Using Dow Chemical Index to Review Emergency Procedure at Laboratory

Present for 2\textsuperscript{nd} ASCEL in Laboratory
Depok, 1 -2 December 2015

B – 027
The laboratory environment can be a hazardous place to work. Laboratory workers are exposed to numerous potential hazards including chemical airborne.

Air contaminant may travel distances. The release of compressed gas may be toxic, flammable, cause asphyxiation, corrosive, and etc., rapidly creating a very dangerous environment.

Most of laboratory procedures define fume hoods, material handling as prevention / control measures, but when emergency releases occurs, a planned response measures must be determined, including safe distance to air contaminant.

By using DOW CEI, organizations can design and operate safer laboratory for people in neighboring plants or communities arising from possible chemical release incidents.
DOW Chemical Exposure Index

A method, developed by The Dow Chemical Company, used to identify and rank the relative **acute health hazards** associated with **potential chemical releases**.

- The CEI is calculated from five factors:
  - a measure of toxicity;
  - the quantity of volatile material available for a release;
  - the distance to each area of concern;
  - the molecular weight of the material being evaluated;
  - process variables that can affect the conditions of a release such as temperature, pressure, and reactivity.
Developing DOW CEI

There are the needed items to develop a CEI:

- A accurate plot plan and surrounding area
- Process flow showing containment, piping if any, and chemical inventories.
- Physical and chemical properties as well as the ERPG / EEPG Values.
- CEI Guide and CEI Forms.
Step 1. Define Chemical Incidents

1. Define hazards that may possible occurs: a leak from gas cylinder when handling, $\text{H}_2\text{SO}_4$ spillage from its container, etc. Chemical inventory list may help to define every single chemical incidents that may happen.

2. Choose the ERPG for each chemical incidents. ERPG is air concentration guidelines for single exposures to agents published by American Industrial Hygiene Association (AIHA), which important to identify downwind areas which might need to take action during a release, determine priority concerns and evaluate the adequacy of containment.
Substitution for ERPG

If ERPG / EEPG values do not exist, deriving substitute values are recommended:

**ERPG-2 (in preferred order)**

1. Use the workplace exposure guideline (Dow IHG, ACGIH TLV or AIHA WEEL).
   a. Use the STEL or ceiling values if one exists.
   b. Use three times the TWA value.
2. If no workplace guideline exists, contact your industrial hygienist for assistance.

**ERPG-3 (in preferred order)**

1. LC-50 divided by 30.
2. Use five times the ERPG-2 substitute value

**ERPG-1 (in preferred order)**

1. Use Odor Threshold value
2. Use ERPG-2 substitute value divided by 10.

*Note:*
ERPG/EEPG values are updated periodically and the latest values are to be used.
Step 2. Estimate AQ

- AQ Known?
  - No
    - Determine liquid release
      - Op. temp > boiling point
        - Calculate AQ (Flash)
          - Not all material airborne
          - Determine Pool Size
  - Op. temp < boiling point
    - Determine AQ (Flash)
      - Determine Vapor from Pool
      - Calculate AQ (Vapor)
    - Calculate AQ (Gas)
      - Select Scenario with largest AQ
      - Calculate AQ (Flash)
        - Determine Vapor from Pool
      - Calculate CEI
        - Calculate AQ (Gas)
          - Select Scenario with largest AQ

Figures:
- Figure A: Liquids simply run out on the ground forming a pool
- Figure B: Partially vaporize forming both a pool and a vapor
- Figure C: Most residual liquids carried away with the vapor
- Figure D: Liquids forming a pool then begins to evaporate from the surface
Step 3. Calculate CEI

- All CEI Calculations assume a windspeed of 5m/sec & neutral weather conditions.
- Since CEI > 200, further risk review is required.

If the CEI calculated value is greater than 1000, set CEI = 1000

\[ CEI = 655.1 \times \sqrt{\frac{AQ}{ERPG - 2}} \]
Step 4-5. Hazard Distance & Summary

The Hazard Distance (HD) is the distance to the ERPG-1, -2, or -3 concentration and is derived from the following equation:

\[ HD = 6551 \sqrt{\frac{AQ}{ERPG}} \]

where:
AQ = airborne quantity (kg/sec)
ERPG = ERPG-1, ERPG-2, ERPG-3 (mg/m³)

If HD is greater than 10,000 meters, set HD = 10,000 meters.
Using DCEI in Labs

Ethanol is stored in a 204 L steel drum under its own vapor pressure at ambient temperature (30°C). Incident take place when handling, creating a leakage out of the drum. Leak / hole diameter is 2 in (50.8 mm). Height of leak above grade is 100 mm.

### Liquid Releases

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid release rate (L)</td>
<td>0.612 kg/sec</td>
</tr>
<tr>
<td>Actual Release Quantity (limited by emergency block valve or quantity available)</td>
<td>183.6 kg</td>
</tr>
<tr>
<td>Fraction Flashed</td>
<td>0</td>
</tr>
<tr>
<td>Airborne Quantity produced by the flash</td>
<td>0 kg/sec</td>
</tr>
<tr>
<td>Quantity of material entering the pool</td>
<td>183.6 kg</td>
</tr>
<tr>
<td>Theoretical Potential Pool area</td>
<td>21.40608604 Sq Metres</td>
</tr>
<tr>
<td>Actual surface area for evaporation</td>
<td>21.40608604 Sq Metres</td>
</tr>
<tr>
<td>Characteristic pool temperature</td>
<td>30 Deg C</td>
</tr>
<tr>
<td>Quantity evaporating from pool</td>
<td>0.027215093 kg/sec</td>
</tr>
<tr>
<td>Total Airborne Quantity</td>
<td>0.027215093 kg/sec</td>
</tr>
<tr>
<td>Chemical Exposure Index</td>
<td>6</td>
</tr>
<tr>
<td>Distance travel by ERPG2 concentration (M_e)</td>
<td>62 Metres</td>
</tr>
<tr>
<td>Distance travel by ERPG3 concentration (M_e)</td>
<td>34 Metres</td>
</tr>
</tbody>
</table>

### Hole / Leak Release

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of liquid available for release (kg)</td>
<td>183.6</td>
</tr>
<tr>
<td>Quantity of gas available for release (kg)</td>
<td>0</td>
</tr>
<tr>
<td>Temperature of released material deg C</td>
<td>30</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>92.13</td>
</tr>
<tr>
<td>Boiling Point C</td>
<td>110.7</td>
</tr>
<tr>
<td>Vapour Pressure (t) 25 C kPa</td>
<td>4.168</td>
</tr>
<tr>
<td>Vapour Pressure at Pool Temperature kPa</td>
<td>5.415</td>
</tr>
<tr>
<td>Liquid Density kg/M3 at storage temp C</td>
<td>857.7</td>
</tr>
<tr>
<td>Liquid Density kg/M3 at BP</td>
<td>790</td>
</tr>
<tr>
<td>Gas Density kg/M3 at 25C</td>
<td></td>
</tr>
<tr>
<td>Heat Capacity (C_p) Joules/kg-deg C</td>
<td>1750</td>
</tr>
<tr>
<td>Latent Heat of Vaporisation (H_v) Joules/Kg</td>
<td>361000</td>
</tr>
<tr>
<td>Ratio of (C_p/H_v)</td>
<td>0.004847645</td>
</tr>
<tr>
<td>Absolute Pressure (P_a) kPa</td>
<td>100</td>
</tr>
<tr>
<td>Gauge Pressure in Process (P_g) kPa</td>
<td>0</td>
</tr>
<tr>
<td>Temperature C</td>
<td>30</td>
</tr>
<tr>
<td>Diameter of hole mm</td>
<td>50.88</td>
</tr>
<tr>
<td>Height of leak above grade (Metres)</td>
<td>0.1</td>
</tr>
<tr>
<td>ERPG2 Mg/M3</td>
<td>300</td>
</tr>
<tr>
<td>ERPG3 Mg/M3</td>
<td>1000</td>
</tr>
<tr>
<td>Dike area M2</td>
<td></td>
</tr>
<tr>
<td>Distance to Property or fence line M</td>
<td></td>
</tr>
</tbody>
</table>
LIMITATION

• Dow CEI do not consider the full range of hazards. To get an overall assessment of process options, it is necessary to use a variety of indices and qualitative techniques, and then combine the results. (*Inherently Safer Chemical Processes: A Life Cycle Approach. CCPS*)
References

Xiao-Ying Yua,*, Clifford S. Glantza, et. all, Enhancing the chemical mixture methodology in emergency preparedness and consequence assessment analysis, Toxicology Journal, Volume 313, Issues 2–3, Pages 174–184, 16 November 2013
Imke Schröder, Debbie Yan Qun Huang, Olivia Ellis, James H. Gibson, Nancy L. Wayne, Laboratory safety attitudes and practices: A comparison of academic, government, and industry researchers, Journal of Chemical Health and Safety, Page 1-11, March 2015
THANK YOU

BEST REGARDS,

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