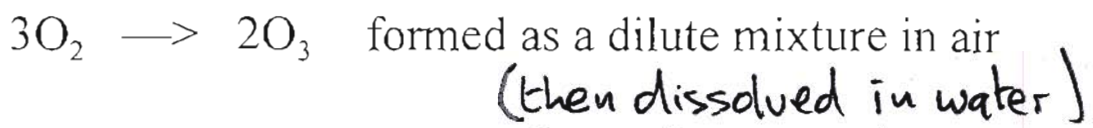


Ozone

- unstable, must be made in situ – by electric discharge on dry O₂ (air)

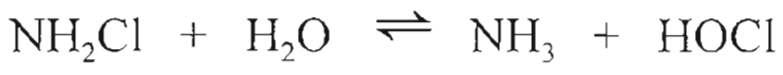


- ozonation equipment is expensive, only economic on a large scale – regional water authorities
For disinfecting water, ozonised air has ~ 1% O₃
- an oxidizing agent, not a chlorinating agent – no taste and odour problems, but cannot be used like ClO₂ as a temporary replacement for chlorine
- no residual in the water, decomposition is pH dependent (also faster at higher water temperature)

rate $\propto [OH^-]^{0.55} \cdot [O_3]^2$ ↘ O₂
(via OH⁻, HO₂⁻)

Chloramine, NH₂Cl

- only used in domestic applications ... cottages etc
- a source of “available chlorine”



UV radiation

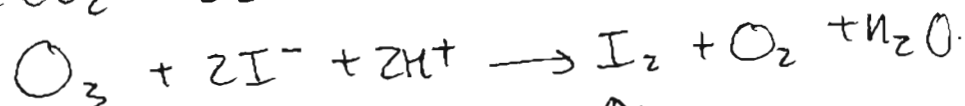
- uses UV-C at 254 nm – major output of a low pressure mercury discharge lamp (germicidal lamps)
- kills microorganisms by photochemical cross-linking of DNA, which absorbs strongly at this wavelength
- unlike preceding methods, uses a simple flow-through system (no holding tank) because contact time is short (seconds) rather than $\frac{1}{2} \rightarrow 1$ h \rightarrow low installation cost
- not influenced by pH or temperature
- applicable to large and small scale installations, even domestic use
 — UK (treats 14.5 million gallons of water daily)
- water must be clear and free of absorbing solutes
- no toxic residues (as long as no organics present)

Cost comparison (text, p. 212)

- small installations: UV is cheapest, then chlorine
- large installations: chlorine is cheapest by a wide margin

Analysis of Cl_2 , ClO_2 , NH_2Cl and O_3

- iodometric titration



↑
liberated I_2 titrated against
standard sodium thiosulphate

Drinking Water Quality

- see section 7.9 (text) and Table 7.2.

Standards (US) vs Guidelines (Canada)

Metals in drinking water

- solubilization in acidic waters (acid mine drainage (AMD) much later)
 - ↳ from rock (usually ex sulphides) (text p 354)
- concern because most are cumulative poisons (rate of excretion is slow): Hg, Pb, Cd, Cu, As

- lead a problem in older homes ("plumbing"/solder)
 - lead and mental retardation (also lead-based paints)
 - soft water more of a problem: Pb slightly more electropositive than hydrogen

Hot water piping worse - more soluble - "scale" left in heater

- "first draw" water hence dissolves from pipe because there is no "scale" (CaCO₃) on the pipes
- Pb concentrations reduced from 50 to 10 ppb

- cadmium a relatively recent problem, with the use of Cd in electroplating and Ni-Cd rechargeable batteries

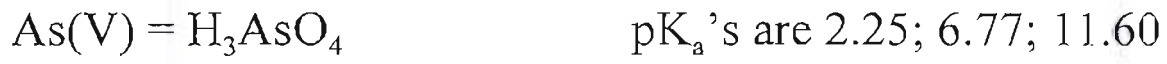
- mercury as a problem more often associated with food intake than water

- more details on lead, mercury } later
arsenic }

- arsenic a serious problem, especially in parts of Asia: Bangladesh, Taiwan, Vietnam
 - levels in Bangladesh recorded 1-5 ppm in some places
 - problem associated with wells drilled to avoid drinking microbially-contaminated surface water
 - skin eruptions, skin cancer, internal cancers, "blackfoot disease", neurotoxicity: hundreds of thousands affected
 - testing of wells for those safe to drink

- WHO limit for arsenic: previously 50 ppb, lowered to 10 ppb
- US controversy over reduction of limit to WHO standard; new standard effective February 2006
- problem for certain municipalities

As Chemistry



As(III) commonest in ground water

Promising method for As removal:

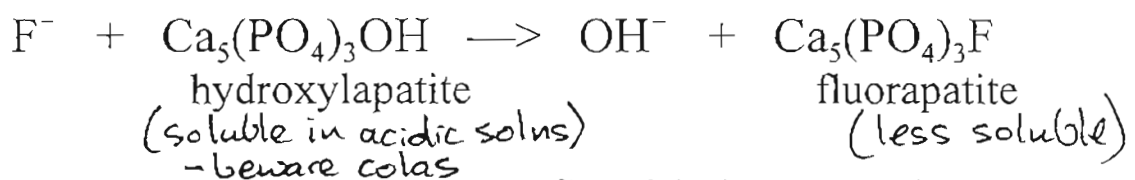
- oxidize As(III) to As(V)
- chemisorb arsenate formed to $\text{Fe}(\text{OH})_3$ [this is not FeAsO_4 as might be supposed]

- nitrate generally a problem in rural areas:
 - contamination of wells from fertilizer (also manure seepage (Feed lots) - hog manure)
 - 45 ppm (10 ppm of nitrate nitrogen)
 - methemoglobinemia in infants can result in mental retardation (diminishes oxyhemoglobin formation).
 - active agent is actually nitrite ^(NO₂) formed by reduction of nitrate by intestinal bacteria
 - nitrite ion can nitrosate amines and amides → carcinogenic nitrosamines

complexation between hemoglobin and NO₂⁻



- fluoridation: to medicate or not to medicate?



- beware the comment "fluoride is a rat poison, so don't put poison in the water" ("the dose makes the poison")
- small "safety factor" between benefit and dental fluorosis (mottling of teeth)
- dental health is improving in North America (Paracelsus (1493-1541) ↑)

Text p220 discusses aluminumⁱ ← grrr!!

- - - some confusion about it's effects on humans.
- - - possible link to Alzheimers.