

THE PERMANENT INORGANIC GROUNDWATER POLLUTION BY BIOLOGICALLY TREATED WASTEWATER FROM SUGAR REFINERIES

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ABSTRACT

The disposal of an as well organic as inorganic highly polluted wastewater is always causing problems. If, in addition, this water is produced only during a few months in a year, anyone is looking for a cheaper alternative to a normal wastewater plant with a discharge into a river. By example of the different wastewater disposal systems of five sugar refineries and their groundwater pollution, which is proved with a large number of groundwater-quality investigations, it is explained, how much the aspect of the inorganic salt load has to be part of all considerations.

INTRODUCTION

In the region between Köln (Cologne) and Aachen (Federal Republic of Germany) sugar-beets are grown at about 30 % of the agricultural effective area and worked up at 9 refineries. Six of them belong to the region of the "Großer Erftverband" (GEV). The disposal of the great amount of wastewater, which is produced during a season (3 months) has mainly been done by discharging it into the subsoil. Quite soon it had been recognised that this could pollute the groundwater but for a long time the main attention belonged to the extremely high organic load. The investigations of the GEV at about 1.100 groundwater samples from about 50 groundwater observationwells, many of them had been specially installed for this purpose, showed, which of the wastewatertreating- and wastewaterdisposing-systems worked best on this special subject. But the investigations also showed the permanent groundwaterpollution, caused by the equally high load of inorganic salts. The amount of the total groundwater-pollution differs depending on the type of biological pretreatment because the decomposition of the organic substances, which is normally going on in the subsoil, causes secondary-reactions which are also polluting the groundwater.

RESULTS

The central subject of the investigations is the wastewater produced by the sugar refineries. It has some typical, process determined characteristics, even though there are great differences between the waters of the single refineries. The referenced data are related to the concentrations found at the especially investigated plants (ref. 1).

1. High organic load (BSB₅ between 4000 and 6000 mg/l)
2. High content of carbonates (medium at 2500, tops over 3000 mg/l)
3. High content of chloride (medium at 800, tops over 1000 mg/l)
4. High content of potassium (medium at 500, tops over 600 mg/l)
5. High content of iron (13 to 17 mg/l)
6. Low content of nitrat (often less than 0,5 mg/l)
7. Low content of sulfat (often less than 5 mg/l)

If the wastewater is disposed by infiltration via in terms changing infiltration basins with damed up water, after pretreating in sedimentation basins, not only the load of inorganic salts gets into the subsoil and the groundwater. Because of lacking oxygen the organic decomposition in the enlived part of soil is uncompleted. Therefore it is going on in the groundwater, where the decomposition of the organic load is consuming all dissolved oxygen. But normally there is not enough oxygen dissolved and that is why nitrat and sulfat are reduced down to ammonium and sulphureted hydrogen. In most cases even these oxygen supplies are not sufficient and groundwater keeps its reducing character even downstream the wastewater plant. A normalization comes up when mixing with unpolluted groundwater, by adding of the ordinary groundwater regeneration under regulary used areas and by contacting the oxygen in the air of subsoil pores. The size of the area with reducing groundwater conditions is increasing according to the quantity and the degree of organic pollution of the wastewater.

When the wastewater is pretreated in sedimentation basins and then spread or sprayed over agriculturally used areas, the secondary reactions are of less importance. Because of the extremely reduced load per m² there is a sufficient supply of oxygen in the soil where the decomposition is nearly completed. Nevertheless the inorganic salt-load gets completely into the groundwater causing its permanent pollution.

The biological treatment of the wastewater via sedimentation basins and stack basins causes a nearly total decomposition of the organic load. When this water is spread or infiltrated, the groundwater still will be polluted with the inorganic salts. The only way to prevent this is to discharge the biologically treated wastewater into a river or other receiving water. But even this method is not neutral to groundwater in any case, because the normally used sedimentation basins with a layer of loam or clay for sealing are not tight enough. This results from the saisonal work of these plants. The loam, which is sticking to the harvested beets

is washed away before processing. With all the water it gets into the sedimentation basins, where it can settle. This sedimentation goes on without a reasonable pre-condensing in this water saturated medium. Besides this a hydraulic connection exists between nearly all pores, which results quite a good permeability for the damed up water. During the months of spring and summer, when these plants are not used for sedimentation or other things, the top of the sediment can dry. At the same time very intensive vegetation develops on this highly manured soil. The growing plants drive their roots deep into the sediment and in some cases stronger roots can destroy an artificial sealing of loam. Even clay and plastic foils are no barrier. The new flooding in the autumn encloses and covers all these plants. Some of them are quite strong, so they can resist to moldering for a time, which is long enough to make the finally rotted substance of roots and stalks to give good ways for the water. This and the life which belongs to the soil (earthworms etc.) give a permeability even more comparable to the primary material, an agricultural soil than to a tightened loam. A permeability factor of $k_f = 1 \cdot 10^{-5} - 1 \cdot 10^{-6}$ m/s is guessed.

When a plant for the infiltration of wastewater is stoped after several years of use, this does not mean a rapid rehabilitation of the groundwaterquality. In dependence to the groundwater-velocity and the rate of groundwater-regeneration there is just a decrease in concentration by dilution for the not decompositionable matter. The GEV's investigations also show, that specially under an intensive infiltration a stack of dirt can build up and remain in the sediment, where it will be only destructed very slowly. The stack developed by precipitation out of oversaturiered solutions as well as by adsorption at soil particles. This is also valid for organic matter held back in an environment preventing the biochemical decomposition. In this way even the area with a reducing character may be kept for a long time, in a special investigated subject even longer than 5 years.

SUMMARY

Condensating it has to be said, that when disposing a wastewater, which is highly polluted as well with an organic as with an inorganic load, the organic side of the problem can be managed while not enough interest has been given to the load of inorganic salts. This is basically valid to all types of wastewater. The discussed examples only deal with the wastewater from sugar refineries because the pollution, caused by different types of plants could be documented by a large number of groundwater-analyses. When planing a new wastewater plant, it has to be checked if in that site a delivery of salts to the groundwater may be tolerated or not.

REFERENCES

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