experiments, and in December 1907 he took part in the 1st Mendeleev Congress in St. Petersburg, where he made the report on the results of his research, including those carried out earlier in France and Germany. Interestingly, in the capital, Ziegler lived in the apartment of his older brother, Emil Karlovich, at Konnogvardeisky boulevard, house number 19.⁷⁹ In 1908 the Warsaw Polytechnic Institute of Emperor Nicholas II was returned to Warsaw, and M.K. Ziegler, like other educators, resumed educating there. In 1908 Mikhail Karlovich began to publish parts of the book "Investigation of alloys of iron with sulfur and the phenomenon of hot-brittleness of steel". Interestingly, the 3rd part was first published, partially reported at the Mendeleev Congress, and in 1912 the 1st, 2nd and 4th parts were printed. Today, any metallurgist will say that sulfur has the greatest influence on the hot-brittleness of steel. But how many will remember the author of numerous studies on this issue – Mikhail Ziegler?

In the proceeding "All Warsaw" for 1906 it is noted that the acting process engineer court adviser Mikhail Karlovich Ziegler was the acting extraordinary professor of metallurgy, he lived on 63 Koszykowa Street.⁸⁰ However, in March 1906 he received the rank of collegiate adviser.⁸¹ In the proceedings "All Warsaw" for 1907–1912 there were no changes regarding the status and place of residence of the scientist and educator.⁸²

Interestingly, other educators who acted as extraordinary professors also lived on 63 Koszykowa Street: Alexander Yakovlevich Kasmin, Mikhail Ivanovich Lisyansky, Ivan Feodosievich Chorba and educators, for example, Viktor Adolfovich Bernadsky, Georgy Iosifovich Erchikovsky.⁸³

⁷³ CANNR, f. 2082, desc. 2, case 321, p. 26.

⁷⁴ SAKhR, f. R-1682, desc. 2, case 356, p. 69.

⁷⁵ *Ibid.*, p. 70.

⁷⁶ Anonymous₅ 1903, p.314.

⁷⁷ Anonymous₆ 1904, p. 403.

⁷⁸ CANNR, f. 2082, desc. 2, case 321, p. 40.

⁷⁹ *Ibid.*, p. 46.

⁸⁰ Anonymous₈ 1905, p. 278.

⁸¹ CANNR, f. 2082, desc. 2, case 321, p. 89.

⁸² Anonymous₉ 1906, p. 319; Anonymous₁₀ 1908, p. 241; Anonymous₁₁ 1909, p. 249; Anonymous₁₂ 1910, p. 250; Anonymous₁₃ 1911, p. 261.

⁸³ *Ibid.*, p. 249.



Fig. 10. Educators of the Warsaw Polytechnic. Seated from left to right: Prof. Ivan Ivanovich Bevad, Prof. Alexander Nikolaevich Kugushev, Prof. Ivan Feodosievich Chorba, Prof. Viktor Iosifovich Deutsch, Director of the Institute Vladimir Prokhorovich Amalitsky, Prof. Nikolai Konstantinovich Tolvinsky, Prof. Vasily Andreevich Solonina, Prof. Volodymyr Ivanovych Luchitsky. Standing from left to right: unknown, Prof. Ivan Romanovich Braytsev, unknown, Prof. Alexander Leonardovich Vasyutynsky, unknown, Prof. Dmitry Dmitrievich Mordukhai-Boltovskoy, educator Petr Alexandrovich Fedders, unknown, junior laboratory assistant Pavel Vasilievich Naberezhnov (?), senior laboratory assistant Vladimir Andreevich Vanyukov (?), Prof. Mikhail Karlovich Ziegler. The photo is from 1913 and is in Public Domain.

In October 1908 M.K. Ziegler was elected Secretary of the Mining Department.⁸⁴ He became a Knight of the Order of St. Stanislaus, 3rd class.⁸⁵

Mikhail Karlovich was not an armchair scientist. He traveled a lot and successfully to various metallurgical plants of the Russian Empire – from the Urals (including the Zlatoust plant), where he visited in 1910⁸⁶, to the plants of the Kingdom of Poland, which he visited in June 1914, even before the start of the First World War.⁸⁷

The Ural factories became the serious school for Ziegler. One listing of factories is respectful. Mikhail Karlovich visited: Kochkar and Miass gold mines, Nadezhda steel plant, Nizhny Tagil and Lunevsky plants, Kyshtym mining plants, Perm cannon plant, consulted with the Chief Manager of the Ural mining plants mining engineer Pavel Petrovich Boklevsky, with the mining head of the Zlatoust mining district mining engineer Anatoly Alexandrovich Zelentsov, mining chief of the Goroblagodatsky mining district mining engineer Alexander Stepanovich Levitsky. Ziegler's sociability and noble origin allowed him to make useful contacts and obtain large amount of necessary information.⁸⁸

In 1915 Ziegler visited factories in the north of the Russian Empire –Konchezersky and Olonetsky. From each trip he took out something useful for raising his technical level, for educating metallurgy, new topics for course and diploma design of students.⁸⁹

⁸⁴CANNR, f. 2082, desc. 2, case 321, p. 51.

⁸⁵CANNR, f. 2082, desc. 2, case 321, p. 75.

⁸⁶*Ibid.*, p. 84.

⁸⁷*Ibid.*, p. 129.

⁸⁸*Ibid.*, p. 85.

⁸⁹*Ibid.*, p. 138.

For example, having visited Zlatoust, he simply fell in love with damask steel—the most famous steel in the history of metallurgy. Using the methods of the brilliant Russian metallurgist Pavel Petrovich Anosov (1799–1851), in 1911 Mikhail Ziegler managed to obtain cranked damask steel. It should be noted that at the beginning of the 20th century other Russian metallurgists, such as Dmitry Chernov, Mikhail Belyaev, Andrei Vinogradov, also worked on damask steels. All of them achieved some success, and A. Vinogradov in 1919 even defended his dissertation “Soft damask steel and the origin of the damask pattern”⁹⁰.

Based on the results of research Mikhail Karlovich publishes the work “Ueber Damast” (“About Damask Steel”), published in the journal “Metallurgie” in 1911. Mikhail Karlovich received damask steel in order to prove that the technique of Pavel Petrovich Anosov, with its careful implementation, allows any metallurgist to obtain this most famous steel.

M.K. Ziegler was the author of the original theory of directional solidification of steel, which was partially confirmed only in the fifties of the 20th century with the development of continuous casting steel in the USSR.

In 1911 the 200th anniversary of the birth of M.V. Lomonosov was widely celebrated, and director of the Warsaw Polytechnic Institute of Emperor Nicholas II V.P. Amalitsky prepared the speech for the celebrations entitled “The Significance of Lomonosov’s Works on Mineralogy, Geology, Metallurgy and Mining Art”.⁹¹ In 1912 it was published as the booklet with small articles of several educators, including M.K. Ziegler. His 4-page article was called “Iron and its production” based on the book by M.V. Lomonosov “The first foundations of metallurgy, or ore affairs”, published in 1763.

On May 21, 1912 M.K. Ziegler defended his thesis at the Mining Department of the Warsaw Polytechnic Institute of Emperor Nicholas II on the topic “Investigation of iron alloys and the phenomenon of steel hot-brittleness”⁹², and on May 31, 1912 he received the title of adjunct and the post of extraordinary professor.⁹³ In May 1913 he became an ordinary professor with the rank of State Councilor.⁹⁴

In 1912 the educating of metallurgy at the Warsaw Polytechnic Institute of Emperor Nicholas II was expanded. The educator of general metallurgy was process engineer Vladimir Yakovlevich Mostovich, the senior laboratory assistant of the department of general metallurgy was process engineer Mikhail Fedorovich Ortin, the junior laboratory assistant of the department of iron metallurgy was process engineer Pavel Vasilyevich Naberezhnov.⁹⁵

It is not surprising that in April 1913 the delegation of 11 employees of the Warsaw Polytechnic attended the Second Congress on Mining, Metallurgy and Mechanical Engineering in St. Petersburg.⁹⁶ Honored Professor V.L. Kirpichev presided at the congress. Naturally, Mikhail Ziegler, as the close relative, was a guest of the Kirpichev family. Unfortunately, this was the last meeting between Mikhail Karlovich and Viktor Lvovich. Already in the autumn of 1913, V. L. Kirpichev passed away.

In April 1913 Mikhail Ziegler became a holder of the Order of St. Anna, 3rd degree.⁹⁷

In the proceeding “All Warsaw” for 1913 it is indicated that the extraordinary professor of metallurgy was process engineer, adjunct of the institute, State Councilor Mikhail Karlovich Ziegler, who lives on 75 Koszykowa Street.⁹⁸ The educator of general metallurgy was the

⁹⁰ Gurevich 1985, p. 36.

⁹¹ Amalitsky 1912, pp. 1–12.

⁹² CANNR, f. 2082, desc. 2, case 321, p. 98.

⁹³ *Ibid.*, p. 107.

⁹⁴ *Ibid.*, p. 120.

⁹⁵ Anonymous¹³ 1911, pp. 251–252.

⁹⁶ Rybiev, Polyanskaya 2007, p. 16.

⁹⁷ CANNR, f. 2082, desc. 2, case 321, p. 137.

⁹⁸ Anonymous¹⁴ 1912, p. 250.

process engineer, court adviser Vladimir Yakovlevich Mostovich, who lives on 54 Polna Street.⁹⁹

In 1914 Ziegler's official position and place of residence did not change, and chemical engineer Vladimir Andreevich Vanyukov, who lived on 46a Polna Street,¹⁰⁰ was indicated as an educator of metallurgy, the senior laboratory assistant of the Department of General Metallurgy – process engineer Mikhail Fedorovich Ortin, the junior laboratory assistant of the Department of Iron Metallurgy – metallurgical engineer Pavel Vasilievich Naberezhnov.¹⁰¹ Subsequently, V.Ya. Mostovich, V.A. Vanyukov, M.F. Ortin and P.V. Naberezhnov will do much more useful for the development of metallurgy...

In 1915 the Ziegler family spent their summer holidays in St. Petersburg. They stayed in the apartment of the doctor of medicine Vladimir Ignatievich Voyachek and his wife Nina Viktorovna (Ziegler's niece, the youngest daughter of Viktor Kirpichev).¹⁰²

The Warsaw Polytechnic Institute worked as usual until August 1915, then its staff, educating materials and equipment were evacuated first to Moscow and then to Nizhny Novgorod, where they served as the basis for the creation of a local higher technical school. However, the confusion, numerous relocations, the unsettledness of educators and, especially, students, did not have the best effect on the state of professors and employees of the institute. In March 1917 the Director of the Institute, Honored Professor Vladimir Prokhorovich Amalitsky, was retired for health reasons. Alas, on December 17 (30), 1917 he passed away.¹⁰³

The property of the Ziegler family remained in Warsaw. Mikhail Karlovich in 1916 was noted in the proceeding "All Petrograd" as "a state councilor who lived in Tsarskoye Selo, along Bezymennylane, a member of the Petrograd Zemstvo-City Regional Commission for Supplying the Army".¹⁰⁴ By the end of the First World War, Mikhail Karlovich returned to the institute. In addition, for many years Mikhail Karlovich was the owner of real estate in St. Petersburg. On Podolskaya Street, together with his maternal relatives, the Stukkeys and his younger sister Nina Karlovna (married Orfenova, then Lomshakova), he owned the house.¹⁰⁵ Most likely, he went to Mikhail Karlovich by inheritance. Giving it to anyone was not part of the plans of the nobleman Ziegler.

5. The October revolution and fates of the scientists

On October 25 (November 7), 1917 the October Coup took place, 10 years later it was called the Great October Revolution. Already on March 30, 1918 the decision was made by the local authorities to close the Warsaw Polytechnic Institute, renamed the Nizhny Novgorod Polytechnic Institute. It was supposed to merge it with the Nizhny Novgorod University.¹⁰⁶ On May 22, 1918 Mikhail Ziegler was offered the position of Dean of the Faculty of Mining and Engineering.¹⁰⁷ On August 30, 1918 at the meeting on the opening of the mining and technical faculty, he was elected dean. M.S. Zbyshevsky was elected secretary, mining engineer, and later specialist in the production of cobalt Efim Isidorovich Yelitenko was appointed educator of mining mechanics.¹⁰⁸

⁹⁹ *Ibid.*, p. 251.

¹⁰⁰ Anonymous₁₅ 1913, p. 254.

¹⁰¹ Anonymous₁₅ 1913, p. 263.

¹⁰² CANNR, f. 2082, desc. 2, case 321, p. 139.

¹⁰³ Rybiev, Polyanskaya 2007, p. 84.

¹⁰⁴ Shashkovsky 1916, p. 785.

¹⁰⁵ Yablonsky 1897, p. 1119.

¹⁰⁶ Rybiev, Polyanskaya 2007, p. 111.

¹⁰⁷ CANNR, f. 2082, desc. 2, case 321, p. 173.

¹⁰⁸ *Ibid.*, p. 180.

Mikhail Ziegler was well aware that it would be impossible with his noble origin to work successfully with the new government. At that time, for the most part, careerists and rogues came to the local leadership, who reveled in power and permissiveness, acted in their own interests, which were far from always noble ones and usually not in the interests of others. Representatives of the new government did not report to anyone and were not going to do this, and timid attempts to protest against the deliberately wrong decisions of the authorities were declared counter-revolution. Moreover, the titles of professors, academic degrees, scientific pensions upon reaching 25 years of working in educator positions and much more were abolished by law at the state level. Engineers and educators of higher educational institutions, military and industrialists, officials and people of free professions had to be content with the word “former”.

Just yesterday, they could afford to keep servants and buy real estate, help the needy and go on vacation, perceive honor and respect towards themselves, they were addressed by “Your Excellency” or “Your Honor” and much more. However, the absolute majority of the “formers” have always considered their main achievement in life not only their position in society, their spouse’s jewelry and money in a bank account, but honor, patriotism, family, knowledge, personal libraries, experience and professional skills.

Mikhail Karlovich after talking with the local authorities concluded that from Nizhny Novgorod it was necessary to move closer to the capital – to Moscow or St. Petersburg. There was still the opportunity to work, to purchase equipment for laboratories, experience and knowledge were still appreciated there rather than loud voice and impudent behavior.

And when the new dean of the Mining Faculty D.K. Artemiev began to move the entire faculty to Moscow, Mikhail Karlovich supported him.

By hook or by crook, in the autumn of 1918 by decree of the People’s Commissariat of Education the Mining Department of the former the Warsaw Polytechnic Institute was transferred to the Moscow Mining Academy. Until the end of 1918, professors and leading educators of the faculty moved there, and in the spring of 1919 – material assets and numerous collections of laboratories and classrooms.¹⁰⁹

Mikhail Karlovich participated in the foundation and development of the regulations, plans and programs of the Moscow Mining Academy together with Nikolai Mikhailovich Fedorovsky, Dmitry Nikolaevich Artemyev, Georgy Vasilyevich Klyuchansky and Yan Yanovich Enslin. By the end of 1919 Ziegler was the leading educator of the academy, dean of the metallurgical department, head of the chair of metallography, general metallurgy and the general course of iron metallurgy, which in fact were three chairs. The inability to provide laboratories with equipment, the impossibility of carrying out research work, in which Ziegler was major specialist, led him to the decision to leave the Mining Academy. Mikhail Ziegler, man of honor and dignity, patriot and nobleman, was extremely painful to see the struggle for power of the leaders of the academy, people of not the highest moral qualities. Intuition did not deceive Mikhail Karlovich. Two of the co-founders of the academy (D.N. Artemiev and Ya.Ya. Enslin) did not return home from business trip abroad at the first opportunity. Two others were subsequently repressed by the new government (G.V. Klyuchansky was shot)...

And for more than 90 years Mikhail Ziegler himself was not remembered either as the founder of the Academy, or as the head of actually three chairs.

The last mention of Ziegler at the Mining Academy was on September 24, 1920 at the meeting of the educational section.

From Moscow, Mikhail Karlovich moved to his native Petrograd, taking the post of professor at the Petrograd Polytechnic Institute. This institute was built by his elder brother,

¹⁰⁹ Rybiev, Polyanskaya 2007, p. 134.

Emily Karlovich, Viktor Lvovich Kirpichev was a member of the building committee, and the Institute had a special relationship with Mikhail Karlovich. He was created optimal conditions for work and the scientist became interested in research, as in his youth. Moreover, the nephew Mikhail Viktorovich Kirpichev, the future academician, taught at this institute. Most likely, his mother also lived with him – Matilda Karlovna, the elder sister of Mikhail Karlovich. M. K. Ziegler tried to complete the research he had been doing for many years. But his forces were running out.

In part, his activities are reflected in the journals of the sessions of the State Hermitage Council. They noted that M.K. Ziegler tried to continue his studies of damask steel. Whether he wanted to leave this knowledge to people, or was going to provide the cavalry (the main branch of the army of that time) with destructive weapons – we will not know this. But even if he managed to mass-produce the technology of obtaining ordinary kitchen knives with beautiful original pattern on the surface and blades that do not require sharpening for decades, this would be great achievement in metallurgy.

On April 11, 1921 Mikhail Karlovich inspected the collection of damask blades and suggested that the Hermitage staff should start analyzing these edged weapons. On May 30, 1921 the Hermitage Council adopted a Solomonic decision: “not to extradite, so as not to create precedents”.¹¹⁰ On July 4, 1921 the Scientific Secretary of the Hermitage, F.F. Hess, announced at meeting of the Council the decision of the leadership and explained that the Petrograd Polytechnic Institute had been asked to apply to the Security Department, where the Hermitage had already taken appropriate steps.¹¹¹ Alas, apart from talk, no real steps have been taken.

Thus, museum workers have deprived humanity of the opportunity to reveal the secrets of damask steel – it seems to be ordinary carbon steel with original properties, the blade of which did not require sharpening for decades, even with active use.

Mikhail Karlovich mobilizes his students and employees to complete research to determine the strength of steel depending on the conditions of its crystallization. Under the guidance of Professor Ziegler, engineers Mikhail Porfiryevich Slavinsky, N.I. Berkoltsev, D.F. Karavaev, N.P. Kirillov, A.A. Moskalenko and S.A. Khodkovsky comprehensive studies of the diffusion of impurities in steel were carried out.¹¹² This line of research is promising even today, a hundred years later, since it allows predicting the properties of steel not only during its crystallization, but also during using at elevated temperature and pressure conditions. This made it possible to cast steel by the continuous casting method and use it in nuclear technology, in underwater work, in space exploration and under other extreme operating conditions.

Alas, Mikhail Karlovich did not have time to publish the results of the research. This was done by his students.¹¹³ The authors Nikolay Vladimirovich Ageev and Mikhail Ivanovich Zamotorin bitterly wrote:

M.K. Ziegler together with his students also set up studies of the influence of temperature on the development of diffusion and determination of the temperature of its beginning. These studies were carried out completely only for copper and phosphorus. The study of the effect of mechanical pressure on the diffusion of impurities in steel was planned by M[ikhail] K[arlovich], the samples were prepared, but he did not have enough time to carry out the experiments.¹¹⁴

¹¹⁰ Anonymous¹⁷ 2009, p. 337.

¹¹¹ *Ibid.*, p. 338.

¹¹² Slavinsky 1926, p. 2

¹¹³ Slavinsky 1926, pp. 3–4; Ageev 1928, p. 184.

¹¹⁴ Ageev 1928, p. 188.

The authors of¹¹⁵ believe that the extremely difficult trials that befell Mikhail Karlovich undermined his health. A serious blow to his health was the news of the deportation of his brother-in-law, Yanuariy Alexandrovich Rykov, from the Crimea to the Narym Territory for 3 years, received in December 1924.

According to the historian of the Polytechnic Institute Boris Nikolaevich Menshutkin, on January 20, 1925 Mikhail Karlovich Ziegler died.¹¹⁶

In contrast, in the proceedings “All Petersburg” the name of Mikhail Karlovich was last mentioned in 1922 among the list of professors of the Polytechnic Institute, as living on the territory of the institute in apt. No. 11.¹¹⁷ In the proceeding “All Petersburg” for 1923 and in the proceedings “All Leningrad” for subsequent years the name of Professor Ziegler is not mentioned. The indirect confirmation of the death of Mikhail Karlovich in 1922 is the resumption of the publication of the journal of the Russian Metallurgical Society in 1925. The editor-in-chief of this publication was Ziegler’s colleague at the institute Professor Mikhail Pavlov. In 1925 the magazine published several obituaries. But the death of Mikhail Ziegler was not mentioned. And, if Ziegler passed away in 1922, then such attitude towards the memory of outstanding scientist and educator is quite understandable: obituaries are not published three years later. At the time of his death technical journals on metallurgy practically did not appear in the country.

And we are left with the classic works of Mikhail Karlovich, which today form the foundation of knowledge on steel metallurgy.¹¹⁸ In them, he reveals the secrets he discovered of obtaining high-quality steel from wide variety of ores and using variety of melting units. Even in the last days of his life he worked – he was in a hurry to finish the research he had begun.

6. Conclusions

This publication analyzes the scientific, organizational and educational activities of the outstanding metallurgist Mikhail Ziegler. It was proved that his theoretical and practical work became the basis for continuous casting, one of the most important world inventions of the 20th century in the field of metallurgy. It is shown that the formation of Ziegler as a scientist and educator occurred during his work at the Warsaw Polytechnic Institute of Emperor Nicholas II.

The fundamental work carried out by Mikhail Ziegler and his collaborators: to determine the strength of steels depending on the conditions of their crystallization, to study the diffusion of impurities in steels became the basis for a huge amount of work that ensured the rapid development of metallurgy in the 20th century. The work of Mikhail Ziegler about the effect of sulfur on the service properties of iron-carbon alloys, in particular steels, has long become classic ones. It was he who managed to prove for the first time in the world that sulfur and its compounds have extremely negative effect on all service properties of steels.

Innovative scientific research initiated by Mikhail Ziegler became the basis for the restoration of Russian metallurgy after the revolution of 1917 and the Civil War of 1918–1920.

The development of science already at the beginning of the 20th century can be characterized as gradual transition from the activities of individual scientists to collective cooperation in its most effective form: the scientific school. The scientific team, headed by Mikhail Ziegler, possessed all the main features that characterize the scientific school. In particular, these were: important theoretical and practical results that received worldwide recognition; implementation of results in the industry on global scale; the presence of scientific

¹¹⁵ Blokh, Lebedev, Tarbeev 2018, p. 33.

¹¹⁶ Menshutkin 2012, p. 358.

¹¹⁷ Anonymous₁₆ 1922, p. 638.

¹¹⁸ Ziegler 1901, pp. 25–31; 1908; 1912.

leader and system for training scientific and engineering personnel; the continuity of generations; the development of scientific school, which led to the creation of new educational and scientific centers.

Unfortunately, far from all archival materials and the results of the work of Mikhail Karlovich Ziegler are available to researchers or published in the open press. This gives reason to believe that these materials will still be available to historians and researchers will be able to highlight the last pages of the scientific achievements of the classic of metallurgy Mikhail Ziegler.

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