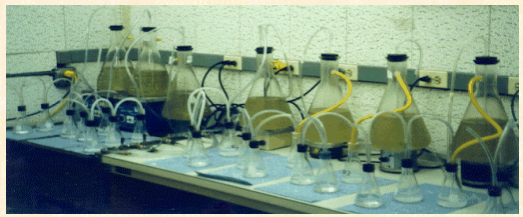
OECD Criteria for Ready Biodegradability: Environmental Interpretation & Study of Alternatives

[1]Nopens, I., [1]Verbrugge, T., [1]Seghers, D., [2]Krzanowska, A., [1]Vanrolleghem, P.A. & ERASM Monitoring & Model Validation Task Force (M&MV TF)

[1]BIOMATH, Ghent University, Coupure Links 653, 9000 Gent, Belgium; [2]P&G ETC, Strombeek-Bever, Belgium



Ready biodegradability test (OECD 301 A-F)

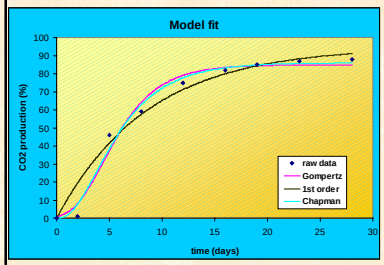
OBJECTIVES

- **Compilation of large Chemical Industry database of *standard test* and *field* biodegradation data**
- **Evaluate reliability of 10 day window (10DW) as indicator of fast & complete mineralisation**
- **Exploration of potential alternative criteria that reflect the concept of 'Ready Biodegradability', and are more environmentally meaningful**
- **Can kinetics derived from ready biodegradability test results be extrapolated to the real environment ?**

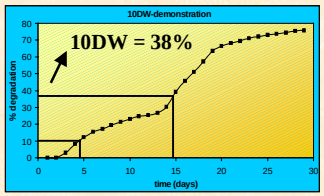
Modeling

- first order Y = A*(1-exp(-k*t))
- Gompertz Y = A*exp(-exp(-k*t))
- Chapman Y = A*(1-exp(-k*t))$^{-1/n}$
- Single Monod
- Double Monod

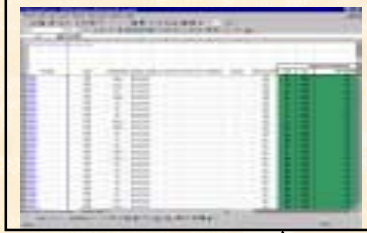
with: A = plateau (%)
k = specific biodeg. rate (day^{-1})



10 day window ?



ERASM Database



CONCLUSIONS

- ***ERASM Database: Properties and Analysis***
  - *> 800 test results* (OECD 301 - 303, monitoring) of commercial chemicals (Excel-sheet)
  - Analysis of classical 10DW gave **false negatives/positives in 25-30% of test cases**, assuming ultimate biodegradation has occurred at 75% (CO_2/ThOD) and 90% (DOC)

- ***Ready biodegradability tests: Possible Alternative ?***
  - Single-step degradation curves fitted with 4 models (i.e. *first order, chapman, gompertz, Single Monod*)
    - **no superior model** identified when describing a broad set of data/chemicals
  - Two-step degradation curves : **Double Monod clearly superior** compared to other models
  - **Curves can be better characterised through curve fitting than via 10DW**
    - datasets with *min. 10-15 data points* required
    - k (day^{-1}), A(%) obtained from parameter estimation
  - **3D-partitioning technique was used to search for alternative criterion (Fig. 1)**
    - Single-step degradation: *combinations of k, A identified* (see table below)
      → better description of functional concept of Ready Biodegradability than 10DW
    - Two-step degradation: 10DW definitely not applicable, 3D-method not yet applied

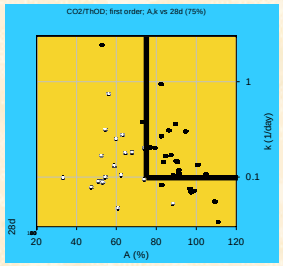


Figure 1

Simple rules for A and k →

Suggested Alternative for 10DW

	DOC		CO_2/ThOD	
Par.	10DW (70%)	28d (90%)	10DW (60%)	28d (75%)
A	> 60	> 80	> 70	> 75
k	> 0.2	> 0.3	> 0.1	> 0.1

- ***Environmental Interpretation and Extrapolation***
  - **No good correlation between OECD 301 (mineralization) and OECD303 test results (parent removal or DOC - Fig. 2)**
  - mineralisation of 50-60% (28 days) in a ready test is adequate to ensure >90% Parent removal in a CAS-test
  - mineralisation < 50 % in a ready test: no prediction of parent removal in a CAS-test possible

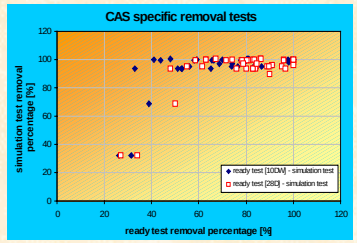


Figure 2

WWTP

River

NEXT STEPS

- continuation of data collection
- apply 3-D partitioning to Double Monod-fitted curves
- Further extrapolation analysis of ready tests to environmental behaviour
- Verification and refinement of EU TGD kinetic defaults used to extrapolate between ready and simulation/field tests

Acknowledgements: M&MV TF = Van Wijk, D. (AkzoNobel), Evans, M. (AstraZeneca), Pagga, U. (BASF), Hirschen, M. (Clariant), Wind, T. (Henkel), Battersby, N. (SHELL), Ur-Rehman, N. (Unilever) & Schowanek, D. (P&G). This study was sponsored by ERASM