ON ENGINEERING ENERGY EFFICIENT INTENSIVE CHEMICAL-TECHNOLOGICAL SYSTEMS IN THE DIGITAL ECONOMY

Yusupov Lazizzjon Abror oglu
A student at the University of South Florida

In the context of the digital economy, one of the main intellectual factors for the successful implementation of the socio-economic and environmental goals of sustainable human development, proclaimed by the UN General Assembly in 2000, is the scientific principles and methods of engineering energy-efficient, intensive, environmentally friendly complex chemical-technological systems suitable for the production of chemical complexes and petrochemical complexes. In accordance with the goals of sustainable development, in the context of the digital economy, intensive chemical engineering processes and energy-efficient, environmentally friendly, digitized, complex chemical engineering processes successfully solve the following main organizational, technological and socio-economic tasks in the real sector of the economy: rational use of natural resources; minimizing man-made emissions, including greenhouse gas emissions; protecting the environment from pollution; preserving the biodiversity of natural systems; socio-cultural harmonization of society; increasing the economic efficiency of industrial enterprises and supply chains; improving the quality of life and increasing life expectancy.

Engineering is a complex technical, computational and graphic, organizational and technical, technical and economic and consulting activity that carries out the following types of various scientific research, design and engineering, computational and analytical, organizational, management and technical and economic work at all stages of the life cycle of chemical engineering systems: pre-project studies, feasibility studies; business planning; design management; project development; construction and commissioning; operation and maintenance management.

To obtain scientifically sound engineering results for optimal, energy-efficient and highly reliable chemical engineering systems and supply chains for the chemical and oil, gas and chemical industries, it is necessary to widely use methods and algorithms of the theory of analysis, optimization and synthesis of chemical engineering systems; resource- and energy-saving logistics methods and the design of optimal organizational and functional structures for energy-saving supply centers; mathematical modeling methods and the theory of artificial intelligence; and digitalization tools developed in the context of the progressive development of the industry.

Given the modern definition of logistics as a type of organizational, technical and managerial activity (in a broad sense) - "detailed, optimal planning of any complex operation", engineering, of course, also applies to the implementation of various logistics activities and the management of the logistics of the supply chain, which is not only the material flows of various industrial products, goods and services, but also the flow of various knowledge and skills. i.e. competencies that represent the most important intellectual product of the modern digital or electronic economy and the knowledge economy.

It should be noted that the scientific direction - chemical-technological systems engineering uses the results of scientific research on chemical technology and chemical production apparatuses (equipment) (English terms: "unit operation", "unit parts"), which are the object of study of the scientific direction "Chemical Engineering" (German name: "Verfahrenstechnik").

In the digital economy, computerized (automated) or digital engineering plays a decisive role. This is a multi-disciplinary, multi-scale (multi-stage) and multi-stage development and implementation of various projects using electronic computers, the Internet and information and communication technologies (ICT), including hardware and software complexes for automated product design; computerized integrated logistics complexes.

The following main types of engineering are carried out at the main stages of the life cycle of chemical engineering systems, supply centers and various facilities: pre-project research, business process planning, technical design and post-project specialized development.

CALS technologies (Computer–Aided Logistics Support – CALS) are an important tool for computerized engineering at various stages of the life cycle of a chemical engineering system. They are a powerful computer-based tool for a modern systematic approach to organizing engineering in the design, construction, operation, maintenance and repair of equipment, as well as in the delivery of high-tech or knowledge-intensive products to the required customer.

The development of CALS technologies allows the creation of distributed virtual manufacturing systems or digital manufacturing systems, in which the process of developing specifications and various design documents containing all the information necessary for the manufacture of a product on software-controlled technological equipment can be distributed in time and space between several organizationally autonomous engineering groups.

The development of a large, common project, carried out by different teams on the principle of three-by-three or parallel design using CALS technologies, ensures reliable transfer of the results of one stage of design to another in a single information space. Changes made at any stage of the design process are simultaneously reflected in all parts of the larger project.

The principle of end-to-end design makes it possible to monitor the integrity of the project, track various changes in design documentation and synchronize them in real time. CALS technologies and the principle of end-to-end design are currently actively used in engineering and technological design of energy-efficient production facilities and enterprises of the chemical and petrochemical industries, with the widespread use of methods and algorithms of the theory of automated analysis, optimization and synthesis of complex chemical engineering systems. These methods are also used in organizational-functional design and multi-period planning of energy-saving optimal technological units in the chemical and petrochemical complex, including gas supply systems.

In the context of the digital economy, globalization, and the transition to sustainable development, five main theoretical and experimental directions of engineering for energy-efficient, environmentally friendly chemical engineering systems can be identified:

1. Increasing the productivity and selectivity of chemical processes by intensification of technological operations and a systematic, multi-stage approach to the management of chemical engineering systems (for example, nano- or micro-structure of catalyst materials).

2. Creation of new miniature combined equipment units based on scientific foundations and new methods of activating chemical engineering systems using multifunctional combined reactors and high-performance catalysts, combined chemical rectification, chemical extraction, etc.

3. Engineering chemical engineering systems using the triple engineering methodology "Process Engineering (molecular engineering) - Process Engineering (Chemical Engineering Systems) - Plant Engineering" (abbreviated 3P-3E methodology) to produce the required high-quality final product.

4. Application of multi-scale computer modeling methods of any chemical engineering systems and phenomena in real conditions from the molecular, micro and macro levels to the production megascale.

5. Application of digitalization methods for chemical engineering systems and central processing plants.

Currently, significant scientific results have been achieved in the areas of multi-scale modeling of chemical and technical systems, conceptual engineering of energy-efficient chemical and technical systems, management of logistics of chemical and technical systems and central processing enterprises, and optimization of chemical engineering systems. It would be expedient if chemists and chemical engineers working in this field paid special attention to the continuous improvement and updating of multi-stage chemical and chemical engineering educational programs based on the integrated use of modern achievements of theoretical and applied chemistry, the theory of energy-efficient chemical and chemical engineering systems. The above considerations can be considered effective for the training of highly qualified and skilled personnel who can successfully solve engineering tasks of energy-efficient, environmentally friendly and sustainable production facilities, enterprises and supply chains in the chemical, biochemical, biometallurgical and petrochemical industries.

Literature

1. Harmsen J. Process intensification in the petrochemicals industry: Drivers and hurdles for commercial implementation. Chem. Eng. Proc.: Process Intensification. 2010. V. 49.

2. Becht S., Franke R., Geißelmann A., Hahn H.A. An industrial view of process intensification. Chem. Eng. Proc.: Process Intensification. 2009. V. 48.

3. Osiadacz A.J. Steady state optimisation of gas networks. Arch. Min. Sci. 2011. V. 56.

4. Osiadacz A.J., Chaczykowski M. Dynamic Control for Gas Pipeline Systems. Arch. Min. Sci. 2016. V. 61. № 1.