APPLICATION OF BIOTECHNOLOGY FOR ODOUR CONTROL IN TANNERIES

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ODOUR CONTROL and BIOTECHNOLOGY

- ❖Public nuisance
- ❖Labour relations
- ❖Occupational health

- •Physio-chemical methods
  - •Conventional and energy intensive
  - •Contaminant is transferred from one phase to another
- •Biological methods
  - •Emerging as competitive alternative
  - •Degrades the contaminants into innocuous or less contaminating products
  - •Wide range of compounds proven recently
  - •Microbial population mobilizes the hydrocarbons mainly to CO_2 and H_2O

BIOTECHNOLOGICAL PROCESSES

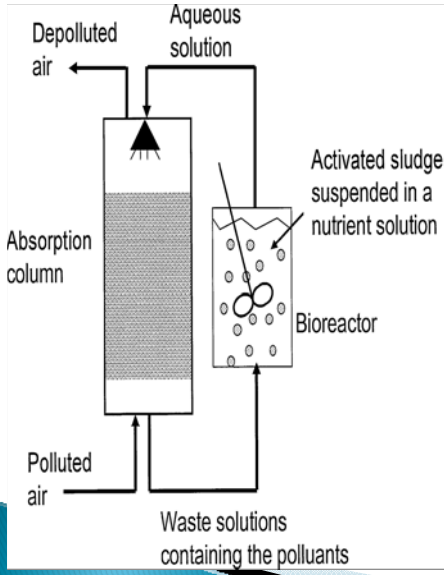
- ❖BIOSCRUBBER
- ❖BIOTRICKLING FILTER
- ❖BIOFILTER

Distribution coefficient (Henry's coefficient) Of compound or mixture of compounds needs to be treated determines the system configuration

Bioscrubber and Biotrickling filter
Microbial population can be dispersed in a liquid phase

Biofilter
Microbial culture immobilized on a carrier material

BIOSCRUBBER



Addition of emulsifying agents in the aqueous solution can significantly improve the elimination of less soluble compounds

BIOSCRUBBER

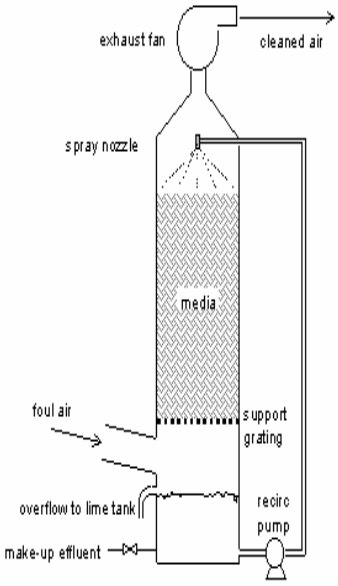
Advantages

- Operational stability
- Good control of the biological parameters
  - pH and nutrients)
- Less pressure drops
- Less space requirement

Limitations

- Treats only
  - readily soluble VOC (alcohols, ketones)
  - compounds with low Henry coefficients (<0.01)
- Production of a sediment sludge
- Production of wastewater.

BIO – TRICKLING FILTER (BTF)



Design of BTFs

- Similar to that of BFs
- Liquid recirculates continuously

Packing material

- Synthetic materials
- Provides surface for biofilm attachment

Recirculating liquid helps

- Control the pH
- Concentration of the nutrients
- Recycle the metabolic end-products

BIO – TRICKLING FILTER (BTF)

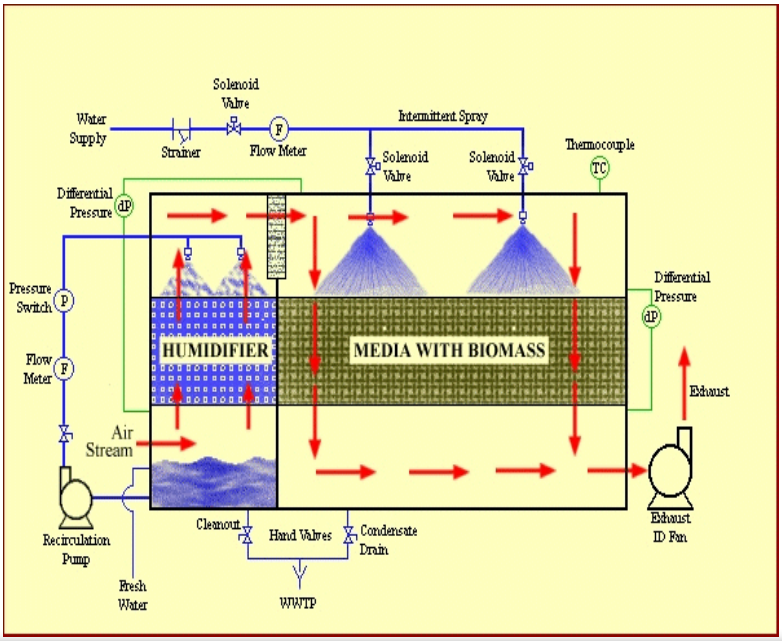
Advantages

- Recirculating liquid
- Better performance

Disadvantages

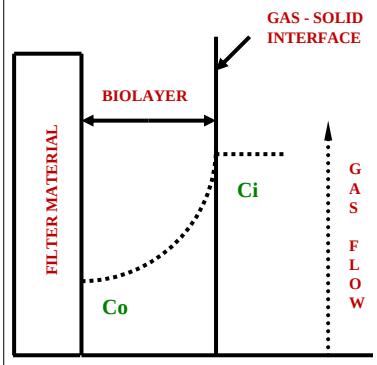
- Biomass accumulation
- Cost
- Replacing the recirculating liquid
- Electricity for blower and pump
- Biomass removal

BIOFILTER



BIOFILTER MECHANISM

Biofilter Principle



Pollutant Penetration and Degradation mechanism in Biofilter

Ci — Initial Concentration of Pollutant

Co — Final Concentration of Pollutant

Two-phase process consisting of

- Transfer of the compounds from the gas phase to water phase
- Oxidation of the absorbed compound by the bacterial species present in the filter.

Biolayer has several roles in biofiltration

- Aqueous environment for bacterial life.
- Nutrients for biological activity.
- Acts as the water/air interface
- Acts as the recipient of the by-products of reaction.

BIOFILTERS

Advantages

- Low investment
- Easy to dispose bedding material
- Low pressure drop
- Little effluent water

Disadvantages

- Requirement of large surface
- Periodic replacement of filter material
- Difficulty of monitoring
  - humidity and pH of the filter material
- Dependence of efficiency on concentration variations

Technical characteristics of bio-scrubbers bio-trickling filter bio-filters

Bioprocess	Microorganisms	Liquid phase	Depollution step
Bioscrubber	Suspended in the bioreactor, in the aqueous growth medium	• Mobile • Continuously dispersed • Recycled	• VOC/air separation within the absorption column • VOC oxidation in the aerated bioreactor
Biotrickling filter	Immobilized on the filtering material	• Mobile • Continuous trickling over the filter bed • Possible recycling	• In the filter bed • In the biofilm
Biofilter	Immobilized on the filtering material	• Occasional bed irrigation with nutrient solutions	• In the filter bed • In the biofilm

IMPORTANT OPERATING AND DESIGN PARAMETERS

- pH
- Temperature
- C:N:P ratio
- Empty bed residence time (EBRT)
- Volumetric gas surface loading rate (VGSLR)
- Pollutant mass loading rate (PMLR)
- Elimination capacity
- Removal efficiency

Odour causing compounds in Tanneries

Process	Compound
Soaking	Foul odour
Limimg, Relimimg& Deliming	Ammonia
Pickling	Hydrogen sulfide
Tanning	Acid vapours
Retanning/ Dying/ Fatliquoring	Kerosene, Solvent and dye overspray, Toluene and toxic dyes
Buffing / Coating	Alcohols, Esters, Ketones, Solvent overspray, volatile organic air emissions, Toluene, xylene
Product Storage	Kerosene, Toluene, Methyl ethyl ketone and Trichloroethylene

VISITS TO TANNERIES - ERODE

Tanneries visited

M/s KKSK Leather Industry

M/s S.A.Abdul Azeez Leather Industry

M/s EKM Leather Industry

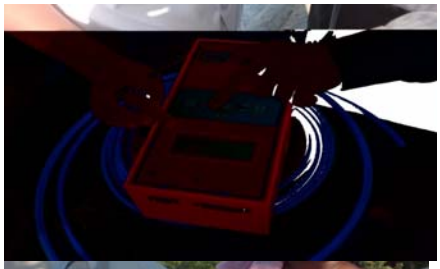
Tanneries identified

M/s KKSK Leather Industry

M/s S.A.Abdul Azeez Leather Industry

CONCENTRATION OF ODOR COMPOUNDS OBSERVED AT SITE

NH_3 (ppm)	H_2S (ppm)
16-65	1-17



PROVEN BIODEGRADABLE COMPOUNDS IN BIOFILTER

- Benzene
- Toluene
- Hydrogen sulfide
- Carbon disulfide
- Mercaptans
- Dimethyl sulfide
- Dimethyl disulfide
- Ammonia,
- Methanol
- Ethanol
- Propanol
- Butanol
- Aldehydes
- Butraldehyde
- Pyridinesacetone
- Styrene
- Xylene
- Methylene chloride
- Di and tri chloromethane
- Tri and tetra chloroethane
- Nitrogen oxides
- Isopentane
- Ethyl acetate
- Gasoline derived voc's

ODOUR CAUSING COMPOUNDS - TANNERY

Ammonia Benzene Xylene
Hydrogen sulfide Toluene

BIOFILTER - AMMONIA REMOVAL

SPECIFICATIONS

Diameter of the filter	0.19 M
Height of the biofilter	0.785M
Height of the filterbed	0.51M
Filter media used	Mixed agricultural residue
Volume	14.5×10^{-3} M^3
Initial MC	58%

Bedding material
(I- coir pith, II-Rice husk, III-sponge, IV- saw dust)

Composite bedding material

LOADING
START UP
OPERATION

MICROORGANISM SOURCES

- Soil samples
- Sludge samples
- Effluent samples

GENERIC SPECIES

- Sulfide oxidizing bacteria
- Ammonia assimilating bacteria
- BTX degrading bacteria

PERFORMANCE - AMMONIA REMOVAL

Parameter	Biofilter (inoculated mixed cultures of ammonia assimilating bacteria)
Removal Efficiency (%)	98
Empty Bed Residence Time (sec)	175
Gas Surface Loading Rate ($m^3/m^2/hr$	10.59
Ammonia Mass Loading Rate ($kg/m^3/hr$)	0.3
Elimination Capacity ($g/m^2/hr$)	75
pH	7.5 – 7.6
Moisture Content (%)	52

INLET AMMONIA CONCENTRATION = 200 PPM

BIOFILTER - REMOVAL OF H_2S

Filter material

Mixed Agri Residue

Filter capacity

20 litres

Moisture Content (Wet) Initial	28%
Moisture Content after 35 days (without Humidifier)	35%
Moisture Content after 35 days (with Humidifier)	65%
Initial pH	8.9
Bulk Density	0.22 gm/cc

Seed culture

Aerobic sludge of distillery plant effluent Treatment plant contains 25,000 mg/l of VSS.

PERFORMANCE – H_2S REMOVAL

Parameter	Biofilter (inoculated mixed cultures of SOB bacteria)
Removal Efficiency (%)	99
Empty Bed Residence Time (sec)	109
Gas Surface Loading Rate (m/hr)	25
Hydrogen sulfide Mass Loading Rate ($kg/m^3/hr$)	91
Elimination Capacity ($g/m^2/hr$)	76
pH	8.9 TO 4.1
Moisture Content (%)	65 TO 50

INLET Hydrogen sulfide CONCENTRATION = 2000 PPM

ON GOING STUDIES ON BIOFILTER FOR THE REMOVAL OF H_2S and AMMONIA

VOLUME = 1 CU.M
MATERIAL OF CONSTRUCTION = PPFRP

FABRICATED AND INSTALLED STUDIES ARE IN PROGRESS

ON GOING STUDIES ON BIOFILTER FOR THE REMOVAL OF H_2S and AMMONIA



PREPARATION OF BEDDING MATERIAL



ON GOING STUDIES ON BIOFILTER FOR THE REMOVAL OF H_2S and AMMONIA



LOADING OF BEDDING MATERIAL



CONCLUSIONS

- Biofilter is a good option for the removal of H_2S and Ammonia at low concentrations
- Moisture Content is an important parameter
- Addition of a Humidifier or irrigations of the bed at regular intervals is a good option to maintain Moisture Content
- Optimum Moisture Content will result in the efficient performance of Biofilter