

Features of chemical engineer to education in Ukraine and Bologna process

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Abstract

The Ukrainian scientific and educational community efficiently works with important increase of competitiveness of the native system of a science and higher education, and also with the increase of this system role in public transformations last years. Bologna process is such instrument by means of which Ukraine hopes to enter into the European community and to increase the quality of education in the country. A National Technical University of Ukraine "Kiev Polytechnic Institute" (NTUU "KPI") is the leading educational establishment in introduction of concepts, methods and purposes of Bologna process and in a direction of chemical engineer education the chemical-engineering department is the best one.

In the relation of matching the programs of chemical engineer education with the international norms, the considerable help gives European Federation of Chemical Engineering (EFCE). This paper is the result of teamwork. The purpose of this paper was a comparative analysis of bachelors and masters education in NTUU "KPI" in accordance with recommendations of EFCE and the search of conversion ways of chemical engineer education in Ukraine in a whole. The analysis of first education cycle (bachelor) enables to define the following. First of all, the curriculums, which are compared, are differ considerably by a less volume of knowledge from non-technical disciplines (humanitarian, social, and economic). In recommendations of EFCE, it is 6 % against 17 % in NTUU "KPI" (in hours this difference is especially visible: 360 hours against 1296 hours). The second feature is a much greater volume of the recommended educational employment from natural-science training: 25 % against 18 % in the curriculum of KPI. The third feature of recommendations is a much greater volume professional training: 36 % against 27 % in KPI. However, this difference is partially compensated by more powerful training in a cycle of knowledge deepening (selected disciplines): in NTUU "KPI" is 38 % against recommended 33 %. The fourth feature is the basic difference between normative forms of certification: in recommendations, the project in chemical engineering is taken almost 19 % of total professional training against certification test in NTUU "KPI". Thus, the significant reduction in first cycle training in socially-humanitarian and economic directions would allow to pass from four annual cycles of education to three annual. Obviously, it can be made only in a case when in high school, there is allocated enough time for socially-humanitarian teaching. We do not think that it approaches for us. The recommendation on intensification of natural-science education of students it is necessary to consider as expedient, mainly, through strengthening of

mathematical training (especially of statistics) and training in information technologies. It is necessary to recognize of most relevant in professional training of bachelors in chemical engineering. First of all, it concerns of new tendencies in chemical engineering such as product engineering, new concepts of sustainable development of a society and new tools like optimal experiment use of the modern software, etc.

Recommendations of EFCE on realization of master cycle have the general nature, because it answers a major principle of expert training as variety, which reflects the needs of the market and opportunities of higher educational universities. Nevertheless, it is necessary to pay attention to some features. Much more hours is taken for improvement of engineering-chemical disciplines with recommendations of EFCE (70 % against 46 % in NTUU “KPI”). The hours practically coincide in studying of general scientific disciplines and mathematics. Less time is recommended to give scientific master's degree study: 17 % against 30 % in NTUU “KPI”.

The other recommendations, which were presented in the document of EFCE (teaching and mastering, industrial experience, estimation of education process, estimation of educational process by students), are generally accepted and realized in our curriculum and educational process.

Keywords: the index of sustainable development, sustainable development management.

1. Introduction

The Ukrainian scientific and educational community efficiently works with important increase of competitiveness of the native system of a science and higher education, and also with the increase of this system role in public transformations last years. Bologna process is such instrument by means of which Ukraine hopes to enter into the European community and to raise quality of education in the country. A National Technical University of Ukraine “Kiev Polytechnic Institute” (NTUU “KPI”) is the leading educational establishment in introduction of concepts, methods and purposes of Bologna process and in a direction of chemical engineer education the chemical-engineering department is the best one.

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Guidelines EFCE. In September, 2003 the European Federation of Chemical Engineering (EFCE) has published substantive Bologna process provisions which purposes Bologna Declaration are approved and supported. Among these purposes, first of all, adaptability of precisely certain comparative system of higher education, in particular, grounded on two-level cycles of training, and also the resulted comparative criteria and methodology of development of curricula, cooperation between universities and circuits of mobility of students is marked

In this application EFCE has declared education modernized guidelines concerning the curriculum of training to the chemists-technologists published before (1994-2000). Upgrade was supposed to be carried out, considering the last reaching in the organization of

researches, in rules of accreditation of curricula and their close link with a science and engineering.

This upgrade has been prepared by Workgroup EFCE and approved by executive committee on July, 14th, 2005. Guidelines are routed on result of training. The body (core) of the curriculum which is recommended borrows about two thirds of size of the general program and leaves space for modification and innovations. EFCE considers that at the first level of training it is necessary to give special value to that is the general essence (core) of chemical engineering, i.e. technology of updating, sharing and chemical conversion of materials and substances.

These guidelines concern to:

- results of main knowledge and skill training in chemical engineering and the results of to transfer knowledge skill in adjacent areas;
- reaching of training results due to a core of the curriculum, an industrial experience, a browse on process of education, a technique of estimation of students knowledge.

The results of training are generalized, thus, it pays attention that should be the main thing in chemical-engineering education. With appropriate subject directions in a science, chemical and other engineering and in nontechnical areas the core of the curriculum offered here, we will add some variety to concrete contents in the general education system.

Thus, different engineers-chemists will be capable to satisfy requirements of different areas and directions of technology: oil refining; productions of commodity and thin (special) chemicals, papers, polymers; food, cosmetic, pharmaceutical and nature protection areas.

In particular, the second educational level will provide knowledge and skill in research area which will be then prolonged at the highest level of education (candidates of sciences).

The significant part of engineers-chemists is involved now for the participation in production of special products and rather smaller part for production of traditional commodity chemicals. While all engineers-chemists still need traditional chemical-technological knowledge, EFCE already sees necessity of inclusion of the certain knowledge from "product engineering" to the core of the general education of the engineer-chemist in order to consider an increasing role of modern material science.

In a chain "guidelines - requirements" from other structures of higher education (including the organization on accreditation), EFCE has formulated the guidelines in the form of training results, i.e. requirements to that students should know or are capable to do after education.

After the first cycle of training the bachelor should:

- to have appropriate basis of knowledge in fundamental sciences (mathematics, chemistry, molecular biology, physics) which should let for them understand, describe and know how to use the phenomena in chemical engineering;
- to understand major principles which underlie chemical engineering (materials, energy, balances of movement; balance; speed of processes and other) and to be able for creation and solution (analytically, numerically, graphically) the majority of tasks in chemical engineering;
- to understand the main concepts of managerial processes;
- to understand principles which underlie methods of definition of processes and products;
- be able to plan, make, explain and create reports at carrying out of experiments;
- to have knowledge of references and to know how to search appropriate data;

- to have base knowledge of public health services, safety and protection of an environment;
- to understand the concept of steady development;
- to understand the main concepts of grocery engineering;
- to have knowledge for implantation in practice of processes and product engineering;
- to know how to analyse challenges in the selected direction;
- to have a certain experience in usage of the corresponding software;
- to know how to project in the selected direction;
- to know how to calculate costs of processes and the certain projects.

The second cycle of training should be characterized by greater differentiation, both between universities, and between students. Thus, the purpose of education here is reached not only due to specific common knowledge, but due to the common methods in formulation and solution of different tasks. After training on the second cycle the master should:

- to be more professional at the selected direction, than at the first level of competence;
- to use more a profound knowledge of the considered phenomena for the construction of modern models;
- to know how to use appropriate computer toolkit;
- to know how to spend modern experiments and to give modern interpretation to the received results;
- to know how to analyse, estimate and compare alternatives which problems concern;
- to know how to synthesize and optimize new solutions;
- to know how to research independently a problem in depth.

EFCE admits, that the end results after the second cycle of education of the future expert (master) will be least equivalent behind duration of traditional cyclic education (4,5-5 years).

Features of guidelines implementation EFCE in Ukraine. Analysing the upgraded guidelines concerning the curriculum of training to the chemists-technologists, prepared by Workgroup EFCE and approved by executive committee, it is necessary to notice, that essential distinction between the first (bachelor) and the second (master) levels of higher education, first, is installed, secondly, the special attention is allocated to results of training which form the skill for the reaching of these results.

It is necessary to underline also, that all guidelines are resulted on the basis of the European system of test units ECTS (European Community Course Credit Transfer System) which is most widespread in the Europe and provides matching results of training at transition from one higher educational putting to another. The size of operation of one academic year according to this system is equated to 60 credits, one credit answers 36 class periods. For obtaining the diploma it is necessary to type the certain quantity of credit points. Therefore, there is a necessity of application of new system of an estimation of knowledge. Comparison of estimations ECTS and system of an estimation traditionally existing in Ukraine are presented in table 1.

Estimation ECTS and definition	Percent	The Estimation traditional	Percent
A - excellent	10	Excellent	10
B - very good	20	Good	40
C - good	20		
D - satisfactory	20	Satisfactory	40
E - enough (satisfies the minimum criteria)	20		
FX - unsatisfactory	10	Unsatisfactory	10
F-Unsatisfactorily (It is necessary additional operation)			

Table 1. Comparison of estimations ECTS and system of estimations traditionally existing in Ukraine

It is considered, that usage of the modular form of the organization of training assists an intensification of educational process; systematizations of mastering of a teaching material; to rise of motivation and the responsibility of students for results of educational activity; to support of appropriate conditions of a program material learning and education for test actions; to the extension of possibilities for all-round disclosure of abilities of students, development of their creative thinking and rise of an overall performance of teaching structure; to support of a stable psychological state of students owing to carrying out of walkthrough of knowledge measure.

The guidelines received from the European Federation of Chemical Engineering directed us on carrying out of the comparative analysis of these guidelines with system of education of bachelors in chemical technology and engineering which is applied for us. The analysis of first education cycle (bachelor) (Table 2) enables to define the following. First of all, the curriculums, which are compared, are differing considerably by less volume of knowledge from non-technical disciplines (humanitarian, social, and economic). In recommendations of EFCE, it is 6 % against 17 % in NTUU “KPI” (in hours this difference is especially visible: 360 hours against 1296 hours). The second feature is a much greater volume of the recommended educational employment from natural-science training: 25 % against 18 % in the curriculum of KPI. The third feature of recommendations is a much greater volume professional training: 36 % against 27 % in KPI. However, this difference is partially compensated by more powerful training in a cycle of knowledge deepening (selected disciplines): in NTUU “KPI” is 38 % against recommended 33 %. The fourth feature is the basic difference between normative forms of certification: in recommendations, the project in chemical engineering is taken almost 19 % of total professional training against certification test in NTUU “KPI”. Thus, the significant reduction in first cycle training in socially-humanitarian and economic directions would allow to pass from four annual cycles of education to three annual. Obviously, it can be made only in a case when in high school, there is allocated enough time for socially-humanitarian teaching. We do not think that it approaches for us. The recommendation on intensification of natural-science education of students is necessary to consider as expedient, mainly, through strengthening of mathematical training (especially of statistics) and training in information technologies. It is necessary to recognize of most relevant in professional training of bachelors in chemical engineering. First of all, it concerns of new tendencies in chemical engineering such as product engineering, new concepts of sustainable development of a society and new tools like optimal experiment use of the modern software, etc.

<i>Guidelines EFCE (the bachelor 3 years)</i>			0916 Chemical technology and engineering (the bachelor 4 years)			
<i>The characteristic of making education process</i>	<i>Minimum quantity of educational credits/hours of learning</i>	<i>Percent from total amount of training (accepted)</i>	<i>The characteristic of making education process</i>	<i>Minimum quantity of educational credits/hours of learning of a cycle</i>	<i>Percent from total amount of training</i>	<i>Maximum quantity of educational credits/hours of learning of a cycle</i>
Nontechnical disciplines	10/ 360	6 (10)	Cycle of humanitarian and social and economic education	24/ 1296	17	28/1512
Science and mathematics	45/ 1620	25 (20-30)	Cycle of is natural-scientific education	25/ 1350	18	28/1512
Chemical engineering (with the project on chemical engineering in size 12 credits=432 hours)	65/ 2340	36	Cycle of professional and practical education	37/ 1998	27	56/3024
IN TOTAL "CORE"	120/ 4320	67	IN TOTAL "CORE"	86/ 4644	62	112/6024
Deepening of disciplines of "core" and other subject directions	60/ 2160	33	Selective subject matters, from them:	53/ 2862	38	60/3240
			- the recommended disciplines at the choice of students	16/864	12	
			- disciplines at a free choice of higher educational putting	37/1998	27	42/2268
IN TOTAL FOR 3 YEARS	180/ 6480	100	IN TOTAL FOR 4 YEARS	139/ 7506	100	172 / 9288
Industrial practice	On conditions of firms		Technological practice	4 weeks (1 credit =54 hour) on 7 semester		
Normative forms of certification	The project on chemical engineering		Normative forms of the state certification	Test graduation examination		

Table 2. Matching of guidelines EFCE with the program of education of bachelors from chemical technology and engineering

The minimum school hours (without taking into account a vacation and examinations) make not less than 80 % from maximum school hours. The maximum school hours are intended for realization of all forms of the organization of training stipulated by the curriculum, including independent operation of students and check actions (examinations).

Recommendations of EFCE on realization of master cycle have the general nature, because it answers a major principle of expert training as variety, which reflects the needs of the market and opportunities of higher educational universities. Nevertheless, it is necessary to pay attention to some features. Much more hours are taken for improvement of engineering-chemical disciplines with recommendations of EFCE (70 % against 46 % in NTUU “KPI”). The hours practically coincide in studying of general scientific disciplines and mathematics. Less time is recommended to give scientific master's degree study: 17 % against 30 % in NTUU “KPI”. The other recommendations, which were presented in the document of EFCE (teaching and mastering, industrial experience, estimation of process of education, estimation of educational process by students), are generally accepted and realized in our curriculum and educational process.

Guidelines EFCE (2 years)			NTUU "KPI" and including 0916 Chemical technology and engineering (2 years)		
<i>The characteristic of education process</i>	<i>Minimum quantity of educational credits/hours</i>	<i>Percent from total amount of training</i>	<i>The characteristic of education process</i>	<i>Quantity of educational credits/hours</i>	<i>Percent from total amount of training</i>
			Theoretical education, including:	84/4356	70
General scientific disciplines and mathematics	15/540	13	- humanitarian and social and economic disciplines	13-11/702-594	11-9
			- fundamental disciplines	16-18/864-972	13-15
Engineering-chemical disciplines	40/1440	33	- special disciplines	55/2970	46
Additional material and extensions	45/1620	38	Scientific researches, education master's attestative operation	36/1944	30
Scientific operation or the project	20/720	17			
IN TOTAL	120/4320	100	IN TOTAL	120/6480	100

Table 3. Matching of guidelines EFCE with the program of education of masters from chemical technology and engineering

Implementation of reforming of educational process. Today National Technical University of Ukraine "Kiev polytechnic institute" has actively switched on in reforming educational process. Within the limits of refinement of higher education system in Ukraine since 2007-2008 passes to realization of education behind the new list of directions. Thus, the structure of education of the bachelor training should be saved which is resulted on figure 1.

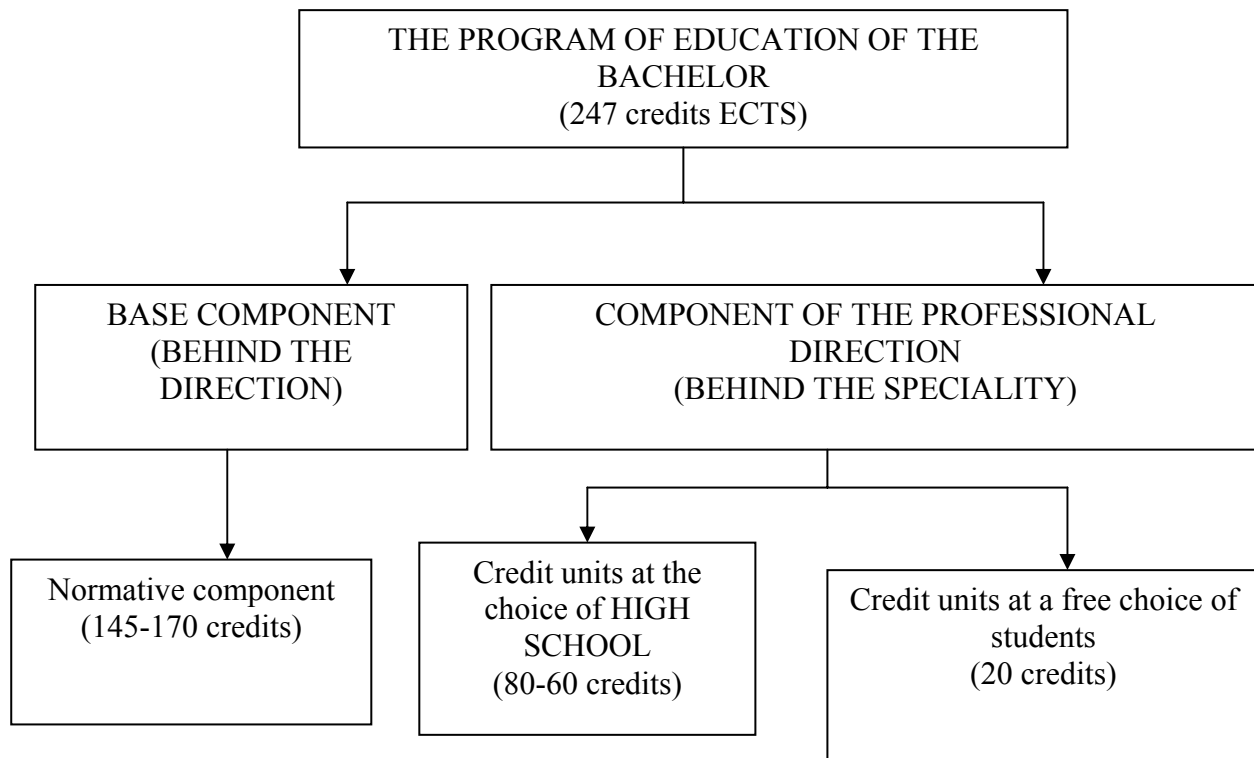


Figure.1. Structure of the baccalaureate program

The resulted structure of the bachelor program corresponds to the new list of directions of education according to which the set of entrants on 2007/2008 is carried out. Transition to credit-modular system of the teaching organization of disciplines, rating system estimation for student's knowledge in ECTS and introduction of two-level education is simultaneously carried out.

Special value of reforming of system education of Ukraine is adapting to a labor market which varies in conditions of transition economy, these processes cause new requirements to the expert which will include wide professional erudition, actual skills and skills in concrete subject branch, and also qualitative education in administrative sphere, sphere of economy and the right. At the present stage, key branches of economy in Ukraine are mechanical engineering, metallurgy, a mining industry, a power engineering, and transport. Greater rates have the information technologies and resources of telecommunication. Therefore in the field of higher education of Ukraine, and also in НТУУ «КПІ» primary branches of knowledge are natural sciences, mathematics and computer science, engineering, transport. Implementation of reform will enable considerably to raise a qualitative professional standard of experts, to provide continuous education, to reach mobility, in particular.

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