Today, we will:

- Begin discussion of **Chapter 3 – Design Criteria**
- Discuss **Section 3.1 – Contaminant Exposure Levels**
- Discuss **Section 3.2 – Fire and Explosions**
- Do some example problems
- Do Candy Questions for Candy Friday

Note: Indoor air quality is concerned not only with air pollution, but also with many other issues. In this chapter we discuss:

- contaminant exposure – Air pollution
- fire and explosions
- noise
- heat stress
- odors
- radiation
- general safety issues

Sec. 3.1 Contaminant exposure levels

- OSHA → publish PELs
  Permissible Exposure Limit (PPM or $\frac{mg}{m^3}$ @ STP)
- NIOSH → publish RELs
  Recommended Exposure Level

PEL based on 8-hr work day
REL " " 10-hr exposure

e.g. benzene → Look up MSDS REL = 0.1 PPM
PEL = 1 PPM

We use PEL unless otherwise stated

- ACGIH – American Conference of Governmental & Industrial Hygienists
  Publish TLV = Threshold Limit Value (Cost $) (copyrighted)

Note: PEL, REL, & TLV sometimes change with time
(see App. A-1)

Kinds of levels:

TWA = time-weighted average

eg. OSHA → use 8 hrs.
↑ Most common

$$TWA_{8\text{-hr}}\ PEL = \frac{1}{8}\int_0^8 C(t)\,dt$$

STEL = short term exposure level or "ST"

$$STEL = \frac{1}{15}\int_0^{15} C(t)\,dt \quad \text{in minutes}$$

STEL > TWA

C = ceiling → should never be exceeded, even instantaneously

C > STEL > TWA

So ... we can have TLV-TWA PEL-C
TLV-STEL PEL-STEL, etc.

RULES FOR WHETHER A VIOLATION HAS OCCURRED

↓

See Fig. 3.1

MIXTURES OF GASES

$$E_m = \text{Exposure Parameter} = \sum_j \frac{y_j}{PEL_j}$$

Criterion → if $E_m > 1$, violation

if $E_m < 1$, not a violation

Eg. Given: gas mixture
- benzene 0.4 ppm
- acetic acid 2 ppm
- perc 30 ppm

8-hr TWA values →

To do: Is this a violation?

Soln:

$$E_m = \frac{y_{benz}}{PEL_{benz}} + \frac{y_{ac.ac}}{PEL_{ac.ac.}} + \frac{y_{perc}}{PEL_{perc}}$$

$$E_m = \frac{0.4 \text{ ppm}}{1 \text{ ppm}} + \frac{2}{10} + \frac{30}{100} = 0.9$$

No — not a violation since $E_m < 1$

Sec 3.2 → Instruments to measure pollutant concentrations

↳ Skim over this material – interesting but not on exam

SEC. 3.3 FIRE AND EXPLOSIONS

Explosions can occur with both vapors (gases) & particles (dusts)

LEL = Lower Explosion Limit = smallest concentration

* at which a spark will cause an explosion.

typ. in $\frac{mg}{m^3}$ or mol fraction (ppm) or % by volume

* Most insurance cos. require $y_j < 10\%$ of LEL

UEL = Upper Explosion Limit – max. conc., above which it won't explode

LEL = fuel-lean limit of flammability

UEL = fuel-rich limit " "

* UEL & LEL are listed on the MSDS

Compare LEL with PEL:

Typically LEL >> PEL

eg Benzene → LEL = 1.2% ⇒ $\frac{\forall_j}{\forall} = 0.012 = y_j$ (mol fraction)

$= 12{,}000$ ppm

PEL = 1 ppm → LEL >> PEL