Classification of Hazardous Areas

Schalk Kruger
Managing Director - ExHACT

SAFA MIE Workshop
Agenda

- Legislation
- **Scope** of Work (SOW)
- HAC team
- Chemicals
- Operating **conditions**
- **Method/s** of HAC
- HAC study
- HAC drawings
- Practical
Legislation

- Your **right** to be safe
- **Employer, employee - safety**
- Regulation of the **things**
- Specific procedure on the **how**
Scope
Team

Bund big enough to contain 120% of the volume of the largest tank

Spills from hose couplings within bund area

High level detector

Truck loading and unloading area undercover

Truck unloading area

Collection sump

Blind collection sump

Drains to sewer or slops tank
Chemicals - Flammability

- Flashpoint
- Fire point
- Boiling Point
- MIE
- Ambient Temp.
- Stoichiometry
- UEL
- LEL
- AIT
- Not flammable (too little Oxygen)
- Auto ignition region
- Not flammable (too much Oxygen)

Temperature (Hot surfaces)

% Concentration of Flammable Vapour

Saturation Vapour Pressure

Ignition Energy (Arcs, Sparks)
## Chemicals – Flammability (Methanol)

### Section 5: Fire and Explosion Data

<table>
<thead>
<tr>
<th>Flammability of the Product:</th>
<th>Flammable.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auto-Ignition Temperature:</strong></td>
<td>464°C (867.2°F)</td>
</tr>
<tr>
<td><strong>Flash Points:</strong></td>
<td>CLOSED CUP: 12°C (53.6°F). OPEN CUP: 16°C (60.8°F).</td>
</tr>
<tr>
<td><strong>Flammable Limits:</strong></td>
<td>LOWER: 6% UPPER: 36.5%</td>
</tr>
</tbody>
</table>

**Products of Combustion:** These products are carbon oxides (CO, CO₂).

**Fire Hazards in Presence of Various Substances:**
Highly flammable in presence of open flames and sparks, of heat. Non-flammable in presence of shocks.

**Explosion Hazards in Presence of Various Substances:**
Risks of explosion of the product in presence of mechanical impact: Not available. Explosive in presence of open flames and sparks, of heat.

**Fire Fighting Media and Instructions:**
*Flammable liquid, soluble or dispersed in water*
- SMALL FIRE: Use DRY chemical powder.
- LARGE FIRE: Use alcohol foam, water spray or fog.

**Special Remarks on Fire Hazards:**
Explosive in the form of vapor when exposed to heat or flame. **Vapor may travel considerable distance to source of ignition and flash back.** When heated to decomposition, it emits acrid smoke and irritating fumes. **CAUTION:** **MAY BURN WITH NEAR INVISIBLE FLAME**

**Special Remarks on Explosion Hazards:**
Forms an explosive mixture with air due to its low flash point. **Explosive when mixed with** Chloroform + sodium methoxide and diethyl zinc. It boils violently and explodes.

SDS - Methanol
# Chemicals – Classification (Methanol)

<table>
<thead>
<tr>
<th>CAS No</th>
<th>Name &amp; Formula</th>
<th>Rel. Dens.</th>
<th>FP</th>
<th>LFL</th>
<th>UFL</th>
<th>AIT</th>
<th>MESG</th>
<th>MIC Ratio</th>
<th>T Class</th>
<th>Equip. Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-56-1</td>
<td>Methanol (=Carbinol) (=Methyl Alcohol) CH₃OH</td>
<td>1.11</td>
<td>9°C</td>
<td>6%</td>
<td>36% @60°C</td>
<td>440°C</td>
<td>0.92</td>
<td>0.82</td>
<td>T2</td>
<td>IIA</td>
</tr>
</tbody>
</table>

**SANS 60079-20-1 data for Methanol**

Gas Group: IIA  
Auto Ignition Temperature (AIT): 440 °C  
Temp class: T2

LFL: 6%  
Flash point: 9 °C  
Relative Density: 1.11

<table>
<thead>
<tr>
<th>Zone Distance</th>
<th>Zone</th>
<th>IIA</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
# Chemicals – Compositions!

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Vol. %</th>
<th>Relative Density</th>
<th>AIT °C</th>
<th>Flash Point °C</th>
<th>LEL %</th>
<th>Group (MESG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propanal (C(_3)H(_6)O)</td>
<td>39%</td>
<td>2.00</td>
<td>188</td>
<td>-26</td>
<td>2.0%</td>
<td>IIB (0.86)</td>
</tr>
<tr>
<td>Butanal (C(_4)H(_8)O)</td>
<td>21%</td>
<td>2.50</td>
<td>205</td>
<td>75</td>
<td>1.7%</td>
<td>IIA (0.92)</td>
</tr>
<tr>
<td>Water (H(_2)O)</td>
<td>14%</td>
<td>0.017</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Ethyl Acetate (C(_4)H(_8)O(_2))</td>
<td>9%</td>
<td>3.04</td>
<td>470</td>
<td>-4</td>
<td>2.0%</td>
<td>IIA (0.99)</td>
</tr>
<tr>
<td>2-Methyl Propanal (C(_4)H(_8)O)</td>
<td>5%</td>
<td>2.50</td>
<td>165</td>
<td>-22</td>
<td>1.6%</td>
<td>IIA (0.92)</td>
</tr>
<tr>
<td>2-Methyl Butanal (C(_5)H(_10)O)</td>
<td>1%</td>
<td>2.97</td>
<td>240</td>
<td>-5</td>
<td>1.3%</td>
<td>IIC (H(_{10}))?</td>
</tr>
<tr>
<td>3-Methyl Butanal (C(_5)H(_10)O)</td>
<td>1%</td>
<td>2.96</td>
<td>207</td>
<td>-5</td>
<td>1.3%</td>
<td>IIA (0.98)</td>
</tr>
<tr>
<td>Ethanal (CH(_3)CHO)</td>
<td>1%</td>
<td>1.52</td>
<td>155</td>
<td>-38</td>
<td>4.0%</td>
<td>IIA (0.92)</td>
</tr>
<tr>
<td>Result (Inference)</td>
<td>&gt;1</td>
<td>165 (T4)</td>
<td>-26</td>
<td>1.6%</td>
<td></td>
<td>IIB (39%)</td>
</tr>
<tr>
<td>Calculated</td>
<td>1.97</td>
<td>165 (T4)</td>
<td></td>
<td>2.093%</td>
<td></td>
<td>IIB (0.87)</td>
</tr>
</tbody>
</table>
HAC - Direct Example

SANS 10089-2: Electrical and other installations in the distribution and marketing sector

- American Petroleum Institute (API) – API RP 500: Petroleum Facilities
- Energy Institute – IP15: Flammable liquids

2 m radius around vent or dip hatch

2 m below tank top ridge

Below ground location such as sump or trench

Legend - zone 0 zone 1 zone 2

IIA T2

If pumps or valves are located in bund areas, their grades of release together with the already existing zone 2 in the bund area shall be considered to change the areas around the pump from zone 2 to zone 1.

Figure A.1 (a) — Closed roof cone or dome tank with class 1 flammable liquid or class II and class III combustible liquids at temperatures at or above flash point
Direct Example - Challenges

A - Pump Rate, flashback arrestor, safety release valve, operational conditions, ambient temperature changes

B - Relative density

C - Relative density, liquid leaks, sampling flushing

D - Lots of applications i.e. Zone 1, over classification

E - Only for these chemicals

Figure A.1 (a) — Closed roof cone or dome tank with class 1 flammable liquid or class II and class III combustible liquids at temperatures at or above flash point
Process streams marking up of PFD based on the operating envelope.
Source of Release - MFD

SOR marking up on MFD based on the operating envelope and PFD.
# Sources of Release

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Example of Leak</th>
<th>Grade of Release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps</td>
<td>Seal</td>
<td>Secondary</td>
</tr>
<tr>
<td>Compressors</td>
<td>Seal</td>
<td>S</td>
</tr>
<tr>
<td>Vents</td>
<td>Full Bore</td>
<td>Primary</td>
</tr>
<tr>
<td>Valves</td>
<td>Gland/Seal</td>
<td>S</td>
</tr>
<tr>
<td>Pressure relief valves</td>
<td>Full Bore</td>
<td>P</td>
</tr>
<tr>
<td>Small bore connections</td>
<td>Fitting Leak</td>
<td>S</td>
</tr>
<tr>
<td>Piping systems</td>
<td>Gasket</td>
<td>S</td>
</tr>
<tr>
<td>Flanges, blinds</td>
<td>Gasket</td>
<td>S</td>
</tr>
<tr>
<td>Pig receivers and launchers</td>
<td>Full bore or Partial Release</td>
<td>P</td>
</tr>
<tr>
<td>Liquid pools</td>
<td>Vaporisation</td>
<td>Continuous</td>
</tr>
<tr>
<td>Sumps</td>
<td>Vaporisation</td>
<td>C</td>
</tr>
<tr>
<td>Drains (Open)</td>
<td>Vaporisation</td>
<td>C</td>
</tr>
<tr>
<td>Drain Points</td>
<td>Full bore or Partial Release</td>
<td>P</td>
</tr>
<tr>
<td>Sample points</td>
<td>Full bore or Partial Release</td>
<td>P</td>
</tr>
</tbody>
</table>

Grading SOR based on type of release.
Zones

- **Zone 0:** Continuous release - All the time
- **Zone 1:** Primary release - During normal operations
- **Zone 2:** Secondary release - During abnormal operations

Zone type based on grade of release.
### Ventilation

<table>
<thead>
<tr>
<th>Grade of release</th>
<th>Ventilation</th>
<th>Degree</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>Fair</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>Poor</td>
</tr>
</tbody>
</table>

| Continuous       | (Zone 0 NE) Non-hazardous | (Zone 0 NE) Zone 2 | (Zone 0 NE) Zone 1 | Zone 0        | Zone 0 + Zone 2 | Zone 0 + Zone 1 | Zone 0 |
| Primary          | (Zone 1 NE) Non-hazardous | (Zone 1 NE) Zone 2 | (Zone 1 NE) Zone 2 | Zone 1        | Zone 1 + Zone 2 | Zone 1 + Zone 2 | Zone 1 or zone 0c |
| Secondary        | (Zone 2 NE) Non-hazardous | (Zone 2 NE) Non- | (Zone 2 NE) Non- | Zone 2        | Zone 2        | Zone 2        | Zone 1 and even zone 0c |

Changing SOR grade or Zone based on ventilation.
Dispersion - Liquid/Vapour

1. More volatile components remain as vapour in vessel
2. Heavy components form droplets
3. Composition of droplets and vapour change with distance downwind
4. Discontinuity in cloud composition as heavy droplets rain out
5. Re-evaporation lighter pool components

Dispersion: PHAST Pamphlet from Det Norske Veritas (DNV)
Dispersion – Stages - Equations

Dispersion - CFD

Dispersion shape and concentration
Dispersion – Concentration

LFL of Methanol at 6% or 60 000 ppm = 0.8 m

Dispersion centreline concentration and distance
Meteorological Conditions

- Solar Radiation
- Evaporation
- Precipitation
- Wind speed, height and direction
- Relative humidity
- Barometric pressure
- Topography
- Ambient air temperature
Dispersion Constraints

• Congestion of SORs
• Obstacles to dispersion
• Enclosed spaces i.e. trapping of dispersion
Study

• **Traceable** i.e. references, calculations, reproducible
• **Approved** by accountable persons
• **Defendable** arguments
Drawings

• Top view
• Side views
• Cuts
• Different levels of structures
• Chemical products table
• SOR table (Zones 0 and 1 only and perimeter zone 2)
• Approvals
Dispersion Shapes

Gas

Gas with Dripping

Liquid

Gas with Spillage

SANS 60079-10-1
Result - Direct Example
Result – Source of Release
Scenario 1

(*) Aperture to be provided to avoid siphoning.

(**) For typical control valve arrangement refer to article on EnggCyclopedia
Scenario 2
Conclusion

Legislative compliance promotes a safe and controlled environment.

“Hazardous Area Classification” is a statement that expresses an action.

Hazardous Area Classification done properly provides multiple benefits.