

REM TECHNOLOGY

BIOREMEDIATION OF SITES WITH UNCONTROLLED METHANE FORMATION

Patent IT N. 0001393404 – Procedure for reducing methane production and emissions from landfills and waste recovery sites.

➤ CRITICAL ISSUES

Old or run out landfills, as well as restored sites with untreated paper sludge, can be source of biogas uncontrolled release, leading to diffused methane emissions in the atmosphere, sometimes for years.

REM (bioREmediation of sites with uncontrolled Methane formation) technology was initially developed to solve a recovered site with untreated paper sludge which caused uncontrolled biogas production. The consequent uncontrolled release of methane induced hazardous conditions, with risk of explosions. The paper sludge was used for environmental restoration (R10 "spreading of sludge from the paper industry onto the soil for the benefit of agriculture" - recovery of material, in particular organic matter) pursuant to Ministerial Decree 5/2/98.

Along these activities, the diversified behaviour of paper sludge was verified to be:

- ▲ stable under aerobic conditions;
- ▲ unstable under anaerobic conditions with high biogas production (indeed, paper sludge are currently also exploited for the microbial capacity of methane generation, methanogenesis).

ADA acquired REM technology, which resulted in very effective bioremediation of the recovered paper sludge site. Similar hazardous conditions of uncontrolled methane emission can also arise for old or run (out) unlined landfills, in which methane generation is residual and difficult to be kept under control, especially if without biogas collection systems.

Furthermore, as prevention measure, the technique can be applied to:

- innovative design of environmental restoration with paper sludge (R10), as an innovative and safe biomass recovery methodology;
- temporary storage of waste, even before disposal in landfill to reduce methane emissions.

➤ INNOVATIVE ASPECTS AND RELATED BENEFITS (with reference to the most common technologies)

REM technology - *Innovative low impact bioREmediation technology to reduce Methane emissions and hazardous conditions* - is applied to environmental restoration with paper mill sludge, to eliminate or prevent dangerous situations in the event of uncontrolled methane production and migration. It is an *in situ* bioremediation technology, with catalytic biosystems, based on combinations of tailored compost with cellulolytic enzymes. REM technique possesses environmental and economic sustainability: it does not require removal of paper sludge, the use of water and electricity during its operation.

Benefits from the REM technique are:

- reduction of acoustic and visual impact,
- mitigation of diffused emissions of methane and other biogas,
- reduction of operating costs,
- accelerated site recovery.

➤ ACTIVITIES

The REM technology was at first developed and applied to an ex-quarry area in Imola (BO), where 60,000 t of paper sludge were used for an environmental restoration, a site of approximately 49,000 m². There were explosions due to the migration of biogas a farmhouse adjacent to the site. The REM intervention was aimed at the agricultural recovery of the site (see annexed papers).

The implementation of the intervention was carried out with the collaboration of private companies AMEK company (its patent and enzymes production) and APICE, University & Italian research Agencies (ENEA, University of Bologna - DICMA) together with public Bodies (Regional ArpaE, Municipality of Imola, Azienda USL of Imola – public sanitary agency).

➤ RESULTS

Main results are:

- **An intervention design/project**, in which the technical interventions were integrated by an appropriate monitoring plan for the solid, liquid and gaseous phases to evaluate their effectiveness in real time even in the presence of great heterogeneity in the area.
- **A site-specific bioremediation (biostimulation) treatment system** obtained by creating a physical discontinuity thanks to the introduction of a special low-density compost rich in microorganisms capable of degrading the cellulosic material ("designed or tailored" compost) which allowed:
 - the progressive reduction of CH₄ concentration (\downarrow 50% average value within 14 months) in correspondence with O₂ \uparrow (doubling of the average concentration in the same period),
 - the reduction of the source term over time (reduction > 70% in 14 months), as evidenced by measurements of the biochemical methanation potential (BMP) of the sludge present on the site,
 - the prevention of biogas accumulation and overpressure, through a network of biofilters made with tailored compost which allowed the **passive drainage** of the biogas and the bioconversion from CH₄ to CO₂ in their passage (from the bottom to the surface).

REM treatment system represents a **circular economy** practice, using waste to prepare a "**tailored**" compost, which can also be **specialized for other specific types of contaminated soil** remediation.

➤ Training

Le Experimental activities were carried out in synergy with training activities; several master's theses have been carried out on this project at Bologna University.

Example https://amslaurea.unibo.it/619/1/ruffilli_claudia_tesi.pdf.pdf
<https://amslaurea.unibo.it/1488/>

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