CYANIDE BETWEEN NECESSITY AND RISK

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***Abstract**: Cyanide is a substance that becomes toxic under certain conditions. However, the general population regards it as a strong poison, irrespective of the conditions in which it is used. This opinion which has been taken over and enhanced by the mass media which turned it against the mining industry which has a long history of using cyanides. However, there is very little evidence that cyanide is a major risk factor for the health of the staff handling it or for the environment, particularly when all the measures provided by occupational safety regulations have been met. The hostile attitude towards the use of cyanide in the processes of precious metal extraction is at present artificial and exaggeratedly supported and encouraged by some non-governmental environmental organisations and by some mass-media trusts which invoke the cyanide-related mining incidents. As it results from the official findings, such incidents were caused either by designing errors or by errors in operating the mining tailings.*

***Key words:** cyanide, risk factor, powerful poison, gold, environment, accident*

1. Introduction

The term *cyanide* has a strong impact on the population when used in connection with mining activities, since it is perceived as and associated with strong poison. Only 13% of the world cyanide production is used by the mining industry; the rest is used for other activities which are not affected by its bad reputation. An important quantity of cyanide is released into the environment resulting from exhaust gases, vegetation, burning of biomass, the chemical industry, cigarette smoking, etc. We can therefore conclude that cyanide is obtained industrially in a number of different forms, but it can also be generated by various other human activities as well as plants.

Cyanide is a substance that becomes toxic under certain conditions. However, the general population regards it as a strong poison, irrespective of the conditions in which it is used. This opinion which has been taken over and enhanced by the mass media which turned it against the mining industry which has a long history of using cyanides. However, there is very little evidence that cyanide is a major risk factor for the health of the staff handling it or for the environment, particularly when all the measures provided by occupational safety regulations have been met.

The human body can come into contact with cyanide by breathing, drinking water or eating contaminated foods, as well as by touching it directly (cutaneous contact).

Gold is one of the water-insoluble noble metals. For the dissolution of gold are required a complexant, such a cyanide, which stabilises the gold species in solutions, and an oxidant, such as oxygen. The cyanide content in the solution necessary in order to assure the dissolution can be of 350 mg/l or 0.035 % (as NaCN) [15], or 0.01%...0.05% in very diluted solutions [32].

Alternatives complex agents for gold, such as chlorides, bromides, thiourea and triosulphate, which are less stable, require oxidants and more aggressive conditions for the dissolution of gold. These reactives pose risks for both health and the environment and are also more expensive. All these account for the prevalence of cyanide as a chief reactive in the extraction of gold from ores ever since it was first used industrially, in the late 19th century [15] (studies on the solubility of gold in cyanide solutions were performed in 1783 and the process of cyanide use was patented in 1887).

2. Chemism

The term *cyanide* defines the chemical substances containing the cyano anion (CN^-) which consists of one carbon atom triple-bonded to a nitrogen atom. Cyanide can be either produced naturally or manufactured industrially and under certain quantitative conditions becomes a poison, depending on the dose and exposure time, like many other chemical substances. However, what makes cyanide special is that it is one of the most active and quick-acting toxic substances. The best known substances included in the generic name of cyanide are cyanhidric acid (HCN), a gas, and two simple salts – sodium cyanide and potassium cyanide – used for the extraction of precious metals.

Cyanhidric acid and the (CN^-) ion are free cyanides.

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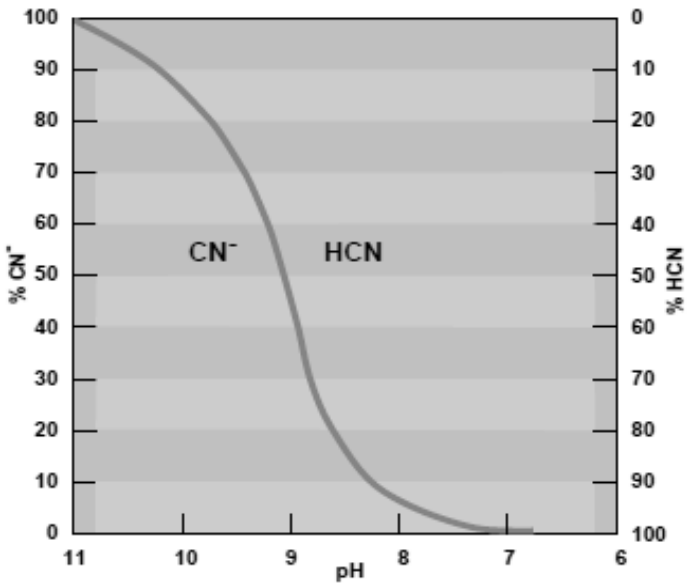
Thiocyanate (sulphocyanide or rhodanide) is a chemical compound found in many foods and plants. It results from the reaction of a free cyanide with sulphur. This reaction occurs in the industrial wastes containing cyanide (the mining tailings ponds) and in the human body after the ingestion of cyanide. Thiocyanate has a lower toxicity than free cyanide. The anthropogenic sources of thiocyanate are the herbicides and the industrial processes, while the natural sources are represented by the decomposition of certain plants (the ones belonging to the Brassica genus, such as cabbage, mustard, etc.). Thiocyanate is biodegradable in both aerobic and anaerobic environments, as well as in water and soil.

Table 1 explains the notions of *total cyanide*, *weak-acid dissociable (WAD) cyanide* and *free cyanide*.

Table 1 *Species of cyanide [15]*

Total cyanide	Complexes very stable in medium-acidity environments – with Au, Hg, Co and Fe		
	WAD cyanide (dissociable in weak-acid environments)	Low- or medium- stability complexes – Cd, Cu, Zn cyanide	
		Free cyanide (the most toxic form)	CN^-
			HCN^-

The toxicity of cyanide is generated by the release of the (CN^-) ion. Discharged into the environment, this anion has a low affinity to alkaline metals, but a high affinity to the ferric ion (Fe^{3+}) and other metals. Within the tailings ponds there are large quantities of ferric ions and metals, which creates the conditions for the generation of cyanide compounds which are less stable and more toxic.



Source: Scott and Ingles, 1981.

Figure 1 *Chemism of cyanide in the ore preparation process*
CN^-/HCN balance by pH [32]

Solid sodium cyanide dissolved in water generates Na^+ ions and CN^- anions. CN^- anions combine with hydrogen, resulting cyanhidric acid (HCN), a toxic component which can volatilise and disperse into the air ().

According to Figure 1, almost all the free cyanide is present as HCN when the pH of the solution is 8 or below. At a pH = 10.5 nearly all the free cyanide is CN^- and the technological process must be conducted in such a way as to keep the pH lower than this value. In normal pressure and temperature conditions the HCN and CN^- concentrations are equal for pH = 9.4 [32].

3. Exposure to cyanide and risks

The most common sources of cyanide exposure for the population are active and passive smoking as well as the combustion of all kinds of materials, such as wood, plastic, biomass, etc. In Romania biomass is burnt frequently and, which is even more serious, people burn plastic, rubber, etc. in their households. Another important source of exposure to cyanide is represented by exhaust gases from vehicles.

People can also risk cyanide intoxication if they eat big amounts of certain fruit seeds and stones, such as apricots, apples, peaches, etc., as well as certain vegetables, such as white beans or tapioca roots, etc. The cyanide content of certain varieties of white beans amounts to 100 to 3120 mg/kg [37]. Other sources mention values ranging from 100 to 170 mg/kg which are common in the white beans in the U.S. ([8] from [1]). Concentrations of 660 mg/kg sulphocyanide were found in plants from the Brassica genus ([29] from [1]), while in the soil treated with rapeseed residues the sulphocyanide concentration was 6 mg/kg ([3] from [1]).

The cyanide contents of the cassava- or manioc-rich diet of the Tukanoan Indians of north-western Amazonia is estimated to be in excess of 20 mg/day ([6] from [1]).

Many studies, among which *Toxicological Profile for Cyanide* [1], published in the U.S.A. in 2006, and *Study on Assessment of the Health Risk for the Population* [16], published in Romania in 2005, conclude that the highest risk of cyanide intoxication is represented by the exposure to exhaust gases and smoking, both active and passive. 9209 cases of occupational disease were reported in Maramureş county in the period 1972-2011. Occupational morbidity was represented chiefly by silicosis. However, such cases of occupational disease due to cyanide intoxication were recorded [27].

The risk of disease increases greatly with the presence of non-rehabilitated tailings pond which continuously generate silicogenic dust rich in heavy metals and acid draining, i.e. acid waters and heavy metals.

A contrastive risk analysis published in the *Annual Environmental Report* for the years 2010 and 2011 – *The Situation of the Environmental Factors in Romania, Chapter 8. Environment, Health and Quality of Life* (www.anpm.ro) – reveals a disturbing situation. In 2010 there were 260 cases of acute occupational intoxication with pesticides, of which 15 deaths. In the year 2011, according to the records, there were 185 cases of intoxication with pesticides, of which 19 deaths. But these figures don't seem to vex anyone.

The risk of death or serious disease due to cyanide exposure is smaller than that of being killed by lightning [22].

A study of the risk of disease due to exposure to industrial population, issued by "Iuliu Moldovan" Institute of Public Health of Cluj Napoca for the period 2000-2004 (a period during which the company SC Transgold SA Baia Mare was operating) emphasises that the normal concentrations of thiocyanate in urine were somewhat exceeded. Thus, the figure for non-smokers was 5 mg/l, while for smokers it was 16 mg/l. The significant difference between the two categories draws attention on the risk of exposure to cyanide from other sources than industrial activities. In percentage, in a small number of persons from the studied groups the normal values were increased (4.8% of Bozânta-Săsar group and 5.2% of the Baia Mare group) [16]. Another series of studies published in *Toxicological Profile of Cyanide* [1] reveals significant differences between the level of thiocyanates in the plasma, saliva and urine of smokers vs. non-smokers (about three times higher).

Cyanide gets into or out of the bodies of animals and humans in the same ways. Also, cyanide has not been reported to cause cancer [1].

Based on many studies on the metabolism of cyanides carried out on animals it has been concluded that, once in the body, cyanide rapidly gets into the blood circuit. An important part of it (80%) converts into thiocyanate, which is less toxic and is eliminated through urine. The rest combines with hydroxocobalamin, carbon dioxide, cyanhidric acid and formic acid (HCOOH) and converts into cyanocobalamin or vitamin B12.

4. Anthropogenic sources of cyanide

American scientists [1] identified the following main sources of human-generated cyanide discharge:

- into the water: metal processing industry, steelworks, organic chemical industry. The contribution of mining to water pollution is considered negligible, although the total content of cyanides in the exfiltration of tailings ponds ranges between 0.3 and 310 mg/l ([12], [25] of [1]). Cyanide is treated with hydroxide and sodium hypochloride and converted into less toxic compounds. The non-punctual cyanide sources are generated by farming and road maintenance (the salt used as antiskid). It was estimated that the quantity of ferrocyanide used as antiskid in wintertime in the north-eastern part of the U.S. amounts to 907 t ([10], [13] of [1]).
- into the air: the chief source of cyanide are the exhaust gases from vehiclest, followed by the

plastic manufacturing and cyanhidric acid manufacturing industries, then the steel manufacturing industry, coal burning, oil refining, municipal waste burning, cigarette smoking, the deposits of household wastes, the pesticides used for farming, etc. It is assessed that 20 t of cyanhidric acid are generated by the mining industry, while cigarette smoking generates 340 t, pesticides 62 t and incineration 81.6 t ([10] of [1]). Worldwide, the emissions from the mining industry are assessed at 20000 t ([18] of [1]), while the emissions generated by biomass burning – cyanhydric acid and acetonitrile – amount to 1.678 million tons ([6] of [1]), i.e. 83.9 times higher. In 2003 the American industry monitored for cyanide emissions reported an estimate 517 t of cyanhidric acid and 142 t of cyanide compounds discharged into the atmosphere [1].

- into the soil: the household waste deposits and the salt used as antiskid on roads. A total of 1340 t cyanide compounds and one ton of cyanhidric acid were estimated to have been discharged into the soil in the U.S. in 2003. [1].

5. Alternatives to cyanide

For the gold and silver processing industries cyanide represented an alternative to amalgamation, allowing bigger productions, protection of staff's health and lowering the environmental impact. The first pilot plant – a demonstration station – operated in Queensland, Australia, in 1888, and the first plant was built in New Zealand. In South Africa the gold production rose from 300 ounces in 1890 to 300000 in 1893. In the U.S. the production rose from 1.7 million ounces in 1892 to 4.5 million in 1905. Cyanide marked a significant progress in gold processing, transforming it into a much more economical process than gravitational separation or amalgamation. [20].

The cyanidation technology has been improved and, at the same time, many processing methods have been considered as alternatives to cyanidation. Among these, the use of sodium thiosulphate, which was applied commercially in the period 1875-1895 for silver ore processing. In the same context the risks and costs of such technologies have been analysed and assessed. Based on these studies, the Relative Risk Scores obtained indicated that the cyanidation technology poses the smallest risk of all technologies. The thiosulphate technology is far riskier than the cyanide technology. (Table 2)

Table 2 *The risk by types of lixiviation [20]*

	Lixiviation system	**Relative Risk Score**
1	Sodium cyanide/lime	41
2	Bromine/bromide/sulphuric acid	159
3	Chlorine/chloride	193
4	Ammonium thiosulphate/ammonia/copper	219
5	Thiourea/Ferric sulphate/sulphuric acid	1574

In the 1980s and 1990s many academic and industrial studies focused on the ammonium thiosulphate technology. This is a much more complex but more efficient technology than the thiosulphate technology [20].

Some alternatives based on thiourea, thiosulphates, thiocyanates, etc. used for the extraction of precious metals from gold and silver concentrates involve both costs, and environmental and health risks that are far bigger than the cyanide technology [14].

6. Cyanide in mining and specific standards

In the year 2000, when the Baia Mare cyanide spill happened, 460 mining plants worldwide were using cyanide and 90% of the world gold production was being obtained through cyanidation [22]. The worldwide production of cyanhydric acid was estimated to be 1.4 million t/year, of which 18% was converted into sodium cyanide for the mining industry. The rest of 87% was used for other industries (adhesives, electronic parts, products for fire control, cosmetics, paints, varnishes, nylon, pharmaceutical products, plexiglas, table salt and salt for road management, etc.).

The worldwide production of NaCN in the period 1998-2012 and the one envisaged for 2015 are illustrated in the table and chart below. These show that the constantly increasing production has tripled as a result of the market's demand.

Table 3 *Worldwide production of sodium cyanide*

Year	1998	2006	2009	2012	2015
NaCN production in tons	280000	500000	760000	797000	915000

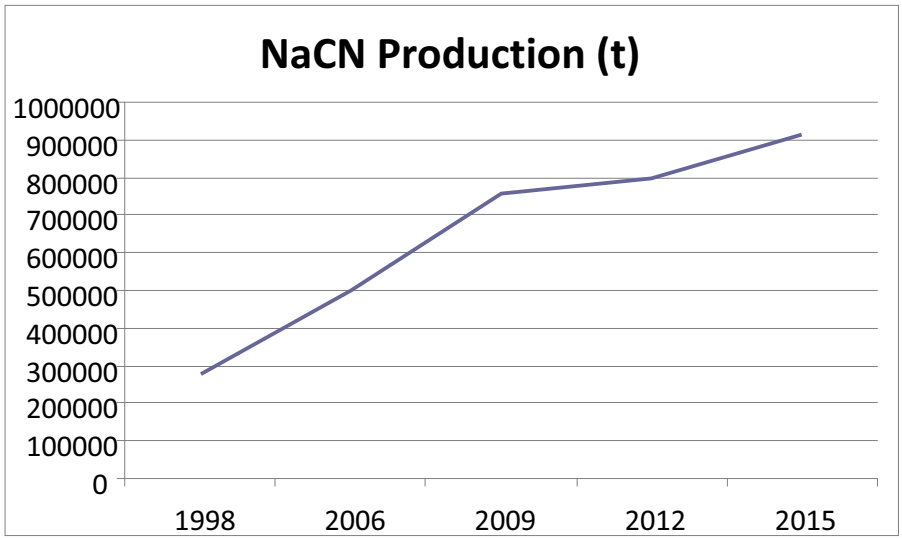


Figure 2 *The NaCN production in tons in the period 1998-2013 and estimates until 2015*

Biodegradation is a very important process for the cyanide in the surface waters and depends on many factors, such as: the cyanide concentration, the pH, the temperature, the existence of nutrients and the acclimatization of microbes. The cyano ion is toxic for microorganisms at concentrations of 5...10 mg/l ([17]; [19] of [1]); through acclimatization their tolerance to this compound increases ([24] of [1]). Certain pure microorganism cultures can degrade the cyanide solutions with low concentrations in aerobic or anaerobic media ([8], [9],[11]of [1]).

In waste waters, such as the ones from the gold tailings ponds the concentration of cyanide ions and sulphocyanides is naturally lower due to the acclimatization of the local microflora in the ponds. ([2],[23],[28]of[1]). A number of microorganisms which have been identified, such as Actinomyces, Neisseria, Pseudomonas, Thiobacillus, etc., are capable of absorbing, converting and/or precipitating the cyano ion, thecyanate and the thiocyanate. Some of these species, for example Pseudomonas, can use the cyano ion and the thiocyanate as a basic source of carbon and nitrogen. Therefore they are very efficient for cyanide degradation. In fact the commercial applications for the degradation of cyanide from the mining waste waters is based on Pseudomas ([2] of [1]).

Cyanide regulations include a very large range and differ from one country to the next, depending on the level of the knowledge about this phenomenon and various psychological aspects. For example, in Romania, according to Governmental Resolution (HG) 730/1997, in January 2000 when the Baia Mare spill occurred, the acceptable maximum total cyanide contents for the waters discharged in the emissary was 0.05% mg/l, and the maximum acceptable content of free cyanides in drinking water was, according to STAS 1324/1991, 0.01 mg/l. Both these regulations were still valid in 2000 [5]. The laws became somewhat more permissible with the introduction of Law no. 458/2002, modified through Law no. 311/2004, which translates into Romanian legislation Directive 98/83/CE on the quality of water intended for human consumption, which provides for drinking water a maximum admissible content of total cyanides of 0.05 mg/l, and of free cyanide of 0.01 mg/l. For the waste waters HG 352/2005 provides an admissible content of total cyanides of 0.1 mg/l in the waters discharged into a NTPA-001emissary. In the U.S.A. the maximum admissible concentration of cyanides for drinking water is 0.2 mg/l, 20 times higher than in Romania.

In 2006, Directive 2006/21/CE recommended that the concentration of dissolvable cyanides in a weakly acid medium in tailings ponds should be reduced to the lowest possible level by using the best available techniques (BAT's). For the tailings ponds which have obtained occupancy permits and were operational in 2008, this. Directive provides a gradual reduction of the concentrations of the respective cyanides at the discharge of the waste in the pond, as follows:

- as of 1 May 2008 – maximum 50 mg/l;
- as of 1 Mai 2013 – maximum 25 mg/l;
- as of 1 May 2018 – maximum 10 mg/l.

The maximum admissible value of 10 mg/l is also imposed for the plants which were to obtain their environmental permits after May 1, 2009. These measures are applied nationwide through the translation of the Directive into Government Resolution (HG) no. 856/2008.

The comparison of the cyanide concentrations to the maximum admissible values provided by the

national and international regulations has generated much controversy since 2000 when the cyanide spill at the Aurul tailings pond of Baia Mare occurred. The maximum cyanide concentrations measured by the Public Health Direction of Maramureş County in the wells in Bozânta village, downstream from the tailings pond, on 11.02.2000 were of 0.66 mg/l [5]. This, according to the Romanian standards, means 66 times higher than the maximum admissible concentration, which is alarming. However, by the American standards this value would be only 3.3 times higher than the maximum admissible value. If we compare things further, we can equate the consumption of two litres of water with a cyanide content of 0.66 ml/l with smoking three cigarettes or eating 100 grams of white beans.

According to UNEP [36], the cyanide concentration in wells was 80 times higher than the maximum admissible value on February 10th, but on February 20th it dropped within admissible limits.

According to the tests performed by SGA Maramureş, the free cyanide content in the slime pulp discharged in the period 31.01-01.02.2000, right after the leak, was 126 mg/l, whereas the total cyanide content was 405 mg/l. A concentration of 19.14 mg/l was detected in the Lăpuş river, while in the Someş river, at Cicîrlău, the concentration amounted to values between 13.26 and 0.082 mg/l [5]. The water treatment station of Szolnok, Hungary was closely monitored; in such conditions no exceeding of the Hungarian cyanide contents was found (in 2000 Hungarian standards provided a maximum of 0.1 mg/l, which was 10 times more permissive than the Romanian standards). The cyanide pollution incident did not endanger the Hungarian public system of water distribution [36].

According to the information presented by SC Romaltyn Mining SRL, until 2006 the cyanide content in the tailings pond was between 200 and 300 mg/l. At present within Romaltyn plant there is a plant which destroys the cyanide from the slime pulp resulting from processing, which uses the INCO (SO_2-Air) procedure, through which the concentration of dissociable cyanides in mildly acidic medium will be reduced to the lowest possible level – below 10 mg/l, by using the best available techniques (BAT). The detoxification tests of the slime pulp with a total cyanide content of 358 mg/l and a WAD of 328 mg/l, showed the reduction of the cyanide concentration to the value of 1.43 mg/l total cyanide, 0.0705 mg/l WAD and 0.129 mg/l free cyanide [33].

As a result of treating the water in the Aurul tailings pond in the station of Romaltyn Mining, the waste waters discharged in the emissary are going to meet the quality standards provided by the regulations in force, i.e. NTPA 001 (0.1 mg/l). The previous technology, used in 2006, did not include destroying the cyanide in the slime pulp or treating the pure water from the tailings pond within the treatment station before being discharged in the emissary.

In our opinion, in consideration of all the facts presented above, the whole outlook on the 2000 Baia Mare spill changes completely. Presented as a very serious, even catastrophic, incident, it brought about a serious prejudice to Romania's image, the mining activity and Baia Mare's image. We must emphasize the evolution of the cyanide concentrations presented by UNEP 2000 [36]. The figures indicate that upon discharge in Aurul tailings pond the cyanide concentration was 19.4 mg/l, after which the concentration decreased to 7.8 mg/l, to suddenly soar again to 32.6 mg/l in Csenger, Hungary. It seems that nobody has tried to find an explanation for these spectacular differences.

In the same context there is the „mystery" of the dead fish in Hungary. On the internet ostentatious photos of the dead fish are still associated with the name of our city, thus continuing to manipulate the public opinion. Nobody bothers to ask the simple question: why did the fish die only in Hungary and up to there, in the Lăpuş and the Someş nothing like this happened? This incident generated hysterics against cyanide due to the denaturation of facts by both the mass media and the authorities. The incident was serious indeed, but the errors in connection with its causes and the way in which it was managee are even more serious. Anywhere in the world there would be a penal trial and the people found responsible or guilty for these errors would be punished. Today this spill is considered even more than a serious incident, a catastrophe, a disaster, etc., even without a court order which, based on technical expert's reports, should prove responsibilities and guilt, and establish the level of damage. Which makes any opinion ungrounded, a mere speculation made by unauthorised people.

The current situation of the cyanide in the Aurul tailings pond shows significantly lower cyanide concentrations, decreasing from 250 mg/l in December 2005 (when the last quantities of waste were deposited in the pond) to WAD cyanide values of 0.155 mg/l and total cyanide values of 0.228 mg/l, which are average values. These values were measured on samples of water drawn from the tailings pond in January-February 2014 from 23 piezometres all around the dam. After drawing the samples, the chemical analysis was performed by Romaltyn laboratory. These tests confirm the

capacity of cyanide degradation and infirm the opinions according to which cyanide continues to exist for longer periods of time and pose a major risk for the environment.

7. The history of cyanide use in Baia Mare

In February 1939, based on the research studies carried out by the Research Laboratory of Lupeni on the gold and silver ore from Săsar mine, was opened, close to the current premises of SC Romaltyn Mining SA, a cyanidation plant with a capacity of 100 t/day, with tools delivered by two companies, Humboldt from Germany and Dorr Oliver from Holland. Subsequently this plant was expanded to 220 t/day in 1958, 550 t/day in 1959 and 990 t/day in 1960 [4]

In 1962 the cyanidation capacity was increased to 60,000 t/year and gold-rich pyrite concentrates from IM Brad were received for processing as well. The Săsar Preparation Plant, which in 1999 became part of Aurum Baia Mare Mining Exploitation, processed both ore and gold-and silver-rich concentrates using classic cyanidation, while Transgold company used the "CIP" technology [4].

Processing the ore from Săsar Mine using direct cyanidation:

Table 4 *Processing the ore from Săsar mine using direct cyanidation [4]*

Year	Sasar ore (t)	Specific NaCN consumption (g/t)	Total NaCN consumption (kg)
1939	28144	1412	39739.3
1940	29887	1201	35894.3
1945	5226	1302	6804.3
1955	94717	2115	200326.5

Processing concentrates using cyanidation:

Table 5 *Processing gold-and silver-rich concentrates using cyanidation [4]*

Year	Săsar (t)	Nistru, Ilba, (t)	Apuseni (t)	Total Concentrates (t)	Specific NaCN consumption (g/t)	Total NaCN consumption (Kg)
1955	629	-	-	629	2115	1330.3
1965	14587	-	24621	39208	10600	415604.8
1970	18725	-	19799	38524	8346	321521.3
1975	17980	26890	27300	72170	6120	441680.4
1980	18900	7210	32100	58210	6041	351646.6
1985	18100	2570	35400	56070	6140	344269.8
1990	14650	5790	33320	53760	7208	387502.1
1991	13485	9465	17835	40785	6369	259759.7
1992	13285	12380	15691	41356	6518	269558.4
Year	Sasar, ore (t)	Meda tailings pond (t)	Concentrates (t)	Total (t)	Specific NaCN consumption (g/t)	Total NaCN consumption (Kg)
1999	84228	1370160	145179	1599567	1400	2239393.8
2000	142539	1073022	36641	1252202	1590	1991001.2
2001	272800	1031068	14477	1318345	1350	1779765.8
2002	268530	104796	49036	422362	1680	709568.2
2003	248623	-	32951	281574	2320	653251.7
2004	215056	-	63974	279030	2260	630607.8
2005	277439	-	-	277439	2300	638109.7

Based on the figures in Tables 4 and 5, one can note that significant quantities of cyanide were used for the mining activity, amounting to 300 to 400 t cyanide/year in the 1960s, 2000 t in the years 1999 and 2000, and 600 to 700 t cyanide/year in the period 2002-2005. The use and handling of such large quantities of cyanide involves risks as well, but these did not become apparent either in the production activity concerning the staff or for the population or the environment. This assertion is supported by the answers received from the authorities who are in charge of risk exposure.

The real environmental risk for Baia Mare has to be associated with the acid draining generated by the acid waters loaded with heavy metals which lead destroy the water life and load the soil. The

accumulation of heavy metals in plants and animals and implicitly in the products derived from plants and animals is an important risk factor for people's health and causes the degradation of the environment.

The mines were closed down but the risk entailed by the mining activity was completely ignored.

The existence of the non-rehabilitated tailings ponds, closed-down mines or mines which have not been conserved properly poses real short-, medium- and long-term risks. The Central Pond, located upstream from Baia Mare city, is an important source of pollution with acid waters, heavy metals and dust. All these sources of long-term risk exceed by far the risk of using cyanide over a definite period of time, in a controlled system.

8. Conclusions

Cyanhydric acid has existed since life appeared and developed on Earth, as a precursor of amino acids. Carbon and nitrogen are present in the molecules which form the basis of all forms of life. Unlike synthetic chemical substances, which do not decompose easily and accumulate in the trophic chain, cyanides naturally convert into less toxic substances as a result of a number of physical, chemical and biological processes.

In the last years, the interest of the public, the mass media and the political class in the environmental implications of using cyanide for mining has grown immensely. In fact, the use of cyanide worldwide has a very long history. Although it is a highly toxic substance, its impact on the environment as a result of the mining industry has been smaller than that of other chemical substances. The studies on the incidents which occurred in Australia, Canada, New Zealand and the U.S. concluded that only three deadly accidents were caused by cyanide over a period of over 100 years. Following the investigation of these cases, the suspicions were inconclusive [32].

The hostile attitude towards the use of cyanide in the processes of precious metal extraction is at present artificial and exaggeratedly supported and encouraged by some non-governmental environmental organisations and by some mass-media trusts which invoke the cyanide-related mining incidents. As it results from the official findings, such incidents were caused either by designing errors or by errors in operating the mining tailings.

The information about the persistence of cyanide in the mining waste deposits for longer periods of time has been circulated vehemently lately, creating the impression that there is an imminent risk in any situation where cyanide is used for mining activities. The tests on the evolution of the cyanide content in Aurul tailings pond over the period 2006 – 2013 shows a significant decrease of this content, of 1250 times.

It is remarkable that nowadays in all European countries any precious metal extraction process using cyanidation can be carried out only if the rules and regulations in force are observed. Also, regulation documents for such activities can only be issued if all the safety and protection rules concerning the environment and health have been met.

The development of any human society takes place in close connection with the development of its economy if this can be sustained in safe conditions for both the environment and the population.

After the 2000 Baia Mare cyanide spill the international interest in the risks involved by using cyanide has become very strong, leading to the issuance, by many organisations including governments, NGOs, academic organisations, consultants, industries, financial institutions, between the years 2000 and 2002, of a Cyanide Code for the mining industry (http://www.cyanidecode.org). In 2005 this document was signed by 14 companies, and in May 2013 by 135 companies based in 47 countries (38 mining companies, 16 cyanide manufacturers and 81 cyanide transporters). 95 gold mines were certified according to Cyanide Code in the year 2013. The Code was recognised as well by G8, a group of countries including Canada, France, Germany, Italy, Japan, Russia, United Kingdom and U.S.A. In any business it is the investor, i.e. the one who pays and assumes the highest risk, who has biggest interest in diminishing any risk. To this end the banks, which take the best precautions when they finance mining projects (which involve high investments), have adopted and applied the Cyanide Code as a good practice rule. Thus, IFC (International Finance Corporation) as part of World Bank, as well as BERD (the European Bank for Reconstruction and Development) and other financial organisations apply the Cyanide Code in their operations. The Code recommends a maximum value of 50 mg/l cyanide in the tailings ponds, compared to 10 mg/l recommended by the European Directive at present.

The management of the risk associated with the use of cyanide for mining activities has been studied extensively and it involves an engineering approach, close monitoring and the implementation of the best practices in order to prevent and minimise any potential discharge of cyanide into the environment.

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