THE OPEN CELL LANDFILL - A SUITABLE APPROACH FOR LANDFILL DESIGN AND OPERATION IN THE TROPICAL REGION

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Meeting all outlined standards of sanitary landfill may be technologically and economically impractical in most developing countries. Therefore, the goal should be to meet the more important aspects to the extent possible under the existing set of technical and financial limitations. This paper summarizes our experiences and research focusing on a simple but effective as well as efficient design and operation of landfills in the tropical region. The main objective is still the prevailing reduction of both liquid and gaseous emission but also to find suitable construction and operation principle that fit the local settings. As a representative country of the tropes Thailand has been selected. Features of Thailand's landfills either dump sites or sanitary landfills have been analyzed. The majority of landfills as well as dumpsites are below 10 ha and the daily input is likely less than 50 tons/d. In fact 40% of the landfills receive less than 20 tons/day and 70% less than 50 tons/day. Comparable small landfill sizes with 40% less than 4 ha and 70% less than 8 ha indicating a limited lifetime, too. Due to these facts very common for the entire region, intensive gas recovery is hardly feasible; the degree of mechanization for compaction, leachate treatment and management has its limitations, too. Generally speaking the equipment and personnel of those landfills is neither appropriate for sustainable landfill operation nor are they prepared to consider any kind of post-closure management.

As a suitable approach for developing countries landfills the open cell approach is suggested. That doesn't differ too much from the current operation mode given that this happens intentionally. Basics for an open cell approach is a state of the art bottom layer and drainage system is established, above which solid waste is disposed of in thin layers. Figure 1 shows the comparison of leachate generation of a reference system (sanitary landfill) and an open cell lysimeter over a period of more than 3 years. The leachate caused by the open cell equals around 70 % of the total rainfall. Compared to the reference system around 35% more leachate is generated. Considering the tropical downpours during rainy season a reasonable flushing will occur and accordingly a well functioning drainage layer is required.

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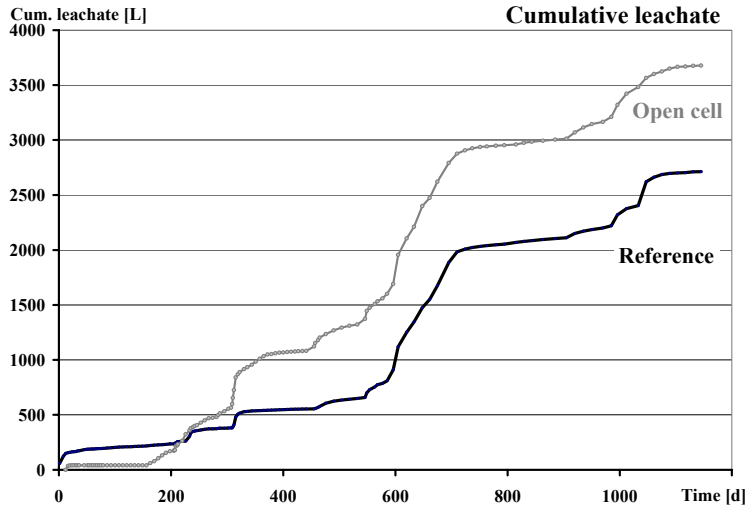

Figure 1: Leachate generation of reference system and open cell lysimeter

Due to a low compaction and in consequence rather aerobic/anoxic degradation than a stable methanogenic phase deems not to be reached for such an open cell landfill. Consequently, using the thin layer system aerobic in-situ degradation and a natural compaction will be simultaneously obtained. Provided the relative high ambient temperature degradation happens exceptionally fast. Considering the pollution load discharged by the excessive leachate the open cell features a specific COD load that is around 25% higher than the reference system but the specific TKN load exceeds nearly 100% the reference's discharge (see Figures 2 and 3). Whereas the nearly proportional increase of COD load is associate with the rise of the flow the higher TKN load deems to be either an effect of enhanced degradation with release of nitrogen constituents or the outcome of higher leachability. No matter about the transfer mechanism the reduction of nitrogen at that ratio is a reasonable feature for future post-closure measures. It also calls for an extended period of "open" operation. At the final phase reported so far the TKN concentration reached during rainy season 250-300 mg/L decreasing to 70-100 mg/L during the following dry season.

Under practical settings a reasonable storage of emerging leachate is absolutely necessary and an appropriate storage capacity has to be supplied. Part of the open cell concept is a proper management with storage, (partial treatment), and re-circulation. The water management shall further exploit the enormous evaporation capacity not only throughout the dry season but also and especially during the rainy season.

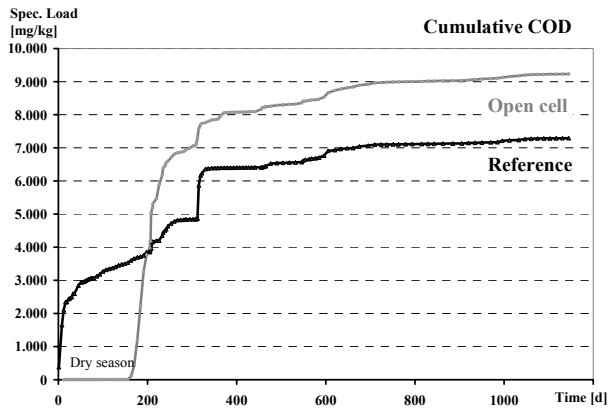

Figure 2: Comparison of specific COD-load

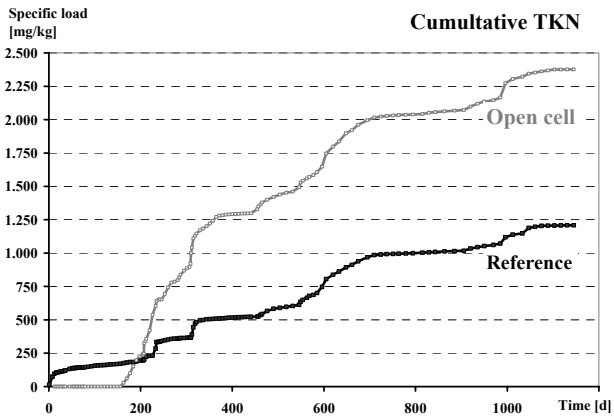

Figure 3: Comparison of specific TKN-load

The leachate recirculation contributes to the leachate treatment, and during the dry season enhances the degradation process. An additional nitrogen leaching is envisaged and a degradation of leachate constituents throughout the entire process is expected.

Full scale experiments proved the applicability of the concept. The following recommendations can be given: The incoming waste shall be spread at layers of 30-50 cm, above which a next layer should be dispensed earliest one month later. Degradation and a natural compaction occur; negative emissions and bad smells like in ordinary landfill are nearly neglectable. During the expected degradation leachate shall be recirculated to maintain optimum moisture content. More important the spraying of leachate prevents the generation of flies and other rodents, which can cause a reasonable nuisance at the open phase of the landfill. Another kind of nuisance is associated with blowing of papers and plastics; control measures have to be taken in order to avoid such an impairment of nature and landscape. As more information is collected about the distinct influence of monsoon affecting the performance of landfills in the region logical consequences can be drawn. Thus specific solutions especially for the numerous medium sized landfills can be reasoned. It requires a reasonable area if operated and managed properly that will exceed the area current landfills occupy. However, it fits in the available low-cost and low-technology approach and promises a low-emission final disposal.