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Remediation of Acid Tar Lagoon

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Chapter 16

REMEDIATION OF ACID TAR LAGOON

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ABSTRACT

Slovenia (20,000 km^2, 2 million inhabitants, 750,000 in employment) is industrialised to a medium extent. Many ecological problems have remained from past periods (‘old ecological burdens’). Many of them are legal waste dumps resulting from the technology used in these past periods. One of these is the acid tar waste dump in the northeast of the country, close to the border with Austria (‘Pesnicki Dvor’, in operation from 1966 to 1983). In addition to mineral and sulphonated mineral oils, acid tar also contains well dispersed heavy metal salts of lead, zinc copper, arsenic and barium. The surface area of the acid tar at the dump was between 3,000 and 3,500 m^2. The total thickness of the acid tar and water was 5 m, and the pH value of the water below acid tar was approx. 1.5. In 2006 the clean-up of the dump began:

- Excavation of the tar and contaminated earth;
- Technological process of solidification of the tar;
- Loading and removal of the solidificate or the product of the incineration process;
- Capture and cleaning of waste acid gases;
- Cleaning of water from the dump at a treatment facility.

The process of solidification of the acid tar took place in a plate mixer (approx. 80 tonnes a day), the addition of active additives (CaO, $Ca(OH)_2$, $CaCO_3$) amounted to approx. 25 tonnes a day, and the total daily volume of all additives used was approx. 20–50 m^3. The daily production of solidificate from acid tar and contaminated earth was 90 m^3.

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More detailed results of the clean-up and cleaning from the polluted water process will be shown by individual stage of the process, with a timescale and the relevant measurements and data.

The end result of the clean-up is the removal of all acid tar and polluted soil, the removal of all surfaces and facilities used during the clean-up, the introduction of clean earth and the re-cultivation of the area ('greening').

Keywords: remediation, acid tar, lagoon, solidification

1. INTRODUCTION

Many ecological problems remain from the past in Slovenia. These are primarily contaminated sites, featuring a range of contaminants (e.g. heavy metals, acid tar, industrial wastes etc.). Remediation of some of them started years ago and is still the lastly still today. These activities go hand in hand with high costs. In most cases the owners or administrators no longer exist, so the high costs of remediation generally have to be provided by the state. A refinery company, Rafinerija Mineralnih Olj Maribor, was founded in 1947 near Maribor (an industrial city near the border with Austria) to process waste motor oil collected in Slovenian territory. The refining of waste, used technical motor and industrial oil with sulphuric acid produces a hazardous and unusable waste product – acid tar. In addition to mineral and sulphonated mineral oils, acid tar also contains exceptionally well dispersed free sulphuric acid, heavy metal salts (lead, zinc, copper), while process sulphuric acid contains barium and arsenic. In 1967 a landfill for residue from waste oil refining was built in Pesniski Dvor (a small village near the city of Maribor) in line with then applicable regulations. The landfill site operated until 1983. There are two more landfills nearby, which also represent an ecological burden on the environment. An attempt was made between 1983 and 1986 to add fly ash to the pit in addition to the embankment. The pit embankment was supported with iron (*sic*) sheet piling, and a trench was constructed to prevent the inflow of storm water into the acid tar pit. In 1994 the preparation of technical documentation for remediation of the landfill began, which defined the acid tar pre-treatment process with solidification. In 2000 measurements of geotechnical and seismic parameters were started at three acid tar landfills, which produced accurate data on the content, quantity, and contamination of earth and water. In 2001 waste process water treatment started, which used a process to isolate sulphuric compounds. In 2001 a plan for the complete remediation of the Pesniski Dvor landfill was included in projects financed from the national budget, which was set for completion by end of 2006. In 2003 physical, chemical and other applied tests of laboratory-prepared acid tar solids were carried out. This established the conditions of how the solidification, incineration and final disposal of incineration residuals shall be performed. Location of the landfill is presented in Figure 1 (Resolution on National Programme of Environmental Protection in Period from 2005 to 2012, 2005).

Figure 1: Location of landfill

1. 1 State of landfill before remediation

The remediation area for the abandoned acid tar landfill is larger than the actual landfill pit and embankment itself. The project included construction of purpose-built remediation facilities in the wider remediation site, for which all the required permits under the legislation of the time were acquired. The site covers an area of 2.8 ha.

The overall site includes two sub sites:

1. the landfill location which includes the enclosed landfill pit within leachate collection trenches and the sheet piling-supported embankment and
2. the location with facilities for process equipment and handling areas.

The existing technical process equipment is intended to separate emulsions from previous remediation phases, and was installed on a reinforced concrete 540m^2 apron and including the following main technical devices:

- boiler with burner and chimney
- 2 heat-insulated decanting cisterns (50 m^3)
- cistern for eliminated oil (50 m^3)
- heating oil tank (50 m^3)
- 2 heat-insulated pre-decantors (50 m^3)

- heat exchanger
- emulsion, oil and water pumps.

Infrastructure facilities were constructed in parallel with technical facilities and equipment (Lipovsek and Kovac, 2007).

1.2 Basic characteristics of landfill

The landfill area enclosed within embankments covers 3000 to 3500 m^2. The surface layer of water was 4000 m^2. The (estimated) volume of contaminated land was 5000 m^3. The volume of sediment (highly viscous acid tar, fly ash, wastewater treatment sludge) was an (estimated) 15,000 m^3. The total thickness of the layer of water and the greatest depth of acid tar was 5 m. The land at the bottom of the landfill was clay. Profile of the landfill in presented in Figure 2.

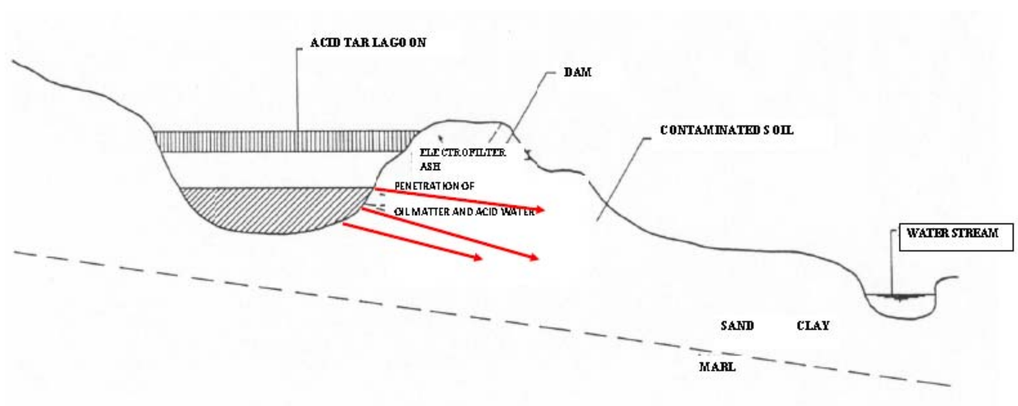

Figure 2: Profile of the landfill

2. MATERIALS AND METHODS

The technical process of acid tar solidification incorporates these technical processes:

- extraction of acid tar and contaminated land and internal transport of excavated material to the equipment which separates the largest items, such as timber, stone and others, from the material
- technical process of acid tar solidification
- capture and treatment of waste acid gas in scrubber
- solid material incineration

- revitalization of site through recultivation.

A rotating crane and excavator with telescopic arm are used to excavate acid tar and contaminated earth. The capacity of both machines is 10 tons per hour. After separating larger debris with the aid of a wheel loader, the acid tar is mixed at the loading point with additives, such as coal particulates, paper sludge, municipal waste treatment sludge, sawdust, etc. This ensures uniform granularity and flowability of the excavated material.

The solidification process starts with the transport of excavated and material mixed with additives past a magnetic separator (which removes any metal particulate present) to the mechanical mixer. This has a volume of 1.2 m^3, and is equipped with blades with a special form for stirring viscous and solid materials with controlled dosage of incoming components. Neutralising additives such as CaO, $Ca(OH)_2$ and $CaCO_3$, which neutralise the acidity, are added to the mechanical mixer on the basis of a preliminary analysis. Lengthy stirring and sufficient residence time ensure the best possible level of neutralisation. The mechanical mixer can mix approximately one tonne of material in a single batch. The quantities of neutralising additives may be changed, not only due to a low pH, but also due to moisture content or the energy value of the product. The residence time for the mechanical mixer is 2–3 minutes. Neutralisation in a mechanical mixer releases reaction heat, which depends on the neutralisation additives used. The increased temperature makes the mixture more viscous. Process water is added if required. The higher temperature also increases SO_2 emissions. The optimum temperature is 70°C and it cannot exceed 100°C, as H_2SO_4 and SO_3 also evaporate at that temperature, as do lighter fractions of oil and polycyclic hydrocarbons. The mechanical mixer is also equipped with an extraction device that removes harmful emissions to air caused by the process. Waste air is taken from the mechanical mixer to a reaction drum where dust particles are removed. From there gas emissions are conducted to the scrubber, where the neutralising liquid is NaOH. Cooled, stabilised, mainly small-grain material comes out of the reaction drum. This falls down a slope to a chute with a belt conveyor which moves the solidification product to a covered storage area. The addition of neutralisation additives during the solidification process releases heat which causes SO_2 and SO_3 to evaporate from the acid tar. At excess temperature (over 100°C), H_2SO_4 and lighter volatile fractions of mineral oils and polycyclic aromatic hydrocarbons also evaporate from acid tar. The total quantity of waste gases is around 3000 to 5000 m^3 per hour, which is conducted into a wet washing process and active carbon absorption (Hodalic et al, 2004).

Extraction takes place in this process equipment:

- acid tar and contaminated earth receiver: 250 to 500 m^3/h

- belt conveyor: 250 to 500 m^3/h
- mechanical mixer: 500 to 1000 m^3/h
- reaction drum: 1000 do 2000 m^3/h

Extraction is carried out using a fan, which has a capacity of 5000 Nm^3/h. Before entering the scrubber, waste gases are conducted via a solid particle isolator, which separates off particles.

The scrubber is placed above a tank of absorbent washing solution of NaOH, concentration 10%. The scrubber consists of two units: the first unit has a volume of 40 m^3, in which washing with a NaOH solution takes place, and has a pH regulation system and a chemical dosing device built in. The gases are conducted from the first unit into the second, in which there is a centrifugal fan that extracts the washed waste gases via an active carbon filter and into a container with H_2O_2, where Na_2SO_3 oxidises to Na_2SO_4. The scrubber's guaranteed SO_2 absorption rate is 98%. The initial concentration of SO_2 in the waste gas is approximately 5000 mg/m^3. Operational monitoring is carried out during remediation at the cleaned gas outlet point. If the legally permitted emissions of SO_2 are exceeded, solidification capacity is reduced.

The purpose of the active carbon filter is to remove volatile organic compounds (PAHs, lighter fractions of mineral oils, etc.).

2.1 Incineration of processed acid tar solids

After the solidification process, the neutralised acid tar is transported to Germany for incineration, where it will be processed into a secondary energy product suitable for co-incineration in a thermal power plant.

The thermal power plant uses coal with a high sulphur content. Transport takes place in containers. A short and simplified schematic illustration of the technical solidification process is shown in Figure 3.

Contaminated land is processed with reactive additives according to acidity levels. The earth is also transported to a processing plant where it will be processed into construction material. Scheme of technological process and scheme of mass flow are presented in Figures 4 and 5 (Lipovsek and Kovac, 2007).

The anticipated quantity of processed and transported solidified acid is around 50,000 tonnes, with the anticipated time scale for the entire process judged at around 3 years (Lipovsek and Kovac, 2007).

2.2 Revitalisation of site through recultivation

The revitalisation and recultivation of the area currently containing the acid tar pit will take place after conclusion of the technical process of acid tar solidification in line with landscaping norms. Revitalisation will be carried out in accordance with spatial planning acts. The pit will be covered and the surfaced turfed and planted with trees (Hodalic, et al, 2004).

3. RESULTS AND DISCUSSION

The average excavation rate was and still is 8 t of acid tar per hour. A smaller quantity of excavated acid tar makes it easier to manage SO_2 emissions from excavation, as well as the emission and neutralisation of sulphates and sulphides in the reaction drum during both solidification and neutralization.

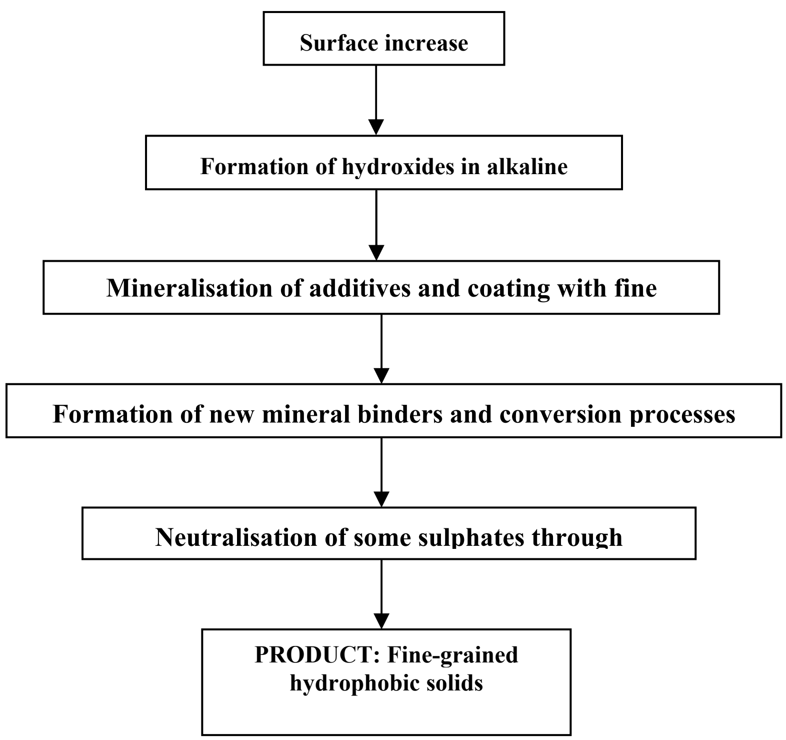

Figure 3. A schematic illustration of the technical solidification process

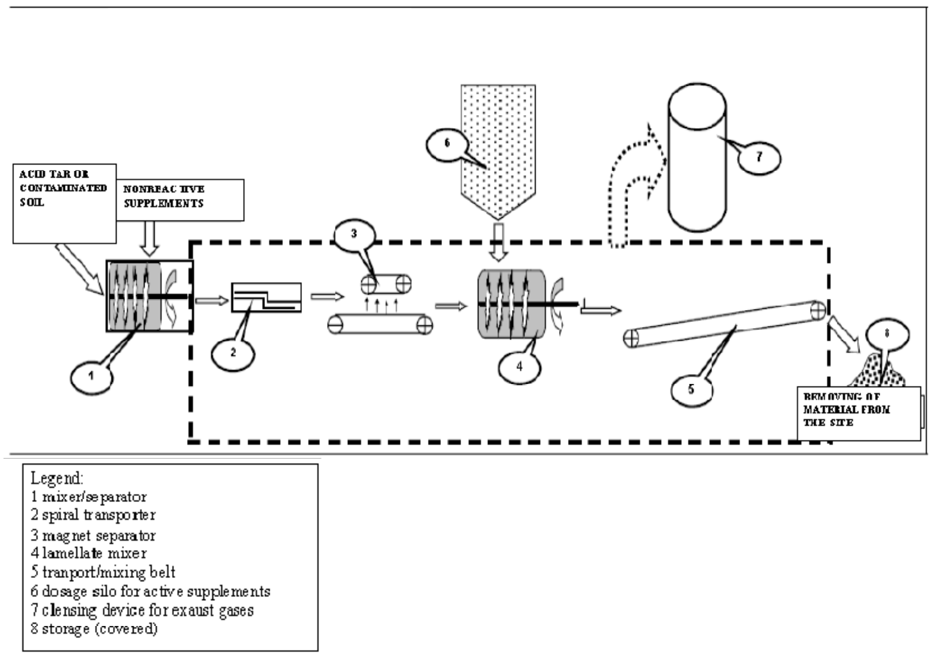

Figure 4. Scheme of technological process

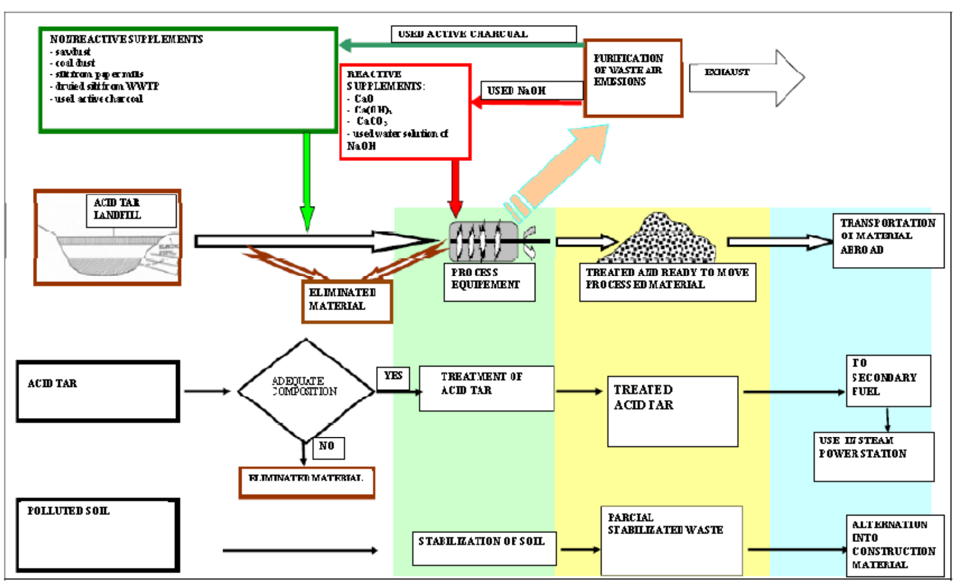

Figure 5. Scheme of mass flow

Table 1 indicates the mass balance for the acid tar excavation, solidification, neutralization of emissions, filling and removal of solid material.

Table 1. Mass balance for the acid tar excavation, solidification, neutralization of emissions, filling and removal of solid material

Quantity of acid tar excavated per hour	8 tonnes
Quantity of acid tar excavated per month	1600 tonnes
Acid tar density	1.1 to 1.3 t/m^3
Use of non-reactive additives per day	6 to 8 tonnes
Quantity of acid tar dosed into the mechanical mixer together with non-reactive additives	8.5 t/h
Quantity of neutralising additives (CaO, $Ca(OH)_2$, $CaCO_3$) per hour	2.7 tonnes
Use of neutralising additives per day	25 tonnes
Volume of all additives used per day	20 to 53 m^3
Total quantity of acid tar and additives dosed into the mechanical mixer per hour	8.2 to 9.6 m^3
Quantity of solid material produced per hour	10.5 to 14.2 tonnes
Quantity of solid material produced per hour	13.2 to 18.3 m^3
Solid material production per day	145 to 180 m^3
Number of (20 tonnes) lorries removing acid tar	5 to 7
Ratio dosed of acid to contaminated earth	2:1
Quantity of product per hour of processed contaminated earth during solidification	9 m^3
Quantity of solidified acid tar product and contaminated earth per day	90 m^3

3.1. Treatment of wastewater from acid tar pit

After excavation from the pit is complete, there will only be a pump placed in the pit, which will pump out all (storm) water to a wastewater treatment plant. The waste treatment plant in the acid tar pit areas is required to clean water produced during the solidification process as well as storm water contaminated by contact with acid tar. In the past storm water was already being treated before emission of the water into two water courses that run in the direct vicinity of the acid tar pit, just as treatment is required during the process. The water will continue to require treatment in future, until the revitalisation is completed. Ground water that has not passed to the water courses also requires treatment. The existing municipal treatment plant has a treatment capacity of 10 m^3/h and is intended to isolate mineral oils, for neutralisation of acidic process waters from the solidification process, neutralisation of metal oxides from the water-resistant layer of the acid tar landfill and for oxidisation of hydrogen sulphide. The waste treatment plant phases:

- oils and emulsions removed from water in gravitational oil-water separator
- contaminated water from the landfill site is then run off to a hopper

- the water is passed through an oil scraper and a settlement tank
- sulphide oxidation and pH regulation then takes place in baths
- the next phase is coagulation, flocculation, precipitation and sludge sedimentation followed by filtration in sand filters and active carbon absorption.

The treated water is released to a local stream, while part of the water is used for the technical needs of solidification and the waste treatment plant. Water samples are analysed before release. Table 2 indicates typical physical-chemical analysis of process monitoring before the start of the solidification process and before release to the Gacnik stream (Hodalic et al, 2004).

Table 2. Typical physical-chemical analysis of process monitoring before the start of the solidification process and before release to the Gacnik stream

Parameter	Limit value for release to water course	Sample 1	Sample 2
Flow on sampling (m^3)		56.2	51.3
Temperature (°C)	30	22.2	19.3
pH	6.5-9.0	9.1	9.3
Insoluble solids (mg/L)	60.0	11.2	4.8
Settled solids (mg/L)	0.5	≤ 0.05	≤ 0.05
COD (mg/L)	300	135	145
BOD_5 (mg/L)	30	10	23
Toxicity	4.0	3.0	1.0
Cu (mg/L)	5.0	≤ 0.05	≤ 0.05
Cd (mg/L)	0.1	50.005	≤ 0.005
Cr^{6+} (mg/L)	0.1	/	≤ 0.005
Ni (mg/L)	0.5	≤ 0.05	≤ 0.05
Pb (mg/L)	0.5	≤ 0.05	≤ 0.05
Hg (mg/L)	0.01	≤ 0.001	≤ 0.001
AOX (mg/L)	0.5	0.08	0.02
Ammonium nitrogen (mg/L)	50.0	3.6	0.8
Nitric nitrogen (mg/L)	35.0	0.40	0.25
Nitric nitrogen (mg/L)	5.0	/	2.0
Arsenic (mg/L)	0.1	≤ 0.01	≤ 0.02
Zinc (mg/L)	2.0	0.1	0.1
Total chrome (mg/L)	0.5	≤ 0.05	≤ 0.05
Chloride (mg/L)	30	20	22
Sulphate (mg/L)	300	500	340
Sulphide (mg/L)	0.5	≤ 0.05	≤ 0.05
Total hydrocarbons (mg/L)	10.0	≤ 0.1	≤ 0.1
BTX (mg/L)	0.1	≤ 0.05	≤ 0.05

The results of the physicochemical analyses indicate that the sulphate content is occasionally excessive and the pH value occasionally too high. The sulphate content was higher due to the solubility.

The results of the physicochemical analyses indicate that the ground water in the area is of good quality, with a notable reduction in mineral oil content.

The waste treatment plant has sufficient capacity to treat process water, water from the water-resistant layer, and for treatment of collected storm water from the surfaces around the process equipment.

Waste process water is produced during the washing of waste gas in the scrubber. Water use for wet cleaning in the scrubber is around 0.3 to 0.5 m^3/h due to recirculation of the washing liquid. Part of the process water arrives at the waste treatment plant from condensate and from the reaction drum. Part of the process water is returned to the solidification process.

3.2 Results of water monitoring for outflow and sediment in the Gacnik stream 2004

Analyses of Gacnik stream water were taken from two points – before the impact of the acid tar landfill and after output of the treated water, following processing at the acid tar landfill treatment plant. In addition to general parameters, a number

Table 3. The physicochemical analysis of water and sediment from the Gacnik stream – 2004

Parameter	Water (before outflow)	Water (after outflow)	Sediment (before outflow)	Sediment (after outflow)
Water temperature (°C)	19.0	19.5	/	/
pH	7.9	7.9	/	/
Elec. conductivity (μs/cm)	1250	650	/	/
Oxygen (mg/L)	7.6	8.4	/	/
O_2 saturation (%)	88	97	/	/
Insoluble solids (mg/L)	13	28	/	/
Dried solids (%)	/	/	100	97
Dried solids – wet filtration (%)	/	/	40	30
Sulphate (mg/L)	45	42	/	/
COD (mg/L)	≤ 5	≤ 5	/	/
PCB-28 (μg/kg)	/	/	≤ 1	≤ 1
PCB-52 (μg/kg)	/	/	≤ 1	≤ 1
PCB-101 (μg/kg)	/	/	≤ 1	≤ 1
PCB-138 (μg/kg)	/	/	≤ 1	≤ 1
PCB-153 (μg/kg)	/	/	≤ 1	≤ 1
PCB-18 (μg/kg)	/	/	≤ 1	≤ 1
EOX (mgCl/L)	/	/	≤ 1	≤ 1
Mineral oil (mg/L) (mg/kg)	≤ 0.005	≤ 0.005	66	70
Zn in water (g/L) in sediment. (mg/kg)	≤ 10	≤ 10	90	101
Pb in water (g/L) in sediment. (mg/kg)	≤ 1	≤ 1	25	20

of additional pollution parameters were selected that could indicate the impact of the acid tar landfill on water courses. The analysis was also performed on sediment from the same points. Table 3 indicates the physicochemical analysis of water and sediment from the Gacnik stream – 2004.

The similarity of the two sets of results in the table indicates that the quality of the water course at both sampling points is similar. Only the oxygen content is poorer, while the organic compound content is also higher, but the content of insoluble solids, sulphates, mineral oils and metals (Zn and Pb) are not higher.

The analysis of sediment, which is laid down over a lengthier period, indicates that the mineral oil content is higher.

3.3 Potential impact of acid tar landfill on ground water between drainage channels

In the potential area in which acid tar could threaten the ground water due to the penetration of pollutants through the embankment, holes were drilled from which ground water samples were regularly taken and the main acid tar pollution parameters were monitored. There were 7 such holes and in 3 of them there was an increased value for soluble solids, sulphate ion, mineral oils, volatile compounds, and partially barium and reduced pH values. This represents a threat to the ground water and the possibility of these pollutants penetrating to the Gacnik stream. Table 4 illustrates the chemical analyses for the holes in the acid tar landfill site in 2003.

Table 4. The chemical analyses for the holes in the acid tar landfill site in 2003

Parameter	Unit	VI	V2	V3	V4	V5	V6	V7
pH		7.9	7.5	6.8	7.5	7.3	6.3	7.5
Dried solids	mg/L	990	880	1400	1280	1900	2520	1340
Ash content	mg/L	960	780	1210	1020	1430	2000	1110
Total P	mg/L	0.5	0.5	0.2	0.3	0.1	0.1	0.1
Zn	mg/L	2.0	0.6	18.0	0.05	0.12	0.1	0.08
Cu	mg/L	≤ 0.4	≤ 0.4	≤ 0.4	≤ 0.4	≤ 0.4	≤ 0.4	≤ 0.4
Mn	mg/L	0.20	1.2	15	0.40	0.50	0.85	0.50
Mo	mg/L	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Ba	mg/L	1.6	2.5	4.5	4.0	5.8	5.7	3.5
Cr	mg/L	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05
Pb	mg/L	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5	≤ 0.5
Ni	mg/L	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	0.1	≤ 0.05
Cd	mg/L	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05
As	mg/l.	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05
F	mg/L	0.36	0.65	0.20	0.20	0.14	0.14	0.18
SO_4^{2-}	mg/L	30	60	1000	760	1020	1950	1000
Cl	mg/L	380	200	20	35	50	50	35

Table 4. Continued

Parameter	Unit	VI	V2	V3	V4	V5	V6	V7
CN^-	mg/L	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01
$N0_2^{2-}$	mg/L	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.01
Mineral oils	mg/L	0.05	0.03	0.20	0.10	0.25	2.30	0.05
VOC	mg/L	≤ 0.005	≤ 0.005	0.005	0.005	0.030	0.050	0.007
Halogenited organic compounds	µg/L	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05
PCB	»g/L	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05	≤ 0.05

Samples were also taken in 2004, but only from these holes, where the analyses had deteriorated from the previous year, i.e. from holes V3, V5 and the new hole V8. Table 5 illustrates some chemical properties of ground water measured from 3 holes in 2004.

Table 5. Some chemical properties of ground water measured from 3 holes in 2004

Parameter	Unit	V3	V5	V 8
Hole depth	M	10.2 J	7,5	6,5
Water level	M	0.66	0.85	2.5
Air temp.	°C	23	22	23
Water temp.	°C	14.5	14.8	13.9
pH		7.5	6.8	5.9
Conductivity	µs/cm	1350	1080	120
O_2 saturation	%	25	44	60
Oxygen	(mg/L)	2.5	4.3	6.2
KPK	(mg/L)	15	60	≤ 5
Sulphates	$mgSO_4^{2-}/L$	10	320	25
Mineral oils	µg/L	≤ 6	7	≤ 6

The 2004 measurements indicate that the water insufficiently aerated, or that the oxygen content is relatively low. The sulphate content was also excessive and in some points the acidity level was also too high (hole V8, permitted pH value is from 6.5 to 9.5). Other parameters indicate that the water quality is improving and the impact of the acid tar landfill is falling, as the mineral oil and sulphate content was down.

3.4 Solidification process of waste

The abandoned acid tar landfill holds below water: highly acidic acid tar, mix of acidic acid tar and earth, fly ash and solid residue from the wastewater treatment process. These are all residue from previous remediation attempts (before 1990).

Table 6 indicates the estimated quantities of waste from previous remediation attempts.

Table 6. The estimated quantities of waste from previous remediation attempts

Surface layer of water (pH = 6 do 7)	4000 to 6000 m^3
Floating oil emulsion	Removed on an ongoing basis
Sediment volume: acid tar, fly ash, earth, waste treatment sludge	approx. 15,000 m^3
Volume of contaminated earth	approx. 5000 m^3

These forms of waste have been and will be processed in a similar manner to acid tar. It is expected that during processing some waste will appear that is not suitable for processing and solidification, such as pieces of iron, stones, barrels with unknown contents (due to illegal tipping), abandoned synthetic compounds and other. These will be separated off by a separator. This waste will be mixed with neutralising additives and handed over to an authorised waste management company. The anticipated quantity of such waste should not exceed 200 m^3 or 1% of the quantity anticipated for processing during remediation (Lipovsek and Kovac, 2007).

4. CONCLUSION

The remediation of acidic coal tar at Pesnica was successfully concluded in 2008. The entire broader area has been horticulturally landscaped and in that state put forward for its new use. In Slovenia there are 10 active industrial landfill sites and one hazardous waste landfill. In addition to the active landfills there is also a series of abandoned landfill sites, which came about due to inappropriate disposal of industrial waste. Some of them have already been remediated, e.g. foundry sand landfill at Crnomelj and the consequences of PCB pollution by electronic industry Iskra at Semic in the 1980s.

The greatest environmental threat at present is from the acid tar landfills near Maribor (Studenci and Bohova), the industrial waste landfill at Globovnik near Ilirska Bistrica, and a red mud and ash landfill at Kidricevo. These old polluted areas require special technical solutions and increased investment. Their remediation is planned as part of waste management strategy.

Remediation programmes have already been prepared for all the old polluted areas, and remediation work is already underway in Kidricevo and Globovnik, while the remediation of the coal tar landfills at Studenci and Bohova has been postponed due to administrative procedure, and primarily due to a lack of funds (Resolution on National Programme of Environmental Protection in Period from 2005 to 2012, 2005).

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