PROBLEM SPECIFICATION

There are many concepts with unclear contents, which are sometimes called fuzzy sets, in economic geography. Structural units of the economy, including economic sectors, types of activity, and some fields, the boundaries and structure of which are difficult to define, can be considered among them. Although there is no need in high accuracy here, in some cases, it is necessary for the estimation of economic structures and changes; interindustry and international comparisons; and working out programs and developing strategies for this or that industry.

The problem of identification and structuring is relevant for all industries, but it is more severe in the chemical industry, which is one of the key fields outstanding in its globalization level, innovation, and high growth dynamics. The chemical industry still does not have any clear definition and composition other than the one that was formed in the 1960s–1970s. It is easy to check addressing encyclopedias with their differences and inaudibility in this respect [3–5, 8, 19, 29] or to concrete economic and economic–geographical works concerning the chemical industry, which differ in the identification of the boundaries and the industry composition, in particular, in the question concerning its subindustries, such as pharmaceutics, manufacture of perfumes and cosmetics; mining chemical industry; and manufacture of man-made fibers, manufacture of plastics and synthetic rubber, and others [1, 2, 7, 9, 13–15, 17, 27].

Let us investigate in detail the chemical industry, its boundaries and composition, and how important they are for economic and geographical studies of the field and for rendering help for its development.

METHODS FOR IDENTIFICATION AND STRUCTURING OF BRANCHES

The three main approaches, such as raw-material, technological, and product, have always been used in the identification and structuring of industrial branches.

The raw-material approach pays attention to raw materials as it follows from the name. The approach is the base of classifying industries and subindustries, such as oil refining and wood working; meat, fish, and dairy products (consisting of the food industry); cotton, wool, and linen (in the textile industry), etc.

The raw-material approach is not applicable for isolating the chemical industry because of the huge variety of its raw and other materials, which it shares with many other industries (oil, gas, coal, wood products, minerals, water, air, etc.). That is why when Wikipedia determines the chemical industry as an industry, which includes products from hydrocarbon, mineral, and other raw materials [8], the mentioned types of raw materials are almost insignificant because they can be used in many other industrial branches. Characterizing chemical industry from the position of the raw-material approach, it is possible to say that it
represents a branch, which uses (or can use) any raw materials.

The raw-material approach does not allow for the separating of the chemical industry from a series of linked industries, such as oil refining, coke industry, and others. In addition, it usually reduces the composition of the chemical industry, separating subindustries from it.

At the same time, it is rather convenient for the internal decomposition of the chemical industry, allowing, in particular, for the distinguishing of the following sectors:

(1) **Oil-based chemical industry** is a complex of chemical productions based on oil and natural gas processing [6], including the production of basic organic chemicals (olefin, aromatics, and methanol) and a variety of intermediate and some final products, such as plastics, synthetic fibers and rubbers, surface-active materials, antifreezes, solvents, etc.

(2) **Gas-based chemical industry** is a specialized complex as part of oil-based chemical industry combining chemical productions on the base of natural and associated petroleum gases, including production of some basic organic chemicals, such as methanol, olefins (mainly, ethylene and propylene), and their derivates (sometimes also ammonia without derivates).

(3) **Coal-based chemical industry** is a complex of chemical productions based on coal; it can include carbide acetylene chemical industry, ammonia and methanol production (on the base of synthesis gas), and also processed products of coal tar, such as benzene, toluol, naphthalene, anthracene, cresol, pyridine, coumarone—indene resins, and others.

(4) **Wood-based chemical industry** is a complex of chemical productions based on processed wood products, which includes the production of some organic chemicals, such as ethanol, methanol, acetic acid, glycerin, furfural, resin, turpentine, and also some final products (such as bark extract, feeding yeast, and lignin).

Sometimes the potassic fertilizer industry, chloric chemical industry, processing of fats and oils, and other sectors are also distinguished in the chemical industry in respect of their raw-material characteristics.

Such an aggregative division of the field gives an economic geographer an opportunity to look at it as an aggregate sector developing in close conjunction with raw material sources, such as between petrochemicals and oil refinery plants, gas-based chemical industry and gas-processing plants and gas fields, coal-based chemical industry and metallurgic bases, wood-based chemical industry and the forest industry and woodworking, etc. The high development level of these sectors in some regions of the world (oil- and gas-based chemical industry in the Middle East, oil-based chemical industry in China and Republic of South Africa, wood-based chemical industry in Scandinavian countries and Russia, etc.) is easily grasped in the geographic context.

Combination processes in these sectors leading to the formation of integrated chains of multistage raw-materials processing and formation of large industrial complexes on this basis can be a research object.

At the same time, raw materials sectors do not comprise the whole chemical industry (in particular, they do not include productions based on specific or mixed raw materials), and they are badly described by statistics. They also stand out by their unclear boundaries and high mobility.

Thus, in the period from the 19th century to the beginning of the 20th century, almost all basic organic chemicals and ammonia were included in the coal-based chemical industry, because they were mainly produced from coal. In the second half of the 20th century, when oil displaced coal as the basic raw material, almost all products, not to mention new products, such as olefin (ethylene, propylene, and butadiene), oil-based chemical industry; at the same time, acetylene disappeared from the scene because of the competition exhibited by ethylene. Thus, coal-based chemical industry has almost zero own products, not taking into account exotic products, such as naphthalene and anthracene. Forest chemical industry suffered from the expansion of oil raw materials: its traditional products (methanol, resin, turpentine, and others) started to be produced from oil and gas raw materials, or their production was terminated.

However, in some countries (such as China, Vietnam, and the Republic of South Africa), coal is an important chemical raw material providing up to 15–20% of total output and up to 60–70% of output in some subindustries. Thus, China still mainly produces ammonia, methanol, benzene, and polyvinyl chloride from coal, although the volumes are bigger than the ones of other countries of the world (up to 30% of the world production of ammonia, 25% of methanol and benzene, etc.).

Thus, coal and oil-based chemical industries are divided by rather unclear and conventional bound-