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Odour formation and control

Bruce Jefferson

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Contents

- **Introduction**
- **Odour sources**
- **Odour measurement and mapping**
- **Legislation**
- **Treatment options**

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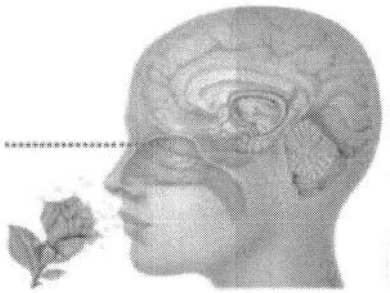
Odour

- What is an odour…
- Something that activates our sense of smell
- Can be good or bad..
- Unpleasant rather than harmful



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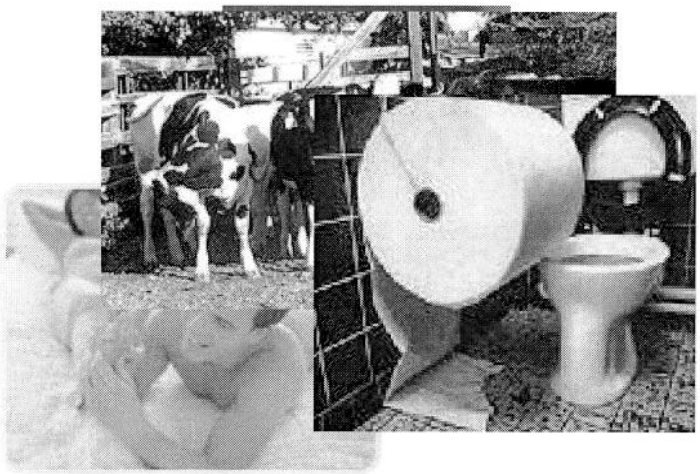
Odours we know…



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Odour type

Odour compound	Threshold (ppm_v)	Characteristic odour
Ammonia	46.8	Pungent, irritating
Chlorine	0.314	Pungent suffocating
Methyl mercaptan	0.0021	Decayed cabbage
Sulphur dioxide	0.009	Pungent, irritating
→ Hydrogen sulphide	0.0047	Rotten eggs
Thiocresol	0.000062	Skunklike, rancid

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Odour formation

- Odourous compounds in wastewater normally contain either nitrogen or sulphur
- Generated from:
  - Microbial respiration
  - Metabolism (fermentation)
- Industrial discharges: volatile organic compounds (VOC) – solvents, petrol derivatives

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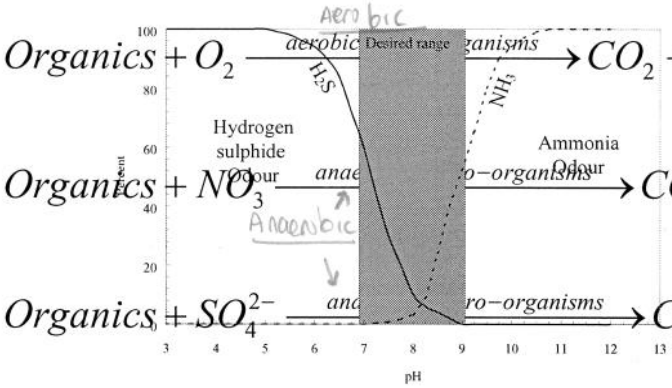
Formation

$$Organics + O_2 \xrightarrow{aerobic} CO_2 + H_2O$$

$$Organics + NO_3^- \xrightarrow{anae} CO_2 + N_2$$

$$Organics + SO_4^{2-} \xrightarrow{ana} CO_2 + H_2S$$



Prevention is better than cure

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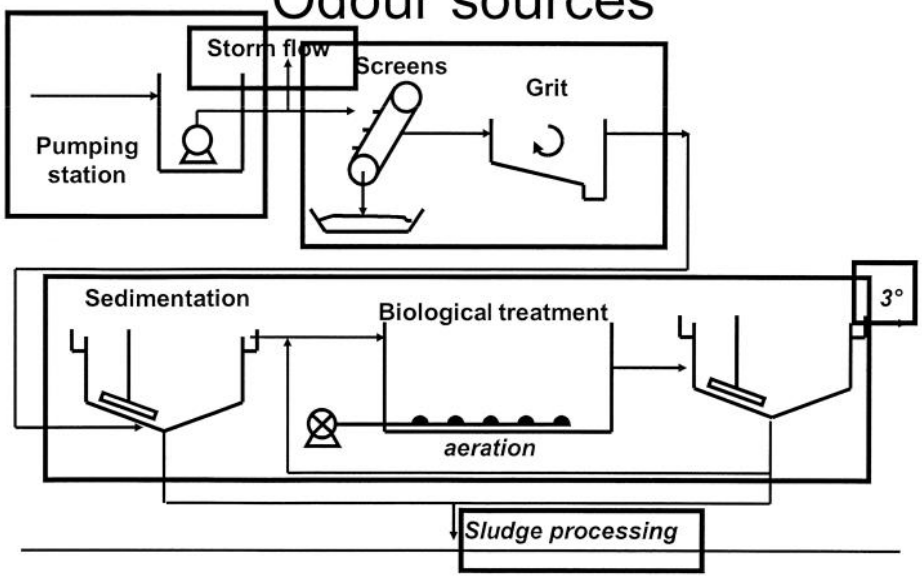
Odour sources



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Top of a sludge tank

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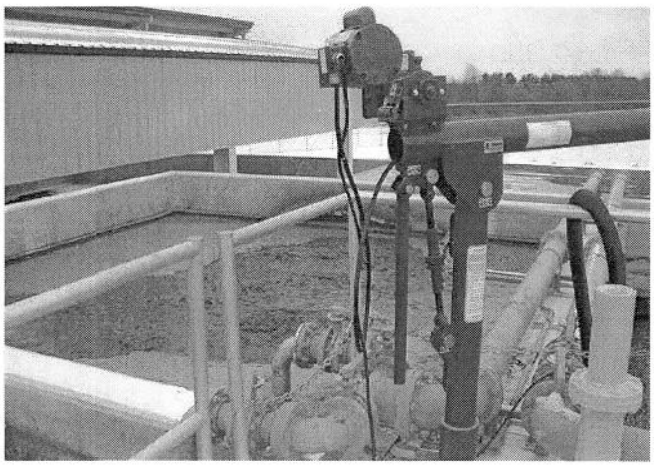
Sludge tank



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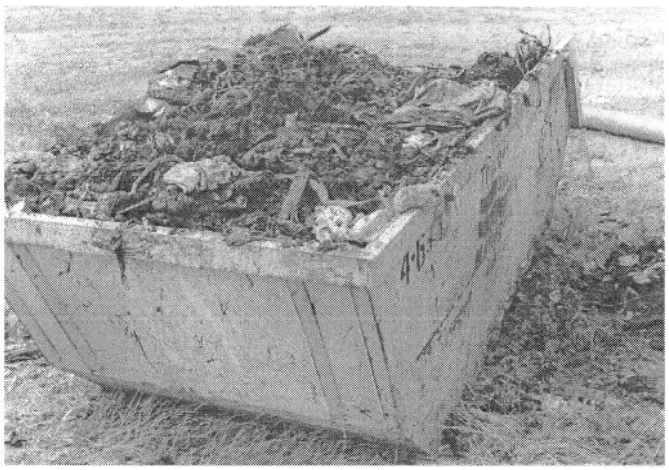
Screenings



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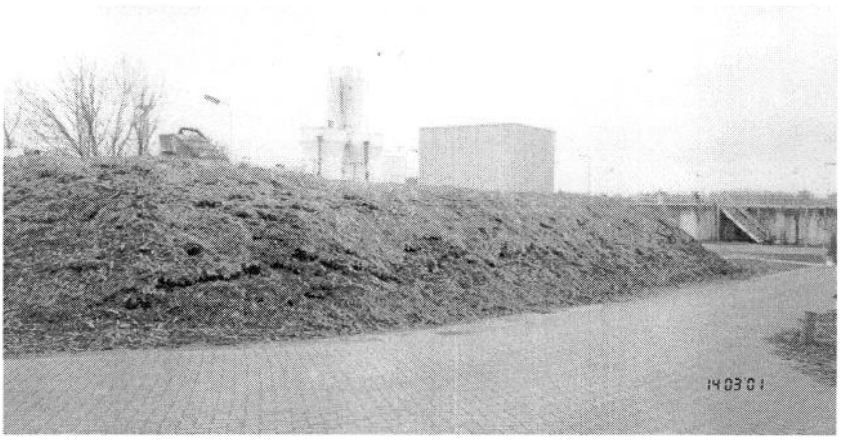
Composting



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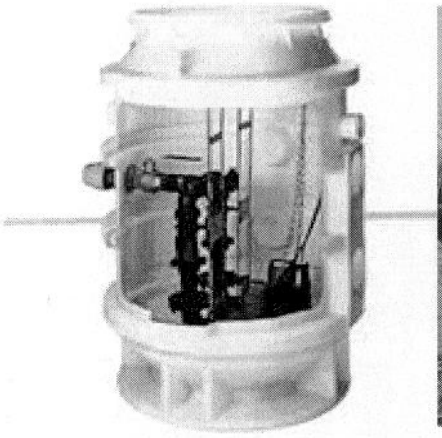
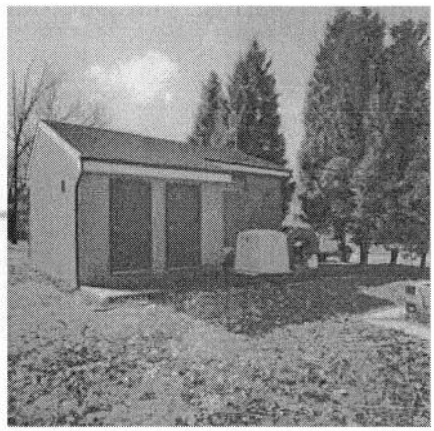
Pumping station





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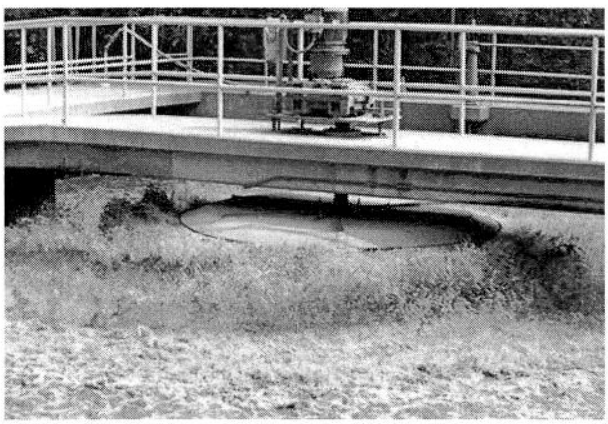
Activated sludge



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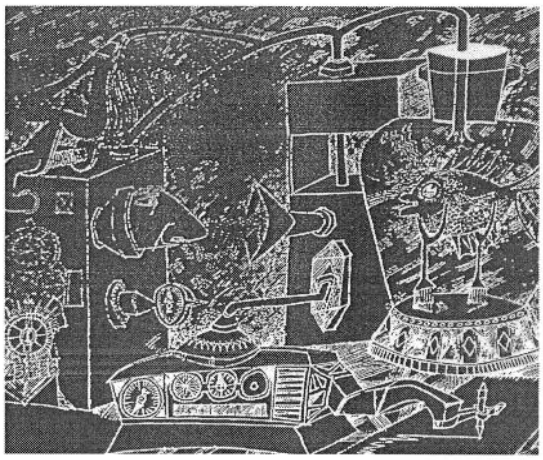
Odour measurement



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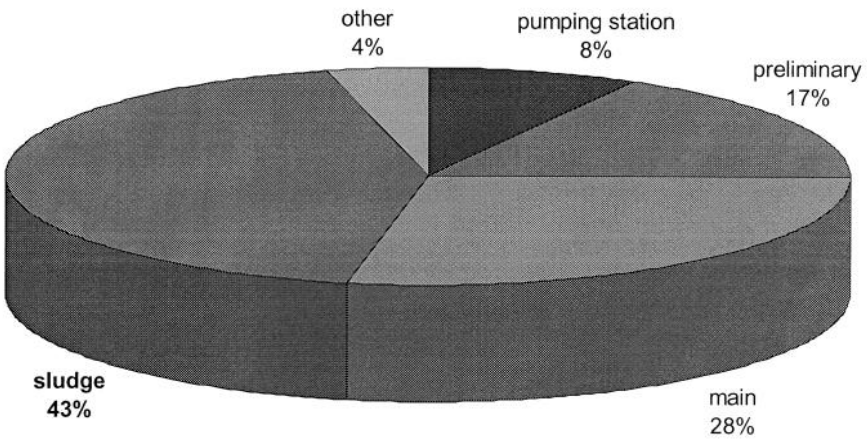
Sources



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Sensory attributes of odour

- PARAMETERS -

THRESHOLD	**Concentration when first detected**
DISCRIMINATION	**Ability to discriminate between odours**
INTENSITY	**Perceived strength at different concentrations**
HEDONIC TONE	**Pleasantness**
ODOUR QUALITY	**Association and complexity**

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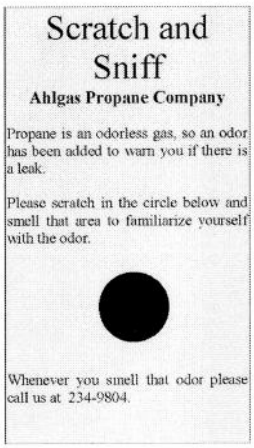
Odour measurement units


Scratch and Sniff

Ahlgas Propane Company

Propane is an odorless gas, so an odor has been added to warn you if there is a leak.

Please scratch in the circle below and smell that area to familiarize yourself with the odor.

Whenever you smell that odor please call us at 234-9804.

- ppmv mL per m^3
- (Not the same as ppm)

- Odour units: olfactometry
- As the number of dilutions at which 50% of the odour panel can detect no odour.
- $ou.m^{-3}$

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Measurement methods

- Analytical
- Sensory
- Collection

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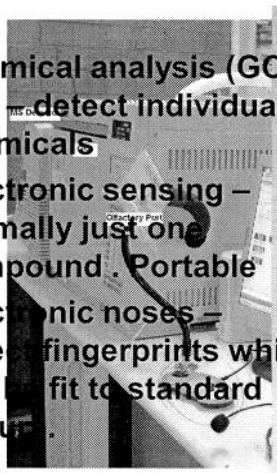
Analytical

- Chemical analysis (GC-MS) – detect individual chemicals
- Electronic sensing – normally just one compound . Portable
- Electronic noses – detect fingerprints which can be fit to standard odours.



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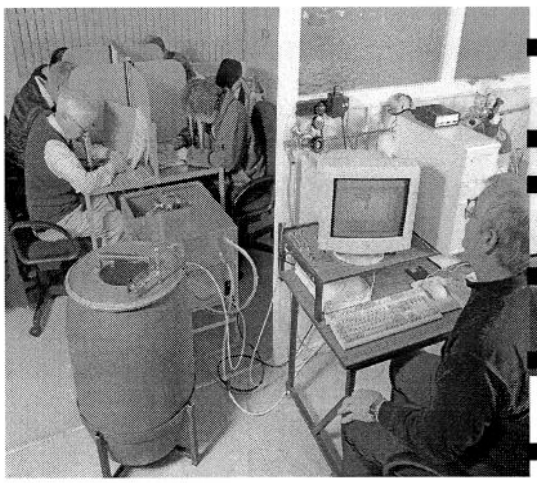
Sensory



- Determine concentration
- By progressive dilution
- (Threshold)
- Reference to another gas
- (Suprathreshold)
- >100 Ou.m^{-3}

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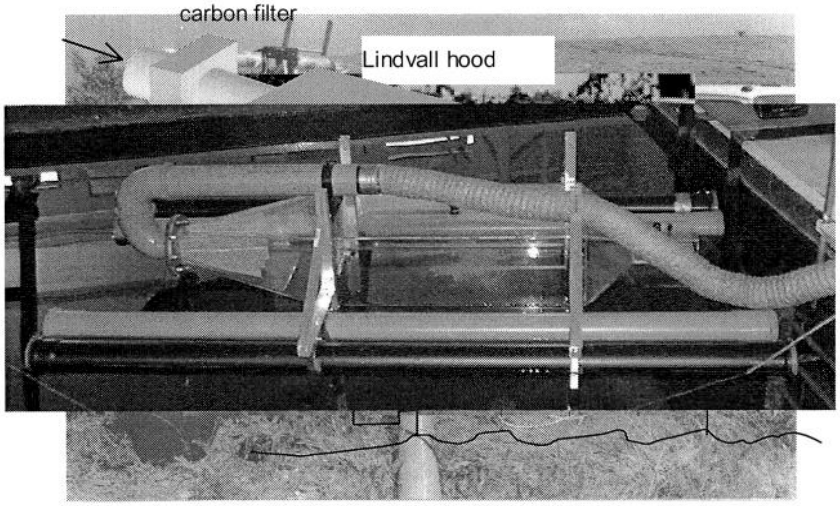
But what about collection



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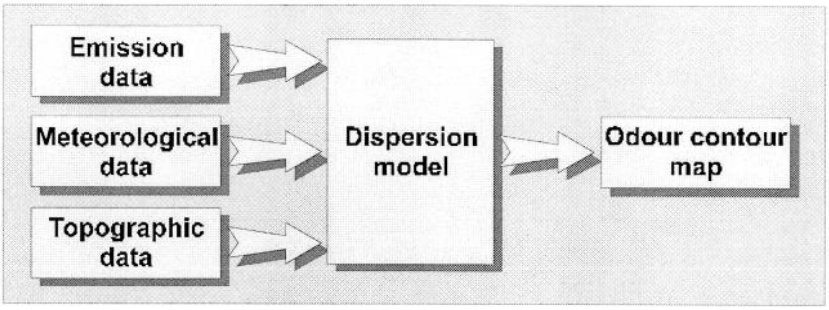
Odour mapping



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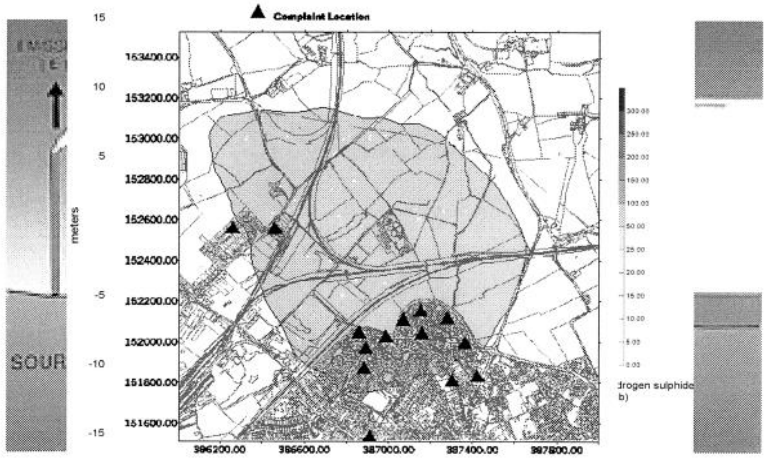
Odour mapping



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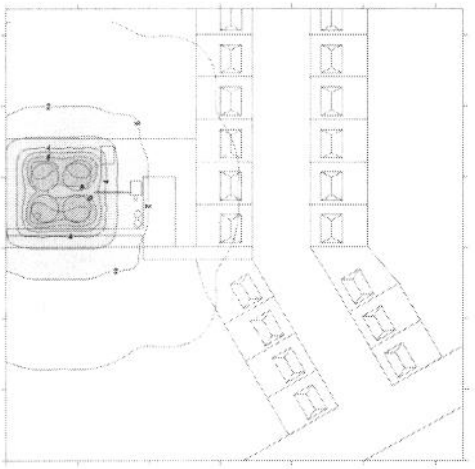
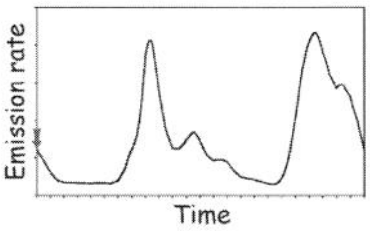
Odour mapping





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Odour does respect a boundary

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How much is too much?

- Use of "epidemiological measures" to determine acceptable limits
  - acute - high concentrations / short time scale
  - chronic - low concentrations / long time scale
- Concentration
- Frequency
- composite unit of concentration and frequency based over one year of exposure,
  - e.g. "between 5-10 ouE/m3 at the 98-percentile; or
  - "not to exceed 5 ouE/m3 at the 99-percentile"

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Regulation

- Two approaches
  - It doesn't matter..., it's only a smell..., it doesn't affect anyone's health..., they're using it as an excuse to interfere (NIMBY).
  - It causes complaint..., this may stop our operations in future..., it won't go away..., odours influence the perception of competence or control over operations...,
  - ...you choose, but....

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Regulation (EHOs)

	1993/94	1997/98
Complaints received	6,116	5,583
Notices served	86	41
Prosecutions	5	2

"...odour is currently one of the most successful grounds for objection and refusal for the development of new waste treatment processes..."

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Technology options

- **Prevention**
  - **Avoid anaerobic conditions**
  - **Reduce 1° sludge storage time**
  - **Employ preventative chemical dosing**
- **Treat in liquid phase**
- **Minimise transfer into gas phase**
- **Minimise odours formation near boundary**
- **Capture and treat**
  - **Covers**
  - **Technology selection**

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Technology options

- Sprays and chemical dosing
- Chemical scrubbers
- Biotreatment
- Dry scrubbers

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Spraying

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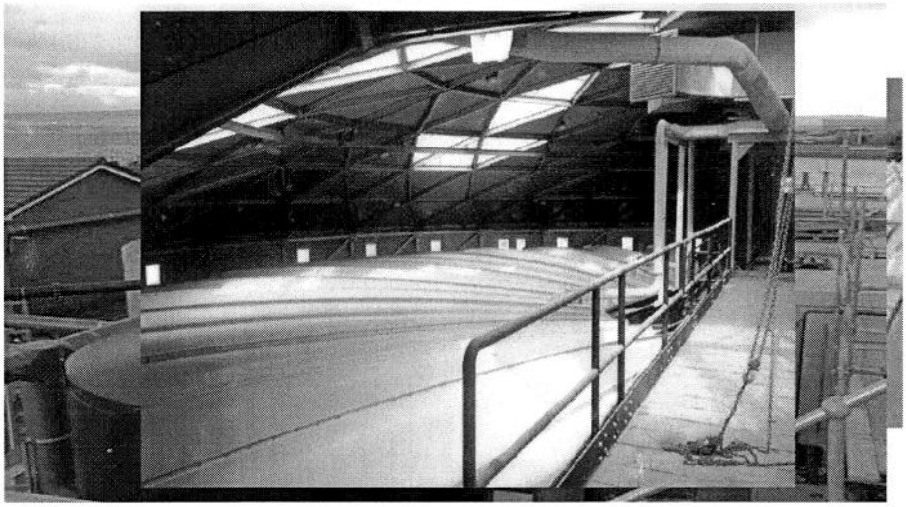
Covers



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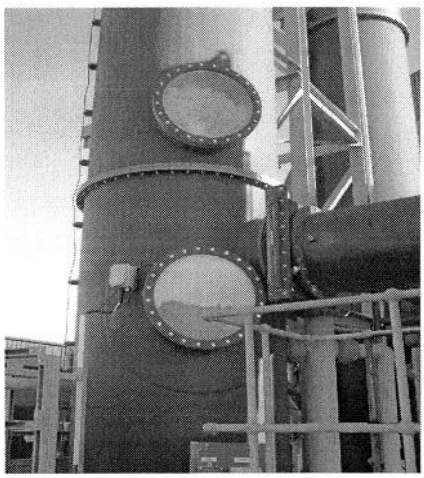
Chemical scrubbers



- High maintenance requirements
  - recognised by staff allocated
- Much effort given to improving performance
- Popular, due to:
  - greater control options
  - ability to ramp-up performance for peaks
- S deposition noticed where overloaded
- Mechanical problems

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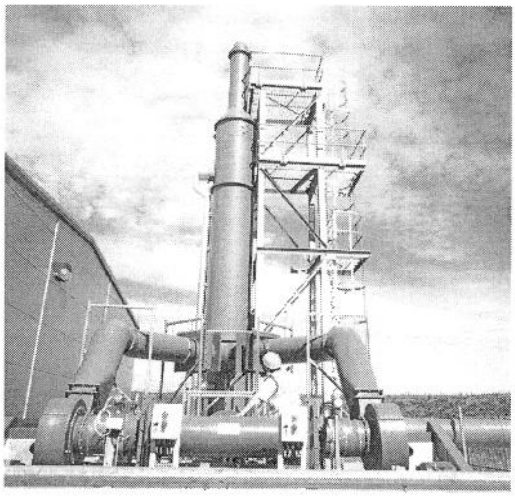
Chemical scrubber



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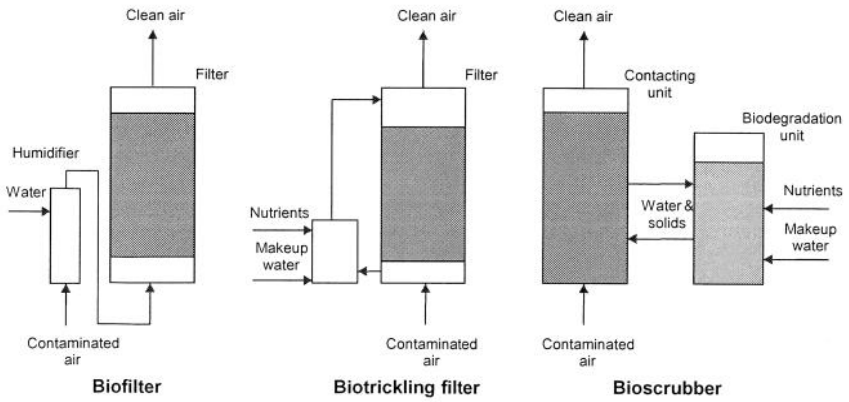
Biotreatment



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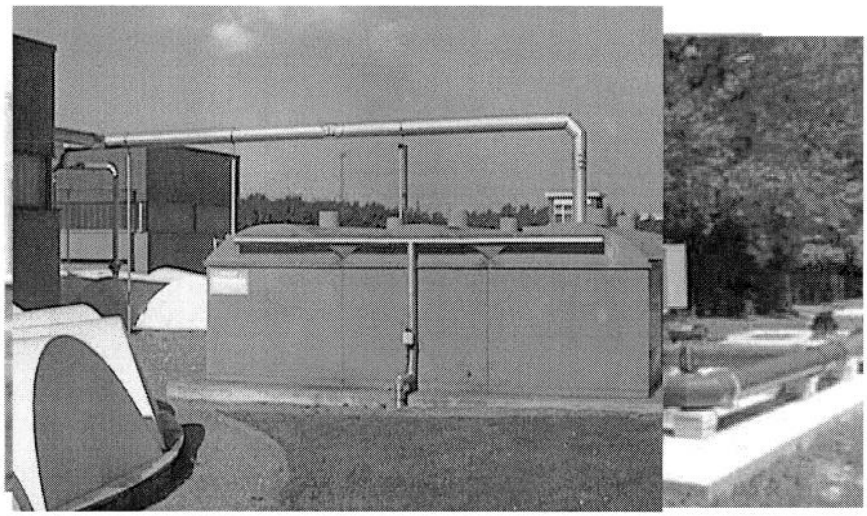
Biofilters



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Biotreatment

	Biofilter	Biotrickling filter	Bioscrubber
Advantages	Simple Low cost	Simple Low cost	Good control Very stable
Disadvantages	Low conc Load variation	Moderate conc Load variation	
Application areas	Sludge holding Pump stations	-	Sludge processing
Application frequency	common	not used	not common
Removal H_2S NH_3 VOC	 good good moderate	 good moderate moderate	 good good good

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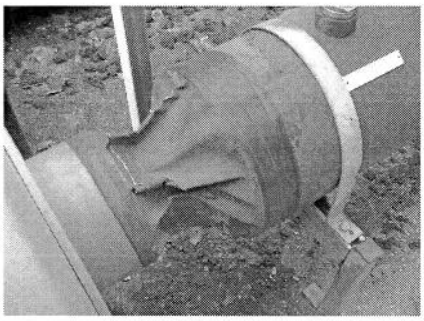
Biotreatment



- Opinions of performance media specific:
  - Peat/Heather – poor
  - Calcified media – good
- Popular, low maintenance
- Very unpopular!
  - Difficult to understand
  - High maintenance requirements
- Opinion of performance is poor
  - Especially for peak loads

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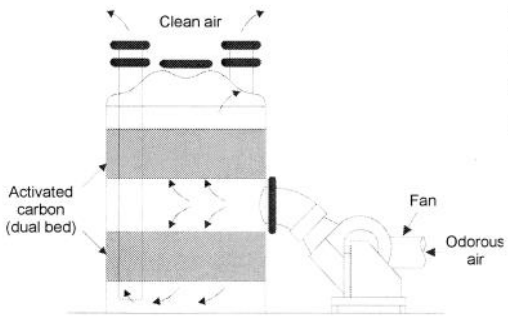
Technology options



- Low/intermittent loads
- Polishing
- Outlet < 50 ppb
- Mixed view of performance
  - Good where used for polishing
  - Poor where subjected to higher loadings
  - commissioning issues
  - regeneration

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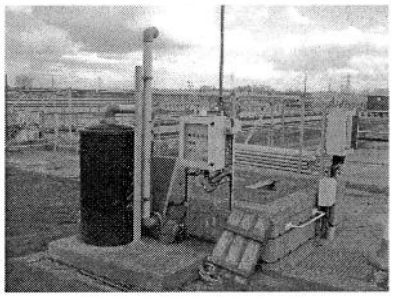
Dry scrubbers



- Adsorber + oxidiser
  - Peacemaker (ClO_2) most common (65%)
  - Sulfatreat (Fe_2O_3) (25%)
  - Purafil ($KMnO_4$ + other) (10%)
- Enhanced H_2S but may reduce other odourants as pore space used up
- Wide conc range
- Generally popular
- Low maintenance requirements
- Appear to work well

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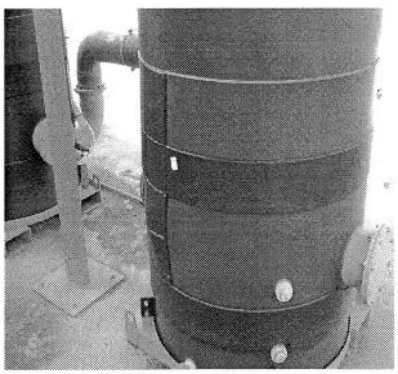
Dry scrubbers (CIF)



- $Fe_2O_3 \rightarrow Fe_2S_3 \rightarrow S$
- Roughening filters
  - Never used alone
  - Buffer out high load variations
- Low maintenance requirements
- Mixed opinions
  - Slow start-up (humidity?)
  - Overloading
  - Media degradation
  - Casing failure

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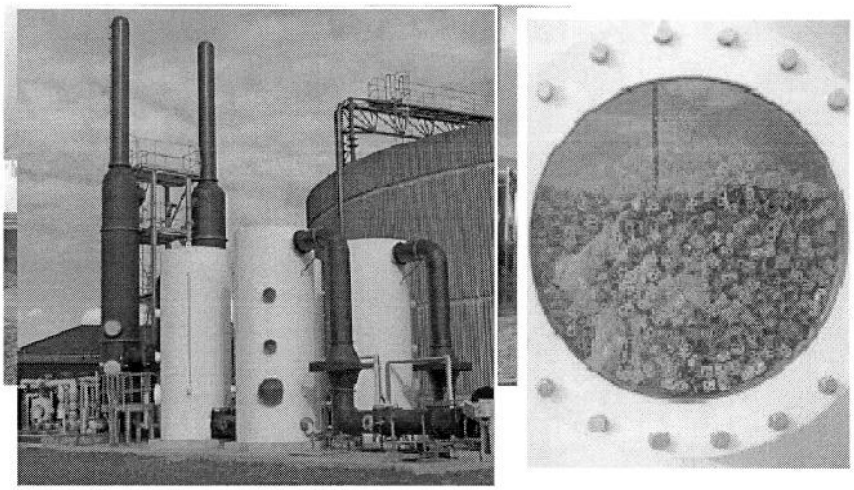
Dry scrubbers (ERG)



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Technology options

Technology	Strengths	Weaknesses
Absorption	High rate Control Flexibility	Cost Maintenance VOCs
Biotech	Low cost Ease of op Perception	Low solubility chem Irrigation Load variation
Dry processing (adsorption)	High flow Ease of op Low cap cost	Regeneration Can have high opex Mixed for VOCs