Investigation of Toxicity of Waste Water of "AVTOVAZ" Company by Using Biological Testing Methods

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Abstract. **During industrial activity of Public Joint Stock Company "AVTOVAZ" there is emission of waste water to Kuibyshevsky water reservoir. Principles of control of degree of toxicity of waste waters and other toxins are discussed. Results of investigation of toxicity of waste water of "AVTOVAZ" company as a factor of negative impact to environment on the example of Kuibyshevsky water reservoir are described. Results allow drawing the following general conclusions: the surface waters of Kuibyshevsky water reservoir in the place of emission of waste water of Public Joint Stock Company "AVTOVAZ are toxic, but do not have acute toxicity.**

Keywords: **waste water, toxicity, biological testing, method, monitoring**

J. INTRODUCTION

The problem of water resources pollution presently has the global meaning. Waste waters of industrial enterprises are one of the main sources of water pollution.

During industrial activity of Public Joint Stock Company "AVTOVAZ" there is emission of waste water to Kuibyshevsky water reservoir. That is why it is important to carry out research of estimation of waste water of "AVTOVAZ" company to hydro-biological parameters of Kuibyshevsky water reservoir, as well as to other objects of environment. For the investigation of degree of toxicity of waste water of "AVTOVAZ" company it is convenient to use biological testing methods.

This paper is devoted to description and to analysis of results of investigation of toxicity of waste water of "AVTOVAZ" company as a factor of negative impact to environment on the example of Kuibyshevsky water reservoir.

II. KUIBYSHEVSKY WATER REZEVOIR AS AN OBJECT OF INVESTIGATION

Presently in the world more than 30,000 water reservoirs are exploited and erected. Total volume of water of reservoirs is exceeding 6,000 km^3. 95% of this volume have large (with volume exceeding more that 100 billion m^3) water reservoirs. On the territory of former USSR there were erected 237 large water reservoirs. The largest one in the world is Bratsky water reservoir according to water volume (volume exceeds 169 km^3) and Kuibyshevsky water reservoir is the second largest one in the world according to water surface (5900 km^3).

Kuibyshevsky water reservoir was formed from1955 to 1957 during the construction of Zhigulyovskaya (former Volzhskaya Hydroelectric Power Station) in the middle part of the river Volga near to the Zhiguli Mountains. The length of Kuibyshevsky water reservoir exceeds 650 km. Total square of Kuibyshevsky water reservoir is 644,800 hectares. Total capacity of reservoir is 58,000 billion m^3, useful capacity – 34 600 billion m^3.

Kuibyshevsky water reservoir is plain, lake-river kind having a complicated configuration. Narrow parts, having the view of a large river, interchange with lake-view broadenings. The most significant width of Kuibyshevsky water reservoir (up to 40 km) is in the Kamsky mouth. Maximal depth of Kuibyshevsky water reservoir is 40 meters; medium depth is 9.4 meters.

According to the article 65 of Water Codex of the Russian Federation, the width of water protective zone and of a coastal protective stripe of Kuibyshevsky water reservoir is determined as equal to 200 meters because the reservoir has especially valuable fisheries. According to the Russian State Standard ГОСТ 17.1.2.04 - 77 “Values of State and Rules of Taxation of Fishery Water Objects”, Kuibyshevsky water reservoir corresponds to the objects of high fishery category.

The place of emission of "AVTOVAZ" company waste water into Kuibyshevsky water reservoir is shown on the figure 1.

Fig. 1. The place of emission of "AVTOVAZ" company waste water into Kuibyshevsky water reservoir

TABLE I

DISTRIBUTION OF POINTS FOR ESTIMATION OF DEGREE OF EFFECT OF TOXICANTS ON THE MAN AND ENVIRONMENT

Name of indicator of estimation	**Parameter of estimation**	**Points**
Irritating effect on eyes	No effect	0 points
	Weak effect	1 point
	Irritating effect	2 points
Skin-resorptive effect	No effect	0 points
	Weak effect	1 point
	Irritating effect	2 points
Sensitizing effect	No effect	0 points
	Weak effect	1 point
	Irritating effect	2 points
Toxic substances assignable under exploitation of lubricating cooling liquids (for estimation the substance corresponding to the most high class of danger is selected)	I class of danger	4 points
	II class of danger	3 points
	III class of danger	2 points
	IV class of danger	1 point
Toxicity during inside-stomach injection (medium mortal dose (LD50) under injection into the stomach)	LD50 ≤ 5000 mg/kg	2 points
	LD50 > 5000 mg/kg	1 point
	Toxic impact is not determined	0 points

III. PRINCIPLES OF CONTROL OF DEGREE OF TOXICITY OF WASTE WATERS AND OTHER TOXINS

Environmental control of toxicity is a complex procedure including estimation of sources of toxicity, determination of the most potentially dangerous zones of toxicity of urban territories, selection of methods for estimation of toxicity, analysis of results of estimation of toxicity, conclusions about the degree of toxicity, and, finally, development and implementation of methods concerning reduction of negative impact of toxicants.

Toxicity can be measured by its effects on the certain target (e.g. an organism, organ, tissue or cell). As individuals typically have different levels of response to the same dose of a toxin, a population-level measure of toxicity is often used which relates the probabilities of an outcome for a given individual in a population [1, 2]. One of generally accepted target of such measure is the LD_{50}. When such data does not exist, estimates are made by comparison to known similar toxic things, or to similar exposures in similar organisms. Then, "safety factors" are added to account for uncertainties in data and evaluation processes. For example, if a dose of toxin is safe for a laboratory rat, one might assume that one tenth that dose would be safe for a human, allowing a safety factor of 10 to allow for interspecies differences between two mammals; if the data are from fish, one might use a factor of 100 to account for the greater difference between two chordate classes (fish and mammals). Similarly, an extra protection factor may be used for individuals believed to be more susceptible to toxic effects such as in pregnancy or with certain diseases. Or, a newly synthesized and previously unstudied chemical that is believed to be very similar in effect to another compound could be assigned an additional protection factor of 10 to account for possible differences in effects that are probably much smaller. Obviously, this approach is very approximate; but such protection factors are deliberately very conservative, and the method has been found to be useful in a deep variety of applications [2, 4].

Assessing all aspects of the toxicity of cancer-causing agents involves additional issues since it is not certain if there is a minimal effective dose for carcinogens, or whether the risk is just too small to see. In addition, it is possible that a single cell transformed into a cancer cell is all it takes to develop the full effect.

It is more difficult to determine the toxicity of chemical mixtures than a pure chemical, because each component displays its own toxicity, and components may interact to produce enhanced or diminished effects. Common mixtures include industrial waste, gasoline, cigarette smoke etc. Even more complex are situations with more than one type of toxic entity, such as the discharge from a malfunctioning sewage treatment plant, with both chemical and biological agents [1, 3, 4].

Biological monitoring is the kind of environmental monitoring, which allows estimating efficiently the degree of the toxicity of different sources. Presently many scientists have carried out research devoted to using biological indicators as test-objects. For example, it is well known that for estimation of quality of water Woodiviss index is used. For estimation of degree of the toxicity of water medium, green protococcus algae Chlorella (*Chlorella vulgaris* Beijer) and craw fishes *Daphnia magna* Straus are often used as test-objects.

New method for estimation of toxicity has been suggested by the authors of this paper. Characteristic feature of the developed method in comparison with existing methods is complex consideration of the main toxicological values of toxicants (e.g. lubricating cooling liquids) on the basis of its point-rating ranging.

The following toxicological characteristics have been taken into consideration:
- irritating effect on eyes;
- skin-resorptive effect;
- sensitizing effect;
- toxic particles assignable under exploitation of lubricating cooling liquids (number of singled out toxicants and it class of danger);
- toxicity during inside-stomach injection.

In table 1 the scheme of distribution of points during estimation of degree of toxic effect of lubricating cooling liquids on the man and environment is presented.

IV. Determination of degree of toxicity of waste water of "AVTOVAZ" company by biological testing methods

Biological testing of probes of surface waters of Kuibyshevsky water reservoir has been provided in laboratory conditions. Experimental research has been carried out in the state accredited R & D laboratory NIL-9 "Vibration, Acoustics, Ecology and Life Protection" of Togliatti State University according to the requirements of accredited methods for determination of acute toxicity of probes of surface fresh, ground, drinkable, sewage waters, water extractions from soil, sewage sediments and wastes in laboratory conditions by variation of optic density of test-culture green protococcus algae Chlorella (*Chlorella vulgaris* Beijer) according to the method ПНД Ф 14.1:2:3:4:10-04 16:1:2:3:3.7-04 and by determination of mortality of craw fishes Daphnia (*Daphnia magna* Straus) according to the method ПНД Ф Т 14.1:2:4.12-06, 16.1:2:3:3.9-06.

Results of biological testing of some probes are submitted below.

Probe 1

1. Investigated probe does not cause toxic effect on the test-object *Daphnia magna* Straus. 100% survival rate of test-object has been observed during the initial toxic dilution multiplication factor for all the time of exposure (48 hours).
2. Investigated probe causes toxic effect on the test-object *Chlorella vulgaris* Beijer. Toxic dilution multiplication factor is 9 times, which corresponds to toxic medium.

Probe 2

1. Investigated probe does not cause toxic effect on the test-object *Daphnia magna* Straus. 100% survival rate of test-object has been observed during the initial toxic dilution multiplication factor for all the time of exposure (48 hours).
2. Investigated probe causes toxic effect on the test-object *Chlorella vulgaris* Beijer. Toxic dilution multiplication factor is 3 times, which corresponds to feebly toxic medium.

Probe 3

1. Investigated probe does not cause toxic effect on the test-object *Daphnia magna* Straus. 100% survival rate of test-object has been observed during the initial toxic dilution multiplication factor for all the time of exposure (48 hours).
2. Investigated probe causes toxic effect on the test-object *Chlorella vulgaris* Beijer. Toxic dilution multiplication factor is 3 times, which corresponds to feebly toxic medium.

Results of biological testing allow making the following general conclusions. According to the results of biological testing of probes of surface waters of Kuibyshevsky water reservoir in the place of emission of waste water of Public Joint Stock Company "AVTOVAZ" into Kuibyshevsky water reservoir, it is determined that the investigated probe does not cause toxic effect on the test-object *Daphnia magna* Straus. However, the investigated probe causes toxic effect on the test-object *Chlorella vulgaris* Beijer. Toxic dilution multiplication factor differs from 3 to 9 times, which corresponds to toxic medium. Thus, the surface waters of Kuibyshevsky water reservoir in the place of emission of waste water of Public Joint Stock Company "AVTOVAZ" into Kuibyshevsky water reservoir are toxic, but do not cause acute toxicity.

It should be noted that even feebly toxic medium may cause significant negative influence on water reservoir biota. Therefore it is necessary to develop efficient methods and means of further minimization of negative impact of toxicity of waste water of Public Joint Stock Company "AVTOVAZ" on Kuibyshevsky water reservoir.

V. Conclusions

Public Joint Stock Company "AVTOVAZ" is one of the largest enterprises of Russia. Industrial activity of "AVTOVAZ" may cause some negative impact on environment. Emission of waste water of "AVTOVAZ" to Kuibyshevsky water reservoir has been considered a potential negative factor of influence. Kuibyshevsky water reservoir as an object of investigation has been described.

Principles of control of degree of toxicity of waste waters and other toxins have been discussed**.**

Results of investigation of toxicity of waste water of "AVTOVAZ" company as a factor of negative impact on the environment on the example of Kuibyshevsky water reservoir have been described. Results allow making the following general conclusions: the surface waters of Kuibyshevsky water reservoir in the place of emission of waste water of Public Joint Stock Company "AVTOVAZ are toxic, but do not cause acute toxicity.

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Andrejs V.Vasiļjevs, Leila P.Hamidullova, Vera V.Podurujeva, Sergejs S. Solovjovs. Valsts sabiedrības „AVTOVAZ" notekūdeņu toksiskuma izpēte, izmantojot bioloģiskās testēšanas metodes

VS "AVTOVAZ" ir viens no lielākajiem uzņēmumiem Krievijā. "AVTOVAZ" rūpnieciskās darbības var izraisīt negatīvu ietekmi uz apkārtējo vidi. "AVTOVAZ" notekūdeņu emisiju Kuibiševas ūdenskrātuvē uzskata par potenciāli negatīvu ietekmes faktoru.
Kuibiševas ūdenskrātuve tika aprakstīta kā pētījuma objekts. Kuibiševas ūdenskrātuve tika izveidota 1955.-1957. gadā Žiguļu (bijusī Volgas) Hidroelektrostacijas būvniecības laikā Volgas upes vidusdaļā blakus Žiguļu kalniem. Kujbiševas ūdenskrātuves garums pārsniedz 650 km. Kuibiševas ūdenskrātuves kopējā platība ir 644 800 hektāri. Ūdenskrātuve ieņem otro vietu pasaulē pēc ūdens virsmas platības.
Par notekūdeņu un citu toksīnu līmeņa kontroles principiem notiek diskusijas. Toksiskuma vides kontrole ir kompleksa procedūra, kas ietver toksiskuma avotu novērtēšanu, pilsētas teritoriju potenciāli visbīstamāko zonu noteikšanu, toksiskuma novērtējuma metožu atlasi, toksiskuma novērtējuma rezultātu analīzi, secinājumus par toksiskuma pakāpi un, visbeidzot, toksisko vielu negatīvās ietekmes samazināšanas metožu izstrādi un ieviešanu. Bioloģiskais monitorings ir ekoloģiskā monitoringa veids, kas ļauj efektīvi novērtēt dažādu avotu toksiskuma līmeni. Līdz šim brīdim daudzi zinātnieki ir veikuši pētījumus, veltītus bioloģisko indikatoru kā testēšanas objektu izmantošanai. Piemēram, ir labi zināms, ka ūdens kvalitātes novērtēšanai pielieto Vudivisa indeksu. Kā testēšanas objektus ūdens vides toksiskuma līmeņa novērtēšanai bieži izmanto zaļo vienšūnas aļģi hlorellu (Chlorella vulgaris Beijer) un vēzīšus Daphnia magna Straus. Šī darba autori piedāvā jaunu toksiskuma novērtēšanas metodi. Izstrādātās metodes īpatnība salīdzinājumā ar jau esošajām metodēm ir kompleksā toksisko vielu (piem., dzēsēšanas smēršķidrumi) toksikoloģisko pamatvērtību izskatīšana, klasificējot pēc punktu skaita.
Ir aprakstīti "AVTOVAZ" kompānijas notekūdeņu toksiskuma pētīšanas rezultāti kā negatīvas ietekmes uz apkārtējo vidi faktors, izmantojot Kuibiševas ūdenskrātuves piemēru. Minētie rezultāti ļauj izdarīt sekojošos vispārīgos secinājumus: Kuibiševas ūdenskrātuves virszemes ūdeņi VS "AVTOVAZ" notekūdeņu emisijas vietā ir toksiski, bet neizraisa augstu toksiskumu. Jāatzīmē, ka pat vāji toksiska vide izraisa ļoti negatīvu ietekmi uz ūdenskrātuves floru un faunu. Tādēļ ir nepieciešams izstrādāt efektīvas metodes un līdzekļus VS "AVTOVAZ" notekūdeņu negatīvās ietekmes un Kuibiševas ūdenskrātuvi minimizācijai.

Андрей В. Васильев, Лейла Р. Хамидуллова, Вера В. Подуруева, Сергей Г. Соловьев. Исследование токсичности сточных вод ОАО "АВТОВАЗ" с использованием методов биотестирования

ОАО «АВТОВАЗ» является одним из самых больших предприятий в России. Промышленная деятельность «АВТОВАЗа» может оказывать негативное влияние на окружающую среду. Эмиссия сточных вод «АВТОВАЗа» в Куйбышевское водохранилище считается потенциально негативным фактором влияния.
Как объект исследования, было описано Куйбышевское водохранилище. Куйбышевское водохранилище было создано в 1955-57 годах во время строительства Жигулёвской (ранее – Волжской) гидроэлектростанции в средней части реки Волга рядом с Жигулёвскими горами. Протяжённость Куйбышевского водохранилища превышает 650 км. Общая площадь Куйбышевского водохранилища равна 644 800 гектарам. Водохранилище является вторым в мире по площади водной поверхности.
Принципы контроля уровня токсичности сточных вод и других токсинов являются предметом обсуждения. Контроль токсичности окружающей среды - это комплекс процедур, включающий в себя оценку источников токсичности, определение потенциально наиболее опасных зон токсичности городских территорий, выбор методики оценки токсичности, анализ результатов этой оценки, заключение об уровне токсичности и, наконец, разработка и внедрение методики по уменьшению негативного влияния токсинов. Биологический мониторинг является видом слежения за средой, который позволяет эффективно оценить уровень токсичности различных источников. К настоящему моменту многими учёными были проведены исследования, посвящённые использованию биологических индикаторов в качестве объектов тестирования. Например, хорошо известно, что для оценки качества воды используется индекс Вудивисса. Для оценки токсичности водной среды в качестве объектов тестирования часто используют одноклеточные водоросли хлорелла (Chlorella vulgaris Beijer) и рачков Daphnia magna Straus. Авторами данной работы была предложена новая методика оценки токсичности. Особенностью разработанной методики является комплексное рассмотрение токсикологических величин токсичных веществ на основании их классификации в зависимости от количества пунктов.
Результаты исследования токсичности сточных вод компании «АВТОВАЗ» были описаны как фактор негативного влияния на окружающую среду на примере Куйбышевского водохранилища. Данные результаты позволяют сделать следующие выводы: поверхностные воды Куйбышевского водохранилища в месте эмиссии сточных вод открытого акционерного общества «АВТОВАЗ» токсичны, но не являются причиной высокой токсичности.