



Direct Reading Exposure Assessment Methods for Isocyanates: Current Options and Future Needs

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Topics

- Why are direct-reading exposure assessment methods (DREAM) useful for MDI & TDI?
- Current DREAM options for diisocyanates
- Future needs in DREAM for diisocyanates



Why are DREAM Useful for MDI & TDI?



What are Isocyanates?

- “Isocyanates” refers to compounds containing the isocyanate functional group (-NCO).
- Commonly, the term is used to describe commercially important diisocyanate monomers used in the production of various polyurethanes.
- Toluene diisocyanate (TDI) and diphenylmethane diisocyanate (MDI) are the diisocyanates that Dow sells to customers who make polyurethane products:
 - Flexible foams (e.g., bedding and seat cushions)
 - Rigid foams (e.g., insulation)
 - Elastomers and coatings (e.g., footwear & automotive components)



Why DREAM for MDI & TDI?

- Primary effect of inhalation over-exposure: respiratory sensitization and occupational asthma
 - Evidence supports 20 ppb ceiling / STEL as protective for prevention of respiratory sensitization
 - Toxicology suggests avoidance of brief high peak exposures important
- ➔ Rapid, in-field indication of such situations for workers is important



Current DREAM Options for MDI & TDI



Current DREAM Options for MDI & TDI

- Demands on DREAMs for MDI & TDI
 - Low (ppb) Exposure Guidelines
 - Reactive species (+/-)
 - Aerosol vs. vapor (MDI)



Current DREAM Options for MDI & TDI (con't)

- *Colorimetric Methods*
 - Reaction with colorimetric reagent coated on paper tape, plastic film substrate
 - Orange / red color develops; read by visual color comparator or photodiode
 - Pro:
 - » Fairly sensitive (1 ppb) and specific
 - » Cost reasonable
 - Con:
 - » Some cross-sensitivities (e.g., NOx)
 - » Doesn't differentiate between different isocyanates
 - » Responds to color density; dirt, high humidity will register
 - » Shelf life limited – refrigerated storage required

Colorimetric DREAM Devices

- Instruments —
 - Air pumped through paper tape (reel)
 - Hand-held or stationary
 - Numerical display, alarms & datalogging
 - 30 sec to 4-min sampling time



Colorimetric DREAM Devices

- Dosimeter Badges —
 - Diffusive sampling using paper / polymer patch
 - Qualitative / semi-quantitative (comparator)
 - 15 min exposure needed to read 20 ppb



Current DREAM Options for MDI & TDI (con't)

- *Non-colorimetric Methods: IMS (Ion Mobility Spectrometry)*
 - Ni⁶³ ionization, TOF-type MS detection
 - Pro:
 - » Sensitive and specific
 - » Rapid response
 - » Compact
 - Con:
 - » Expensive
 - » Ni⁶³ Source may pose travel problems
 - » Little industry experience with it yet





Future DREAM Needs for MDI & TDI



Future DREAM Needs for MDI & TDI

- **Key need:** Exposure Profiling
 - Short-term peak measurements
 - » Smallest time increment possible
 - » High sensitivity
 - » Rapid recovery
 - Data-logging
 - Compatible with video exposure assessment
 - » Time stamp
 - » Software for easy synchronization
 - Easily worn by worker



Future DREAM Needs for MDI & TDI (con't)

- Sensitivity & Specificity
 - 0.1 ppb to accomodate possible lower OELs
 - Differentiate TDI, MDI from other isocyanate-containing species (e.g., aliphatic isocyanates (HDI, IPDI), oligomers, methyl isocyanate, isocyanic acid)
 - Accurate readings of isocyanate-containing aerosols
 - Absence of environmental effects (dust, humidity, NOx interference)
 - Accuracy +/- 25% min



Future DREAM Needs for MDI & TDI (con't)

- Device requirements
 - Lightweight (< 3 lbs [1.4 kg])
 - Worker-wearable without interference in tasks
 - Battery powered (minimum 8-hr run time)
 - User-adjustable alarm points (including no alarm option)
 - Flexible, user-friendly data download software compatible with standard software (e.g., Excel)
 - UL-approved, intrinsically safe
 - Consumables shelf-life > 6 months
 - “Reasonable” cost



Hurdles for New DREAM Development

- Market size vs. development cost
 - DREAM very useful to isocyanate and polyurethane producers
 - Technical demands for isocyanate DREAM high
 - Market small compared to other more general DREAM uses
- How the isocyanate industry can help:
 - Laboratory evaluation of new devices
 - Field evaluation of new devices