# HUMIC SUBSTANCES APPLIED TO THE DETOXIFICATION OF THE SOLID WASTE FROM INGA BRAZILIAN ZINC COMPANY

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## I. INTRODUCTION

The mining of mineral sources as well as the industrial processing of raw materials can be responsible for spoiling many soil, surface and landscape. Presently, in several countries, there are pits, dumps and waste piles covering substantial areas and arising serious environmental problems. Solid and liquid waste resulting from the processing of mineral resources occupies vast territories worldwide and contains high concentrations of toxic substances.

In Brazil, the scenario is not different. A representative adverse ecological situation is present on the territory of the INGA Company. There, the resulting waste from the electrolytic zinc production has been dumped for long period of time without the proper actions being undertaken.

Wastes containing substantial quantity of heavy metals, such as the ones originating from mining and metallurgical activities, are especially dangerous ones since heavy metals are extremely toxic. Differing from other polluting agents, they are not destructible and can only be distributed in biosphere. Therefore, the detoxification of such wastes as well as that of their surrounding subsoil consists in a contemporary challenge towards the solution of an important environmental problem.

Some companies as well as scientific groups have been working in that sense. Some of which consider the use of humic substances as a possible treatment route. The EPhAT Ltd-Russia is among them and it has been divulging successfully attempts on treating liquids effluents and degraded soils, both based on the use of humic mineral concentrate (HMC), produced by themselves (Shulgin et al, 1998). Humic substances are found to be present in all soils and natural waters (Aiken et al., 1985). And, it has been observed that HMC containing humic acids promotes the fast forming of a specific and stable soil structure, enables an optimal soil micro flora formation and stimulates the progressing growth of plants.

Besides reducing the toxicity of wastes, HMC allows to improve significantly the physical characteristics of subsoil made of waste. By adding valuable agronomic qualities, HMC enables the development of rich soil from such wastes, since they will be used for normal plantation. The introduction of HMC influences positively on a number of physical and chemical properties of soil such as reaction to habitat, ability to absorb, ability to buffer and structure. Meanwhile, the increase of the humic acids percentage in soil improves biological qualities. High contents of humic mineral concentrates cause a better aggregating, porosity, absorbing and water-keeping capacities.

In this context, the study of the detoxification of zinc production solid waste by the introduction of HMC as well as its influence on the improvement of the agronomical qualities of the soil from such waste constitutes the focus of the present work.

## II. MATERIAL AND METHODS

The waste resulting from the zinc production consists in a loam-like substance of reddish-brown color and the company dump has the presence of metals such as cadmium, lead, copper, iron, nickel, manganese and, more significantly, zinc.

The acidity of the subsoil specimen taken, measured on water suspension, was 6.2-6.5.

In the case of the experiments on the HMC influence on zinc supply to plants, the tests were carried out on a chemically and biologically inert substance – perlite. Wheat and beans were used as test crops and 150 mg/L was chosen as the zinc contrast dose. Zinc contents in plants were determined by ICP-AES, and the determinations were carried out threefold.

For the waste detoxification experiments, barley was used as test crop and the repetition of variants was quadrilateral. Biometrical researches took place in the eight 24-hours.

## III. RESULTS AND DISCUSSIONS

**Analysis of influence of HMC on supply of ions of zinc to plants**

Tables 1 and 2 present, respectively, the results on growth of surface mass and accumulation of zinc ions on plants surface parts.

Table 1 - Influence of zinc ions on the growth of surface mass of plants during five 24-hours periods in the presence and absence of HMC in substract

| Crop | Pure Perlite (control), %* | Perlite + Zinc, %* | Perlite + HMC + Zinc, %* |
|---|---|---|---|
| Beans | 100 | 32 | 104 |
| Wheat | 100 | 59 | 89 |

*percentage relative to the control sample

Table 2 - Accumulation of zinc ions on plants surface parts, grown on perlite containing 150 mg/L of zinc

| Crop | Pure Perlite (control) | Perlite + Zinc, ppm | Perlite + HMC + Zinc, ppm |
|---|---|---|---|
| Beans | 52 | Death of plants | 74 |
| Wheat | 44 | Death of plants | 70 |

It can be observed that, in both cases, the introduction of HMC represented a positive influence. The growth of surface mass which was drastically reduced by the introduction of zinc was almost neutralized by presence of HMC. The accumulation of zinc ions on surface parts increased with the introduction of HMC and the death of the plants has also been avoided.

**Analysis of influence of HMC on the detoxification of waste**

Tables 3 and 4 show the results on plant growth and growth of surface biomass in a subsoil from zinc production solid waste by the addition of different HMC doses, respectively.

Table 3 - Influence of HMC introduction on growth of plants

| Variants | Average plant height, cm | Percentage relative to the control |
|---|---|---|
| Subsoil (Control) | 10.1 | 100.0 |
| Subsoil + 0.5% HMC | 13.3 | 131.7 |
| Subsoil + 1.5% HMC | 14.5 | 143.6 |
| Subsoil + 3.0% HMC | 16.4 | 162.4 |

Table 4 - Influence of HMC on the growth of plants surface biomass

| Variants | Average plant mass, g/can | Percentage relative to the control |
|---|---|---|
| Subsoil (Control) | 0.54 | 100.0 |
| Subsoil + 0.5% HMC | 0.68 | 125.9 |
| Subsoil + 1.5% HMC | 0.79 | 146.2 |
| Subsoil + 3.0% HMC | 0.92 | 170.4 |

It can be seen that the increase of HMC dosage is responsible for increasing both the height of the plants and surface mass. Therefore it can be said that both parameters are positively influenced by the introduction of HMC.

**Analysis of influence of HMC on qualities of subsoil made of waste**

Tables 5, 6 and 7 present the results of changes in structural content, density and porosity of subsoil from zinc production solid waste, respectively.

Table 5 - Structural content of subsoil (by dry fractionation)

| Variant | Aggregates dimensions, mm | | | | | | Degree of Structure K |
|---|---|---|---|---|---|---|---|
| | Mezoaggregates | | | | | Micro-aggregates | |
| | 7 - 5 | 5 - 3 | 3 - 1 | 1 – 0.5 | 0.5 – 0.25 | < 0.25 | |
| Subsoil (Control) | 6.0 | 17.0 | 22.5 | 13.0 | 19.0 | 22.5 | 3.4 |
| Subsoil + 0.5% HMC | 4.5 | 14.5 | 27.5 | 19.5 | 13.0 | 21.0 | 3.8 |
| Subsoil + 1.5% HMC | 0 | 11.0 | 27.5 | 25.0 | 18.5 | 18.5 | 4.4 |
| Subsoil + 3.0% HMC | 0 | 13.5 | 38.5 | 27.0 | 26.5 | 7.5 | 12.3 |

Table 6 - Subsoil density changes while introducing HMC

| Variant | Density, $g/cm^3$ | Percentage relative to the control |
|---|---|---|
| Subsoil (Control) | 1.14 | 100.0 |
| Subsoil + 0.5% HMC | 1.11 | 97.4 |
| Subsoil + 1.5% HMC | 1.06 | 93.0 |
| Subsoil + 3.0% HMC | 1.00 | 87.7 |

Table 7 - Changes in moisture capacity and porosity by HMC introduction

| Variant | Complete moisture capacity, % | Porosity |
|---|---|---|
| Subsoil (Control) | 51.2 | 57.8 |
| Subsoil + 0.5% HMC | 53.0 | 58.9 |
| Subsoil + 1.5% HMC | 53.5 | 60.7 |
| Subsoil + 3.0% HMC | 55.0 | 61.5 |

It can be seen that the addition of HMC contributes to the increase of structure degree, while contributing to the decrease of density and increase of porosity of the subsoil. Consequently it can also be observed a positive contribution to these parameters in terms of agricultural properties.

## IV. CONCLUSIONS

The use of HMC, produced by EPhAt Ltd., resulted in a toxicity reduction of the INGA solid waste present in the dump.

The waste treated by HMC had its agricultural qualities improved up to natural subsoil standards, pointing out to the possibility of using a HMC process to recover the spoiled area.

In that way, the waste could be used as bulk material for leveling relief roughness with no need for burying, within an interesting ecological solution for the existing problem.

## References

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