

Atelier Rabat 2012

Atelier de Réflexion sur "Assurance Qualité"

Quality Management of Landfill Construction

Part 2: Emission Treatment, Landfill Operation and QM-Enforcement

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on behalf of

GIZ PGPE Maroc

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Sheet 1

Quality Management of Landfills Overview

- Landfill Gas Collection and Treatment
- Leachate Management and Treatment
- Landfill Operation
- Proposals for a System of Accreditation
- QM-System Implementation Schedule

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Sheet 2

Landfill Gas Collection and Treatment

Necessity of Gas Collection and Treatment

- Composition of landfill gas
 - methane
 - carbon dioxide
 - air (oxygen and nitrogen)
 - organic pollutants
- Risks of landfill gas
 - explosions caused by methane
 - suffocation caused by carbon dioxide
 - long-term intoxication caused by organic pollutants
 - intensified greenhouse effect caused by methane
 - malodour

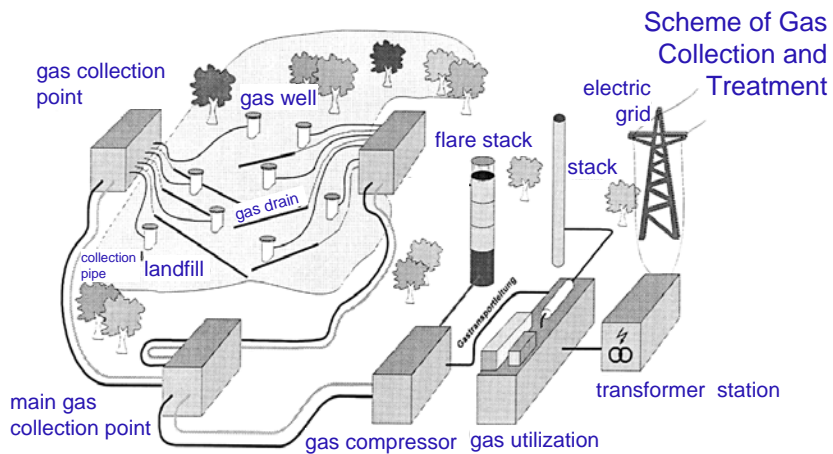
Landfill Gas Collection and Treatment

Tasks of Landfill Gas Management

- Prevention of gas migration to off-site properties or landfill structures
- Passive venting of gas through the landfill cover system
- Extraction of landfill gas for the purpose of emission control or energy recovery

Landfill Gas Collection and Treatment

Landfill Gas Management - System Elements



(Source: Rettenberger, 1995)

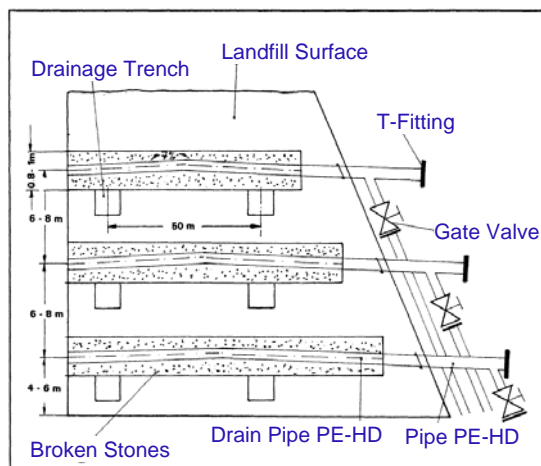
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Landfill Gas Collection and Treatment

Horizontal Gas Collection - Part 1



Scheme of a
Horizontal Gas
Collection System
with Gas Drains

(Source: Rettenberger, 1996)

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Landfill Gas Collection and Treatment

Horizontal Gas Collection - Part 2



Gas Drains
Made from PE-HD

(Source: www.rehau.de, internet-download)

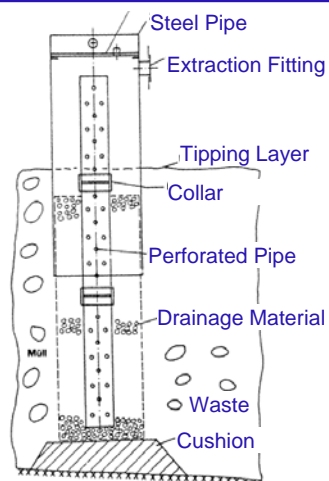
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Landfill Gas Collection and Treatment

Vertical Gas Collection - Part 1



Gas Well Torn
During Disposal

(Source: Rettenberger, 1996)

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Landfill Gas Collection and Treatment

Vertical Gas Collection - Part 2



Top of Gas Well for Tearing During Disposal

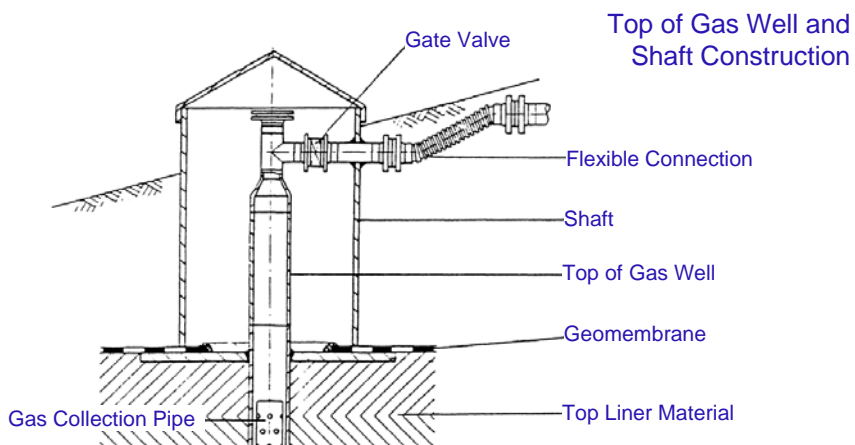
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Landfill Gas Collection and Treatment

Vertical Gas Collection - Part 3



(Source: Rettenberger, 1996)

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Landfill Gas Collection and Treatment

Vertical Gas Collection - Part 4



Top of Gas Well

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Landfill Gas Collection and Treatment

Gas Collection Equipment



Gas Compressor

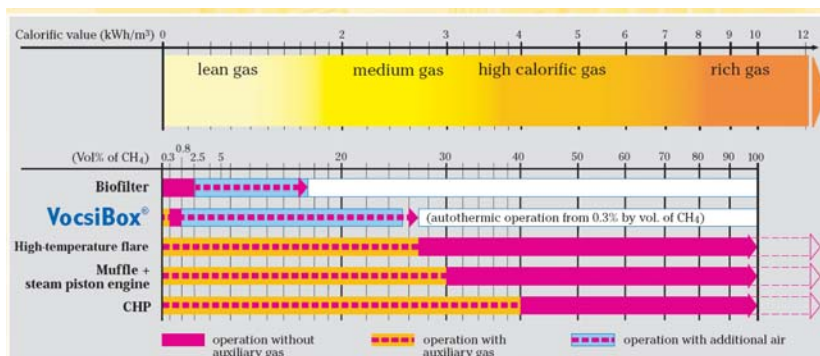
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Landfill Gas Collection and Treatment

Landfill Gas Treatment - System Elements



Ranges of Operation of Landfill Gas Treatment Systems

(Source: Haase, 2010)

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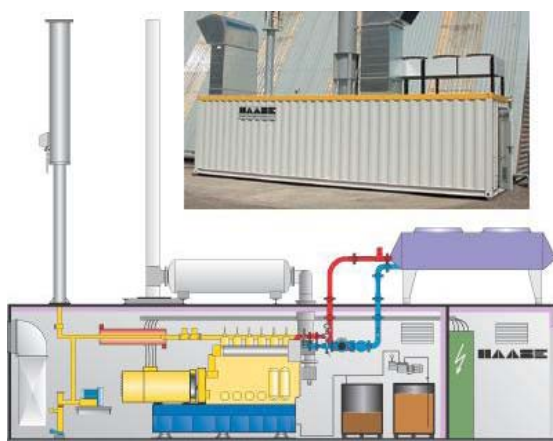
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Landfill Gas Collection and Treatment

Combined Heat and Power Unit - Part 1

Container Unit
for a CHP



(Source: Haase, 2010)

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Landfill Gas Collection and Treatment Combined Heat and Power Unit - Part 2



Container Unit
for a CHP

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Landfill Gas Collection and Treatment High Temperature Flares



High-
Temperature
Gas Torch

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Leachate Management and Treatment

Overview of Management Systems - Part 1

- Methods of Leachate Management
 - recirculation
(low leachate quantity and dry waste)
 - **evaporation**
(under arid climates, pre-treatment useful)
 - vaporisation
(in case of no surface water in the neighbourhood)
 - off-site treatment
(together with municipal sewage, pre-treatment useful)
 - **on-site treatment**
(2 - 3 treatment stages necessary for high discharge quality)

Leachate Management and Treatment

Overview of Management Systems - Part 2

- Leachate Recirculation
 - + accelerated degradation of BOD₅, COD
 - increasing leachate volume in landfill
 - partial necessary on landfills in the Middle East
- Evaporation
 - + simple and cheap alternative
 - + ideal circumstances under arid climates
 - to be used for significant leachate reduction

Leachate Management and Treatment

Overview of Management Systems - Part 3

- Off-site Treatment
 - + possible when neighbourhood to sewage TP
 - transport with trucks expensive
 - practical solution under particular circumstances

- On-site Treatment
 - + total treatment possible
 - very often difficult to operate and expensive
 - at least to be used for pre-treatment
(treatment before evaporation to minimise emissions)

Leachate Management and Treatment

Overview of Treatment Methods - Part 1

Overview of Methods of Leachate Treatment (1)

Method	Comments
Physical Methods	
Sedimentation	Low Costs
Evaporation	Preconcentrating constituents
Physical/Chemical Methods	
Activated Carbon Adsorption	Suitable for hydrophobic compounds in wastewater
Resin Adsorption	Suitable for chlorinated hydrocarbons, other hydrocarbons, aromatics
<u>Membrane Process/ Reverse Osmosis</u>	Reverse Osmosis, good retention
Ion Exchange	Only specialised ions suitable

Leachate Management and Treatment

Overview of Treatment Methods - Part 2

Overview of Methods of Leachate Treatment (2)

Method	Comments
<u>Chemical Methods</u>	
Wet Oxidation with H ₂ O ₂	No concentrating, elimination of residual COD and AOX
Wet Oxidation with Ozone/ UV-Treatment	No concentrating, elimination of residual COD and AOX
Wet Oxidation with Ozone/ Fixed bed catalysts	Fast reaction process
<u>Biochemical methods</u>	
Anaerobic treatment	No energy needs for oxygenation, no surplus sludge
Anoxic treatment	Denitrification
<u>Aerobic treatment</u>	Elimination of COD/BOD, most cost effective method
Nitrification	Oxidation of ammonia nitrogen from nitrite to nitrate

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Leachate Management and Treatment

Overview of Treatment Methods - Part 3



Landfill Wehrden,
County of Höxter
– Leachate
Treatment with
Reverse Osmosis

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Leachate Management and Treatment

Overview of Treatment Methods - Part 4



Landfill Wehrden,
County of Höxter
– Post-Treatment
of Concentrate
with Vaporisation

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Leachate Management and Treatment

Assessment of Treatment Methods - Part 1

- Anaerobic Lagoons
 - + simple and low-cost method
 - + suitable for highly loaded leachate
 - sensitive to low temperatures, only pre-treatment

- Aerated Lagoons
 - + favoured method of leachate treatment in warm climates
 - + simple, good removal of BOD ($BOD_5/COD > 0.4$)

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Leachate Management and Treatment

Assessment of Treatment Methods - Part 2

- Activated Sludge Plant
 - + better performance than aerated lagoons
 - more difficult to operate

- Aerobic Digesters
 - + good removal of BOD, less volumes than lagoons
 - more sensitive in operation

Leachate Management and Treatment

Example for the Middle East - Part 1

- Requirements on Leachate Management
 - sporadic and changing leachate production
 - use of high evaporation, partial leachate recirculation
 - treatment capacity for organic load

 - low to moderate investment and operation costs
 - low rate of equipment not produced in Iran

Leachate Management and Treatment

Example for the Middle East - Part 2

- Leachate Treatment Process
 - main process: evaporation
 - supported by biological pre-treatment
 - efficiency of aerated lagoons: 50 % (to be tested)
 - leachate recirculation in case of difficulties
 - rate of leachate recirculation: < 15 %
- Technical Specifications of the Ponds
 - lagoons with geomembranes
 - suitability of minerals has to be testes

Leachate Management and Treatment

Example for the Middle East - Part 3

- Storage and Anaerobic Lagoon
 - for buffering changes in leachate discharge
 - outlet for leachate recirculation
 - similar construction like aerated lagoon
 - sealed with geomembrane liner
 - in summer times operated as anaerobic lagoon
 - in winter times aeration is recommended

Leachate Management and Treatment

Example for the Middle East - Part 4

- Aerated Lagoon
 - for pre-treatment of leachate before recirculation
 - otherwise strong odour and operational problems
- artificial aeration necessary due to high BOD
- local conditions excellent (space, temperatures)
- sealed with geomembrane liner
- aeration with floating aerators

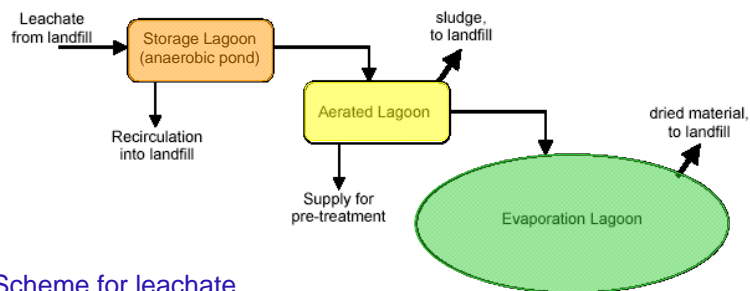
Leachate Management and Treatment

Example for the Middle East - Part 5

- Evaporation Lagoon
 - flat pond without aeration
 - surface/volume-ratio for high evaporation
- recommended liner:
compaction of natural soil with “self-lining”
- capacity for evaporation split into two lagoons
- for emptying one lagoon without disruption

Leachate Management and Treatment

Example for the Middle East - Part 6



Scheme for leachate management in arid climates

(Source: Ramke, 2005)

Landfill Operation

Tasks of Landfill Management and Operation

- Management Tasks
 - definition of waste admitted to disposal
 - entrance control
 - daily inspection
 - recording
- Operational Tasks
 - pre-treatment of waste
 - waste compaction
 - daily earth cover
 - collection of litter

Landfill Operation

Landfill Site Infrastructure - Part 1



Overview of an
Entrance Area

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Landfill Operation

Landfill Site Infrastructure - Part 2



Access Road,
Gate and Fence

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Landfill Operation

Landfill Site Infrastructure - Part 3



Collection Point
for Hazardous
Wastes from
Households

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Landfill Operation

Landfill Site Infrastructure - Part 4



Scale bridge

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Landfill Operation

Landfill Site Infrastructure - Part 5



Collection Point
for Recyclables

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Landfill Operation

Tasks of Landfill Management - Part 1

- Definition of Waste Admitted to Disposal
 - definition of a list with waste admitted to disposal (municipal waste, commercial waste, non-hazardous waste)
 - description of non-hazardous waste admitted to disposal (classification number, short description, characteristic parameters)
 - definition of a list with waste forbidden to be disposed of (industrial and hazardous waste, acc. to a classification system)

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Landfill Operation

Tasks of Landfill Management - Part 2

- Wastes Excluded Generally from Disposal in the EU
 - liquid waste
 - wastes which are in landfills
 - explosive, corrosive, oxidizing, highly flammable or flammable
 - hospital or other clinical wastes which are infectious
 - whole used tires

Landfill Operation

Tasks of Landfill Management - Part 3

- Entrance Control - Part 1
 - municipal waste: checking of the transport papers
 - non-municipal waste: checking of the waste documentation
 - check of correspondence with waste admitted to disposal
 - determination of weight or volume of the waste

Landfill Operation

Tasks of Landfill Management - Part 4

- Entrance Control - Part 2
 - determination of weight or volume of the waste
 - check of the waste by its properties at the entrance (odor, color, consistency, components etc.)
 - check of the waste by its properties at the point of deposit
 - keeping a register of quantities and characteristics of waste

Landfill Operation

Tasks of Landfill Management - Part 5

- Documentation of Permanent Conditions
 - documentation of the installed technical protection measure
 - constructional measures during operation
 - responsible operator and controlling administration
 - situation of staff, working schedule
 - operating instructions (landfill and equipment)
 - updated emergency plans (fire protection, hospital etc.)
 - maintenance of equipment
 - laboratory, equipment and activities

Landfill Operation

Tasks of Landfill Management - Part 6

- Daily Recording
 - types and mass of wastes disposed of
 - all regular activities of operation
(staff, machinery, expenses for fuel, maintenance of equipment)
 - all activities such as construction works etc.
(incl. restoration measures, maintenance of landfill structure)
 - documentation of unexpected events
 - results of daily control of landfill operation
 - all measurements of emissions and environmental impacts

Landfill Operation

Waste Disposal and Compaction - Part 1

- Objectives of Waste Compaction
 - **saving landfill volume** by increasing the density of waste
 - reduction of the **risk of fire** by minimising the intrusion of air
 - less attractiveness for **vermin**
(flies, cockroaches, rats, snakes)
 - less blowing of **dust and litter**
- Requirements in Germany
 - Landfill operation has to ensure maximum use of landfill volume by **best possible compaction** of wastes disposed of.

Landfill Operation

Waste Disposal and Compaction - Part 2



Modern
Compactor

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Proposals for a System of Accreditations

Overview

- National Office of Landfill Technology
 - on behalf of the Ministry of the Environment
 - supported by scientific-technical associations
 - directed by a steering committee
- Regional Offices of Landfill Technology
 - part of the regional administration (wilaya)

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Proposals for a System of Accreditations Overview

- Project related protagonists
 - owner or operator
 - designer
 - prove engineer
 - construction company
 - third party expert

Proposals for a System of Accreditations Tasks on the National Level

- National Office of Landfill Technology
 - definition of **standards**
 - accreditation of **designers**
 - accreditation of **construction companies**
 - accreditation of **prove engineers**
 - accreditation of **third party experts**
 - accreditation of **reference laboratories**
 - permission of **construction products**
 - **training**

Proposals for a System of Accreditations

Tasks on the Regional Level

- Regional Offices of Landfill Technology (Wilaya)
 - approval of **correctness of procedures**
 - **confirmation of selection** of designers and prove-engineers
 - **issuing of licenses** for start of construction
 - confirmation of selection of contractors and third-party experts
 - **spot checking** of construction
 - **final inspection** and acceptance
 - **inspection of landfill operation**

Proposals for a System of Accreditations

Project Related Tasks - Part 1

- Owner/Operator
 - commission of designer
 - commission of prove engineer
 - commission of third party expert
 - commission of construction company
 - **application** for licenses
 - **report** to regulatory authority

Proposals for a System of Accreditations

Project Related Tasks - Part 2

- Designer
 - planning and design
 - site supervision

- Prove Engineer
 - review of design documents
 - proving certification of design documents

Proposals for a System of Accreditations

Project Related Tasks - Part 3

- Construction Company
 - in-house quality testing of construction execution

- Prove Engineer
 - third party quality testing of construction execution
 - survey
 - geotechnical works
 - geosynthetical installations

QM-System Implementation Schedule Part 1

- Phase 1
 - preparation of legal preconditions
 - establishing of the National Office of Landfill Technology

- Phase 2
 - finalisation of guidelines and manuals
 - establishing of the Regional Offices of Landfill Technology
 - training of the accreditation team

QM-System Implementation Schedule Part 2

- Phase 3
 - training of members of regulatory authorities
 - training of potential prove engineers and laboratories
 - training of potential certified designers and companies

- Phase 4
 - accreditation of prove engineers and laboratories
 - accreditation of designers and construction companies

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