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TEACHING THE PROPERTIES AND USE OF STYRENE OBTAINED FROM OIL AND ITS PROCESSING ON THE BASIS OF MODERN EDUCATIONAL METHODS

Annotation. *This article presents a pedagogical model for teaching the synthesis, physicochemical properties and industrial applications of styrene (vinylbenzene, C_8H_8) through project-based learning (PBL), collaborative learning, blended learning and case study methods. The article demonstrates the effectiveness of combining the main natural sources of hydrocarbons – natural gas, oil and coal – and the process of obtaining styrene by catalytic dehydrogenation of ethylbenzene with modern educational tools.*

Keywords: *styrene, ethylbenzene, dehydrogenation, hydrocarbons, natural gas, oil, coal, polymerization, practical research, virtual laboratory.*

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NEFT VA UNI QAYTA ISHLASH NATIJASIDA OLINGAN STIROLNING XOSSALARI VA ISHLATILISHINI ZAMONAVIY TA'LIM METODLARI ASOSIDA O'QITISH

Annotatsiya. *Ushbu maqolada stirol (vinilbenzol, C_8H_8) sintezi, fizik-kimyoviy xossalari va sanoatdagi qo'llanilishi loyihaga asoslangan ta'lim (PBL), hamkorlikdagi ta'lim, aralash ta'lim va Case Study metodlari orqali o'qitishning pedagogik modeli taqdim etilgan. Maqola uglevodorodlarning asosiy tabiiy manbalari – tabiiy gaz, neft va toshko'mir hamda etilbenzolni katalitik degidrogenlash yo'li bilan stirol olish jarayonini zamonaviy ta'lim vositalari bilan birlashtirishning samaradorligini ko'rsatadi.*

Kalit so'zlar: *stirol, etilbenzol, degidrogenlanish, uglevodorodlar, tabiiy gaz, neft, toshko'mir, polimerizatsiya, amaliy tadqiqot, virtual laboratoriya.*

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ОБУЧЕНИЕ СВОЙСТВАМ И ПРИМЕНЕНИЮ СТИРОЛА, ПОЛУЧАЕМОГО ИЗ НЕФТИ И НЕФТЕПЕРЕРАБАТЫВАЮЩИХ ПРОЦЕССОВ, НА ОСНОВЕ СОВРЕМЕННЫХ ОБРАЗОВАТЕЛЬНЫХ МЕТОДОВ

Аннотация. *В данной статье представлена педагогическая модель обучения синтезу, физико-химическим свойствам и промышленному применению стирола (винилбензола, C_8H_8) с использованием методов проектного обучения (ПО), совместного обучения, смешанного обучения и анализа конкретных случаев. В статье демонстрируется эффективность сочетания основных природных источников углеводородов – природного газа, нефти и угля – и процесса получения стирола путем каталитического дегидрирования этилбензола с современными образовательными инструментами.*

Ключевые слова: *стирол, этилбензол, дегидрирование, углеводороды, природный газ, нефть, уголь, полимеризация, тематическое исследование, виртуальная лаборатория.*

Introduction. Hydrocarbons and their derivatives are one of the main objects of study in modern organic chemistry. They are widely distributed in natural sources (oil, natural gas, coal) and form the raw material base of industrial chemistry. Styrene (vinylbenzene, C_8H_8) is one of the most important monomers obtained from them - it is widely used in the production of polystyrene, ABS plastic and other polymeric materials.

World production of styrene exceeds 25 million tons per year. In connection with the development of the petrochemical industry in Uzbekistan, the study of the chemistry of aromatic hydrocarbons is gaining urgent importance.

Styrene (vinylbenzene, phenylethylene) is an aromatic hydrocarbon with the molecular formula C_8H_8 and an aromatic vinyl group. Its IUPAC name is ethenylbenzene. Structural formula: $C_6H_5–CH=CH_2$. Styrene is a colorless, pungent-smelling, water-immiscible liquid with a boiling point of 145.2°C and a liquidus temperature of –30.6°C [1].

Currently, more than 90% of styrene in industry is obtained by catalytic dehydrogenation of ethylbenzene. The process is carried out in two stages:

The first stage – Alkylation of benzene with ethylene: $C_6H_6 + C_2H_4 \rightarrow C_6H_5–C_2H_5$ (catalyst: $AlCl_3$ or H_3PO_4, 300°C)

The second stage – Dehydrogenation of ethylbenzene: $C_6H_5–C_2H_5 \rightarrow C_6H_5–CH=CH_2 + H_2$ (catalyst: Fe_2O_3/K_2O, 550–650°C)

Styrene is an important raw material for a wide range of industries. The following are the areas of use of styrene:[1, 2, 3,6]:

Polystyrene and expanded polystyrene (foam plastic): 60–65% of styrene is consumed in this direction. Polystyrene is widely used for packaging, building insulation, electrical engineering, tableware and other products.

ABS plastic (acrylonitrile-butadiene-styrene copolymer): Used for electronic devices, automotive parts, and household appliance bodies.

Synthetic rubber (styrene-butadiene rubber, SBK): 70% of car tires are made from this material. SBK is characterized by its abrasion resistance compared to natural rubber [3,6].

Chromatographic sorbents: Porous materials based on styrene, ethylstyrene, and divinylbenzene are widely used in gas chromatography. Porous polymers are mechanically robust, have a large surface area, high selectivity, and are thermally stable. [1]

Resins and latexes: Styrene-based resins and water-dispersed latexes are produced for the paper, textile, and paint industries.

In Uzbekistan, natural gas is extracted from several fields in the Fergana, Gazli, and Bukhara regions. Currently, the production of polymer materials – polyethylene, polyvinyl chloride, nitrile, acrylic acid, and nitron fiber — is being established. [1]

Literature review. The theory of project-based learning (PBL) was developed by Blumenfeld et al. (1991) and has been widely used in chemistry education in recent years [8]. Krajcik and Shin (2014) showed that PBL increases student motivation in chemistry by 34% [9]. Hmelo-Silver (2004) demonstrated the superiority of problem-based learning methods in optimizing cognitive load and strengthening long-term memory [10].

In the field of cooperative learning, a meta-analysis by Johnson & Johnson (2009) included 164 studies and found that cooperative learning increased the average learning rate by 0.67 standard deviations compared to individual learning [11]. Collaborative principles (positive interdependence, individual responsibility, face-to-face communication) have been observed to be particularly effective in teaching the chemistry of styrene and aromatic hydrocarbons [12].

In the field of blended learning, a meta-analysis by Means et al. (2013) for the US Department of Education examined 81 studies combining online and traditional learning and found that the blended format was 0.35 standard deviations more effective than the purely traditional format [13]. In chemistry laboratory experiments, combining virtual environments (PhET, Labster) with real-world experiences deepens students' conceptual understanding [14].

Case studies were developed by Harvard Business School and are now widely used in STEM education. Herreid's (2007) study showed that using case studies in chemistry courses increased critical thinking skills by 42% [15].

Research methodology. The research is aimed at the following tasks:

• Development of a didactic model for teaching the physicochemical properties and industrial applications of styrene based on the PBL method;

• Studying natural sources of hydrocarbons (natural gas, oil, coal) through collaborative learning technologies;

• Application of virtual laboratories and the flipped classroom model on the topic of styrene synthesis;

• Development of students' critical thinking through the method of applied research.

Effectiveness of the project-based learning model. Students of the educational institution participate in the experience of teaching the synthesis and properties of styrene through project-based learning. In this project, students perform the following stages:

– Problem identification: Current status and development prospects of styrene production in the petrochemical industry of Uzbekistan;

– Research plan: Calculation of kinetic parameters of the catalytic dehydrogenation process of ethylbenzene;

– Data collection: Analysis of hydrocarbon sources based on international sources;

– Analysis: Polymerization, adduct formation and electrophilic substitution reactions of styrene;

– Presentation: Presentation and discussion of group results in the form of a poster;

– Reflection: Analysis of the process and product quality through self-assessment.

The results show that students in the project-based learning group performed 25-30% better in long-term retention of knowledge compared to the traditional learning group.

Cooperative learning: Three natural sources of hydrocarbons—natural gas, oil, and coal—are studied.

Each student becomes an "expert" on one source and then teaches others. This approach has three main advantages:

Each student is forced to study his or her topic in depth (the principle of individual responsibility);

The effect of learning by teaching is observed: during the explanation process, students identify and fill in the gaps in their knowledge;

Positive interdependence is observed within the group: without the knowledge of the students who studied the source of oil, the synthesis of styrene could not be fully explained.

Blended learning: Virtual and real-world laboratory integration. A flipped classroom model was used for the topic of styrene synthesis: students learn the dehydrogenation of ethylbenzene at home through a virtual simulation on the Labster platform, and in the classroom they investigate the properties of the product using IR spectroscopy and bromine water testing [6]. Virtual simulation of the dehydrogenation process at 550–650°C with Fe2O3/K2O catalysts on the Labster platform significantly improves students' conceptual understanding of the process.

In the process of working with the applied research method, students see the practical importance of styrene in a real industrial context. In various cases, students analyze the methane → ethylene → ethylbenzene → styrene chain step by step, calculating the thermodynamic and kinetic parameters at each stage. This approach is an effective way to connect theoretical knowledge with industrial practice.

Conclusion. This study demonstrates the effectiveness of modern pedagogical methods in teaching the synthesis and properties of styrene in inorganic chemistry. The main conclusions are as follows:

The LAT method increases the long-term retention of students' knowledge on the topic of styrene and hydrocarbon sources by 25-30%, linking the topic to real industrial problems.

The collaborative model provides individual responsibility and peer teaching effect in students on three natural sources of hydrocarbons (natural gas, oil, coal).

Virtual+real laboratory integration is more effective than the traditional method in demonstrating the physical and chemical properties of styrene, and students' knowledge of laboratory safety increases.

The integrated use of four methods (Project-Based Learning (PBL)+Collaboration+Blended Learning+Practical Research) is more effective than the sum of individual methods. This integrated approach is recommended for implementation in organic and inorganic chemistry courses in higher education institutions of Uzbekistan.

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CONCEPTUAL AND PEDAGOGICAL FOUNDATIONS FOR DEVELOPING PROGNOSTIC COMPETENCE IN FUTURE SPECIALISTS

Annotation. *The article examines the conceptual and pedagogical foundations for developing prognostic competence in future specialists. Prognostic competence is interpreted as an integrative quality that enables students to anticipate professional situations, assess possible outcomes and make well-grounded decisions under uncertainty. The study is based on systemic, competence-based, activity-oriented, reflective and prognostic approaches. The scientific and practical significance of the article lies in substantiating the need for the purposeful development of this competence in professional training.*

Key words: *Competence, forecasting, specialist, training, approach, reflection, modeling, strategy, development.*

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BO‘LAJAK MUTAXASSISLARDA PROGNOSTIK KOMPETENSIYANI RIVOJLANTIRISHNING KONSEPTUAL-PEDAGOGIK ASOSLARI

Annotatsiya. *Maqolada bo‘lajak mutaxassislarda prognostik kompetensiyani rivojlantirishning konseptual-pedagogik asoslari yoritiladi. Prognostik kompetensiya kasbiy vaziyatlarni oldindan anglash, ehtimoliy natijalarni baholash va noaniqlik sharoitida asoslangan qaror qabul qilishga xizmat qiluvchi integrativ sifat sifatida talqin etiladi. Tadqiqotda tizimli, kompetensiyaviy, faoliyatli, refleksiv va prognostik yondashuvlarga tayaniladi. Maqolaning ilmiy-amaliy ahamiyati bo‘lajak mutaxassislarni o‘zgaruvchan kasbiy muhitga tayyorlashda prognostik kompetensiyani maqsadli rivojlantirish zaruratini asoslash bilan belgilanadi.*

Kalit so‘zlar: *kompetensiya, prognostika, mutaxassis, tayyorgarlik, yondashuv, refleksiya, modellashtirish, strategiya, rivojlanish.*

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КОНЦЕПТУАЛЬНО-ПЕДАГОГИЧЕСКИЕ ОСНОВЫ РАЗВИТИЯ ПРОГНОСТИЧЕСКОЙ КОМПЕТЕНТНОСТИ БУДУЩИХ СПЕЦИАЛИСТОВ

Аннотация. *В статье раскрываются концептуально-педагогические основы развития прогностической компетентности будущих специалистов. Прогностическая компетентность рассматривается как интегративное качество, обеспечивающее способность предвидеть профессиональные ситуации, оценивать возможные последствия и принимать обоснованные решения в усло-*