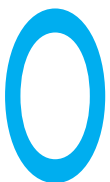


РЕАЛІЗАЦІЯ ЗАХОДІВ МІНІМІЗАЦІЇ ВПЛИВУ НА ДОВКІЛЛЯ ТА ЗБЕРЕЖЕННЯ ГРОМАДСЬКОГО ЗДОРОВ'Я НА СУЧАСНИХ ВІТЧИЗНЯНИХ ЦУКРОВИХ ЗАВОДАХ У РАМКАХ ДИРЕКТИВИ 2008/50/ЄС

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IMPLEMENTATION OF MEASURES FOR MINIMIZATION OF ENVIRONMENTAL IMPACT AND PRESERVATION OF PUBLIC HEALTH AT MODERN DOMESTIC SUGAR-REFINERIES WITHIN THE DIRECTIVES 2008/50/EU



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ugar industry is one of the largest in the food industry and the agriculture of Ukraine. Not only sugar but also the main products of its manufacture such as a waste, pulp, and molasses which occupy a significant place in the forage reserve for the cattle husbandry, are of great importance for the economy of the country [1-3]. The construction of sugar-refineries and factory settlements was carried out in Ukraine in the late nineteenth and early twentieth centuries. At that time, there

were no relevant regulatory documents regarding sanitary zones from the production facilities to the workers' dwellings [4, 5].

At present, according to the town-planning situation, historically developed individual residential building is situated near the territory of sugar-refineries, that requires the study of the impact of the consequences of the plants' operation on the environment and the sanitary-and-hygienic conditions of the inhabitants of the adjacent building and

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Мета роботи. Гігієнічна оцінка ефективності заходів зі зменшення забруднення атмосферного повітря на сучасних вітчизняних цукрових заводах та розробка санітарно-гігієнічних вимог щодо мінімізації негативних наслідків їхньої діяльності на довкілля та громадське здоров'я.

Матеріали та методи досліджень. У статті використано такі методи: бібліосемантичні (для аналізу нормативно-правового регулювання), теоретичні (ретроспективне використання даних наукових досліджень), аналітичні та санітарно-епідеміологічної експертизи проектних матеріалів.

Результати досліджень. Проаналізовано проектні матеріали діючих цукрових заводів з різними технологіями поводження з виробничими відходами, зокрема з сирим жомом. Для дослідження було обрано цукрові заводи, які мають у складі виробництва жомові ями для зберігання сирого жому. Для порівняння з традиційними технологіями виробництва було проведено дослідження на цукровому заводі з новою технологією сушки жому. За результатами наукових

досліджень встановлено, що ліквідація жомових ям та перехід на нову технологію сушки жому зменшує техногенне навантаження на довкілля та мінімізує вплив наслідків діяльності підприємства на здоров'я населення прилеглої житлової забудови, що відповідає вимогам чинних вітчизняних нормативних документів та вимогам Директиви 2008/50/ЄС.

Висновки

1. Впровадження заходів мінімізації впливу на довкілля на сучасному цукровому заводі № 3 з новітніми технологіями (сушка жому, жомогрануляційне відділення) порівняно з цукровими заводами № 1 та № 2 з традиційними технологіями виробництва забезпечило зменшення забруднення атмосферного повітря та відповідає вимогам чинних ДСП № 173-96 та Директиві 2008/50/ЄС.

2. Розрахункові максимальні приземні концентрації забруднюючих речовин на межі нової нормативної 100 м СЗЗ для цукрового заводу № 3 з модернізованою технологією виробництва відповідали вимогам «Державних санітарних правил планування та забудови населених місць. ДСП № 173-96» (п. 5.4), «Переліку гранично допустимих концентрацій хімічних та біологічних речовин в атмосферному повітрі населених місць» та Директиві 2008/50/ЄС «Про якість атмосферного повітря та чистіше повітря для Європи».

Ключові слова : директива ЄС, заходи мінімізації впливу на довкілля, санітарно-гігієнічні вимоги, громадське здоров'я, цукрові заводи з новою технологією виробництва цукру.

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the development of the appropriate measures.

Objective. The aim of the work was to carry out a hygienic assessment of the implementation of the measures for the reduction of ambient air pollution at the modern domestic sugar-refineries within the Directive 2008/50/EU of the European Parliament and the Council of 21 May 2008 «On the quality of ambient air and cleaner air for Europe» and to develop the sanitary-and-hygienic requirements for the minimization of the impact of the negative consequences of their operation on the environment and public health.

Materials and methods. In the study we applied bibliosemantic method (for the analysis of normative-legal regulation), theoretical method (retrospective use of scientific research data), analytical one, and sanitary-and-epidemiological examination of design materials.

Results. According to the results of the scientific sanitary-and-epidemiological examination of design materials on the substantiation of the reduction of the sanitary-and-protective zone for sugar-refineries with a traditional sugar production technology and the introduction of the new technologies for pulp drying, the experts of the Laboratory of Sanitary-and-Epidemiological Examination of Planning and Development of Human Settlements have established the following.

Three sugar-refineries, operating on the basis of the traditional sugar production technology (two objects) and a new

technology (one object), were chosen for the study.

All investigated sugar-refineries are characterized by a large number of the production waste – raw pulp which requires the storage pulp pits located on the territory of the industrial site, have the large areas, and are open. In the operation of the pulp pits, the pollutants enter in the ambient air, they are characterized by the odorous chemicals – hydrogen sulphide, ammonia, acetic acid, butyric acid.

In order to reduce the impact of these aerogenic toxicants of the pulp pits on the human, architectural and planning solutions are used, namely their remoteness to the normative distance that is defined by «The State Sanitary Regulations of Planning and Development of Human Settlements. SSR № 173-96» (Appendix № 4). Sugar refineries, using the pulp pits for the storage of wet pulp, are referred to the third hazard class with a standard sanitary-and-protective zone (SPZ) of 300 m.

The sanitary-and-protective zone is considered as a functional area between an industrial enterprise or other production facility which is a source of harmful environmental factors, and the nearest residential building or the objects equivalent to it, that is created to reduce the negative impact of these factors on the level of the hygienic standards in order to protect the population from their adverse impact. This definition is provided in the Article 114 of the Land Code of Ukraine [6].

As a result of the scientific sanitary-and-epidemiological assessment of design materials, concerning existing sugar refineries, the following was established. Investigated sugar-refineries had the following capacities: sugar-refinery № 1 (with a traditional sugar production technology) – 4.2 thousands sugar beets per day, sugar factory № 2 (with a traditional sugar production technology) – 8 thousands sugar

beets per day, sugar refinery № 3 (with a new sugar production technology) – 6 thousands sugar beets per day. At the investigated facility – sugar-refinery № 3, in order to replace the traditional pulp pits for storage of raw pulp, the new modern technological solutions – pulp drying shops, granulation departments, and new storage conditions for dry pulp were designed. Those technologies allowed the clearing of the industrial territory from liquidated pulp pits for their rational use. The change in the technology of the management with the industrial waste at the sugar refineries, namely the handling with a raw pulp, provided a reduction of the environmental impact that complied with the requirements of the Directive 2008/50/EU of the European Parliament and of the Council «On the quality of ambient air and cleaner air for Europe», 21 May 2008 [7]. New introduced technologies have provided the basis for the transfer of the enterprise from a higher hazard class (hazard class III) to a lower class of hazard (hazard class IV). The above-mentioned modernization of the enterprise has changed the existing town-planning situation, as the adjacent territory of the enterprise SPZ is cleared, which meets the requirements of the town-planning legislation in the provision with all possibilities for the rational use of land resources.

By the sanitary classification of the enterprises, productions, and facilities in the «State Sanitary Regulations for Planning and Development of the Settlements. SSR № 173-96» (Appendix № 4), the sugar-refineries with the wet pulp silos are referred to the third hazard class with a standard SPZ of 300 m, sugar-refineries without wet pulp silos are referred to the fourth hazard class with a standard SPZ of 100 m.

After modernization the structure of the sugar-refinery № 3 includes basic and auxiliary production. The main production includes a beet processing workshop, a juice

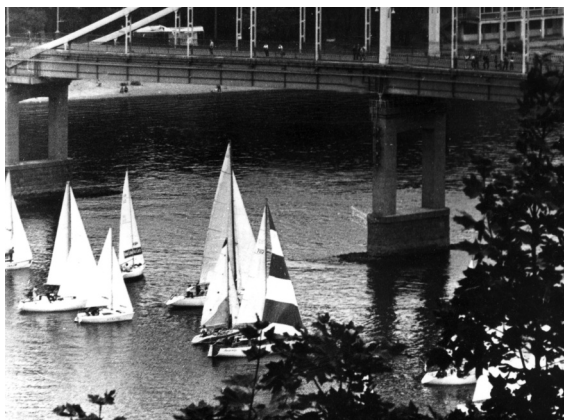
cleaning workshop, a pulp drying workshop, a production workshop, a laboratory. The auxiliary production includes the following units: an electrical workshop, an instrumentation-and-automation workshop, HPP, a mechanical workshop, a warehouse for finished products, the warehouses for limestone, coal, sulphur. Delivery of raw materials is carried out by railway transport. The shipment of finished products is carried out by motor transport.

The scheme of the sugar production by the new introduced technology (complete liquidation of the pulp pit) consists of the following stages: transportation of the sugar beets from the field piles with the help of the conveyor to the station for additional cleaning of sugar

roots and the separation of the impurities from the raw materials; weighing of sugar beets and their transportation to the beet cutter; cutting of the beets into chips; extraction of sugar from chips; liquefaction of sugar and formation of diffusion juice; purification of juice (purification with limestone milk, the first saturation and fil-

tration, the second saturation and filtration); thickening of juice to the syrup state; sugar crystallization; centrifugation of the massecuite; sugar drying; packaging; and warehousing of finished products.

In the process of saturation, lime milk and carbon dioxide are used as a result of burning limestone in a gas-fired furnace



ФАКТОРИ ДОВКІЛЛЯ І ЗДОРОВ'Я

Characteristics of the capacity of sugar-refineries, gross emissions, and state of the ambient air at the normative SPZ taking into account a technology of sugar production

No	List of sugar-refineries by their capacity	Size of normative SPZ for sugar-refineries with wet pulp silo/without wet pulp silo	Gross emissions	Calculated concentrations of the specific pollutants at the normative SPZ, in the proportions of MAC
1	Sugar-refinery № 1 with a traditional sugar production technology, capacity of 4.2 thousand tons of sugar beets per day	300	503.4892 t/year, including: nitrogen dioxide – 55.4273 t/year, carbon oxide – 421.0640 t/year, sulphur dioxide – 8.7469 t/year, ammonia – 8.0916 t/year, sugar dust (sucrose) – 2.4017 t/year, calcium hydroxide (hydrated lime) – 0.4319 t/year, inorganic dust – 0.3246 t/year, butyric acid – 0.0955 t/year, acetic acid – 0.318 t/year, dry dust of beet pulp – 0.68638 t/year, hydrogen sulphide – 0.0058 t/year	at the normative SPZ of 300 m nitrogen dioxide – 0.53 MAC, carbon oxide – 0.53 MAC, sulphur dioxide – 0.45 MAC, ammonia – 0.27 MAC, sugar dust (sucrose) – 0.50 MAC, calcium hydroxide (hydrated lime) – 0.477 MAC, butyric acid – 0.46 MAC, acetic acid – 0.24 MAC, dry dust of beet pulp – 0.56 MAC
2	Sugar-refinery № 2 with a traditional sugar production technology, capacity of 8 thousand tons of sugar beets per day	300	436.2412 t/year, including: nitrogen dioxide – 101.1202 t/year, carbon oxide – 275.0733 t/year (63.06%), sulphur dioxide – 43.6279 t/year, ammonia – 12.0942 t/year, sugar dust (sucrose) – 3.1929 t/year, calcium hydroxide (hydrated lime) – 0.5535 t/year, inorganic dust – 1.1309 t/year, butyric acid – 0.3763 t/year, acetic acid – 0.1294 t/year, dry dust of beet pulp – 0.06997 t/year, hydrogen sulphide – 0.0011 t/year	at the normative SPZ of 300 m nitrogen dioxide – 0.33 MAC, carbon oxide – 0.19 MAC, sulphur dioxide – 0.30 MAC, ammonia – 0.15 MAC, sugar dust (sucrose) – 0.48 MAC, butyric acid – 0.42 MAC, acetic acid – 0.46 MAC, dry dust of beet pulp – 0.50 MAC
3	Sugar-refinery № 1 with a traditional sugar production technology, capacity of 6 thousand tons of sugar beets per day	100	458.7033 t/year, including: nitrogen dioxide – 58.7434 t/year, carbon oxide – 317.5557 t/year (69.23%), sulphur dioxide – 6.7632 t/year, ammonia – 0.3360 t/year, sugar dust (sucrose) – 1.7053 t/year, calcium hydroxide (hydrated lime) – 34.7156 t/year, inorganic dust – 0.0036 t/year, butyric acid – 0.3763 t/year, acetic acid – 0.1294 t/year, dry dust of beet pulp – 3.1184 t/year	at the normative SPZ of 100 m nitrogen dioxide – 0.664 MAC, carbon oxide – 0.736 MAC, sulphur dioxide – 0.821 MAC, ammonia – 0.257 MAC, sugar dust (sucrose) – 0.590 MAC, calcium hydroxide (hydrated lime) – 0.537 MAC

phur dioxide, was at the third place, its gross emissions were from 8.7469 t/year (1.74%) to 43.6279 t/year (10%) of the pollutants' total number.

At the sugar-refinery № 3 with a new technology, the pollutant

– calcium hydroxide (hydrated lime) was the third, its gross emission was 34.7156 t/year (7.57%) of the pollutants' total number.

At the sugar-refinery № 1 with the traditional technology,

Diagram 1

Gross emissions of the pollutants into the ambient air from the auxiliary production (boilers and stoves) of the sugar-refineries in % of total number of gross emissions



with a use of coking coal.

Characteristics of the capacity of these sugar-refineries, gross emissions of the pollutants in the ambient air including the technology of sugar production are shown in the table.

According to the submitted design materials, the gross emissions of the pollutants in the ambient air in the operation of all three investigated sugar-refineries made up from 436.2412 t/year to 503.4892 t/year.

The analysis of the data in Table 1 shows that the gross emissions from the auxiliary production, namely emissions from their boiler-houses and kilns, have shared the first place by the main contribution to the formation of gross emissions of the pollutants in the ambient air in the operation of sugar-refineries.

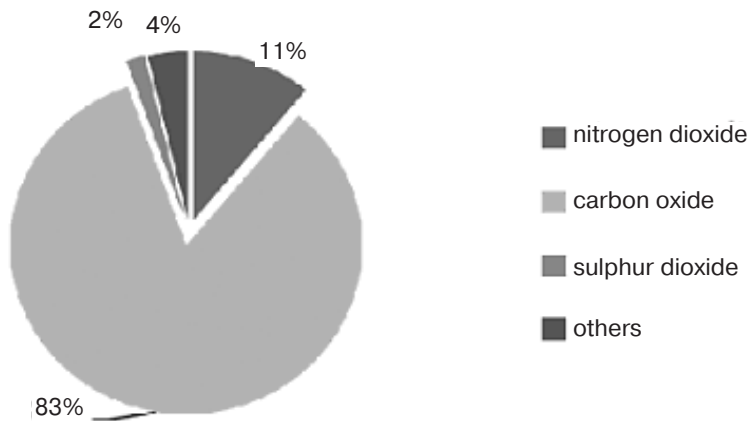
Gross emissions by three major pollutants (nitrogen dioxide, carbon oxide, sulphur dioxide) constituted from 387.0623 t/year (84.4%) to 476.2382 t/year (97%) of the total emissions of the pollutants.

In the operation of these objects, the number of the emissions of carbon oxide was the largest, its amount made up from 278.0733 t/year (63.74%) to 421.064 t/year (83.6%) of the total number of the pollutants.

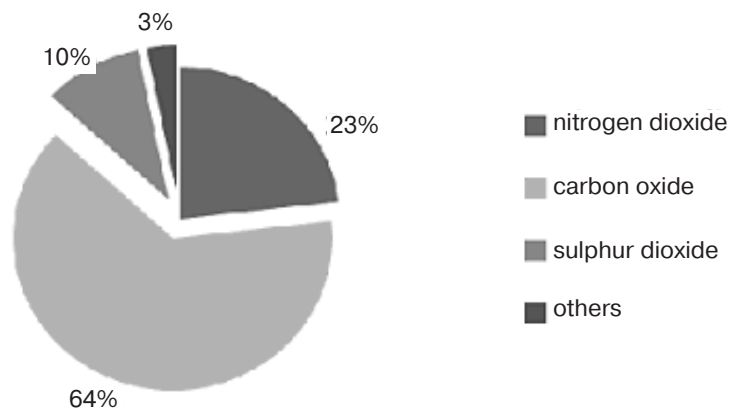
The pollutant – nitrogen dioxide was the second, its gross emissions made up from 55.4273 t/year (11%) to 101.1202 t/year (23.18%) of the pollutants' total number.

At the sugar-refineries № 1 and № 2 with the traditional technology, the pollutant, sul-

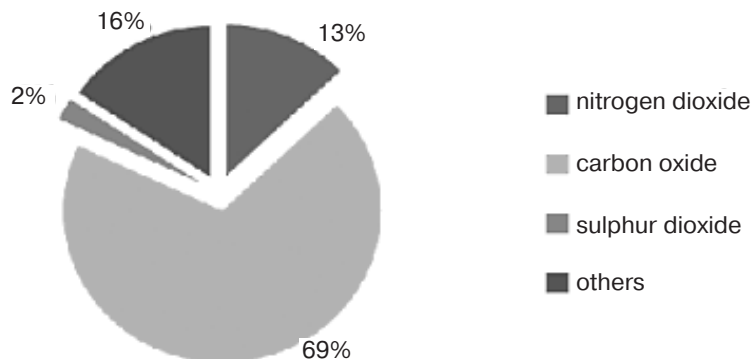
Sugar-refinery № 1



Sugar-refinery № 2



Sugar-refinery № 3



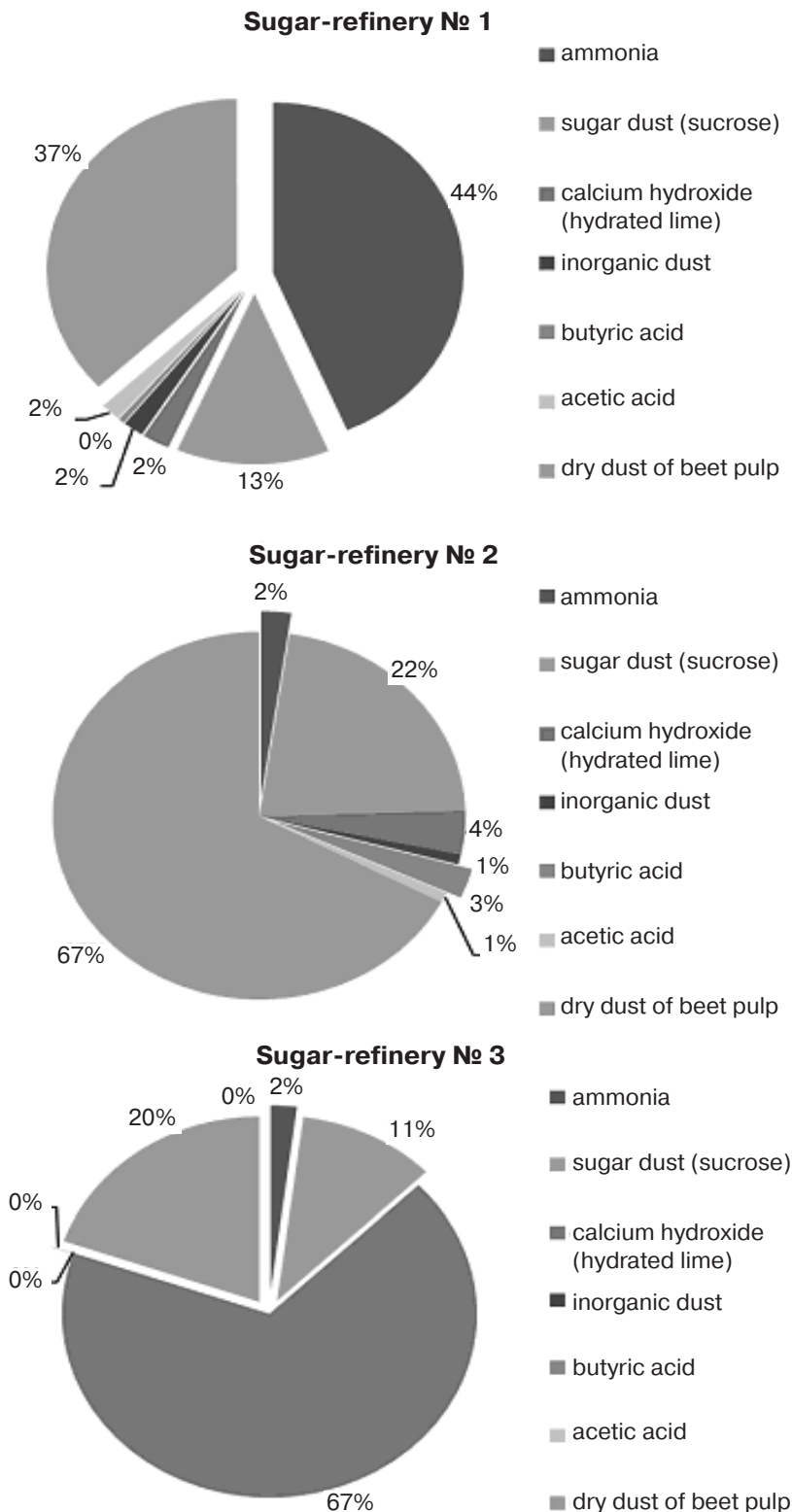
ammonia was the fourth, its gross emission made up 8.0916 t/year (1.61%); at the sugar-refinery № 2 with the traditional technology, sugar dust (sucrose) was the fourth with the emissions of 3.1929 t/year

(0.73%); at the sugar-refinery № 3 with a new technology, the emissions of sulphur dioxide made up 10.7632 t/year (2.35%) and shared the fourth place.

Characteristics of the gross

Diagram 2

The gross emissions of the specific pollutants from the main production of sugar-refineries into the ambient air in % of the total number of gross emissions



emissions from the auxiliary production (boilers and stoves) of the sugar-refineries in the ambient air are given in the diagram 1.

The gross emissions of the specific substances typical for the basic production of sugar: sugar dust (sucrose) – 2.40017 t/year (0.48%) at the sugar-refinery № 1 with the traditional technology; calcium hydroxide (hydrated lime) – 0.5535 t/year (0.13%) at the sugar-refinery № 2 with the traditional technology; dust of dry beet pulp – 3.1184 t/year (0.68%) at the sugar-refinery № 3 with a new technology were at the fifth place.

The gross emissions of the specific pollutants from the main production of the sugar-refineries into the ambient air are shown in the diagram 2.

According to the results of the modernization of the production at the sugar-refinery № 3, the calculations and field studies on the impact of the operation of the sugar-refinery at the adjacent residential area were carried out. The calculations of the gross emissions of the pollutants into the ambient air showed a decrease of the gross emissions of the pollutants by 40.0007 t/year (7.8%). The liquidation of the pulp pit and the transfer to pulp drying technology ensured the total absence of hydrogen sulphide, butyric and acetic acids in the gross emissions of that enterprise. Fitting of the technological units of the sugar-refinery with the aspiration systems with a dust collecting equipment – wet scrubbers of the Venturi tube type and L-3000 (with the efficiency of 95.3-96.5%)

IMPLEMENTATION OF MEASURES FOR
MINIMIZATION OF ENVIRONMENTAL IMPACT AND
PRESERVATION OF PUBLIC HEALTH AT MODERN
DOMESTIC SUGAR-REFINERIES WITHIN
THE DIRECTIVES 2008/50/EU

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Objective: Hygienic assessment of the implementation of the measures for the decrease of ambient air pollution at the modern domestic sugar-refineries and developed sanitary-and-hygienic requirements for the minimization of the impact of their negative consequences of their operation on the environment and public health.

Materials and methods: We used the following methods in the study: bibliosemantic (for the analysis of the application of standard-and-legal regulation), theoretical (retrospective use of the data of the scientific research), analytical, and sanitary-and-hygienic examination of design materials.

Results: In this article, the design materials of existing sugar-refineries with the different technologies of the industrial waste handling, in particular with raw pulp, were analyzed. The sugar-refineries, including the pulp pits for the storage of wet pulp in its production, were chosen for the study. For comparison with the traditional production technologies, research was carried out at a sugar-refinery with a new pulp drying technology. According to the results of the research, the liqui-

dated of pulp pits and the transfer to a new pulp drying technology reduces the technogenic load on the environment and minimizes the impact of the consequences of the enterprise's operation on the public health of the adjacent residential building which complies with the requirements of the current domestic normative documents and the requirements of Directive 2008/50/EU.

Conclusions:

1. Implementation of the measures for the minimization of the environmental impact of the sugar-refinery № 3 with the latest technologies (pulp drying, pulp granulation department) in comparison with the sugar-refineries № 1 and № 2 with traditional production technologies ensures a decrease of atmospheric air pollution and meets the requirements of existing SSR № 173-96 and Directive 2008/50/EC according to the following criteria.
2. Designed maximum surface concentrations of the pollutants at the border of the new normative SPZ of 100 m for the sugar-refinery № 3 with the modernized production technology corresponded to the current domestic «State Sanitary Regulations for Planning and Development of the Settlements. SSR № 173-96» (p. 5.4) and «List of Maximum Allowable Concentrations of Chemical and Biological Substances in the Atmospheric Air of the Settlements» and the Directive 2008/50 / EU of the European Parliament and of the Council for the Ambient Air Quality and Cleaner Air for Europe, 21 May 2008.

Keywords: EU directive, measures to minimize the environmental impact, sanitary-and-hygienic requirements, public health, sugar-refineries with a new sugar production technology.

ensured reduction of gross emissions in comparison with the gross emissions before its reconstruction that contributed to a reduction of the technogenic environmental load and improvement of the sanitary-and-hygienic conditions of the residence of the population in the building adjacent to the sugar-refinery which met the requirements of the domestic and the European sanitary legislation, viz. SSR № 173-96 and Directives 2008/50/EU.

Taking into account that the vast majority of gross emissions of the pollutants into ambient air at all three investigated sugar-refineries is produced by the auxiliary production (boiler houses, kilns), it is recommended to introduce the nature protective measures, in particular, air purification systems and a change of the type of the fuel used in the boiler-houses of sugar-refineries – a transfer to the natural gas, that is a requirement of existing SSR

№ 173-96 and Directive 2008/50/EU.

According to the calculations carried out in the designs submitted for the examination, the maximum surface concentrations of the pollutants at the border of the normative SPZ of sugar-refineries were at the levels: sulphur dioxide – from 0.15 MAC to 0.823 MAC; nitrogen dioxide – from 0.144 MAC to 0.66 MAC; carbon oxide – from 0.056MAC to 0.736 MAC, they did not exceed the hygienic norms of «The State Sanitary Regulations of Planning and Building of the Settlements. SSR № 173-96» (p. 5.4) and «List of Maximum Allowable Concentrations of Chemical and Biological Substances in the Ambient Air of the Settlements», 03.03.2015, approved by the Chief State Sanitary Doctor of Ukraine.

Conclusions. Implementation of the measures for the minimization of the environmental impact of the sugar-

refinery № 3 with the latest technologies (pulp drying, pulp granulation department) in comparison with the sugar-refineries № 1 and № 2 with traditional production technologies ensured a reduction of ambient air pollution and met the requirements of existing SSR № 173-96 and Directive 2008/50/EC according to the following criteria:

1. Replacement of the traditional technology of dry pulp storage at the investigated facility with the introduction of new modern technological solutions: designed pulp drying workshops, pulp granulation departments, and new storage conditions for dry pulp caused to vacate the industrial area of the facility from the liquidated pulp pits for the rational use and contributed to the rational use of vacated areas of the sanitary protection zone of the enterprise to update the existing town-planning situation of the settlement.

2. Operation of the sugar-refinery № 3 with the new pulp drying technology provided the basis for its transfer from the higher class of hazard (Class III) to the lower class of hazard (Class IV) and the substantiation of the application of the new normative SPZ of 100 m in accordance with the «State Sanitary Regulations for Planning and Development of the Settlements. SSR No.173-96» (Appendix № 4);

3. Liquidation of the pulp pit and transfer to a new pulp drying technology ensured the reduction of gross emissions of the pollutants by 7.8%, complete exclusion of hydrogen sulphide, butyric and acetic acids from gross emissions of sugar-refineries, that in turn reduced the technogenic load on the environment and improved sanitary-and-hygienic living conditions of the population residing in the housing estate adjacent to the sugar-refinery.

4. Designed maximum surface concentrations of the pollutants at the border of the new normative SPZ of 100 m for the sugar-refinery № 3 with modernized production technology corresponded to the current domestic «State Sanitary Regulations for Planning and Development of the Settlements. SSR №173-96» (p. 5.4) and «List of Maximum Allowable Concentrations of Chemical and Biological Substances in the Atmospheric Air of the Settlements», 03.03.2015 and the Directive 2008/50/EU of the European Parliament and of the Council for the Ambient Air Quality and Cleaner Air for Europe, 21 May 2008.

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