

# The Use of Leaching Tests in DQRA

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# Leaching is just leaching, right?

BS EN12457-1 to 4:2002

CEN/TS14429:2005

CEN/TS14405:2004

EA NEN7375:2004

NRA R&D Note 301:1994

NEN

AFNOR

SPLP

TCLP

CEN/TS16637:2014 tests

wacky stuff

ASTM LEAF tests

MEP

DIN

EA NEN7371:2004

BS ISO18772:2008 tests

# What you may learn

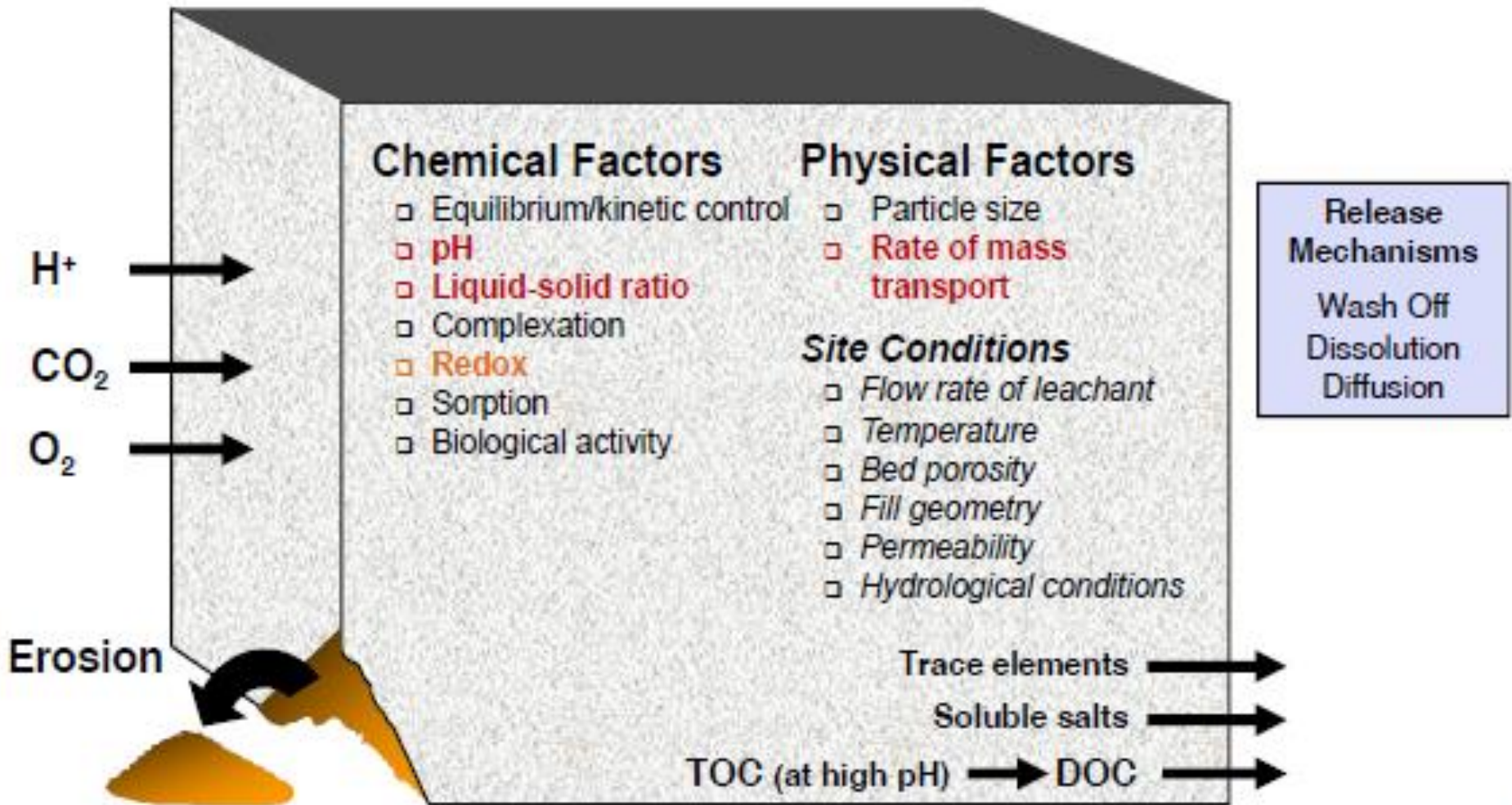
- The leaching process/es
- The main types of leaching test available
- Common pitfalls in applying to DQRA
  - WAC, damn WAC and lies
  - numbers, numbers, just gimme numbers
  - who needs a source term anyway?
- The airy and the sticky
- What more do we need?
  - (audience participation)



# What is leaching?

- The removal of soluble substances and colloids from a solid (e.g. soil, aggregate, roof tiles), through percolation or diffusion, when placed in contact with a liquid
- Leaching is a variable feast, even from the same solid material
- Leaching tests are designed to reflect exposure, under percolation or surface contact (diffusion), conditions and/or to accelerate the leaching process
- They do not REPLICATE field behaviour

# Controlling mechanisms



from Kosson *et al.* 2012 LEAF Overview

# Test frameworks

- CEN/TC 292 (waste characterisation)
  - BS EN 12920:2006 framework (hint: should be followed when developing conceptual model)
  - range of tests for availability, pH dependence, batch, percolation and diffusion (standard (batch) others TSs)
- CEN/TC 351 (release from construction products)
  - 3 TS for test selection, percolation and diffusion (all TSs)
- ISO/TC 190 (soil quality)
  - BS ISO 18772:2008 (based on EN 12920 approach)
  - range of ISO/TS 21286 tests for pH dependence, batch and percolation (published as TSs 2007)
- ASTM LEAF – Leaching Environmental Assessment Framework
  - working with Europe, comprehensive set of tests, data management and modelling (geochem and mass transfer) tools



# Types of leaching tests (1)

- Batch test (single or serial)
  - relatively simple
  - relatively fast (24 hours)
  - widely available
  - relatively low cost
  - eluate volume vs analytical suite
  - designed as a compliance test, does not provide info on behaviour (although 2-stage limited behaviour) or leaching mechanism
  - at L/S 10 may miss risk drivers through dilution
  - likely to miss peak concentration of declining source substances
  - L/S may be greater than field exposure conditions
  - extrapolation needed to lower L/S, in my experience this is rarely done



# Types of leaching tests (2)

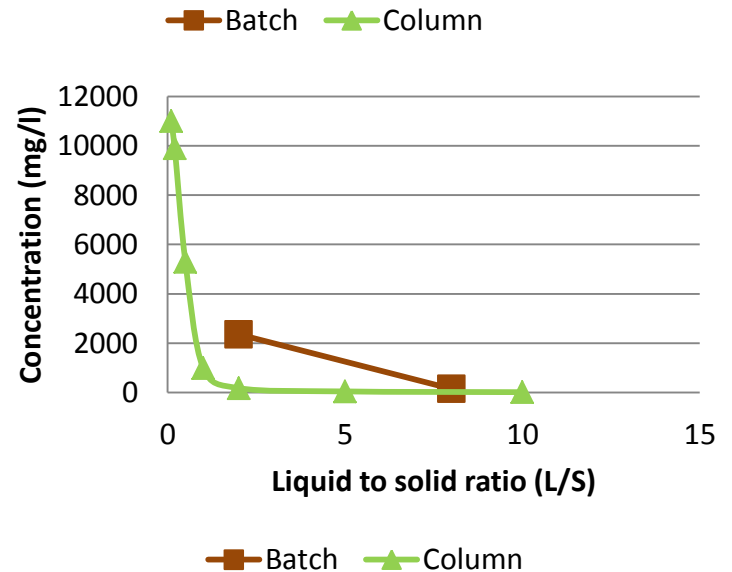
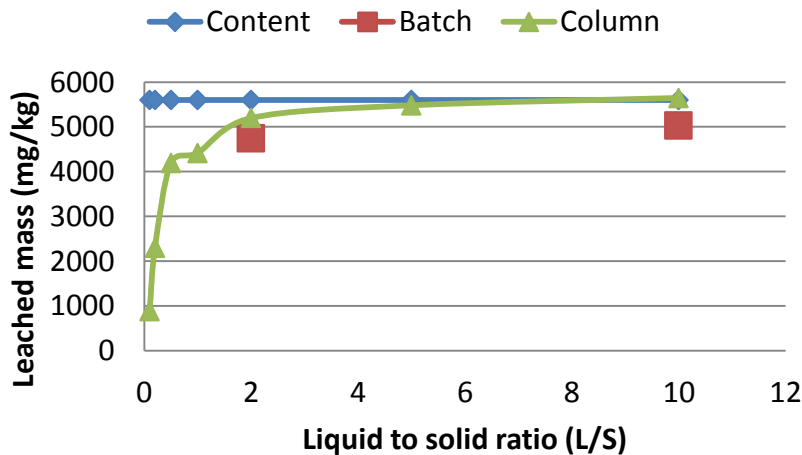
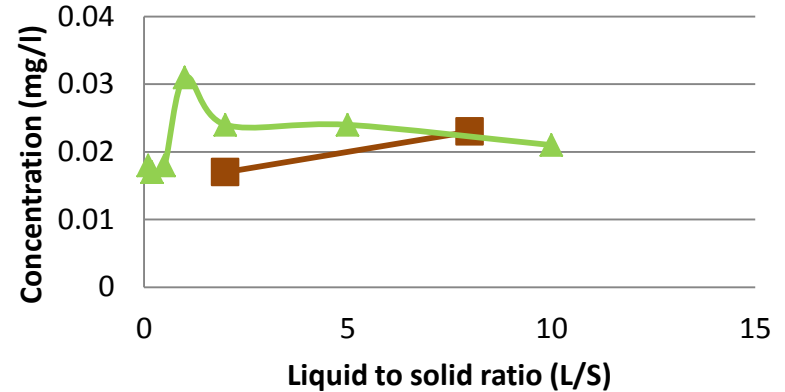
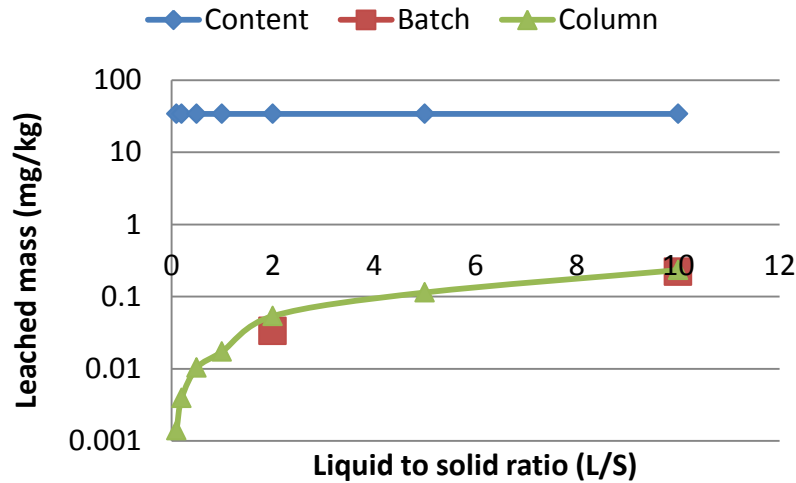
- Percolation test (upflow)
  - more complex set-up
  - runs for 3-4 weeks, depending on soil
  - not widely available (few UK labs)
  - larger sample size than batch test
  - 1<sup>st</sup> eluate volume vs analytical suite
  - relatively high cost (set-up plus 7 eluates)
  - minimal separation steps – less risk of adsorption
  - designed to provide info on **leaching behaviour** of granular materials
  - remediation – selection, treatability, verification?
  - may be run recirculating (non-standard) to ensure equilibrium e.g. PAH





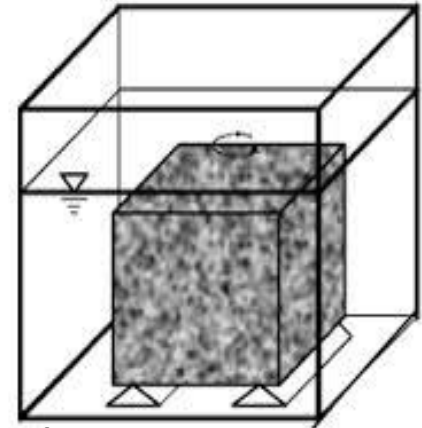
# What do results look like?

## How do they compare?



# Types of leaching tests (3)

- Diffusion (tank) test
  - relatively simple set-up
  - runs for 64 days (compliance test for 4)
  - not widely available (few UK labs)
  - relatively high cost (set-up plus 7 eluates)
  - larger sample size than batch test
  - provides info on leaching mechanism and for modelling release
  - can be used on monolithic and sheet-like materials, and adapted for dense compacted granular material



# To WAC or not to WAC – Is that the question?

- WAC batch test and analytical suite are often specified. What about WAC limits?
- How does this fit with your conceptual model?
  - are test conditions fit for purpose (e.g. L/S)?
  - are the analytes substances of interest?
- WAC batch tests may be validated and standards, but are they fit for purpose?
  - generic modelling of landfill scenarios
  - generic “average” partition coefficients
  - status of substances (DWS vs MRVs)

# Numbers, numbers, ...

- What numbers float your boat?
  - Concentrations in mg/l? If so what does the concentration from a batch test actually mean?
  - Mass release in mg/kg? If so, how will you use the data? Are you simply comparing to waste acceptance criteria? If so, why?
  - Mass release in mg/m<sup>2</sup>? If so, how will you use the data? Many people use concentrations from a tank test. If you do, what is your justification?
  - Remediation validation – how will you make a before-after comparison, especially if soil treatment is S/S?
  - If you collect them (numbers) make them work!

# Developing the source term

- Advice has been clear for a number of years that leaching test results are preferable to content and partition coefficients
- Think about what the test results mean?
- How do they relate to your conceptual model?
- What is the relevant timescale you are modelling?
- What are the likely rates of infiltration?
- What is the release mechanism?
- What redox conditions do you expect?
- What about organics? ..... the airy and the sticky

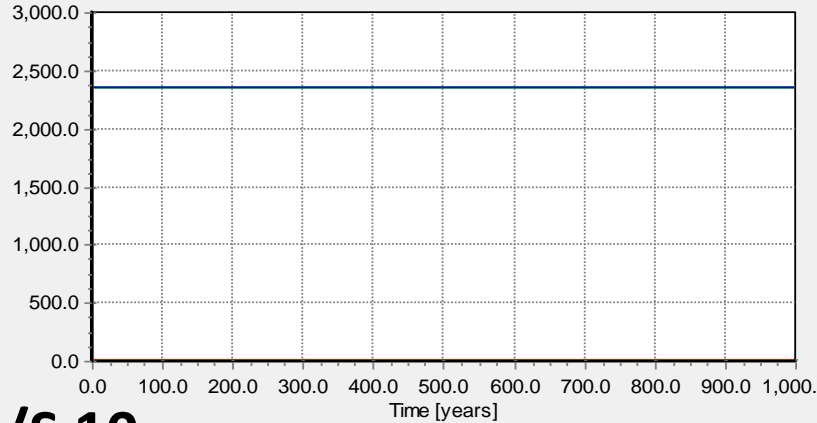
# Implications for DQRA?

## Batch test results – L/S

### L/S 2

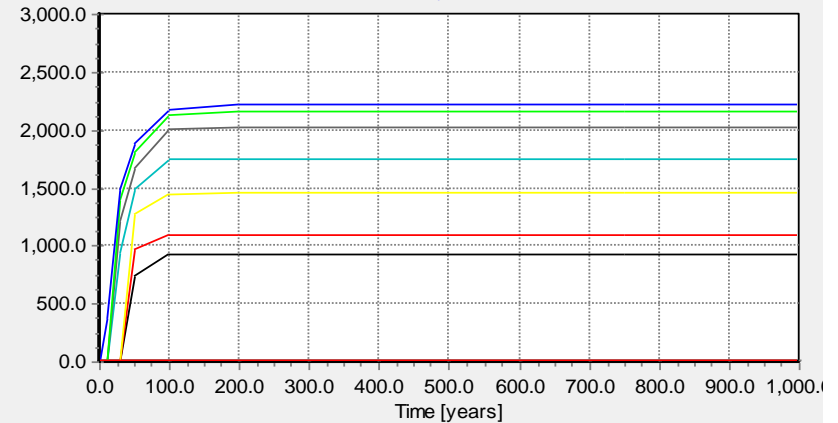
Results: Testium LS 2, Scenario 1a- Amenity embankment Source concentration - 1001 Trials

Time History



Results: Testium LS 2, Scenario 1a- Amenity embankment Receptor concentration Compliance point 50m - 1

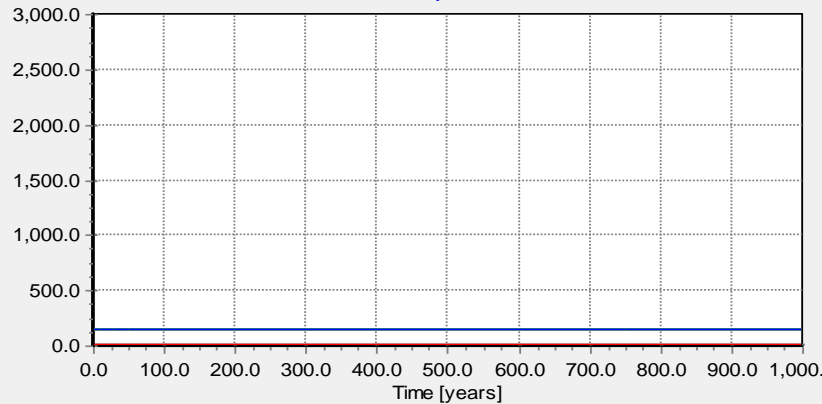
Time History



### L/S 10

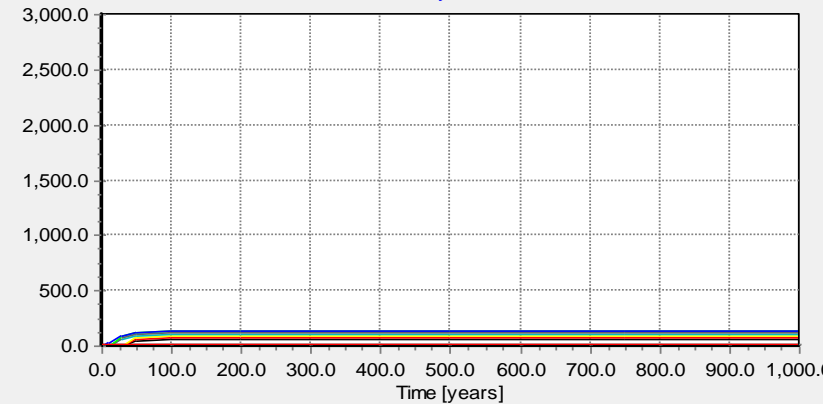
Results: Testium LS10, Scenario 1a- Amenity embankment Source concentration - 1001 Trials

Time History



Results: Testium LS10, Scenario 1a- Amenity embankment Receptor concentration Compliance point 50m - 1

Time History



F:\Leaching test constant source.csm  
2016-06-26 15:46:28



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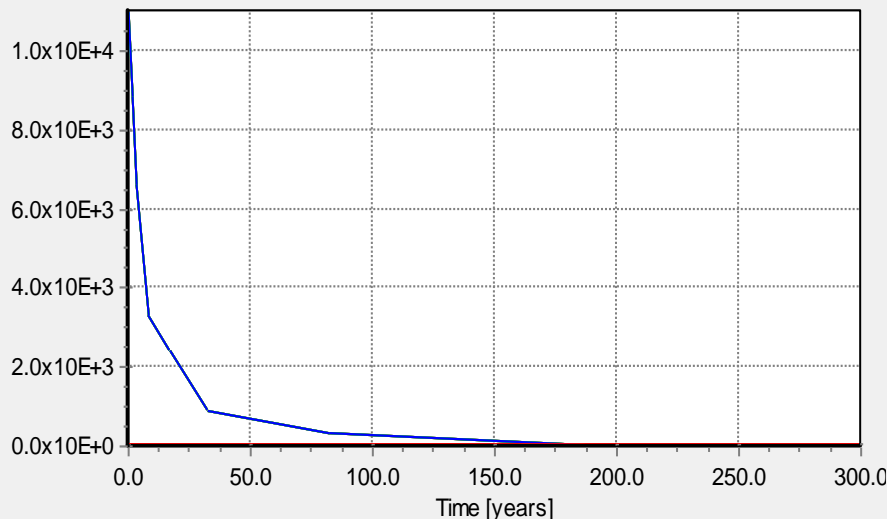


# Implications for DQRA?

## Percolation test - Declining source

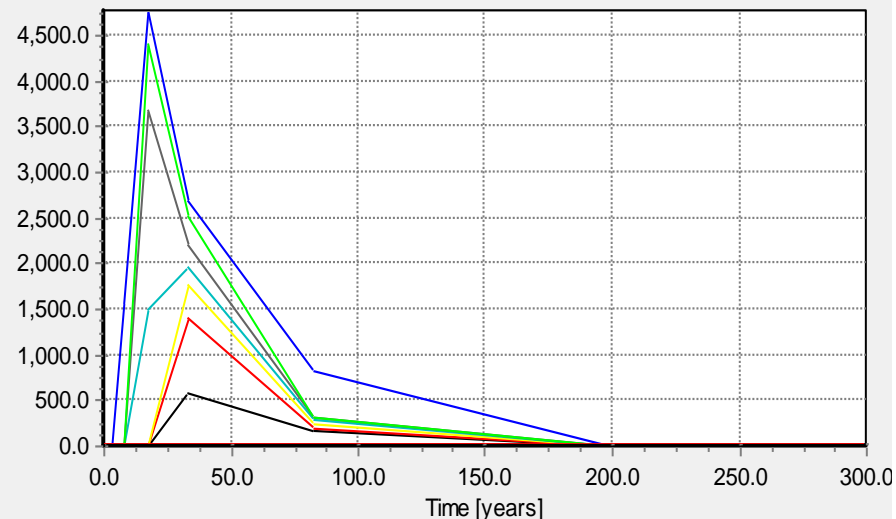
- Declining term – from accumulated release curve (mg/kg)
- Do NOT use “book” values to define rate of decline
- Model run with very low  $K_d$

Results: Testium, Scenario 1a- Amenity Embankment Source concentration - 1001 Trials  
Time History



F:\Leaching test declining.csm  
2016-06-26 16:32:33

: Testium, Scenario 1a- Amenity Embankment Receptor concentration Compliance point 50m - 100  
Time History



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2016-06-26 16:32:33

# How to deal with organics?

- Most tests are not validated or designed for leaching of organics
- The airy ones – can volatile loss be accommodated in test design (e.g. zero headspace)?
- The sticky ones – how can (local) equilibrium be established?
  - batch test duration >24 hrs
  - centrifuge, not filter
  - percolation test - recirculation
- The soluble ones – should be OK subject to adsorption being addressed
- ISO/TS 21268 tests are designed for non-volatile organics and inorganics
  - published but not validated. Equilibrium?

# Audience participation

- What do we need to do to make best use of leaching testing?
  - Regulatory acceptance of leaching tests, including non-standard?
  - Are UK labs tooled up to deliver the range of tests?
  - Do we need more tests?
  - Do we need more guidance?
    - test selection
    - developing the source term
  - What about training?
  - Any other issues?

