WATER CONTAMINATION BY FLY ASH FROM ROAD CONSTRUCTION

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Abstract

The paper present determining the extent of surface water and groundwater contamination by fly ash from road construction. Groundwater and surface water are fundamentally interconnected. It is often difficult to separate the two because they feed each other. This is why one can contaminate the other. Water is an ideal solvent, some products placed on or in the soil will eventually end up in the groundwater. The extent to which human activities threaten groundwater quality depends on the types and amounts of materials use how they are used, and the risk of spills or accidents. Fly ash is a by-product of the combustion of pulverized coal in power station. Fly ash is an amorphous glassy material consisting of silica, aluminum, iron and calcium oxides plus other minor constituents. Fly ash has a long history of usage. It has been used in a variety of applications including as an addition to cement and concrete, for grouting mines and caverns, as a fill material for embankments, as a road construction binder, etc. It is waste material with changeling chemical and mineralogical characteristic. Because of that, it necessary observation its impact on environment and possible consequences at around soil, surface water and groundwater. It needs continue measurement contaminate concentration with stochastic models of transport contamination or measurement in site. Control concentration specific pollutant or group of pollutants in water, air or soil must be in function for protecting human health and environment.

Good water management is the key to protecting water quality. Sustainable development requires protect unreturned resources natural aggregates; it means made the best and economic uses all existing resource.

Keywords: concentration contamination, water, fly ash.

1 INTRODUCTION

Water pollution means contamination of water due to introduction of some external materials. Water may be polluted either from natural sources or human sources. Transport of pollutants through ground water flow is a very complex phenomenon. A range of physical, chemical and biological processes can influence the tracer drift by the ground water flow. Wastewater discharge impacts on the receiving waters can be grouped into chemical, biochemical, physical, hygienic, esthetic, hydraulic and hydrologic impacts. They can be further classified in terms of duration as acute, delayed or accumulating. One or a few of these impacts dominate technological state of the receiving water. This is the impact to focus on, to describe it quantitatively, and to define measure to improve it. Once the key processes and their describing variables are found, the current state of the receiving water system must be characterized and the effect of various engineering measures estimated.
monitoring is usually too cumbersome and expensive, models must be used that describe the numerous sources of wastewater discharges, the receiving water processes and their respective interactions. Today we already have number of integrated models available for the description of the dynamics in the total system. New approach to protected water quality is sustainable development. The key to sustainable development practices is working with the natural “water in the landscape” processes. Each modification to these processes requires significant investment in infrastructure and ongoing management, and risks major unintended environmental impacts. Modifications to streams and to the patterns and frequency of discharges as a result of urbanization and road building have major impacts on the composition, diversity and abundance of aquatic fauna (biodiversity) in downstream waters.

Ecologically sustainable management principles comprise:
- either the retention of natural streams systems, or construction of vegetated waterways and wetlands
- promotion of “at source storage and detention” of rainwater, as a means of limiting increases in peak discharge and frequencies of discharges downstream, reduction in discharge of pollutants, maintenance of soil moisture and groundwater regimes, and securing opportunities for re-use of rainwater and treated wastewater for water supply purposes.

2 MEASUREMENT WATER CONTAMINATION

Groundwater and surface water are fundamentally interconnected. It is often difficult to separate the two because they feed each other. This is why one can contaminate the other. Water is an ideal solvent, some products placed on or in the soil will eventually end up in the groundwater.

Continuous measurement of all parameters relating to quantities and quality of water, water distribution, sewage networks and treatment plants, is necessary for rational and efficient use of the resource. Real time water information management is essential for preserving biodiversity and safeguarding human lives and the environment from drought, flood and water quality disasters.

It needs continue measurement contaminate concentration with stochastic models of transport contamination or measurement in site. Control concentration specific pollutant or group of pollutants in water, air or soil must be in function for protecting human health and environment.

Modeling transport of pollutants in many case means apply continuity equation, transport equitation and Darcy formulation. Heterorganic characteristic in nature, geological formations and their influence at ground water flow and transport tracer made develop stochastic modeling flow and transport in ground waters. In stochastic approach transport of pollutants in porous medium is accidentally processes and variable for flow and transport are accidentally characteristic too. Processes in observation porous media present realization function of stochastic variable for such process. Flux liquid phase and transport everyone components is always three dimension process. (Figure 1.)
Various in concentrations some components can be made from chemical reactions in liquid or gas phases. Chemical and biological reaction which can change concentration contamination in ground water we can divide in six groups:
- processes of adsorption and desorption
- reaction at the sour base
- processes of melt and sedimentation
- oxidation and reduction
- ionization connection
- microbes cellular synthesis

For formatting and valorization mathematics describe for transport pollutant we need measurement in natural porous medium, and measurement at physical models that is made in laboboratory. Development in laboratories usually serve for describe physical phenomena in ideal condition- suppose porous media is homogeny and anisotropy. For engineering practice significant important are measurement from aquifer. Study of transport pollution in aquifer require spend measurement in site.

Observation allocation some components of contamination required to make series observatory wells and often measurement concentration of contamination. Surveillance monitoring shall be carried out in order to:
- supplement and validate the impact assessment procedure,
- provide information for use in the assessment of long term trends both as a result of changes in natural conditions and trough anthropogenic activity.

Sufficient monitoring sites shall be selected for each bodies identified as being at risk.

The following set of core parameters shall be monitored in all selected groundwater bodies:
- oxygen content
- pH value
- conductivity
- nitrate
- ammonium
Bodies, which are identified at significant risk of failing to achieve good status, shall also be monitored for those parameters, which are indicative of the impact of these pressures. Operational monitoring shall be undertaken in the periods between surveillance monitoring programmers in order to:
- establish the chemical status of all groundwater bodies or groups of bodies determined as being at risk
- establish the presence of any long term anthropogenically induced upward trend in the concentration of any pollutant

3 WATER CONTAMINATION BY FLY ASH USED IN ROAD CONSTRUCTION

Road construction and reconstruction have significant environmental impact specially on surface water and groundwater. According to the sustainable development guidelines the non-renewable sources of natural material need to be protected, some types of waste materials and industrial by-products are being used in road constructions for a number of years already as a substitute for standard materials. There are a number of reasons for this, one being a rational consumption of good quality stone material reserves and the other being large quantities of waste materials stockpiling on the dumping sites.

From a wide range of alternative materials used in road construction, fly ash, with its advantages, holds a significant position in relation to other materials. Fly ash is a by-product produced in the electric utility industry or power plants during the process of combustion of coal in boiler furnaces and material consisting of silica, aluminum, iron and calcium oxides plus other minor constituents. It has been used in a variety of applications in road construction including as an addition to cement and concrete, for grouting mines and caverns, as a fill material for embankments, in road stabilized mixes etc. The already mentioned application options of fly ash and a long term experience in such applications prove its advantages. However, one must not forget that this is only waste material with variable chemical and mineralogical composition whose uncontrolled application could have harmful effects on environment. Namely, properties of fly ash depend on the type of coal used in the combustion process and the process itself in the power plants and this significantly influences the change in ash composition, possible radioactive properties and heavy metal concentration.

Leaching, movement of water through materials containing soluble components, significantly influences the surrounding soil, surface water and groundwater. Variable chemical composition of fly ash can contain elements that will infiltrate groundwater or surface water by leaching and ultimately present danger to the flora and fauna. Influence on water quality have the presence of heavy metals (As, Cd, Cu, Cr, Hg, Pb, Zn etc.,) and organic matter (benzol, phenol etc.)

Methods of determining the pH values and elements (As, Cd, Cr, Va, Cu, Ni, Pb, Zn, Cl, \( \text{NO}_3 \) and \( \text{SO}_4 \)) are defined in the European standard prEN 12506 “Characterization of waste-Chemical analysis of evaluates”. While determining the possible degree of leaching, among the already presented data on the percentage of hazardous elements present, it is also necessary to have
an insight of the hydrological conditions of the environment and the permeability of materials and surrounding soil.

Numerous research projects have tested the degree of potential leaching through construction materials and infiltration into the ground and surface waters through the surrounding soil. Baldwin et al. in conclusion of a comprehensive study on leaching from different waste materials have pointed out that the possible hazardous influence of toxic elements is within very strict valid regulations on water quality, i.e. it does not exceed the allowed limits.

Table 1. presents the standard elements whose presence in the soil and water is being detected in Great Britain from fly ash used in road construction

Table 1. – Leachates found using the DIN 38414-S4 and NRA extraction methods

<table>
<thead>
<tr>
<th>Typical range of leachable elements for UK PFA (mg/L except pH)</th>
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<tbody>
<tr>
<td>Aluminum</td>
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<tr>
<td>Arsenic</td>
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<td>Boron</td>
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<tr>
<td>Barium</td>
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<tr>
<td>Calcium</td>
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<tr>
<td>Cadmium</td>
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<td>Chloride</td>
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<td>Cobalt</td>
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<td>Chromium</td>
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<td>Copper</td>
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<td>Fluoride</td>
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<td>Potassium</td>
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<td>Magnesium</td>
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Notes: the above data include a seawater-conditioned sample resulting in higher chloride values. The Boron content may also be increased. *Indicates below detection limit

The following data are important when evaluating harmful effects of fly ash on the environment: position of the course in the pavement structure and its designed thickness, is fly ash bonded with bitumen or cement and in what quantities is it applied.

Namely, materials bonded with bitumen and cement tend to have significantly lower leaching abilities for two reasons: first, ash particles are surrounded by a bitumen or cement layer preventing water seepage, and second, bonded materials are mainly used for upper base courses that are, compared with the lower base courses, thinner.

Considering the above mentioned, as well as the fact that this material, when well compacted, has a very low permeability, usually $10^{-7}$ m/s, there is no significant influence of hazardous elements on the surrounding waters and soil due to leaching.
A similar conclusion could be reached for non-stabilized base courses under the condition that they are of average thickness and not permanently exposed to moist or damp conditions.

Large quantities of fly ash are being used in road fills, be it as basic material for construction of fills, or as supplement when particle size distribution of the basic material needs to be improved. With such large quantities of fly ash being used, the quantities of toxic elements that can leach into the waters and surrounding soil become significant, although it is a low concentration of such elements. This problem can become even bigger if the drainage from fills is directly released into the watercourse, endangering the living organisms in it. If these watercourses are used for water supply of the surrounding population, or the fly ash fills threaten the springs and ground waters intended for the same purpose, the problems are even more increasing. Although the toxicity effect is low in these circumstances, it must be treated since it can cause changes in the taste and smell of water.

**CONCLUSION**

Surface waters and ground waters are in principle renewable natural recourses; in particular the task of ensuring good status of ground water requires early action and stable long-term planning of protective measures, owning to the natural time lag in its formation and renewal. Such time lag for improvement should be taken into account in timetables when establishing measures for the achievement of good status of groundwater and reversing any significant and sustained upward trend in the concentration of any pollutant in groundwater.

For the purposes of environmental protection there is a need for a great integration of qualitative and quantitative aspect of both surface waters and groundwater, taking into account the natural flow conditions of water within the hydrological cycle. With regard to pollution prevention and control, it should be based on combined approach using control of pollution at source through the setting of emission limit values and of environmental quality standard.

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Modern water management is characterized by considering water systems in their entirety together with all influencing factors and other related systems. Current policy objectives for water management focus on the creation and maintenance of a sustainable living environment, taking into account all demands made on the water system by the different interest. This makes management and control of water resources highly complex issue covering a wide spectrum of activities in the field of assessment, planning, designing, operation and maintenance. Moreover, as in any
other management field, all the above activities take place in institutional, social and political environment. Therefore, the management and control of water resource systems is a multi-disciplinary task requiring different techniques and considerable changes have been observed during the last decade in the approaches towards tackling the problems.

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