Assessment of Waste Streams

Sven Wagner

4th EPSC Conference, 03-12-2024

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Day 2	Program Barcelona Process Safety congress - Tuesday December 3 2024		
Time	**Auditorium**	**Room 5**	**Room 6**
08.30	Registration & Network forum		
09.00	**Prof. Christian Jochum - Learnings from the Correnta waste treatment fatal incident**		
10.00	Coffee break at Network Forum		
Session Chair	*Process Safety Instruments Leader: Randy Garabedian*	*Leadership & Culture Chair: Rainer Hoss*	*Learning from Incidents Chair: Stefan Drees*
10.45	**Andreas Scholz, Vynova - Implementation of the PS Fundamentals at Vynova**	**Ron Stockfleth, Shell - Personal Journey - 11 years of Process Safety Management at Shell**	**Christian Kapp, TotalEnergies - Learning from a Fluid Catalitic Cracking event**
11.20	**Rainer Semmler, TÜVSud - Acoustic emission testing to support Process Safety**	**Andre de Rooij, New Behavior - Modern safety leadership aspects**	**David Keane, Risktec - Safety Critical Task Analysis - Lessons from Industry**

Dr. Sven Wagner (sven.wagner@tuvsud.com)

- 2020 – today Global Business Line Manager Process Safety
- 2018 – today Head of TÜV SÜD's Process Safety Competence Center in Basel (CH) and Board Member of TÜV SÜD Schweiz AG
- 2015 – 2018 Safety Engineering Manager NA (RCP/ON) at BASF Corp. (USA)
- 2012 – 2015 Process Safety Expert at Swissi PS (CH)
- 2011 – 2012 Associate Principal Scientist Process Safety at AstraZeneca AB (S)
- 2000 – 2010 Associate Director Process Engineering/Safety at AstraZeneca AB (S)
- 1997 – 2000 Supervisor Process Safety Laboratory at H. Lundbeck A/S (DK)
- 1995 – 1996 Senior Scientific Officer at the Health & Safety Executive (UK)
- 1985 – 1996 MSc in Chemistry and PhD in Chemical Engineering from TU Berlin (GER)

Accidents from waste

Statistics

HSE, UK - 2008

- 1989 – 2005: 142 incidents involving reactive waste
  - 62% at waste producer site
  - 25% at waste treatment company
  - 8% during transport
  - 5% other
- Reaction types:
  - 19% reaction of metals to produce hydrogen
  - 14% Nitric acid with solvents
  - 10% hypohalites, e.g. bleach
  - 9% Monomers
  - 8% acid – base reactions
  - Unknown and other 32%
- The most reliable data per year averaged at 11 incidents pa

EU (MARS) - 2024

- 1989 – 2022: 85 hazardous waste incident investigated
  - 71% during processing and transferring
  - 28% during storage
  - 1% unknown
- Initiating events:
  - 38% mixing of incompatible waste/unforeseen reactions
  - 32% presence of unexpected waste/contaminants
  - 11% failure of equipment
  - 7% inappropriate handling

Why is chemical waste problematic?

- Waste holds no real financial interest.

- Potentially corrosive
- Toxicity
- Flammability

- **Reactivity:**
  - Varying and often uncertain composition
  - Potentially large-scale operation often in large un-agitated and poorly instrumented vessels
  - Variety of type of waste, e.g. due to new technologies such as batteries etc.
  - No or very limited understanding/knowledge of interactions with other wastes, material of construction as well as contaminants from previous wastes
  - Already work-ups or e.g. solvent recycling maybe not considered real “chemistry” and are potentially not sufficiently assessed
- Typically, no expert group involved in assessing the hazards

Is it hazardous to dissolve an acid in a solvent?

Lessons learned (HSE & EU)

- Pre-acceptance require a useful characterization of the waste
  - Ratios
  - Physical form
  - Hazard information e.g. flammability, toxicity, corrosiveness, reactivity, thermal stability, etc.
  - Originating process information e.g. off-spec material, process interruption, wash-media, recycling etc.

- Establish a robust waste analysis plan
- Establish pre-acceptance procedures
- Incorporate strict waste rejection procedures
- Connect quality assurance with waste supplier management
- Identify realistic accident scenarios and handle mitigation/response procedures effectively

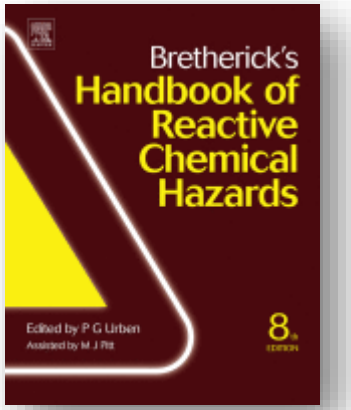
- Sampling (i.e. testing)

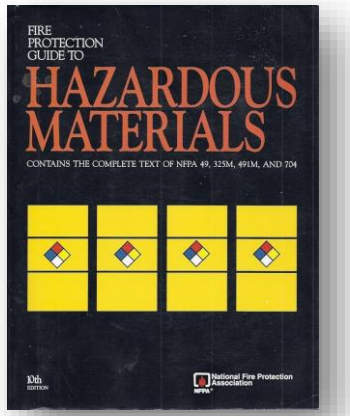
Desktop Screening

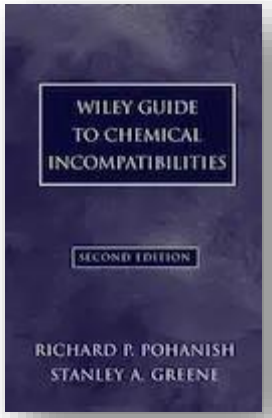
- **Purpose:**
  - to predict potential chemical reaction hazards based on a paper exercise. (That is, without carrying out experiments)

- **Use of public literature:**

  Experience from incidents of chemical processes shows that they are rarely caused by exotic chemistry. That is, most incidents can be explained by chemistry that is readily accessible from public literature.





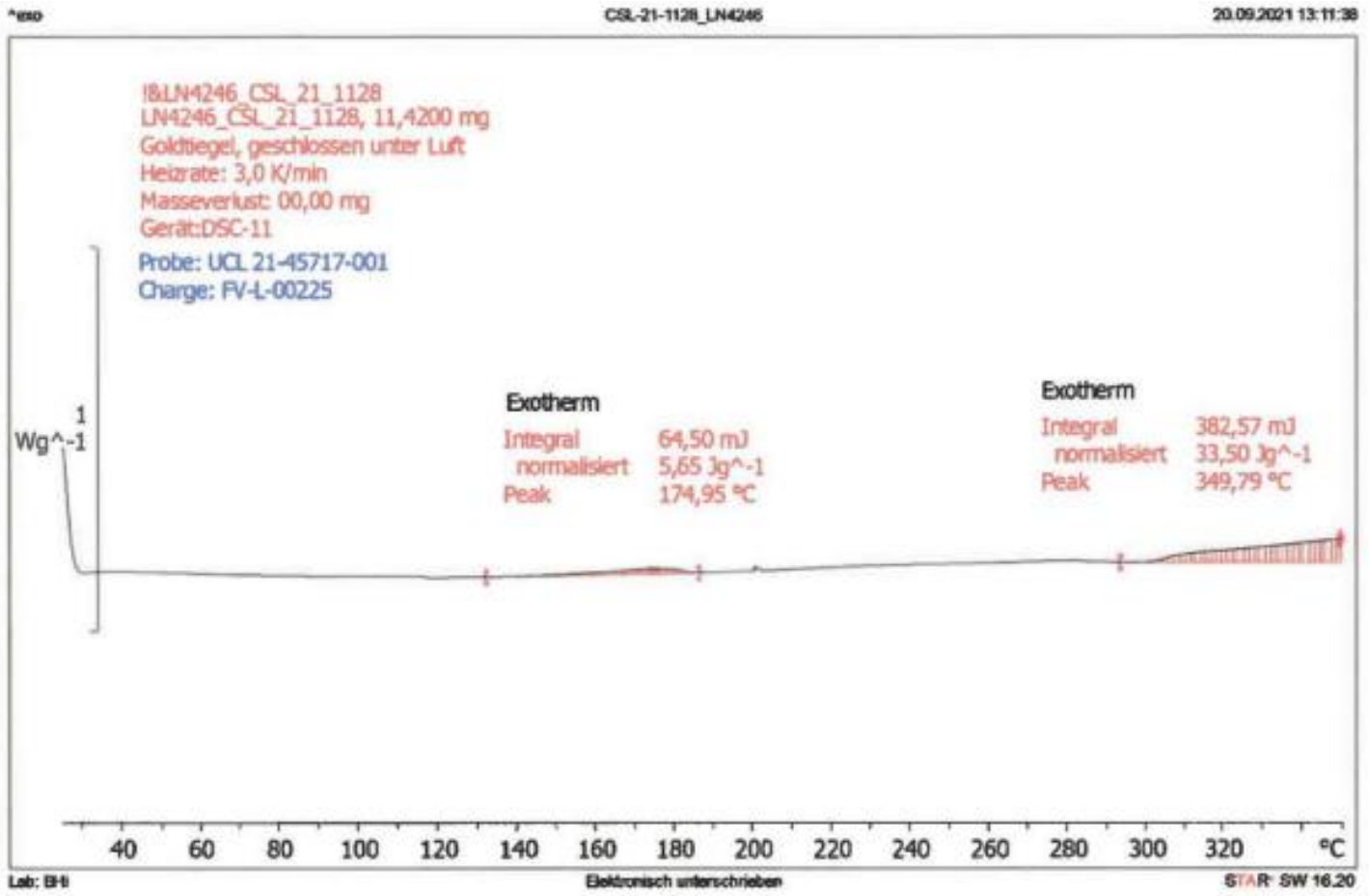


Caution!

If there is no hazard information in the open literature, it does not necessarily mean that there is no hazard

Example incl. thermal screening by DSC

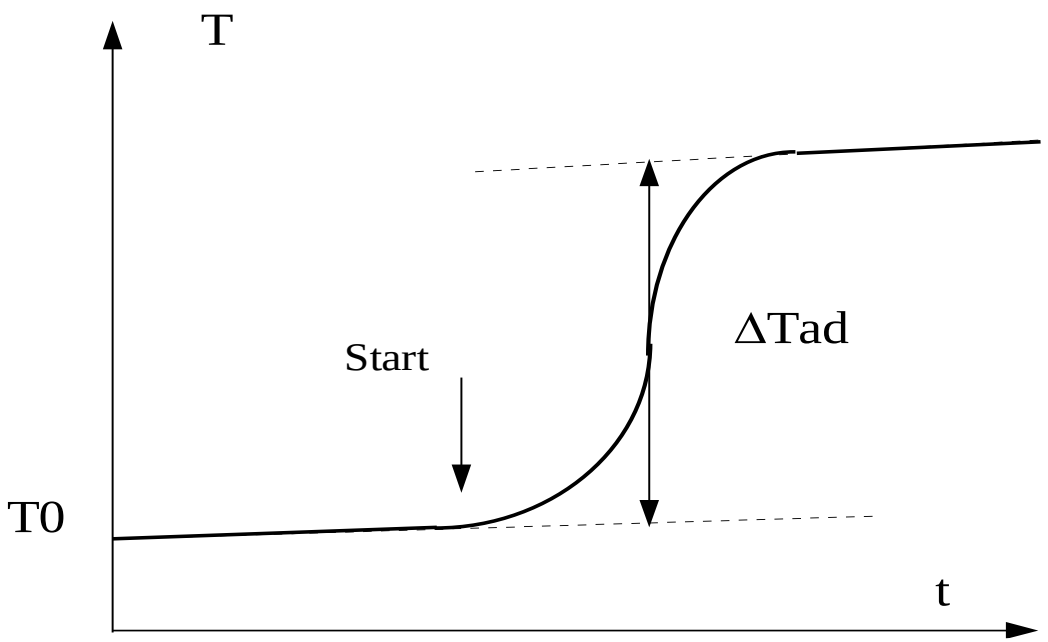
Bestandteil	% min	% max	CAS-Nummer (wenn vorhanden)
Ethanol		<= 70	64-17-5
Methanol		<= 70	67-56-1
Xylol		<= 70	1330-20-7
Toluol		<= 70	108-88-3
Polyetherpolysiloxan		<= 10	68037-64-9
Polydimethylsiloxan		<= 70	63148-62-9
Wasser		>= 10	7732-18-5
n-Butanol		<= 70	71-36-3
Isopropanol		<= 70	67-63-0
1-Allyl-2,3-Epoxy-Propan		<= 15	106-92-3



Obvious hazardous interactions or reactions:

Allyl-epoxy-propane is a reactive alkene which is prone to polymerization and peroxide formation.

Screening using a Dewar flask



Caution:

The mixing of highly energetic and incompatible material may cause severe consequence for the lab environment and operator. Hence, Dewar testing must be conducted with prudent care.

Additional general recommendations

- Separate waste streams as much as possible in dedicated drums or tanks
- Keep vessel scale as small as possible
- Do not mix hazardous/reactive waste but give directly to treatment, e.g incineration
- If mixing of material necessary, provide agitation
- Install sufficient instrumentation
- Have detailed procedures for all reasonable scenarios available.
- Add reoccurring vessel cleaning procedures to limit the amount of unknown contaminations.
- Where applicable, include a controlled and assessed destruction of excess reactive material to you work-up routine (i.e. reduce reactivity of the waste)

Note: The approach for an in-house waste treatment and a commercial treatment facility/company (typically incineration from various industries) will be different.

Thank you for your attention

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