MIKHAIL LOMONOSOV AND SOME ASPECTS OF WOOD CHEMICAL INDUSTRY DEVELOPMENT

Our country and all progressively-minded people in the world are celebrating the 250th anniversary of Mikhail Lomonosov, a prominent scholar who laid the foundations for development of many branches of science. His research efforts in the field of chemistry were of ultimate importance.

When Lomonosov was alive, chemistry was only in its infancy as a science and was perceived more as an art. Lomonosov turned it into an exact science and gave it a clear definition: "Chemistry is a science that describes changes happening in a mixed body, since it is mixed… Since it is customary in science to prove what you state, all the statements made in chemistry also need proof"[1].

In every study he made, Lomonosov relied on the fact that the world around us is material and the actual process of our perception of this world is material, as well. He expressly declared that matter is primary and consciousness secondary, by which he meant that the material objects that exist around us and independently from us act on our senses and arouse sensations, and that our understanding of the world originates from the material process that creates such sensations. In opposition to the idealist philosophers, Lomonosov wrote: "Ideas are perceptions of things or actions in our mind"[2].

Lomonosov never considered the surrounding world to be something completely invariable. He insisted on the unity of all natural bodies, consistency of their physical and chemical properties. His materialistic approach to natural phenomena, deep insight into life and intuitive mind helped Lomonosov develop the theory of the atomic and molecular structure of the matter, according to which all objects are built of the finest particles or 'elements' (atoms); these elements connect with one another to form larger particles – 'corpuscles', or molecules, as we know them today. Relying on this theory, Lomonosov deduced the notions of chemical element, elementary substance and compound. He was the first to discover isomerism and came close to understanding the continuity of the composition of chemical compounds and the law of multiple proportions.

In his belief that all changes in nature are driven by the movement of particles, Lomonosov developed a new theory of heat. He rejected the existence of the 'caloric' element. Heat, according to Lomonosov, depends on the movement of particles inside matter. Looking at temperature as the value that corresponds to the rotation velocity of particles, he came closer to the concept of absolute zero temperature and to realising that it cannot be achieved, since corpuscles are never found in a state of absolute rest.

In his work *Speculations on the Causes of Heat and Cold*[3], Lomonosov was the first to formulate the second law of thermodynamics, pointing out that a cold body cannot take in more heat that a warm body can release.

In his work *An Endeavour Into the Elastic Force of Air*[4], the scholar presented the basic concepts of the kinetic theory of gases that was developed mathematically in the second half of the 19th century by Maxwell, Clausius and others. He also rejected the existence of phlogiston, a mysterious substance that was believed to exist at the time, and demonstrated that oxidation is not caused by removal of phlogiston but is a result of combination of metal and a component of air. As we all know today, this part of air is oxygen. This way, Lomonosov anticipated the theory of oxidation and reduction.

---

[1] M.V. Lomonosov. The complete works. USSR Academy of Sciences Publishing, 1950. Vol. 1: 67, 69.
[2] M.V. Lomonosov. Selected philosophical works. Gospolitizdat, 1950: 455.
[3] M.V. Lomonosov. The complete works. USSR Academy of Sciences Publishing, 1950. Vol. 2: 37.
[4] M.V. Lomonosov. A collection of articles and writings. USSR Academy of Sciences Publishing, 1950. Vol. 3: 33.

Mikhail Lomonosov's major scientific discovery was formulation of the universal law of nature, i.e., the law of conservation of matter and motion, in 1748. In his letter to Euler, Lomonosov wrote: "… all the changes in nature happen in such a way that, if we add something in one place, that something will be lost in another. For instance, if one object gains some matter, another object will lose the same amount of matter; when I spend time sleeping, I take away the same amount of time from my wakeful state, and so on. Since this is a universal law of nature, it applies just as well to the laws of motion: a body that impacts on another body to set it in motion loses as much of its own motion as it imparts to the body that it has just agitated"[5].

Lomonosov knew well that there could be no development in chemistry without experiment. The first Russian research laboratory, which he founded in 1748, was where he conducted a number of unique research efforts of paramount importance for metallurgy, mining and manufacturing of glass and ceramics. He was the first to devise a number of qualitative analysis techniques by using acids and alkali for the deposition reaction and, by introducing weighing scales into chemical practices, he laid the groundwork for the quantitative analysis technique, which made Lomonosov the pioneer of analytical chemistry[6].

Mikhail Lomonosov also deserves credit as the father of physical chemistry. He defined this branch of science as follows: "Physical chemistry is a science that uses physical laws and experiments to explain the cause of the phenomena that occur during chemical reactions in mixed bodies"[7].

Here, Lomonosov proceeds from chemistry to physics.

In his dissertation called *The Origin and Nature of Saltpeter*, he wrote the following: "… we still see it possible to express, in the context of science, the majority of chemistry by substantiating it with its own principles that have been recently adopted in physics; furthermore, we have no doubt that understanding the hidden nature of bodies would be much easier if we combined the physical and chemical facts"[8].

In September 1764, in the draft Academic Procedure, Mikhail Lomonosov wrote: "A chemist with no knowledge of physics is like someone who has to find things in the dark by touch, and these two sciences are so interconnected that one of them cannot be complete without the other"[9].

Working through the challenges of physical chemistry, Lomonosov studied the influence of low temperature and pressure on matter and investigated viscosity, capillary action, crystallisation, development of solutions, and solubility in various conditions. He also took an interest in studying corrosion, cementation, extraction, gelation of solutions, adhesion of gels, etc.

One of the unique things about Lomonosov was his new way of comprehending the role and importance of chemistry and its place among the other sciences that study nature. He did not see how chemistry could develop independently of some practical challenges facing mankind. In his work *The Benefits of Chemistry*, Lomonosov said: "the branches of Chemistry reach far into the mundane business of men"[10]. And while he highlighted this science, Lomonosov did not place it above the others or apart from them. In the same work, "The benefits of chemistry", he specifically cautions the reader against thinking that all good things in life depend on chemistry alone, and against thinking of him as someone who is blinded and fascinated by just one science and scorns the others… "All sciences play an equal role in our wellbeing"[11].

---

[5] M.V. Lomonosov. The complete works. USSR Academy of Sciences Publishing, 1951. Vol. 2: 183–185.
[6] A.Kh. Batalin. M.V. Lomonosov – the pioneer of analytical chemistry. Bulletin of Chkalovskoye Department of the Mendeleyev All-Union Chemical Society, 1949: 13–15.
[7] B.N. Menshutkin. The works of Mikhail Lomonosov on physics and chemistry. USSR Academy of Sciences Publishing, Moscow – Leningrad, 1936: 511.
[8] M.V. Lomonosov. The complete works. USSR Academy of Sciences Publishing, 1951. Vol. 2: 223.
[9] B.N. Menshutkin. The works of Mikhail Lomonosov on physics and chemistry. USSR Academy of Sciences Publishing, Moscow – Leningrad, 1936: 511–512.
[10] Ibid., 382.
[11] M.V. Lomonosov. The complete works. USSR Academy of Sciences Publishing. Vol. 2: 368.

The scientist believed that theory and practice are inseparable and saw how his native country could benefit from science. Lomonosov devoted much attention to examining the natural resources of our country, including various metals and minerals, peat, bituminous coal, petroleum, wood, etc. He thought they should be used to the benefit of mankind and set up a number of manufacturing enterprises. For example, he built a factory in the town of Ust-Ruditsa to produce mosaic compounds, beads, bugles, multi-coloured glassware, etc. Before embarking on this project, Lomonosov had staged thousands of experiments and provided the rationale for the manufacturing processes used at that enterprise.

He also developed the 'theory of colours' and laid the scientific foundation for coloured glass manufacturing. Moving on to production of china, Lomonosov was the first to come up with the idea that a glassy substance plays an important role in the structure of china.

Lomonosov combined his probe into the manufacture of glass and china with investigation into and development of paint production techniques. In 1749, Lomonosov wrote: "… trying to find out how to make Berlin blue and Venice lake, and I found a method for that"[12]. He continued: "I was trying to improve Berlin blue and produce it in large quantities, and I discovered how to do it fairly cheap"[13].

He also made a significant effort in the development of salt manufacturing and other production industries in Russia.

Speaking of Lomonosov's overall contribution to the development of chemistry, we should mention that this man of genius looked far into the future, and his ideas are being successfully implemented by scientists even today.

Mikhail Lomonosov loved his homeland in the North. He wrote: "Numerous facts make me conclude that the earth's interior of the north is also rich in the gifts of nature… but nobody is there to prospect them…"[14].

Lomonosov's ideas have now become very popular in his homeland of the Arkhangelsk Region. The industry that deals with chemical wood processing and deeper utilisation of raw wood has gained paramount importance here. The focal areas of deep utilisation of wood include development of the pulp and paper industry, hydrolysis industry and production of hard density fibreboard and chipboard from wood waste. Other booming domains include destructive distillation of hard wood, production of rosin and turpentine, turpentinic resins, fodder yeast and household chemical products (lacquers, paints, drying oil and soap).

By the end of this seven-year plan period, Arkhangelsk Region expects to increase production of cellulose pulp by a factor of 6.7, paper – by 8.5, and alcohol – by a factor of 2.7. The Region will also start manufacturing cardboard (up to 725 thousand tonnes a year) and produce around 11 million m^2 of hard density fibreboard and chipboard from timber sawing and woodworking waste.

During the current seven-year plan period, the Arkhangelsk Region will expand and renovate existing and build new enterprises and facilities involved in chemical wood processing. The Arkhangelsk Pulp and Paper Mill will manufacture 95 thousand tonnes of paper, 540 thousand tonnes of pulp and 360 thousand tonnes of boxboard a year. A factory producing household and sanitary paper will also be built in the Region. After being renovated, the Solombalsk Paper and Woodworking Plant will annually process up to 1.5 million m^3 of waste from timber sawing and woodworking enterprises and produce 254 thousand tonnes of premium-quality sulphate pulp for export.

The first phase of the Kotlas Pulp and Paper Mill, which is the biggest mill in Europe, has been started up. The enterprise is expected to manufacture 515 thousand tonnes of pulp, including 152 thousand tonnes of rayon-grade pulp, as well as 260 thousand tonnes of sack kraft paper and 350 million kraft paper bags annually.

---

[12] B.N. Menshutkin. The works of Mikhail Lomonosov on physics and chemistry. USSR Academy of Sciences Publishing, Moscow – Leningrad, 1936: 357.
[13] Ibid., 357.
[14] M.V. Lomonosov. Collected articles and writings. USSR Academy of Sciences Publishing, 1940. Vol. 1: 211.

During this planning period, three small factories for destructive distillation of hard wood and ten turpentinic resin factories will be built in the Arkhangelsk Region.

Along with the industrial development, the homeland of Mikhail Lomonosov is set to educate and train engineers and scholars. Arkhangelsk is becoming the hearth and home of the wood chemical science. The Arkhangelsk Forestry Engineering Institute opened in the city in 1929 and is now the alma mater of over four thousand students. Eight of its faculties train engineers in fifteen different specialist fields. One of the Institute's key units is the Chemical Engineering School, which trains specialists in chemical wood processing, production of wood plastics and boards, pulp and paper manufacturing technologies, as well as engineering of machinery and devices for the chemical industry. Chemical departments of the Institute are involved in vigorous research projects. The educational facility has its own fundamental research laboratory for chemical wood processing and reuse of waste from pulp and hydrolysis plants. Other facilities that have dedicated chemical laboratories include the Institute of Forest and Wood Chemistry of the USSR Academy of Sciences, the Northern Research Institute of Industry and the Central Research Institute of Mechanical Wood Processing, as well as all the pulp and paper mills, hydrolysis factories and timber chemical plants.

Mikhail Lomonosov was a great patriot and struggled to transform his homeland in the best interests of the Russian people.

The Soviet people love and cherish this glorious architect of the Russian chemical science, a remarkable and versatile genius of science – Mikhail Lomonosov.

I.M. Bokhovkin
Asst. Prof., CSc (Chem.)

Received on 10 June 1961