



Microbiological treatment of mercury-loaded waste water – the biological **MERCURY-DECONTAMINATION-SYSTEM**



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Mercury in our environment

Mercury salts and organo-mercury compounds are among the most poisonous substances in our environment. The mechanism and extent of toxicity depend strongly on the type of compound and the redox state of mercury. Mercury has various technical and industrial applications. An important technical process which uses mercury is the chloralkali-electrolysis based on the amalgam process. Through electrolysis of a salt solution the bulk chemicals chlorine gas and caustic soda are produced. Because of the extreme toxicity of mercury and the enrichment in the food chain the contamination of the environment with mercury must be prevented as far as possible. Therefore the waste water limit is at 50µg/l and the drinking water limit at 1µg/l within the European Community.

Present clean-up solutions

Available physico-chemical procedures for the clean-up of mercury-loaded waste water have large disadvantages. For example, ion exchange columns are sensitive and expensive. Precipitation by H₂S requires handling of very toxic gas and produces large amounts of secondary mercury-contaminated media. Hydrazine precipitation needs toxic and expensive chemicals and a large amount of energy consumption. The advantages of the biotechnological MERCURY-DECONTAMINATION-SYSTEM are that it is harmless to the environment, efficient, cost efficient and has a broad applicability.

Procedure principle of the MERCURY-DECONTAMINATION-SYSTEM

The MERCURY-DECONTAMINATION-SYSTEM essentially consists of a bioreactor with pumice stone as carrier material for the micro-organisms and an activated carbon filter as a polishing step. The micro-organisms are natural, not pathogenic bacteria (e.g. Pseudomonas), which possess a natural mercury resistance. The micro-organisms convert reactive ionic mercury enzymatically to elemental mercury. This remains in the packed bed of the bioreactor as water-insoluble metal and is no longer toxic for the bacteria.

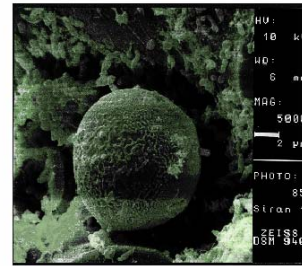
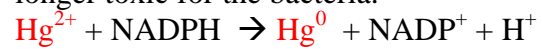


Figure 1: Droplet of metallic mercury in fixed bed

In the activated carbon filter the mercury is cleaned up after the bioreactor to a final concentration of less than 50µg/l.

If the bioreactor is clogged after approximately 1 to 2 years, (mercury enrichment factor of 35.000), the packed bed material is removed and deposited

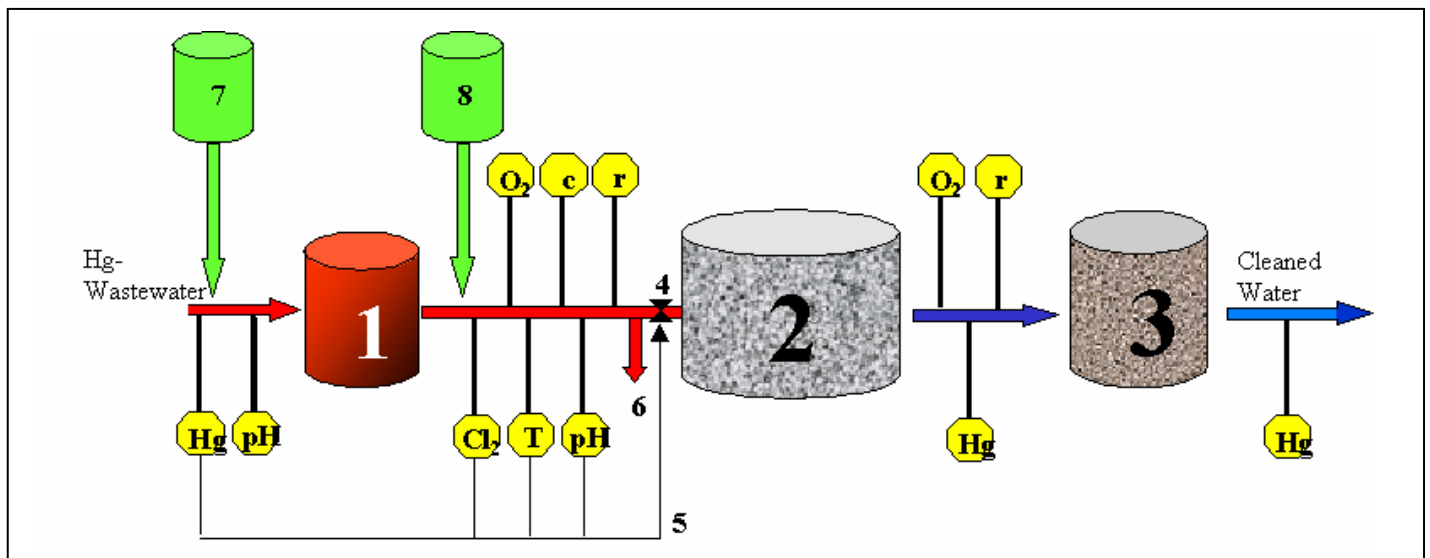


Figure 2: Operation diagram of the mercury-decontamination-system

1 Neutralisation Reservoir; 2 Bioreactor, 3 Activated carbon filter, 4 bioreactor-inflow-valve, 5 Valve gear, 6 Bypass, 7 sodium-alkaline-solution, 8 Nutrient-medium

Range of applications of the MERCURY DE-CONTAMINATION SYSTEM

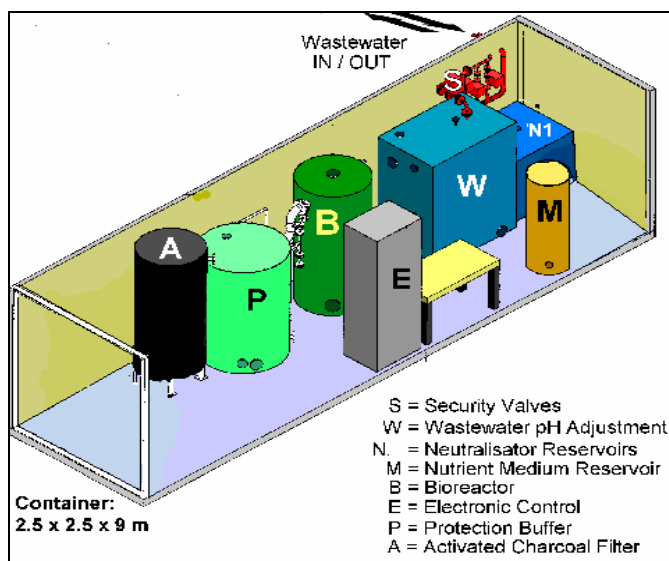
Handling of mercury-loaded waste water

- up to 10 mg/l Hg
- flow of 2 m³/h (volume of bioreactor: 1 m³)
- pH 7.0 ± 0.5
- temperature of 20 - 45°C
- salt concentration up to 50 g/l Cl⁻
- chlorine concentration up to 0.5 mg/l Cl₂

Depending on the pH-value of the raw waste water a previous neutralisation step is necessary. At a temperature above 45°C a cooling system must be installed.

Process features

- MERCURY-DECONTAMINATION-SYSTEM consists of a bioreactor and an activated carbon filter
- Mercury retention efficiency of 99%
- outflow concentration less than 50 µg/l
- automatic continuous operation, control by modem
- full performance immediately after inoculation
- continuous monitoring of Hg, temperature, pH, Cl₂ and oxygen
- period of operation before regeneration 1 to 2 years (approx 35,000 m³ waste water)



Process advantages

- very high stable retention efficiency of 99%
- high space-time yield
- reaching of the waste water discharge limit
- very small reactor volume
- very small space requirement
- mobile system
- simple assembly
- immediately operational
- low operating cost
- chemicals only for neutralisation
- robust against fluctuations in the wastewater (Hg, NaCl, temperature)
- tolerates standby times up to 2 days
- period of operation without regeneration up to 2 years

Fields of application of the MERCURY-DECONTAMINATION-SYSTEM

- ◆ Chloralkali electrolysis
- ◆ Washing waters
 - Buildings
 - Gas-pipelines
 - Wet scrubbers
- ◆ Waste storage seeping water
- ◆ Soil wash water
- ◆ Industrial effluents



Costs of the MERCURY-DECONTAMINATION-SYSTEM

Filling the system:

- Support material 200 €/m³
- activated carbon 1000 €/m³

Operating cost per 100 m³ waste water:

- neutralization (NaOH / HCl) 4 Euro
- sugar 4 Euro
- yeast extract 9 Euro
- electricity 100 KWh

References

- since 1996 experiments with laboratory reactors, longest run time of an experiment more than 1.5 years
- September 1999 - May 2000 pilot operation of the MERCURY-DECONTAMINATION-SYSTEM at chlorine alkali electrolysis factory
- July 2000 – December 2003 operation of the MERCURY-DECONTAMINATION-SYSTEM at chlorine alkali electrolysis factory in the Czech Republic.



Contact

Film and CD as well as further information about the MERCURY-DECONTAMINATION-SYSTEM:

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http://www.gbf.de/mercury_remediation1/index.html

<http://www.biomercury.de/project.html>