MIGRATION OF HEAVY METALS IN THE CONSTRUCTION ENVIRONMENT, AND THE MANAGEMENT OF INDURTRIAL WASTE

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ABSTRACT

Industrial wastes produced from civil engineering projects can lead to severe environmental impacts. One of such waste is heavy metal like mercury (Hg), cadmium (Cd), and lead (Pb) which may have to be disposed of after demolition. However, the disposal of heavy metals at landfills could lead to the migration of metal ions into the surrounding soils, in the form of insoluble hydroxides, such as chromium hydroxides, aluminum hydroxide, iron hydroxides, and thereby posing health risk. Consequently, it is of uttermost importance for heavy metals to be reused in civil construction in order to reduce the volume that could be brought to the landfills or disposal sites. This paper uses analytical concepts to study the ecological, and environmental impacts of heavy metal disposal at landfills, and how their reuse could significantly address the issue of metal leachate into the soil as well as the reduction of its impact on global warming and the environment as a whole. Thus, these heavy metals have been extensively studied and their effect on the environment, and on human health regularly reviewed by international bodies such as WHO with more emphasis on proper discarding of these materials rather than reuse.

INTRODUCTION

The construction industry is the most material consuming amongst other industry thereby generating massive industrial waste (IW). During construction, renovation, and demolition activities, the most hazardous material, produce is heavy metal. The term heavy metal refers to any metallic chemical element that has a high density, and is toxic or poisonous at low concentration Heavy metals have a specific density of more than 5g/cm3. As a component of the Earth's crust they cannot be destroyed or degraded, to a small extent they enter our bodies via the food chain, drinking water and via the air we breathe. As trace elements some heavy metals (copper, selenium, and zinc) are vital to maintaining the metabolic process in the human body. However at higher concentration they can lead to poisoning. Heavy metal poisoning could result from drinking-water contamination (e.g lead pipes). Heavy metal toxicity can often result in damaged or reduced mental, and central nervous function, lower energy levels, and damage to blood composition, ,lungs kidneys, and other vital organs [1] In addition, the use of virgin metals or steel could also pose a problem for global warming, since a ton of steel produces 1.7 tons of carbon dioxide (CO2). [2]

Heavy metals which migrates in to the soil, can form insoluble hydroxides [3] while in the soil, heavy metal have a higher probability to form hyroxo complexes with different quantity of hydroxide ions. (fig.1) demonstrates the formation of these insoluble hydroxides with the aid of concentration- logarithmic diagrams (CLD). The dissolution of hydroxide metal (e.g copper hydroxide) and the formation of its complex compounds is described by three main reaction:

$$Cu(OH)_2 = Cu^{2+} + 2OH \quad lgK_s = -19{,}66$$

$$(2-n)O\,H^- + H^+ = H_2O \quad - lgK_w = 14$$

$$Cu^{2+} + nOH^- = Cu(0H)_n^{2-n} \quad lg\,\beta_n$$

The overall reaction:

$$Cu(OH)_2 + (2\text{-}n)H^+ = Cu(OH)_n^{2-n} + (2-n)H_2O$$

$$lgK = lgK_s + lg\,\beta_n - (2\text{-}n)\,lgK_w.$$

The interval of the precipitation of hydroxides calculated with the aid of CLD will be co coordinated with J. Lure's experimental data. In the neutral soil

the majority of metal (Al, Cr, Zn, Fe (ll), Ni) found in their insoluble states often stagnates due to their limited migratory ability. This leads to accumulation of these elements in the soil. This situation can be named "acceptable condition" (see fig. 1;2;3;4). shows the dissolution of hydroxides and the transfer of heavy metal into hydro complexes.

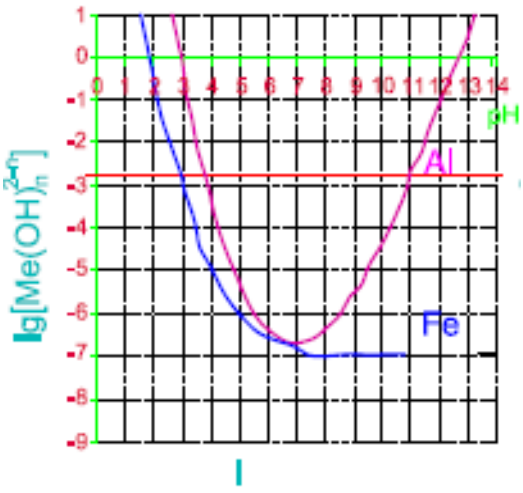

Fig. 1. Curves of metals particle content

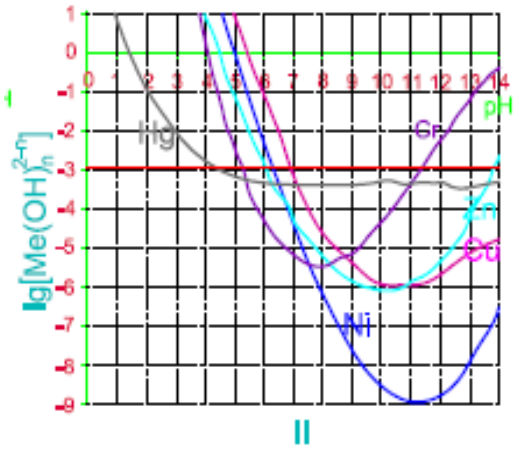

Fig. 2 Curves of metal Particle content

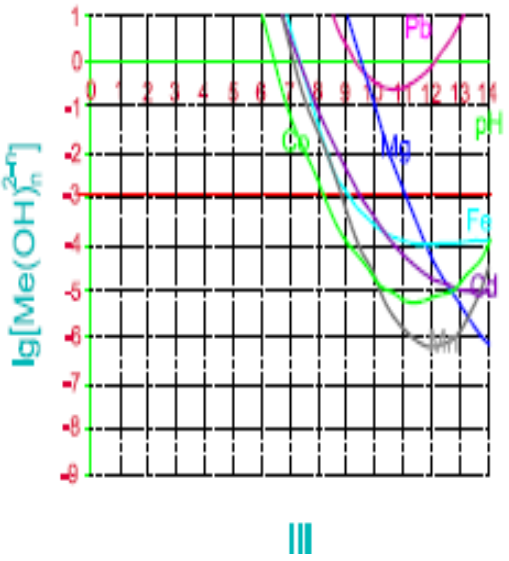

Fig. 3 Curves of metal Particle content

The separation of the groupe should consist of isolating the mobile metal in neutral environment (Fe(II), Cd, Co, Mg, Mn).

In the acid environment the insoluble ions Mez+ are present or particle in the form of [Me (OH) (z- 1)], whereas in the alkaline region it's [Me (OH) nz- n]. In the acid soils (4, 5<pH<5, 8) sod-podzolic, podzolized and malted soils are able to combine together except Fe (II) which are located in the dissoluble form. An increase in the values of pH contributes to the fixation of Cd, Fe (II), Fe (III), Mn, and Ni. In the alkaline medium the dissolved form will be located in connections with Mg, - Al, Cr, Cd smaller quantities. The use of the obtained results comprises of the recommendations regarding the establishment of safe ecologically conditions for application of phosphogypsum, ashes slag of thermal power station and metallurgical slags for the road building in accordance with the conditions of the soil.

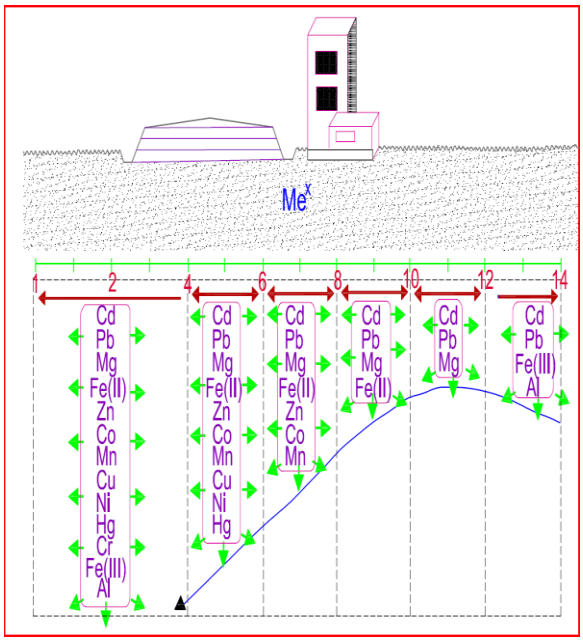

Fig. 4 show Matrix connection of heavy metals in the environment in the case of destruction in civil engineering, constructions

FINDING

According to the results of the study, the authors proposes some recommendations regarding the establishment of the ecologically safe conditions of using phosphor gypsum, and ashes slag of thermal power station for building in accordance with the conditions of the soil. The proposed recommendations relate to all engineered road-building construction, which contain ashes slag, phosphogypsum, metallurgical slags, slimes and other industrial withdrawals, which contains HM, toxic, and radioactive materials, capable of migrating into the soil, the water, and the environment, especially with the destruction of engineered construction. The developed procedure is based on different capability for the migration of HM, and toxic elements in different environment.

WASTE MANAGEMENT

The waste management of the construction industry, -building facilities regulated by a number of normative documents (EUROCODE, American Standards, ASTM international, Russian GOST and others). Establishes documents for withdrawals which are divided by granulometry, density, origin, humidity, solubility and the rest is specified the content of sulfate of calcium, water, phosphates and fluorides. Unfortunately, the content of HM in phosphogypsum and ashes slag is not limited to the chemical composition of withdrawals, ecological cleanliness, health and hygiene properties are not considered.

Engineers therefore, should carry out ecological analyses, which allow usage for preparing the building materials only by purified ecologically industrial withdrawals in order to accomplish their health and hygiene estimation.

The ecological analysis of any project should construction of engineer road-building facilities must consider the following requirements:

- The migration of substances into the environment must be less than the maximum permissible concentration for all environments (ground, water, air);
- Engineered road-building construction, which contains industrial wastes, must not possess toxic and allergenic action;
- the radioactivity of civil construction must be located on the tolerance level;
- it is necessary to take into account the operating conditions of the engineer road-building construction, which contain industrial wastes.

The proposed recommendations should be applied to the materials, utilized for preparing of road bases and coatings, and also road- transport construction. As the withdrawals of industry can be used the blast-furnace slag, the withdrawals of chemical production, ashes slag, phosphogypsum, galvanized slag and others, which allocate in environment of the connection of chromium, lead, nickel, cadmium, gland, cobalt, coppers, aluminum, manganese, to mercury, zinc, barium, arsenic, fluorine and other [4].

The ideas developed by the author's positions contain information necessary for conducting the ecological examination of the materials of engineer road-building construction and can be used by the producers, and enterprises of road building materials. The purposal for chemical hygiene studies the establishment of the chemical composition of withdrawals and possibility of the migration of HM from the construction objects into the environment, the prognostication of possible negative influence IW on the environment and the man.

Industrial wastes frequently contain the radionuclides in the form of a radium-226, thorium-232, potassium-40 and others; therefore radiation monitoring with conducting of ecological analysis is required [5]. We should use the withdrawals for industry in the road building on ground, which accumulate heavy metals and toxic elements (in accordance with the road division into districts of the

country), namely: - on alkaline ground with pH = 10, 2-10, 5;

- On neutral ground, which contribute to the transfer of the majority of metals (Al, cg, Zn, SI, Fe (II), and Ni) into the insoluble forms.

- On ground, rich in clay components;

- On alkaline ground, rich in hydroxides of iron and aluminum, with the presence of lead in the engineering road construction;

- On ground with reducing regime with the formation of insoluble sulfides (over a wide range pH). We should not use withdrawals on ground with the increased migration of heavy metals into the environment: - on the sandy soils;

- On grounds of the rich in the humus components, which form the readily soluble complex compounds with the heavy metals;

- On acidic ground (sod-podzolic, podzolized and malted), when all metals, except Fe (II), are converted into the soluble compounds;

- On neutral grounds, when in withdrawals the connections of Mn are present;

- On acid ground, salted by chlorides, where heavy metals are converted into readily soluble chlorides (solonetzic, solonchak ground, the river valleys, etc.);

- on neutral and alkaline grounds, which contain chlorides, with the use in the road building of the withdrawals, which contain connections Cd, Pb, Fe (II);- on grounds, which contain ammonia;

- On grounds, which contain sulfates;

- On any grounds when in withdrawals the connections of Cd, Pb are present, which are readily soluble over a wide range the values of pH;

- on grounds, whose acidity can increase as a result of the disorganized entering of industrial discharges, precipitation of acidic rains and others, which contributes to the dissolution of hydroxides and to the transfer of metals into the dissoluble hydroxo complexes. Thus, it is possible to make the following conclusions. On the basis of the mobile forms of metals examined the harmful effect of the metals, lixiviated from phosphogypsum it is ash-slag, determined by the position of toxic substances in the system "engineer road-building construction – environment".

It should be better to separate the solubility of hydroxides and hydroxo complexes of heavy and toxic metals into three groups. It is necessary to impose more stringent requirements on the protection of soil cover in the regions with the acid soils. Are developed recommendations regarding the establishment of the ecologically safe conditions of using phosphor gypsum and ash-slag of thermal power station in the construction industry.

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