

WIDELY KNOWN CHEMICAL ACCIDENTS

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Milica Bogdanović

University of Niš, Univerzitetski trg 2, 18000 Niš; e-mail: milica@ni.ac.rs

Abstract. *Accidental chemical contamination of the living environment and peacetime poisoning of people, fish and animals represent the most actual problems of the contemporary world. According to the official UN expert evaluations, these accidents and events inflict severe damages on mankind, make the living environment unbearable, endanger the health and life of humans and animals, as well as of plants, and have considerable material, social and political implications.*

Two chemical accidents were singled out in the analysis of the accidents known to have happened in our country and worldwide. The first is classified as a negative experience and the rise of panic, which is never anticipated in the plans of responding to chemical accidents and which has proved in this case to be of extreme importance, as the consequences could have been avoided or significantly reduced without it. The second event represents an extremely positive experience in terms of a fast and timely reaction to a chemical accident.

Key Words: *chemical accidents, chemical contamination, technical equipment, quick response*

1. INTRODUCTION

According to the International Labor Organization (ILO), considering major chemical accidents recorded worldwide, 35-40% of the accidents occurred during transportation, and 24% are cases that happened in the warehouses. The basic cause of these accidents is related to human error (62% cases), and smaller number is caused by obsolete technology (20% cases).

The world statistics show that, considering all the environmental disasters, chemical disasters take the biggest number of human victims but also leave an open question of the future life of people in the areas where the accidents occurred.

Mass victims and injuries; epidemics and epizootics; fires; floods; destructions; contamination of water, air and land by chemical substances, disorder and panic and other occurrences - can appear in all accident and disaster situations, regardless of whether they are caused by wars, natural disasters or accidental situations. Also, there are no big differ-

ences regarding preventive and safety measures. Uncertainty about the possible occurrence of some danger also appears as one of the common characteristics.

A characteristic of accidents polluting the living environment is that time of the accident occurrence, that is, of the living environment pollution, is unknown. In regard to accidents occurring in production process, a place where damage may occur is known, and in most of the cases, different kinds of pollution may be predicted in industrial sectors and warehouses. Regarding accidents when transporting chemical substances neither place where nor time when an accident may happen is known. In considerable number of cases, it is unknown which chemicals may be released from damaged transportation vehicles and what effect they may have on the living environment.

2. ACCIDENTS IN INDUSTRY AND WAREHOUSES, WORLDWIDE AND IN YUGOSLAVIA

The most serious effects in the history of chemical industry occurred in Bhopal, India, in a chemical factory "UNION KARBIDE - India", which produces pesticides and which is one of the best known multinational companies with its headquarters in the USA.

During the night between December 2 and 3, 1984, a breakdown occurred. At that time, around 40 tons of isocyanate mixed with phosgene, which is more than a couple dozen times more poisonous than hydrogen cyanide, were released into the atmosphere. The release started at 23:00, when water broke into one of three reservoirs and in reaction with the phosgene increased the pressure and temperature, which caused the breaking of the reservoir valves. The three-member team, in charge of watching the reservoirs, was panicking. Two members ran away, leaving the factory grounds, so that the team leader, affected by the toxic gas, was unable to repair the breakage (*Human factor*).

Accident effects: within the first six days after the accident, 50.000 poisoned people sought medical assistance, while eight days after the accident, according to official records, the number of deaths was 2.500, where more than 1/3 were children. In total, there were around 2.000 seriously poisoned people, among whom many were permanently blinded, and some suffered serious nervous system disturbances. The study of the Indian Council for Medical Research, published in 1986, reported that around 25.000 victims from Bhopal who survived, suffered from mental disturbances and permanent respiratory difficulties.

There are many other examples of chemical accidents worldwide. They are unknown in the scholarly and occupational circles. Some of them occurred in industry. One occurred in November 1986, in the chemical factory "SANDOZ" in Basle (Switzerland). Fire spread over the warehouse where there were more than 90 different kinds of chemicals amounting 1.250 tons. Water used for extinguishing the fire, as well as the chemicals, instead of getting into the waste waters reservoir, got into the Rhine River. Also, chemicals got into the river by ground waters. The maximum concentration of chemicals in the Rhine River lasted for 12 days, which is time that water takes to pass the distance from Basle to the North Sea.

The effects of that ecological disaster are the following: 1.200 of Basle citizens sought medical assistance, life in the river suffered a setback; tubular wells used for the drinking water supply were disconnected and stopped being used, so that citizens were supplied by drinking water from cisterns, and the ecological balance was disturbed in a 300 km radius. In the surrounding of chemical industry complex, dead fish, destroyed flora and fauna were recorded.

In Subotica, between May 4 and 5, 1996 in the "Azotara" factory, a breakdown in the production process occurred when, through the factory chimney, particles of approximately 10 tons of the KAN artificial fertilizer were released into the atmosphere. The accident occurred at the moment of an electricity power cut and computer re-programming of the production process, so that for three hours KAN, that is ammonium nitrate that is used for this kind of fertilizer production, was being released through the "Azotara" factory chimney. Farmers in the surrounding of "Azotara" suffered huge damage, because the white powder completely covered plants and trees and they started to wither.

3. ACCIDENTS IN THE TRANSPORTATION OF CHEMICAL SUBSTANCES

The transportation of toxic, flammable and explosive substances by trains, tank-trucks and trucks, is a potential danger for the living environment.

Because it is impossible to anticipate the location of an eventual disaster, it is necessary to organize and carry out appropriate safety measures along the busiest traffic arteries. Considering the large number of accidents which occur during the transportation of hazardous substances both in Serbia and worldwide, the most characteristic ones are the following:

A train that derailed caused the breaking one of three cisterns with arid ammonia at the railroad gage in Nebraska, USA, on February 18, 1969. Seventy-six tons of arid ammonia flowed out of it, and due to low temperatures (-15°C), a cloud was formed immediately above the very ground, covering big surfaces. Parts of the railroad cars and broken cistern damaged several houses next to the railroad. Five people died immediately, four died a little bit later, and 53 people were poisoned, 23 of whom very seriously.

A tank-truck with propylene exploded in the vicinity of a Spanish tourist camp, Los Alfages, in 1978. The fire cloud covered the camp very quickly. There was no hope for the 215 tourists.

In Mississauga, Canada, in 1979, one of the well known accidents in transportation of hazardous substances occurred. One of the freight train car-cisterns loaded with toluene was caught fire and the toluene started burning. On the intersection before the railway station entrance, the railroad car exploded, and other 23 railroad cars loaded with propane and butane, as well as cisterns with 90 tons of chlorine, fell to the ground and were derailed. The explosion of butane and propane was so strong that one railroad car was blown 1 km away and luckily fell into a field. It damaged the cisterns with chlorine, which started flowing out. It should be mentioned that during the railroad car-cistern examination and control which were done at the previous station, around 40 km away from the place of accident, no breakdown was noticed. The railroad car explosion occurred at 23:54. At the same time, it was a signal for emergency situations services on duty. After only 4 minutes, policemen, the fire brigade and ambulance arrived at the scene of the accident. Some citizens were also present. Senior police officers arrived, and after a quick situation assessment and according to the plan got interventions, they established a command point near the place of accident, only 6 minutes after the moment of explosion.

Several minutes after the moment of explosion, the evacuation of people working in a factory near the scene of the accident started. One hour and 30 minutes after the explosion it was established that among the broken railroad cars there were still some out of which chlorine was flowing. A team in charge of chlorine was immediately contacted, in a regional

center 250 km away. At the same time, the evacuation of institutions and citizens was ordered. Within 24 hours, from the area covering 117 km², 250.000 people were evacuated, including 3 hospitals, several elderly people's homes and some other institutions.

The team in charge of chlorine arrived at the scene of the accident 6 hours and 30 minutes after the moment of explosion, and some time before that – the team for propane also arrived. After the necessary measures were undertaken, when the danger was reduced, the evacuated citizens and institutions started returning. Everything finished 6 days after the explosion.

Also, there were some lucky circumstances in this accident. Firstly, the weather was calm, without wind. The second favorable condition was that in the first explosion, the chlorine from the damaged cisterns was lifted by the flaming mushroom of propane into the air, where it was scattered by the air currents. It should be added that the engine driver and motorman, after the first explosion that caught the railroad cars in the middle of the train, uncoupled the first cars and took them to the safe distance, as well as that the ambient temperature was lower than the critical temperature point for chlorine. Later, it was evaluated that if the weather conditions had been unfavorable, approximately 15.000 people would have been dead within the first half hour.

Leakage of poisonous gas out of a tank truck caused the death of 26 people and the poisoning of more than 900 people in the town of Lahore, Pakistan in 1996. There is confusion about the type of gas which also caused the death of many animals. Doctors claim it was ammonia while the chief of the local administration, deputy commissioner Kamran Lasari, believes it was chlorine gas.

Accidental chemical contamination of the living environment and the poisoning of people, fish and animals in peacetime fall under the category of the most pressing problems of the modern world. According to the official evaluations of the United Nations experts, those accidents and events cause huge damage to mankind, make living environments unbearable, endanger the health and lives of people and animals, as well as of plants, and have material, social and political implications of large proportions.

The detection of anyone or anything that causes danger, rehabilitation, and learning how to live together with nature represent a necessary unity and inseparable action which may be observed at the highest level of human organizations (UN, EU, etc), or at more low-scale level such as place of residence, working organizations, sports and similar organizations.

The Commission of the European Communities founded a service for environmental protection named "Nett" (Network for Environmental Technology Transfer).

The main task of this service is to collect, arrange and distribute information at the international level, regarding all factors of importance for environmental protection.

This service pays special attention to preventive warnings about the usage characteristics of new technologies and their influence on the living environment. An advantage is given to so called environmental technologies; updated information on all kinds of pollutions in the whole community area are given, as well as on systems and methods for preventing pollution, or for removing it.

Instead of transferring the technology of modern countries to the developing countries, which brings smaller risks, exactly the opposite happens, that is, so called "dirty" technology is being transferred. Unfortunately, one of the side effects of transferring technology of the developed countries to the developing countries is the accident in Bhopal, which has already been discussed.

Luckily, Serbian experience with accidents and poor application of chemical substances is not similar to those in Bhopal, Missauga, the former Soviet Union and others that happened worldwide, but accidents occurred in Serbia, with significant consequences.

Pouring out of hazardous chemical substances into the rivers and land, appearance of crude oil spots, air polluting by poison gas substances and the like, are important accidents from the living environment aspect.

In the Rivers of Zapadna and Velika Morava, in 1974, along a course of the river 50 km long, water contamination by the pesticide "endosulfan" caused mass extinction of fish.

In section "Amonijak 2" of the factory "Azotara" in Pancevo, on February 25, 1985, while attempting to unfreeze the frozen pipes by hot water, approximately 1 ton of ammonia was released. Nineteen workers were poisoned. Luckily, the poisonous gas cloud lasted only for a short time so that tragedy on a large scale did not occur.

The same kind of gas endangered the town of Sabac on March 18, 1986. An ammonia leak happened at the moment when a railroad car-cistern hit an overpass thus causing valve breakage. The ammonia that was released under big pressure, carried by the wind, endangered the inhabitants of this town. Regardless the effort of specialists and firemen, the leaking was not stopped. All public performances were cancelled in the town, the traffic regime was changed, and the citizens were warned to stay at their homes, with closed windows and doors.

In Sicevacka klisura, on, May 29, 1987, two big trucks from Turkey collided in a tunnel. One of them was loaded with 17.600 liters of isoprophilchloracetate and 2.000 kg of metal sodium. Strong explosions damaged the tunnel arch and the flames were a hundred meters high. Thick smoke covered Sicevacka Klisura (a gorge) for several hours.

In a traffic accident involving a tank-truck in Sicevacka klisura in 1991, seven barrels full of ethilchlorformiat poured out into the Nisava River.

According to the data supplied by the railway company, for the needs of the Nis industry, 7 hazardous substances are transported which is only 2, 15% of the entire transported load. This last datum is questionable due to the reason that, when talking to the people responsible at the railway company, it was stated that transportation of hazardous substances is periodical, and that, on average, 5-6 railroad cars-cisterns are transported daily, whose volume was from 10t for narrow gauge railroads to 50 or 60t, even 80t, for wide gauge international railroads. Most often ammonium is transported (even 50% of the transported load), but as they stated, data exist for only 10-20% of the hazardous substances that are transported by railroads and are contained in shipping documents. Another interesting thing we learned was that shipping documents for international trains in transit are written in the foreign language of the recipient country or the shipper country and are not translated into the Serbian language, and people who work at the stations do not speak foreign languages. They also gave one example when at the station Nis-2 (Popovac), in 1993, at one moment there were 500 railroad cars-cisterns full of gasoline and other kinds of fuel, and one of the railroad car-cistern caught fire. The cistern was aflame, and that threatened to spread to the other two adjacent car-cisterns. Thanks to the engine driver's calmness, the other railroad cars-cisterns were removed, and the cistern in flame was uncoupled and towed away, out of the station, towards the Nisava River, where it burnt completely. Thus, a huge disaster was prevented.

A fire occurred when a railroad worker, during his regular route, with an open flame lamp, came to the railroad car and put the lamp down on the ground; at that moment, the flame blazed up. The cause for this was the gasoline that was flowing out of one of the railroad car-cistern valves. Lucky circumstances were the engine driver's calmness and the fact that the gasoline was flowing out so that there were no conditions for an explosion which would destroy all the other railroad cars-cisterns (and there were 500 of them, all at the same place, and all full).

4. CONCLUSION

Analyzing known accidents worldwide and in our country, two chemical accidents are singled out.

The first one in Bhopal, India, in a chemical factory for the production of pesticides "UNION KARBIDE - India", which is one of the best known multinational companies with its headquarters in the USA, as a negative experience, and the appearance of panic, which is never anticipated in a chemical accident response plan. In this example, it is obvious that panic is very important and that consequences might not have been suffered or might have been alleviated, if there had not been panicking. Also, there was human error.

This and similar examples of accidents show that if a risk assessment detailed analysis existed, uncertainty of chemical accident danger would be reduced. However, even in the most convenient conditions, when the most complete risk assessment analysis exists – there is no absolute certainty about what may happen, or it can be anticipated. Certain, bigger or smaller, uncertainty levels must be taken into consideration, relating both to the kind of danger as well as to its intensity and time of occurrence.

The second, in Mississauga, Canada, in 1979, one of the well known accidents in transportation of hazardous substances occurred and is known for the extremely positive experience regarding the quick and timely response to the chemical accident.

A detailed review of this accident was given for the reason that it certainly leads to the conclusion that good organization, technical equipment and the quick response of relevant services, that is, the relevant departments, as well as the workers' professional and responsible behavior, are of crucial importance for reducing and even preventing the effects of accidents, although this example was not set in a factory, that is, the site of a possible accident, known in advance.

This is the purpose that all these examples serve; to be a constant reminder and warning.

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POZNATI HEMIJSKI AKCIDENTI

Milica Bogdanović

Akcidentna hemijska kontaminacija životne sredine i trovanja ljudi, riba i životinja u vreme mira spadaju u red najaktuelnijih problema savremenog sveta. Prema zvaničnim procenama eksperata Ujedinjenih nacija, ti akcidenti i događaji nanose ogromne štete čovečanstvu, životnu sredinu čine nepodnošljivom, ugrožavaju zdravlje i živote ljudi i životinja, kao i biljaka i imaju materijalne, društvene i političke implikacije velikih razmera.

Analizirajući poznate akcidente u svetu i u našoj zemlji izdvojena su dva hemijska akcidenta. Prvi, kao negativno iskustvo i pojavu panike koju niko ne predviđa u planovima odgovora na hemijski akcident, a na ovom primeru je očigledno da je veoma važan i da su posledice mogle biti izbegnute ili daleko blaže da nije bila prisutna. Drugi, zbog izuzetno pozitivnog iskustva u smislu brze i pravovremene reakcije na hemijski akcident.

Ključne reči: Hemijski akcidenti, hemijska kontaminacija, tehnička opremljenost, brzina reagovanja