Methanol as a fuel – exposure and possible health risks

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Content

• Health effects

• Exposure
  – Routes (ingestion, inhalation, dermal)
  – General population / Occupational

• Conclusion
Health effects of methanol

• Acute toxicity dermal Cat 3; H311
• Acute toxicity inhalation Cat 3; H331
• Acute toxicity oral Cat 3; H301
• STOT SE1; specific target organ toxicity Cat 1.
Metabolism of methanol

Methanol $\xrightarrow{\text{Alcohol dehydrogenase}}$ Formaldehyde $\xrightarrow{\text{Formaldehyde dehydrogenase}}$ Formic acid

- $\text{CO}_2 + \text{H}_2\text{O}$
- Metabolic acidosis and tissue injury

LUNDS UNIVERSITET
Main information source....

- Acute exposure
- Low dose
  - Like ethanol
- High dose
  - Visual impairment
Metabolism of methanol

Methanol $\xrightarrow{\text{Alcohol dehydrogenase}}$ Formaldehyde $\xrightarrow{\text{Formaldehyde dehydrogenase}}$ Formic acid $\xrightarrow{\text{Metabolic acidosis and tissue injury}}$ CO$_2$ + H$_2$O

Etanol $\xrightarrow{\text{ }}$ Acetaldehyde $\xrightarrow{\text{ }}$ Ättiksyra $\xrightarrow{\text{ }}$ Koldioxid & vatten
Exposure routes

• Absorption rate inhalation 53-85% effectively absorbed

• Dermal exposure 0.192 mg Methanol/cm² x minutes, significant percutaneous absorption

• Oral exposure relatively rapidly absorbed from gastrointestinal tract 30-60 min peak

• Biological monitoring
General population exposure

• Urban air – up to 0.1 ppm
• Water (point sources)
• Food
  – Fruit juices ~140 mg/L
  – Neutral spirit < 1.5 g/L
  – Conc. permitted in brandies – 7000 mg/L ethanol
  – Beans, peas, lentils – 1-8 mg/kg
General population exposure

- A vehicle operated on M85 and fully warmed up and parked in a garage gave a maximum conc 1.3 ppm in the garage and 0.75 ppm in the attached house (Tsai et al 2000)
Concentrations in air

Occupational exposure limits:

- 8h TLVs 200 ppm
- 5-15 min STEL 250-1000 ppm

Immediately dangerous to life and health (IDLH) 6000 ppm

Lethal dose ~ 1g/kg bw

• Odour limits
  - Detection ~ 160 ppm
  - Recognition ~ 690 ppm
Occupational exposure

- Refueling methanol-powered buses – 10 ppm
- Mechanics changing fuel filters – 50 ppm
- Spirit duplicator machine operators; teachers and clerks - 300-3000 ppm (intoxicated)
Case "low" exposure long time

Progressive Parkinsonism in a Young Experimental Physicist Following Long-Term Exposure to Methanol
Dermal / inhalation exposure

16 min

8 h

400 ppm

Franzblau et al 1996
Protective gloves

• Breakthrough natural rubber gloves ~ 1h

• ... nitrile or Viton gloves > 1h

• ... PVC gloves < 1h
CASE REPORT

A case of percutaneous industrial methanol toxicity

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Methanol (CH$_3$OH) is a chemical feedstock of increasing importance as well as a commonly used solvent. In the early 1980s methanol production was introduced at a new petrochemical complex in the Saudi port of Jubail. A case is presented of a consultant supervising tank cleaning prior to methanol loading. He wore positive pressure breathing apparatus but no protective clothing. After 2–3 hours working in the confined space of the tank, he worked on deck and continued to wear his methanol-soaked clothing which eventually dried out. Visual symptoms of acute methanol toxicity presented some 8 hours after exposure. The appropriate treatment (with ethanol provided by the ship bond) was carried out in hospital and the individual recovered completely. Most reported cases of methanol toxicity are social in origin, arising from ingestion. This particular case, though unusual, does present some interesting lessons.
Population at special risks

- Persons with skin, kidney, liver or eye disorders may be at increased risk

- Folate-deficient individuals (elderly, poor diet…)

- Diabetics (?)

- Pregnant (?)
Accidental ingestions......

39% of accidental ingestions in the US (1987) from siphoning (young adult males)

Children under 6 year when playing with used containers

Effect with gasoline - vomiting and chemical pneumonitis.

12 mL (a tablespoon) could result in death for a 10 kg 1-year old child.

In 2000 ~20 000 gasoline poisonings - 25% children
Conclusion

• With good occupational hygiene the risk of negative health effects after occupational exposure to methanol is low

• The dermal exposure can be significant

• Special awareness for accidental exposures