

DISPOSAL OF ALUMINUM FROM END-OF-LIFE VEHICLES IN UKRAINE: ANALYSIS OF LEGISLATIVE REGULATION

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End-of-life vehicles form an important waste and materials stream in the context of hazardous substances and secondary raw materials. The transport industry is one of the main consumers of aluminum alloys – the share of aluminum in the construction of vehicles is constantly growing, so a significant amount of the scrap consists of aluminum-based alloys. It is essential to prevent the significant material streams going to the landfill as end-of-life aluminum placed in landfills leads to degradation of natural ecosystems. Aluminum scrap is a valuable production raw material that can be recycled almost indefinitely. In particular, in the European Union end-of-life aluminum is more than 90% recycled in treatment factories. This is primarily facilitated by the adopted legislative regulation of metal waste management. The aim of work is to consolidate and analyze Ukrainian legislation related to the recycling of aluminum, which comes from the transport sector. Thus, the main issues of aluminum waste management and handling in Ukraine are regulated by the Laws of Ukraine “On Waste” (“On Waste Management”), “On Environmental Protection”, “On Ensuring Sanitary and Epidemic Safety of the Population”, “On Scrap Metal”, state classifier DK 005-96 “Waste Classifier”, state standards DSTU 3051-95, DSTU 3052-95, DSTU 2195-99, DSTU 4462.0.01:2005, DSTU 4462.0.02:2005, DSTU 4462.3.01:2006, DSTU 3211:2009, state sanitary rules DSP 201-97, DСанПиН 2.2.7.029-99, etc.. The analysis showed that there is no separate normative document in Ukraine that regulates the process of disposal of products made of aluminum alloys from end-of-life vehicles. It is expedient for our country to use the experience and practical cases of the European Union, where waste has been at the center of the environmental policy initiatives over a long period of time. This causes the need for development of additional legislation and regulatory acts, as well as appropriate technological solutions (in particular, regarding the classification and sorting of scrap, the use of advanced metallurgical processing technologies, and so on). *Key words*: waste management, end-of-life vehicle, recycling, scrap, aluminum.

Утилізація алюмінієвого брухту від транспортних засобів в Україні: аналіз законодавчого регулювання.
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Транспортні засоби, що вийшли з експлуатації, утворюють важливий потік відходів і матеріалів в плані небезпечних речовин та вторинної сировини. Транспортна галузь є одним із основних споживачів алюмінієвих сплавів – частка алюмінію в конструкціях транспортних засобів постійно зростає, тому значну кількість брухту становлять сплави на основі алюмінію. Важливо запобігти надходженню значних потоків матеріалів на звалища, оскільки алюміній із вичерпаним терміном служби, розміщений на звалищах, призводить до деградації природних екосистем. Брухт алюмінію є цінною виробничою сировиною, що може піддаватись повторній переробці практично нескінченно. Зокрема, у Європейському Союзі більше 90% алюмінію, який закінчив термін служби, утилізується на переробних підприємствах. Цьому передусім сприяє прийняте законодавче регулювання поводження з відходами металів. Метою роботи є консолідація та аналіз українського законодавства щодо переробки алюмінію, який походить із брухту та відходів у транспортному секторі. Так, основні питання управління та поводження з алюмінієвими відходами в Україні регулюються Законами України «Про відходи» («Про управління відходами»), «Про охорону навколишнього природного середовища», «Про забезпечення санітарного та епідемічного благополуччя населення», «Про металобрухт», державним класифікатором ДК 005-96 «Класифікатор відходів», державними стандартами ДСТУ 3051-95, ДСТУ 3052-95, ДСТУ 2195-99, ДСТУ 4462.0.01:2005, ДСТУ 4462.0.02:2005, ДСТУ 4462.3.01:2006, ДСТУ 3211:2009, державними санітарними правилами ДСП 201-97, ДСанПиН 2.2.7.029-99 тощо. Аналіз показав, що в Україні відсутній окремий нормативний документ, який би регламентував процес утилізації виробів з алюмінієвих сплавів від відпрацьованих транспортних засобів. Нашій державі доцільно використати досвід і практичні кейси Європейського Союзу, де відходи протягом тривалого часу були в центрі ініціатив екологічної політики. Це зумовлює необхідність розробки додаткового законодавства та нормативних актів, а також відповідних технологічних рішень (зокрема щодо класифікації та сортування брухту, використання передових технологій металургійної переробки та ін.). *Ключові слова*: поводження з відходами, відпрацьований автомобіль, переробка, брухт, алюміній.

Problem statement. Currently, there is an intensive pollution of the environment (pollution of air, soil, water bodies; alienation of territories) by hazardous components of end-of-life vehicles. Nowadays aluminum alloys are widely used in the transport sector for production of body structures, parts of engine, heat exchangers, transmissions, suspension elements, chassis, wheels, battery, wiring, etc.. Aluminum has application in the electric vehicles transport and automotive industry. The use of 100 kg of aluminum in the automobile construction could save up to 640 l of gasoline per 200 thousand km

and reduce CO₂ emissions by 2000 kg [1–3]. Recycling of aluminum in this regard is of particular importance – on the one hand the use of secondary aluminum in the construction of a car is favorable for the environment and human health; on the other hand there is a large amount of aluminum scrap and waste of the automotive industry, and aluminum can be recycled almost indefinitely. It is essential to prevent the significant material stream going to the landfill, otherwise end-of-life aluminum is placed in landfills and special burial sites that leads to degradation of natural ecosystems.

The analysis [4] had shown that despite the fact that after the signing of the Ukraine – European Union (EU) Association Agreement [5], which provides for compliance with the principles of an integrated approach to pollution prevention and control (Directive 2008/98/EU) [6], the implementation of relevant strategies, concepts and programs on waste management at the state and local levels in Ukraine, the problem of disposal of waste and revitalization of the territories occupied by them continues to remain. About 400 mln t of waste is generated in Ukraine annually and only 6% is recycled, which is almost 7 times lower in comparison with the EU countries [4]. Unprocessed wastes are located at landfills and dumps, more than 5 thousand of which were already overloaded in the beginning of war and nearly 30% did not meet environmental safety standards. Thus, the issue of waste management of end-of-life vehicles is of special importance, and aluminum scrap and waste processing must comply with current legal regulations.

The aim of the work is to consolidate and analyze the regulatory framework of end-of-life aluminum recycling in Ukraine. Advantages that increased recycling could bring require strong support of policy makers, collaboration along the whole recycling value chain as well as the implementation of the best world practices in initiatives for Ukraine recovery.

Analysis of recent research and publications. Waste management in aluminum production is among topics of the research of Ozmen M., Aydogan E.K., Lia X., Ma B., Warrings R., Fellner J., Lopez-Delgado A., Tayibi H. and others. Such researchers as Cu J., Roven H.J., Lovik A.N., Modaresi R., Kelly S., Muller D.B. had paid attention to recycling of aluminum from end-of-life vehicles. The issues of sorting of aluminum scrap and waste were investigated by Engelen B., DeMarelle D., Diaz-Romero D.J., Gavade S., Kulkarni S., etc.. An extremely important literary source is the work on disposal of aircraft components by Makarenko D.N. [7], who analyzed the relevant normative and technical basis in the aviation industry; the specified work prompted the author to write this article..

The author [8] highlights two classification groups of aluminum waste and scrap in accordance with the Waste Classifier DK 005-96 [9]: the code 2732.2 “Production-technological waste of aluminum, aluminum alloys and rolled aluminum” and the code 2732.3 “Waste of final products of the production of aluminum, aluminum alloys and rolled aluminum”. In particular, it is a slag formed in the processes of aluminum metallurgy; aluminum powder; gas cleaning waste; ash; sludge; scrap and waste of aluminum and its alloys (piece); aluminum semi-finished products and rolled products, which are not suitable for their intended use or unfitted; rolled aluminum scrap; aluminum, aluminum alloys and rolled aluminum, contaminated with radionuclides and (or) harmful (dangerous) substances, etc.. Another option for the classification of aluminum production waste is the data of the State Statistics Service of Ukraine in non-

metal–metal coordinates. Thus, the researcher [9] divides the actual generation of aluminum waste into two groups: waste in the form of a metal – nonmetal mixture and metal waste.

The paper [10] is devoted to the problems of disposal and recycling of end-of-life aircrafts and their components. Thus, the disposal of a medium-class aircraft gives relative to its total weight, 60...70% of aluminum and its alloys, 10...15% of steel, 10% of composite materials and precious metals, including titanium. Peculiarities of proper handling of end-of-life aviation vehicles as well as environmental and economic problems related to the disposal and recycling of aircrafts, their components and aggregates were considered. An analysis of existing methods and technologies aimed at rational handling of used aviation equipment was carried out.

Opportunities for more complete utilization of aluminum scrap are associated with overcoming serious difficulties in the field of aluminum recycling, the main of which are the dispersion of waste and the difficulty of separating aluminum from the rest of the scrap of bodies, cars, household appliances, etc. [11].

In general, waste management operations of industrial enterprises involve the main following components, which can be identified as separate business processes: waste storage, waste transportation, waste processing, waste utilization, and waste disposal [12]. The researchers state that solving economic and environmental problems in terms of waste at industrial enterprises should, first of all, begin with the creation of a waste management system [13; 14].

The reduction of wastes generation, as well as their use as secondary resources, is of key priorities for the implementation of a circular economy. Production and consumption wastes suitable for recycling are secondary production resources. Focus on waste-free production in many technological processes allows to obtain by-products from production waste, the realization of which can reduce costs and bring additional profits to enterprises. The author [14] is convinced that a key role in the further development of resource conservation in Ukraine belongs to regional management, which should ensure the interaction of all business entities of all forms of ownership in the direction of the formation of effective forms of waste-free production in the region.

The researchers [4] had analyzed the experience of industrial cities in Europe and the United States and assumed that the need for coordinated actions of urban economy enterprises on the principles of industrial symbiosis as a condition for ensuring circular production and the leading role of local governments as an organizer of the territory revitalization process in the environmental aspect is of particular importance.

Presenting main material. The normative and legal regulation of vehicle disposal processes mainly consists in fulfilling the conditions for the disposal of individual materials that make up their elements. General issues of aluminum waste management and handling in Ukraine are regulated by the following basic documents:

1) Law of Ukraine "On Waste" (1998) [15]; the loss of validity will take place on 09.07.2023, the reason – the adoption of the Law "On Waste Management" [16].

The laws mentioned above provide a key definition in the branch. Waste is any substance, material or object that was formed in the process of production or consumption, as well as goods / products that have completely or partially lost their consumer properties and have no further use in their place formation or detection and which their owner gets rid of, intends to get rid of or must get rid of by disposal or removal. The Law of Ukraine "On Waste" is not applied to economic relationships that arise in the process of collecting, harvesting and carrying out operations with scrap metal.

2) Law of Ukraine "On Environmental Protection" (1991) [17; 18].

According to the Article 48 stimulation within the system of environmental protection should be carried out by means of granting preferential terms of taxation for enterprises when implementing measures on the rational utilization of natural resources and the protection of the environment, converting to low-waste, recycling, resource- and energy-saving technologies, organizing the production and introduction of waste treatment equipment for recovery of pollutants and waste processing, devices for monitoring the environment and the sources of emission and discharge of pollutants, as well as for performing other measures directed at improving the protection of the environment.

In the process of designing, constructing, commissioning of new and modernizing operating enterprises, structures and other facilities, improving the existing and introducing new technologies and equipment, as well as in the process of operating these facilities harmful substances and waste should be trapped, recovered and rendered harmless or completely liquidated, and other requirements shall be complied with as to the protection of the environment and the health of people (Article 51).

Article 55 determines that waste enterprises should take effective measures for reducing the volumes and neutralization, recycling, safe storage or burial of industrial, domestic and other wastes. Storage and disposal of wastes should be allowed by special permits of local councils in defined areas within the range of sanitary and ecological standards by ensuring the possibility of their subsequent economic utilization and safety to the environment and the health of people.

The article 56 ("Environmental safety of transport and other mobile vehicles and installations") is of particular concern; it covers technological and operational issues concerning emissions and discharges of vehicles, but does not cover any regulations or norms for materials used in manufacturing of the transport vehicle / under utilization of the end-of-life vehicle.

3) Law of Ukraine "On Ensuring Sanitary and Epidemic Safety of the Population" (1994) [19]; the loss

of validity will take place on 01.10.2023, the reason – the adoption of the Law "On Public Health System" [20].

4) 4) Law of Ukraine "On Scrap Metal" (1999) [21].

Article 1 provides terms and definitions in the sphere of metal waste processing. Thus scrap metal – products or parts of products unsuitable for direct use, which, according to the owner's decision, have lost their operational value due to physical or moral wear and tear and contain ferrous or non-ferrous metals or their alloys, as well as metal products that have an irreparable defect, remnants of ferrous and non-ferrous metals and their alloys. The main operations with scrap metal are processing, and metallurgical treatment of scrap metal. Scrap metal processing is an activity related to bringing scrap metal by sorting or, if necessary, pressing, bagging, crushing, cutting to a state that meets the requirements of the law; extraction of the metal component from slags of metallurgical processing of ferrous and non-ferrous metals and their alloys.

The procurement of scrap metal is carried out by economic entities. Processing (provision of processing services) of scrap metal should be carried out by specialized or specialized metallurgical processing enterprises only. Metallurgical processing of scrap metal should be carried out by specialized metallurgical processing enterprises only (Article 4).

Article 9 establishes that the export of scrap metal, which was formed in military units, military institutions, military educational institutions of the Armed Forces of Ukraine and other military formations of Ukraine, is prohibited. In connection with this norm, in the near future there will be a need to dispose of a large amount of scrap metal, including aluminum and other non-ferrous metals, generated as a result of the military operations.

5) DSTU 3051-95 (GOST 30166-95) "Resource conservation. General concepts" [22].

6) DSTU 3052-95 (GOST 30167-95) "Resource conservation. Procedure for resource conservation indices establishment in the papers on goods" [23].

7) DSTU 2195-99 (GOST 17.9.0.2-99) "Nature Protection. Waste Treatment. Technical certificate of waste. Make-up, content, writing and alteration rules" [24; 25].

This State Standard establishes a definition of waste classification as the process of organizing waste data, which includes the identification of the type of waste according to its condition, composition and properties through nomenclature name, correlation with a certain process of formation and type of economic activity and assignment to any other active systems of grouping or lists (pollutants, secondary resources, toxicants, etc.), categories of substances, materials and other objects, as well as to the specified types of processing, utilization and disposal of waste. Material / material and energy balance is the ratio of quantitative (mass, volume, etc.) substances (products, substances) and energy carriers that enter the place (process) where waste is generated, and substances (products, substances) that are formed

in this place (process), this includes finished products, semi-finished products and waste. The material / material and energy balance is determined by analyzing the material (material and energy) flows and transformations in technological processes (operations) using accounting, regulatory data and so on. The other important definition in the context of processing aluminum waste is waste utilization – the use of waste as secondary material or energy resource.

8) DSTU 4462.0.01:2005 “Environment Protection. Wastes Management (Handling). Terms and concepts definitions” [26].

Waste classification is sorting of data on wastes by assigning according to certain classification features or a system of features to certain groups or lists in accordance with the established logical structure and format of submission of data on waste. Waste identification is establishing the belonging of waste to certain categories and classification groups, taking into account their origin, composition, condition, dangerous properties, as well as technological methods that ensure their disposal or removal. Standardization of waste generation is establishing of technologically determined specific indicators of waste generation per unit of production, processing of raw materials, obtaining energy, carrying out work, and providing service taking into account the material and raw material balance, as well as the norms of material consumption and work modes. Waste accounting is an activity aimed at collecting, registering, summarizing and storing information about wastes at the stage of formation and the stages of subsequent treatment.

9) DSTU 4462.0.02:2005 “Environment Protection Standards Complex in Sphere of Wastes Management (Handling). General requirements” [27].

10) DSTU 3911-99 (GOST 17.9.0.1-99) “Nature Protection. Waste Treatment. Waste Detection and Submission of the Information Data About Waste. General requirements” [28].

This standard refers to such important in production management and ecological economics terms as life cycle of production, product life cycle, material / material and energy balance, product life cycle stage etc.. The generation of waste is predicted at all stages of the life cycle of products, taking into account the subsequent generation of waste during the use of products by the consumer (operation, repair, renovation) and in the processes of waste processing, as well as during the development of emergency plans and elimination of their consequences. At the stages of research, justification of the development and the development process, the requirements of technical tasks include forecasting the formation and detection of waste in the processes of production and operation (consumption) of products, diversion or minimization of waste generation, the possibility of processing waste that is generated as a result of the loss of consumer properties by products. During the implementation of scientific research works, the possibilities of use of available wastes instead of primary raw materials

in the production of developed products are investigated. With the help of the material and energy balance and other methods of evaluating the processes of production and consumption of the developed products, the generation of waste is predicted and preliminary certification of each type of waste, entering predicted or experimentally obtained data is carried out. It should be noted that replacement of primary aluminum by the secondary one is of particular importance and is needed to be applied not for research only, but the whole industry.

11) DSTU 4462.3.01:2006 “Environment Protection. Waste Management (Handling). Order of operations realization” [29].

The final stage of primary wastes accounting is their certification. It covers the consistent collection, summarization and storage of information about each specific type of waste, its origin, technical, physico-chemical, technological, ecological, sanitary, economic and other indicators, methods of measurement and control, as well as technologies for disposal, processing, recycling or removal. Based on the results of certification, waste passports are drawn. Waste is collected by removing it from the places (objects) of generation, sorting (if necessary) according to specified characteristics into homogeneous components as well as storing it in specialized places (objects) to ensure processing, processing, utilization or removal.

13) DSP 201-97 “State sanitary standards for the protection of atmospheric air of populated areas (from pollution by chemical and biological substances)” [30].

The maximum permissible concentrations (one-time, daily average) are set with an indication of the danger class for such aluminum-based compounds as aluminum-potassium alum (potassium-aluminum sulfate), aluminum-ammonium alum (ammonium-aluminum sulfate), aluminum nitrate, aluminum oxide, aluminum sulfate, aluminum chloride, ammonium-aluminum sulfate, potassium-aluminum sulfate, and aluminum fluoride.

14) DSanPiN 2.2.7.029-99 “Hygienic Requirements of Industrial Waste Management and Definition of their Class of Hazard to Health of Population”. [31].

Accumulation and storage of industrial waste at the company's sites is allowed when using waste in the next technological cycle for the purpose of disposal. All industrial wastes, for which methods of secondary processing and their rational use in the public sector have been developed economically, are to be used as secondary raw materials and should not be taken to landfills.

15) DK 005-96 “Waste Classifier” [9].

The Waste Classifier provides informational support in solving a wide range of issues of state waste management and resource use based on the accounting and reporting system, harmonized with international systems, in particular, in the industry ecology, protection of life and health of the population, labor safety, resource conservation, structural restructuring of the economy, certification products (services) and quality systems. What is especially important, that in the highlight of

European integration course of Ukraine, the use of a waste classifier creates a regulatory framework for conducting comparative analysis of the structure and volume of waste generation of all types of economic activity within the limits of European statistics, including European production statistics, as well as comparative analysis of waste-related services at the inter-sectoral, state and interstate levels.

In the context of aluminum and aluminum alloys utilization, the main groups consist of waste from the basic metals production, waste from the production of metal component products, waste from the production of machinery and equipment, waste from productions of machines and electrical apparatus. Metals production output includes waste generated in the process of metal production, including waste from the production of precious and non-ferrous metals, waste from foundry processes; services specialized in the treatment of waste from the production of precious and non-ferrous metals, which are provided for place of waste generation; services specialized in handling process of waste foundries, which are provided at the place of waste generation, etc. To machinery and equipment production waste belong such classification groups as waste from the production of machines and equipment for general machine-building purposes, agricultural machines and machines for forestry, specialized machines and equipment; waste from the production of military equipment and ammunition; household appliance production waste; services specialized in waste management production of machines and equipment, which are provided at the place of waste generation, etc.

The main classification groups of aluminum scrap and wastes are waste from the production of aluminum, aluminum alloys and rolled aluminum; production and technological waste of aluminum, aluminum alloys and rolled aluminum; scrap and waste of aluminum and aluminum alloys in pieces, formed from the production processes of rolled aluminum (aluminum semi-finished products); semi-finished products of own production of aluminum, aluminum alloys and rolled aluminum or the remains of unfinished production of aluminum, aluminum alloys and rolled aluminum, not suitable for intended use; substandard casting of non-ferrous metals; waste of the final products of the production of aluminum, aluminum alloys and rolled aluminum; rolled aluminum substandard, scrap rolled aluminum; rolled products made of aluminum alloys that are damaged, contaminated or unidentified and cannot be used for their intended purpose; products pressed from aluminum alloys that are damaged, contaminated or unidentified and cannot be used for their intended purpose; products stamped from aluminum alloys that are damaged, contaminated or unidentified and cannot be used for their intended purpose; shavings of aluminum alloys; cuttings of semi-finished products from aluminum alloys; scrap and waste of aluminum and its alloys (e.g. scrap of gliders, airplanes, helicopters).

Special attention is paid to waste from manufacturing vehicles. Thus, group 34 includes waste generated in the process of production of cars, trailers and semi-trailers. This activity is classified into waste from the production of cars, trailers and semi-trailers, as well as services specialized in the management of waste from the production of cars, trailers and semi-trailers, which are provided by the place of waste generation.

16) DSTU 3211:2009 "Non-ferrous metals and alloys and waste. General specifications" [32].

This standard is applied to scrap and waste of non-ferrous metals and alloys intended for further mechanical and metallurgical processing. Scrap and waste, which are delivered to the enterprise or shipped from the enterprise, are necessarily subjected to radiation control, testing for explosiveness, and control of contamination with harmful chemical substances. Each vehicle with scrap metal should be accompanied by a document on radiation and explosion safety. Deactivation of scrap and waste contaminated with radioactive substances is carried out by specialized enterprises that have licenses to carry out these works, on the basis of contracts (agreements) with enterprises that perform operations with scrap metal. Scrap and waste generated at enterprises that use radioactive substances in the production process, as well as vehicles in which such scrap metal is transported, must undergo decontamination and be accompanied by decontamination documents.

When carrying out work with scrap and waste of non-ferrous metals and alloys, to which aluminum and its alloys belong, it is necessary to take into account: the nature of the impact on the human body of harmful substances that are released and formed in the process of collecting and processing scrap and waste of non-ferrous metals and alloys, the class of danger and the maximum permissible concentrations of harmful substances in the air of the working area and in drinking water.

Indicators of the microclimate and the permissible content of harmful substances in working zone air must meet the general sanitary and hygienic requirements for working zone air". Requirements regarding the permissible content of harmful substances of the working zone air should be applied to workplaces regardless of their location (in production facilities, on open sites, vehicles, etc.). Dust of aluminum and its alloys (hazard class III, maximum permissible concentration in the air of the working area – 2 mg/m³, maximum permissible concentration of harmful substances in drinking water – 0.5 mg/dm³) causes irritation of the mucous membrane of the eyes, nose, mouth, lung damage.

When working with scrap metal and waste of non-ferrous metals and alloys, it is necessary to take into account the explosive properties of some types of waste of non-ferrous metals and alloys, as well as the explosiveness of foreign substances / explosive objects that may accidentally fall into the scrap metal during its collection and preparation. Thus, aluminum dust has a self-ignition temperature of 470°C; the lower con-

centration limit of flame spread is 10 g/m³ (dry sand, alumina, magnesite powder are effective extinguishing agents). Unloading and checking for explosion safety of aluminum scrap and waste received at the enterprise, as well as removal of explosive objects from them (except undamaged ammunition) must be carried out under the guidance of a pyrotechnician or a controller of scrap and waste of non-ferrous metals who have undergone special training and have the appropriate certification. Atmospheric air protection and control of the content of harmful substances formed during work with scrap metal must be carried out. Wastewater generated during work with scrap metal must be cleaned and removed. Soil protection against contamination by industrial waste must be carried out.

Temporary storage, transportation, disposal and disposal of industrial waste generated during work with scrap metal must be carried out in accordance with the requirements of DSanPiN 2.2.7.029. Scrap and waste should be transported by any mode of transport in accordance with the rules applicable to each mode of transport. Military equipment scrap and aircraft scrap are transported and stored separately from other scrap. Powdered waste of aluminum and its alloys is transported in rubber-cord or metal containers, by agreement of the parties – in semi-trailers. Scrap and waste of non-ferrous metals and alloys subject to primary processing are stored separately by type in accordance with the established classification in boxes, bunkers, compartments and on specially equipped platforms with a hard surface, which makes it impossible for scrap and waste to clog.

In addition to the national normative base of Ukraine it is essential that the role of international organizations (such as United Nations Conference on Environment

and Development UNCED, United Nations Conference on Trade and Development UNCTAD, Organisation for Economic Co-operation and Development OECD, United Nations Environment Program UNEP) in waste management is nowadays changing and strengthening [33]. In the EU solid waste has been at the center of the environmental policy initiatives for many years to reduce negative effects of inappropriate waste management and to ensure more sustainable use of resources [34]. At the current stage, the EU has a policy of 95% disposal of old cars [8]. Nevertheless the way of implementation regulation for end-of-life vehicles had and continues to have a plenty of challenges as well. For instance, the Directive 2000/53/EC [35] on end-of life vehicles requires obligatory collecting, treatment and recovering (which causes 90% recycling of end-of-life aluminum [36]), having no focus on the quality of the materials. This causes the need for development of additional legislation and regulation, and / or the adoption of appropriate technological decisions (in particular, regarding the classification and sorting of scrap, metallurgical processing stages), which indicates the prospects for further research.

Main conclusions. As the analysis showed, there is no separate normative document in Ukraine that regulates the process of disposal of products made of aluminum alloys from end-of-life vehicles; a similar situation is typical for other branches of industry, in particular, aerospace [7]. There is also no separate state law relating to auto-recycling as a whole: basic laws (On Waste, On Waste Management, On Environmental Protection) are supplemented by regulatory documents relating to resource conservation, nature protection, hygienic and sanitary requirements only.

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