# RESEARCH CONCERNING THE STATE OF ENVIRONMENT AFTER SHUT DOWN OF ARAD FERTILIZER PLANT

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**ABSTRACT**

The former Chemical Fertilizer Plant Fertilizer situated at about 15 far from Arad was shut down in 1990 and since that time dismantling of equipment was carried out, but concrete buildings and environment affecting heritage remained on the site. The paper deals with the state of pollution on the site and with the possibilities to liquidate buildings so for reuse of the area and also for correcting the landscape. Demolishing by controlled explosions is a solution that can be so effective as producing no significant pollution.

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## 1. INTRODUCTION

The platform of the former Arad Chemical Fertilizer Plant is situated at about 15-km eastward from Arad and about 2-km far from the closest inhabited area.

The plant was set up in 1971 when construction begun and the first part was started up in 1977. This first part produced NPK type complex fertilizer and had a capacity of 100,000 t $P_2O_5$ per year. As a secondary product ammonium nitrate or nitro-chalk containing 75,250 t N/year resulted.

The basic adopted technology, an imported one, consisted in attack of phosphate ore with nitric acid. So it was necessary to build and start up at the same time ammonia and a nitric acid producing plants. Also suitable deposits and storage places for raw material intermediate products and final products had to be constructed. The necessary utilities such as industrial water, steam (resulting in an electric-power plant), and industrial air were produced and sewage for different type of used water was necessary as well.

In 1976 the construction of a new part of the plant began, this time the urea being the final product. This meant a new 300,000-t/year ammonia plant, similar to the first one, and a. 420,000-t/year urea plant, a new electric-power plant and the suitable deposits. These capacities were stared up in 1983.

In 1990 the plant was shut down because of reasons that are not object of this study and it was never started up again. Afterwards all technologic, electric and automation equipment and the steel constructions was demolished and sold. The technological equipment is dismantled and valorized partly in other plants and mainly as scrap iron. Such way on the platform only concrete and brick constructions and small amounts of unused raw materials such as phosphate and diatomite remained. A surface of 343,482 $m^2$ is involved.

Now only a small part of the plant is occupied by small enterprises that deal with storage and distribution of petroleum derivatives and of chemical fertilizers (produced by others). The remaining area is not used in any way and is occupied by not usable constructions. A proposal for demolishing the existing buildings and industrial reuse of the area was forwarded, but until now the technical solutions were not established and no financing was found.

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However, a general demolishing project and also a special demolition project by detonation were set up. Environment protection authority imposed an assessment that had to contain results of chemical analyses concerning soil pollution and its radioactive contamination, data concerning contamination of underground water and also analyses of concrete to be demolished.

Demolishing concerns buildings of the former complex NPK fertilizer plant, one of the ammonia plants, the urea plant, deposits and the attached scaffolds. These constructions can be classified in two groups, namely one suitable to be demolished "piece by piece" and another that can be demolished either "piece by piece", or with explosives. During demolishing environment affecting pollutants are expected to be noise, dust, the resulting waste, including dangerous ones (asbestos, phosphorite waste).

## 2. ACTUAL STATE OF ENVIRONMENT ON THE PLANT AREA

### a. Water Quality

The actual state of water quality in the area of the former plant is illustrated by the results of analyses carried out by laboratories of specialized water authorities or in laboratories certified by those authorities.

Underground water quality was controlled on samples from wells existing inside and around the plant. Results of one of the latest sampling and analyses are given in table No. 1. ISO standard methods were used.

***Underground water quality***

**Table 1**

| Characteristics | Well number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | F4 | F6 | F7 | F8 | F11 | F12 | F13 | F14 |
| pH | 7.85 | 6.5 | 7.08 | 6.62 | 7.06 | 5.49 | 7.71 | 7.40 |
| Ammonia, mg/l | 0.37 | 1.43 | 1.27 | 2.88 | 0.74 | 3.10 | 3.56 | 0.63 |
| Nitrites mg/l | 0.14 | 0.03 | 0.01 | 0.05 | 0.02 | 0.04 | 0.26 | 0.60 |
| Nitrates mg/l | 195.2 | 45.70 | 199.0 | 189.0 | 10.0 | 48.1 | 285.0 | 204.5 |
| Phosphates mg/l | 0.22 | 0.15 | 0.13 | 4.60 | 0.16 | 1.46 | 0.13 | 0.10 |

However the analyses results are improved compared to previous periods, they generally are worse than the provisions of the drink water quality standard (e.g. pH 6.5 – 9.5, ammonia 0.5 mg/l, nitrates 50 mg/l)

Radioactivity data for water collected in wells are reproduced in table 2 and it can be seen that values do not reach warning limits.

***Radioactivity data for underground water***

**Table 2**

| Characteristics | Well number | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | F4 | F6 | F7 | F8 | F1 | F12 | F13 | F14 |
| Immediate activity Bq/$m^3$ | 312.8 | 233.3 | 119.0 | 122.7 | 229.7 | 266.3 | 915.6 | 268.8 |
| Activity after 5 days Bq/$m^3$ | 219.4 | 108.4 | 96.2 | 82.3 | 82.3 | 81.6 | 855.6 | 123.8 |

Evens taking into account errors of about ±50 Bq/m3 the values are inside the warning value.

The characteristics of water discharged into the river Mures are controlled by the laboratory of the specialized authority. Figures for the latest sample are given in table 3.

***Waste water discharge into river Mures***

**Table 3**

| **Characteristics** | Max. admitted value | ReG.I.Stered value |
|---|---|---|
| **pH** | | 7.68 |
| Suspended matter | 35 | 123.00 |
| Fixed residuals | 2,000 | 655.00 |
| Ammonia | | 71.00 |
| Nitrites | | 0.01 |
| Nitrates | | 16.00 |
| Phosphates / phosphorus | | 23.2/7.56 |
| Phenols | | 0.03 |
| Extractables | 20 | 23.60 |

However in some respects not inside the admitted values, the characteristics of wastewater prove that now household type activities are developed on the site and, at least in this respect, there is no heritage with environmental meaning.

**Air Quality**

During its activity the plant had a polluting influence on atmosphere mainly due to the nitric oxide emissions, but also to ammonia and dust. After shutting down of plant, all this type of pollution was eliminated.

A possible discharge of pollutants to the atmosphere can appear during the future demolishing the concrete buildings, by crashing and transport operations. Classic way of demolishing produces solid particles, but if detonation will be the chosen method further $CO_2$, $N_2$, nitrogen oxides, and carbon monoxide, the latest of high toxicity, can appear.

**Quality of Soil**

Data regarding chemical characteristics of soil ale reproduced in table 4.

***Results of soil analyses***

**Table 4**

| Sampling place | pH | Ammonia | Nitrates | Phosphorus | Kalium |
|---|---|---|---|---|---|
| Nitro-chalk plant | 7.7 | 20.0 | 6.10 | 135.8 | 825 |
| Ureea plant | 7.9 | 0.48 | 0.70 | 139.7 | 450 |
| Packing installation | 7.5 | 0.60 | 0.80 | 432,0 | 1150 |
| Nitric acid plant | 8..0 | 2.18 | 0.83 | 103.5 | 151 |
| Ammonia plant | 8.1 | 1.08 | 2.14 | 25.11 | 265 |
| NPK conditioning | 7.2 | 0.42 | 0.25 | 84.00 | 850 |
| Nitrochalk prilling | 8.1 | 0.64 | 5.90 | 85.60 | 675 |
| NPK plant | 7.8 | 12.4 | 0.72 | 80.80 | 127 |
| NPK pilling | 7.8 | 2.16 | 13.8 | 84.00 | 1920 |
| KCl drying | 8.1 | 2.08 | 0.82 | 93.20 | 1000 |

The gray marked values are above the maximum admitted.

Radioactivity data are as follows (β global activity, Bq/kg):

- Phosphate ore storage area: 1149.2 ± 85.2,
- Ground level: 1454.3 ± 99.5,
- +7m level: 1776.5 ± 114.8,
- Soil inside the plant: 631.4 ± 51.9.

Comparison and criteria value is annual average radioactivity of non-used soil in Arad: 478.7 Bq/kg.

**b. Pollutant content of concrete**

As a possibility to solve the pollution remained after the plant shut down is demolishing the existing concrete buildings, the pollutant content of that concrete can be important. There for analyses of specific pollutants contained in building concrete were carried out. Some of the main results are reproduced in table 5. The analyses produced the highest fluoride content of about 7 – 8mgF/Kg inside the south NPK prilling tower and inside the NPK processing building.

***Pollutant content in concrete of buildings***

**Table 5**

| Sampling place | Nitrate mg N/Kg | Ammonia mg N/Kg | Phosphates mg N/Kg |
|---|---|---|---|
| South NPK prilling tower, outside | 8 | <4 | <4 |
| South NPK prilling tower, inside | 240 | 68 | 62 |
| North NPK prilling tower, outside | 6 | <4 | 8 |
| North NPK prilling tower, inside | 280 | 87 | 72 |
| NPK processing building, outside | 21 | 7 | 25 |
| NPK processing building, inside | 320 | 140 | 56 |
| Nitrochalk prilling tower, outside | 17 | <4 | - |
| Nitrochalk prilling tower, inside | 64 | 14 | - |
| Nitrochalk building, inside | 82 | 22 | - |
| NPK building, inside | 104 | 63 | 35 |

The following comments are given to the analyses of pollutant contents of concrete:

- results for a layer of 0 – 10 mm of concrete was analyzed as deeper ones did not present any of the specific pollutants;
- on the concrete surface mainly calcium nitrate is present because of reaction with calcium carbonate, there for presence of ammonia nitrogen is lower;
- urea could not be found as it suffers a hydrolysis during the time;
- the low fluoride content is due to the low presence of fluorine in fertilizers.

## 3. DEMOLISHING AS A SOLUTION TO AVOID FURTHER POLLUTION AND TO PERMIT REUSE OF LAND

As the area of the former fertilizer plant is so positioned that it can become a flourishing industrial area and some new activities already started there, but the existing old buildings can be a danger for them.

A project for demolishing was set up by the same institution that designed the plant and it has the approval of the local council.

During demolishing the existing water supply network, the existing sewage, the law voltage electric network and the access road network will be used. It is important that specialized people emptied the electrical transformer stations, so these stations contain neither transformers, nor the oil. Such way pollution with them is prevented and not any leakage of oil was found.

During demolishing the main equipment to be used is a concrete breaker, two bucket track excavators, a frontal feeder a bulldozer.

The main technology proposed for demolition is that using explosives. In a previous work the authors referred to that technology (Dumescu, Klein, 2007), conclusion being that this technology is suitable and not dangerous so regarding safety as regarding environment protection. Biali, G. et. colab., 2006, was studied G.I.S techniques for agricultural lands altered by pollution.

As the concrete is not really polluted, the waste resulting in demolition by explosion is not dangerous and can easily be reused as filling material.

## 4. CONCLUSION

Demolishing of the buildings that belonged to the former Arad Fertilizer Plant is not only possible but also a necessity as they are highly degraded, they represent a danger and risk for other objectives on the platform and for the persons working there. Demolishing is a polluting activity but its polluting power is not very high and can be limited by suitable steps on the site.

Reuse of most of the area of the former Arad Fertilizer Plant is possible only by demolishing the very specific buildings. The demolishing is a condition of ecologic, economic and scenery reconstruction of the area.

## BIBLIOGRAPHY

Biali, G., Popovici, N., Morozan, N., (2006), Folosirea tehnicii G.I.S în acțiunea de bonitare a unui teren agricol afectat de poluare cu metale grele, „Geographia Technica, no.1, 2006, ISSN 1842-5135, p.19-25, Cluj-Napoca;

Dumescu F., Klein L., 1994, ,, Studia Universitatis V. Goldis" Arad, 84 - 88;

Dumescu F., Klein L.,1996, ,, Studia Universitatis V. Goldis" Arad, 115 – 122;

Dumescu F., Klein L., 2003, *„Kitekintés-Perspective"*, International Vysegrad Fund, 201- 204, Békéscsaba, Hungary;

Dumescu F., Klein L., 2007, *Contributions to the Study of Diminishing Environmental Heritage of a Chemical Plant*, XI International Eco-Conference, – Environmental Protection of Urban and Suburban Settlements I, Proceedings, Novi Sad, Serbia, 247 – 254.