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3D MODELING OF NITRIC ACID PRODUCTION

Background. 3D modeling allows creating better for students' perception and understanding 3D models of apparatuses, as well as enabling the implementation of different placement variations of these models, which facilitates the task of developing projects of volume-planning decisions in the designing of complex chemical-technological schemes and will contribute to a deeper studying of chemical technologies of inorganic substances and processes of water purification.

Objective. The purpose of the paper is to create Blender 3D models of apparatuses and dilute nitric acid synthesis schemes, as an example of using this 3D environment for the studying of chemical-technological processes.

Methods. Computer modeling of chemical technology equipment on the example of dilute nitric acid production was applied.

Results. The simulating chemical technology objects' main advantages in the Blender environment are considered on the example of created 3D model of the dilute nitric acid production shop. Using the design environment with built-in algorithmic language allows both automating the process of designing chemical production and carrying out constructive calculations of individual apparatus.

Conclusions. The use of 3D modeling techniques in designing improves the quality of both educational and real projects of the chemical technology industry. The learning process with using the real production 3D models creating can improve the quality of chemical engineers because, in the process of such modeling, elements of the scheme that are usually not reflected in plans and incisions (for example, pipelines) are considered. It is essential for the further professional activity of learning chemical engineers. The use of the Python language in Blender gives access to various libraries freely available for this programming environment.

Keywords: Blender 3D environment; 3D model; dilute nitric acid; volume-planning decision; plan-incision.

Introduction

Features of the space-planning decisions, based on the use in the process of studying the drawings of plans and sections of the corresponding industries in 2D, are studied in the process of preparation of chemists-technologists. Experience shows that most students do not quite understand this visualization format, and they make mistakes when performing such drawings, especially when constructing sections.

The development of computer technology allows us to change the way of creating technological drawings from paper to electronic, and the use of 3D technologies provides an opportunity to improve these drawings by improving the perception and understanding of projected objects.

Problem statement

Based on the knowledge of a particular chemical process, obtained in the process of studying at the university, as well as using the experience of visiting this production, it is necessary to develop an appropriate 3D model that most closely matches

the original. In the design process, it is important to understand the methodology of such work, given the lack of an appropriate training course in the training program for chemical technologists.

Creation of the Nitric acid production 3D model

3D modeling makes it possible to depict any 3D surface of an object by using specialized software (using embedded mathematical algorithms) [1]. Nowadays there are various tools for 3D modeling, such as Blender, 3ds Max, SketchUp Make, Sculpttris, Freecad, 3DCrafter, to name a few. These programs create 3D models of equipment, which are better perceived by students (compared to 2D drawings). Also, the accommodation options of designed models are executed there, which makes easier the task of developing projects of volume-planning decisions in chemical technology.

The Blender program was chosen because it is free, and it has a wide range of functionality and user experience. Also, language Python is built into the program to automate design work, as well as to perform any calculations, including calculations of individual apparatus and technological schemes.

As seen in Fig. 1 and Fig. 2, the Blender environment was used to accomplish the above-mentioned tasks and for the creation of equipment's 3D models and 3D model of the synthesis scheme of dilute nitric acid.

3D models can reproduce the real 3D objects by using the 3D modeling program, which converts the set of points in space into various geometric objects such as, for example, triangles, lines and more. As seen in Fig. 3, the process of creating 3D models in Blender begins with the selection and addition of a primitive (which looks like close to the object that is modeling) into 3D space [2].

Primitive is a simple geometric shape, such as a ball, cylinder, cone or other from the set of available in Blender program, which will be used during the modeling process as “building blocks” in the creation of more complex objects.

Further process of object modeling is the application of various operations (displacement, deformation, rotation, extrusion, smoothing and texturing) in the editing mode of a primitive [3]. Moreover, as seen in Fig. 4, these operations can be applied to both of the whole primitive and its individual points, faces, or planes.

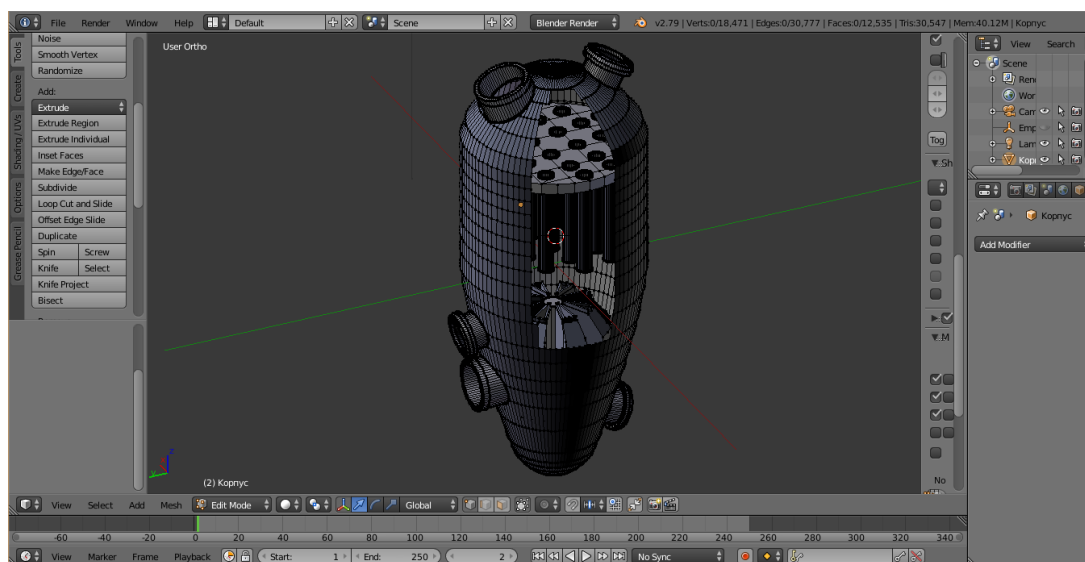


Fig. 1. 3D model of the mixer

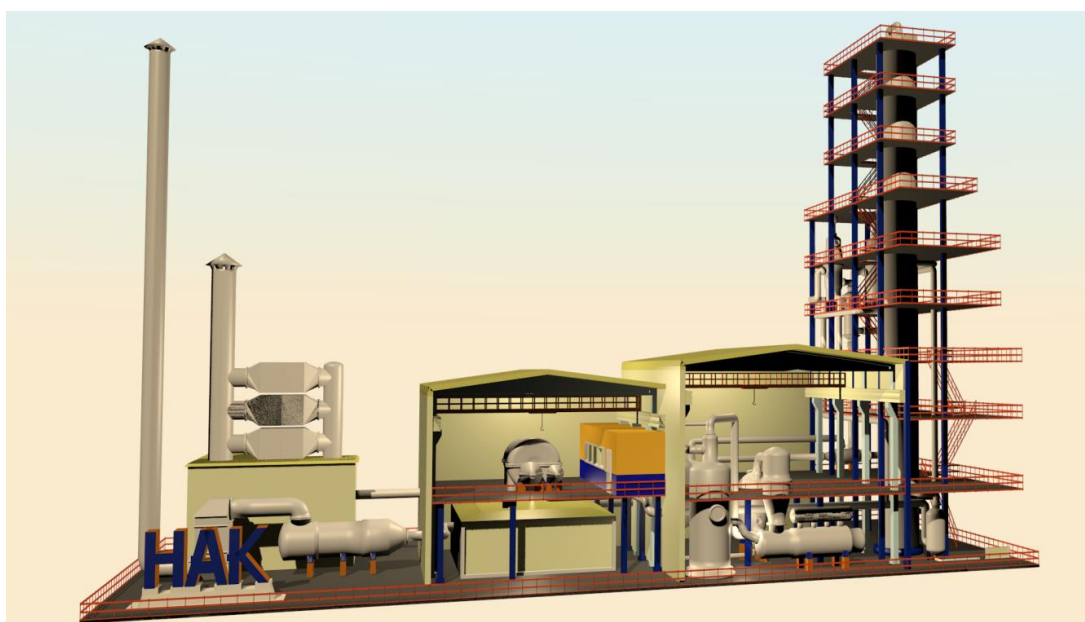


Fig. 2. 3D model of the synthesis scheme of dilute nitric acid

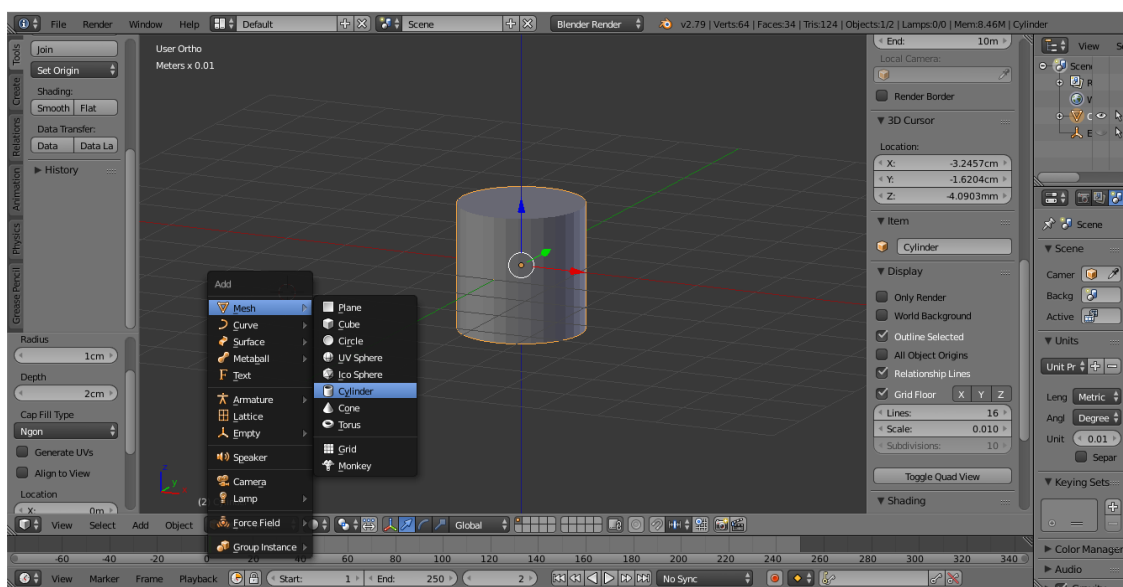


Fig. 3. A sample of a primitive that can be used in the modeling process

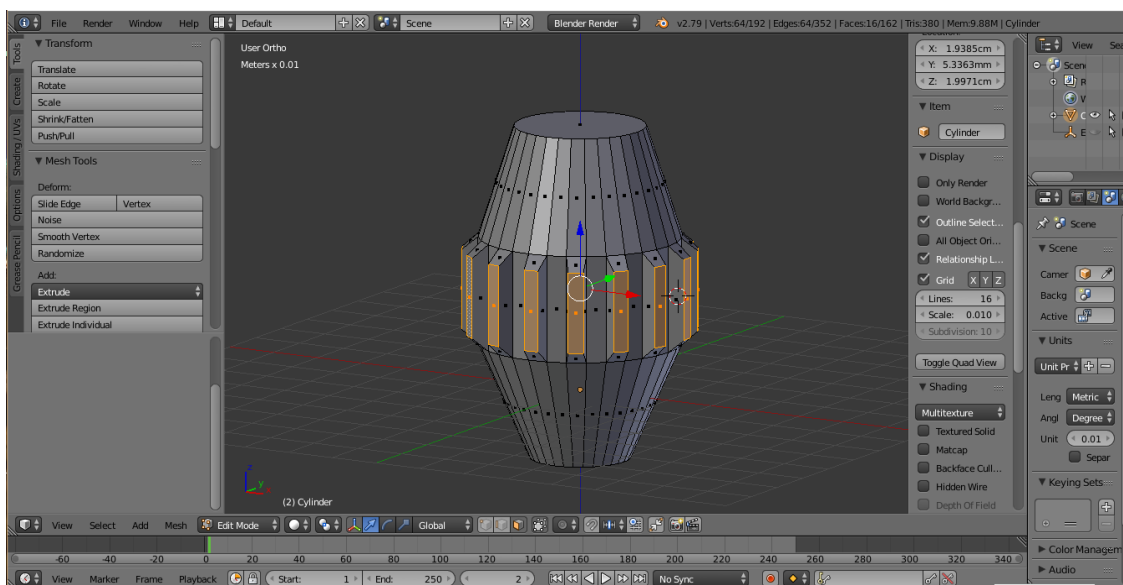


Fig. 4. Sample of the primitive after modeling operations

Useful Blender functions in 3D modeling

It should also be noted that Blender has the ability to use flat drawings (drawings in 2D) as a background that significantly facilitates and accelerates the modeling process of more complex objects, or their groups, such as, for example, chemical plants or factories, as seen in Fig. 5 and Fig. 6. Modeling of individual chemical apparatuses can also be carried out by using a background with 2D drawing. Also, the Blender program supports

the ability to apply different images of plans and incisions to different types of view into the object.

Moving between views onto the object is done by moving (with the simultaneous pressing of the left button) the PC mouse. For a transition to the top view you need to press the button 7 on the numeric keypad, the button 1 to the front view, the button 9 to the top view and the button 3 to the bottom view. For switching between the orthogonal and perspective ways of displaying of the image you need to press the button 5 on the numeric keypad.

The Blender program was chosen to create the 3D model of the shop for the production of dilute nitric acid because it is free and it is very popular among Internet users. Therefore, there are plenty of free online courses and video tutorials for studying it [4, 5], and this program also has a large number of additional functions that are constantly being improved, such as creating of the animations (which can be used for visualization of technological flows and processes in chemical apparatuses) and programming in the built-in language Python (which can be used for creation of electronic simu-

lators for the studying of chemical and technological processes) [6, 7].

The task of creating a 3D model of the shop for the production of dilute nitric acid was realized by the gradual addition of all necessary elements one after the other (floor, walls, props, apparatuses and their props, pipes, hoisting cranes, beam buttresses for the roof, actually the roof, stairs, fences, and inscriptions). Fig. 7 depicts the history of screenshots at all stages of the process of creating elements of the 3D model of the shop for the production of dilute nitric acid.

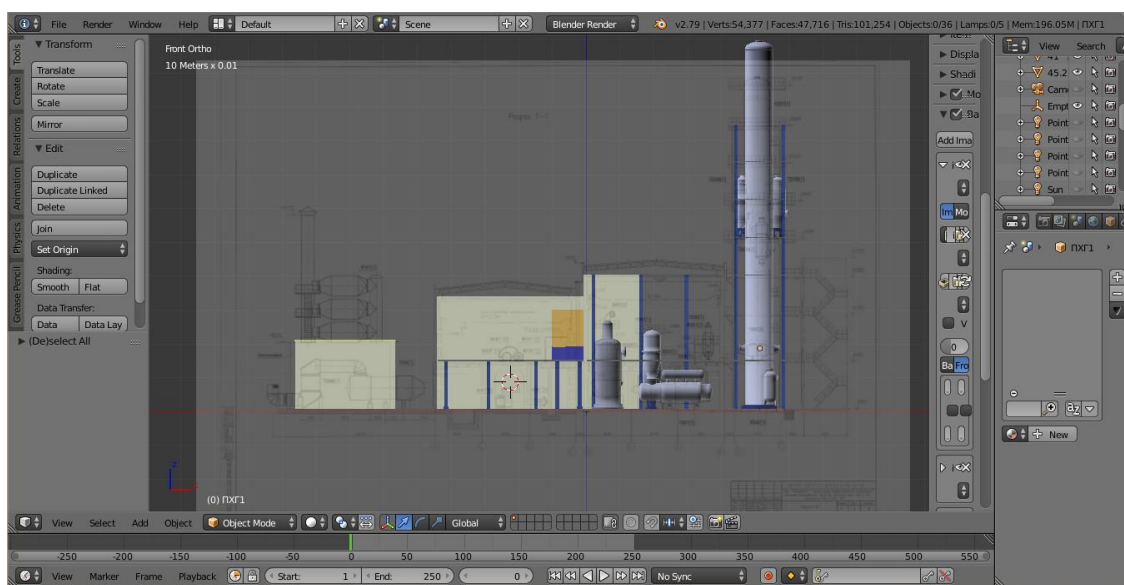


Fig. 5. Using the background image (cross-section) on the frontal view

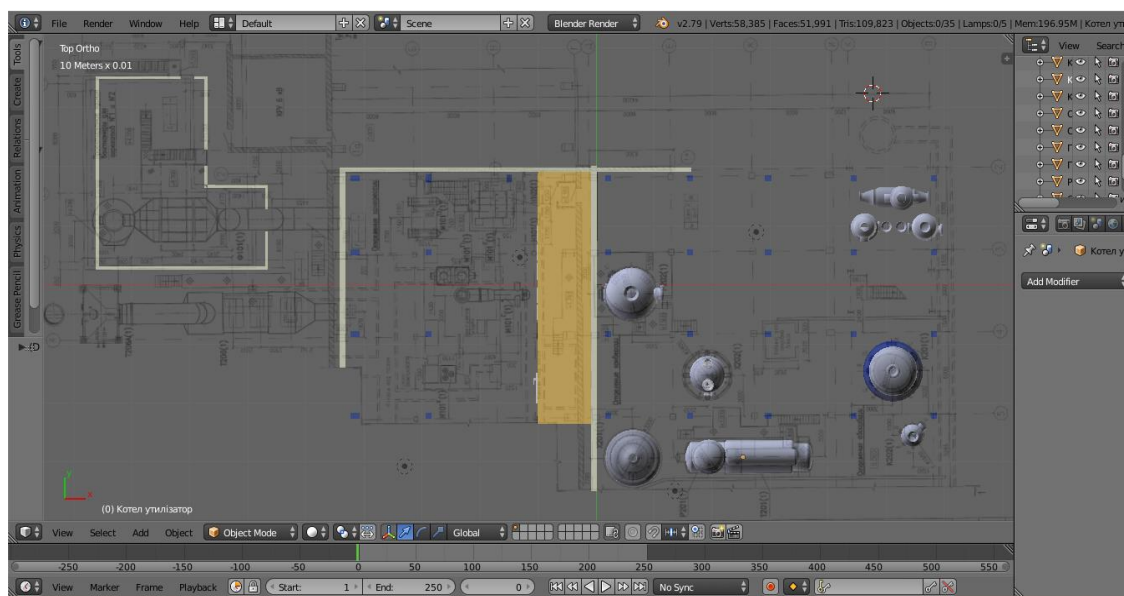


Fig. 6. Using the background image (plan at marks 0.0 and 6.0) in the top view

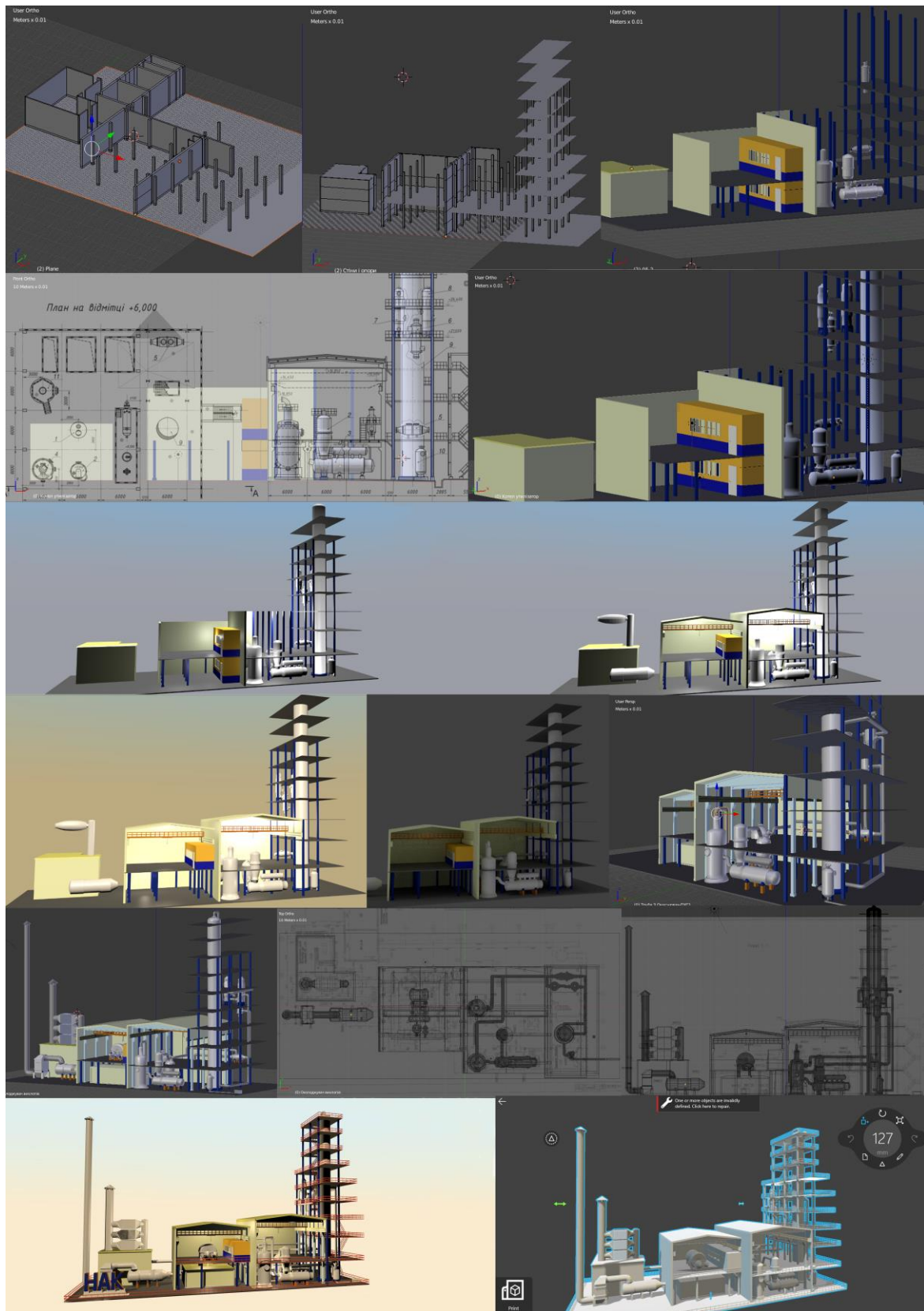


Fig. 7. The stages of all elements creation process

Methodical features of 3D modeling

In the process of learning to work in the Blender environment, the author of the article (the first one) studied several freely available youtube courses in Russian and English. It turned out to be quite enough for the basic actions in 3D modeling, but it took much more effort to solve several problems because there were either no specific instructions or the received recommendations did not work in the specific conditions of our modeling. In this regard, it can be argued that the learning method "Learning by doing" was quite justified, and the work presented here turned out to be research.

However, for the introduction of this approach into the mass educational process, it is necessary to overcome a number of obstacles, both subjective and objective.

First of all, for such designing, it is necessary to study a lot of working methods in a particular program. Of course, the preliminary experience of studying the Compass program for 2D design makes it easier to start, but 3D modeling is significantly different from 2D, which makes it difficult to start this practice.

Obviously, the basic techniques of work can be mastered by existing youtube courses, but may-

be it is more rational to develop a specialized course for the design of chemical plants. In this case, one can use the most common parts of the existing courses in Blender.

On the other hand, it is necessary to preserve the research component in training, so some complex techniques (or rather not obvious) can be left not fully disclosed. The solution of such problems will allow revealing the creative potential of students, of course, on the condition of their independent work on the project.

Conclusions

The task of creation 3D model of the shop for the production of dilute nitric acid was realized and the history of screenshots at all stages of the process was depicted. At the same time, the basic tools for working in the Blender environment were mastered and a number of obstacles (related to the particularities of using this 3D environment for modeling chemical objects) were overcome.

An approach, which was used in this research, will develop a spatial imagination of students in the creation processes of complex chemistry and technology schemes and will promote to a profound study of chemical technologies of inorganic substances and processes of water purification.

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3D-МОДЕЛЮВАННЯ ВИРОБНИЦТВА НІТРАТНОЇ КИСЛОТИ

Проблематика. 3d-моделювання дає змогу створювати кращі для сприйняття і розуміння студентами 3d-моделі апаратів, а також надає можливість виконання різноманітних варіацій розміщення цих моделей, чим полегшує завдання розробки проєктів об'ємно-планувальних рішень при проєктуванні складних хіміко-технологічних схем і сприятиме більш глибокому вивченню хімічних технологій неорганічних речовин і процесів водоочищення.

Мета дослідження. Розробка в середовищі Blender 3d-моделей апаратів і схеми синтезу неконцентрованої нітратної кислоти як приклад застосування цього 3d-середовища для вивчення хіміко-технологічних процесів.

Методика реалізації. Комп'ютерне моделювання хіміко-технологічного обладнання на прикладі виробництва неконцентрованої нітратної кислоти.

Результати дослідження. Розглянуто основні переваги здійснення моделювання об'єктів хімічної технології в середовищі Blender на прикладі розробленої 3d-моделі цеху виробництва неконцентрованої нітратної кислоти. Використання середовища проєктування з вбудованою алгоритмічною мовою дає змогу як автоматизувати процес проєктування хімічних виробництв, так і виконувати конструктивні розрахунки окремих апаратів.

Висновки. Використання методів 3d-моделювання при проєктуванні підвищує якість як навчальних, так і реальних проєктів хіміко-технологічних виробництв. Розробка 3d-моделей реальних виробництв дає можливість підвищити якість підготовки хіміків-технологів, оскільки під час такого моделювання враховуються елементи схеми, які зазвичай не відображаються на пла-

нах і розрізах (наприклад, трубопроводи), що є суттєвим для подальшої професійної діяльності хіміків-технологів. Використання в Blender мови Python дає доступ до різноманітних бібліотек, вільно доступних для цього середовища програмування.

Ключові слова: середовище Blender; 3d-модель; неконцентрована нітратна кислота; об'ємно-планувальне рішення; план-розріз.

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3D-МОДЕЛИРОВАНИЕ ПРОИЗВОДСТВА АЗОТНОЙ КИСЛОТЫ

Проблематика. 3d-моделирование позволяет создавать лучшие для восприятия и понимания студентами 3d-модели аппаратов, а также дает возможность выполнения различных вариаций размещения данных моделей, чем облегчает задачу разработки проектов объемно-планировочных решений при проектировании сложных химико-технологических схем и будет способствовать более глубокому изучению химических технологий неорганических веществ и процессов водоочистки.

Цель исследования. Разработка в среде Blender 3d-моделей аппаратов и схемы синтеза неконцентрированной азотной кислоты как пример применения данной 3d-среды для изучения химико-технологических процессов.

Методика реализации. Компьютерное моделирование химико-технологического оборудования на примере производства неконцентрированной азотной кислоты.

Результаты исследования. Рассмотрены основные преимущества осуществления моделирования объектов химической технологии в среде Blender на примере разработанной 3d-модели цеха производства неконцентрированной азотной кислоты. Использование среды проектирования со встроенным алгоритмическим языком позволяет как автоматизировать процесс проектирования химических производств, так и выполнять конструктивные расчеты отдельных аппаратов.

Выводы. Использование методов 3d-моделирования при проектировании повышает качество как учебных, так и реальных проектов химико-технологических производств. Разработка 3d-моделей реальных производств позволяет повысить качество подготовки химиков-технологов, поскольку в процессе такого моделирования учитываются элементы схемы, которые обычно не отражаются на планах и разрезах (например, трубопроводы), что является существенным для дальнейшей профессиональной деятельности химиков-технологов. Использование в Blender языка Python дает доступ к разнообразным библиотекам, свободно доступным для этой среды программирования.

Ключевые слова: среда Blender; 3d-модель; неконцентрированная азотная кислота; объемно-планировочное решение; план-разрез.

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