Fundamentals of Environmental Chemistry

Environmental Chemicals

(Lecture 3)

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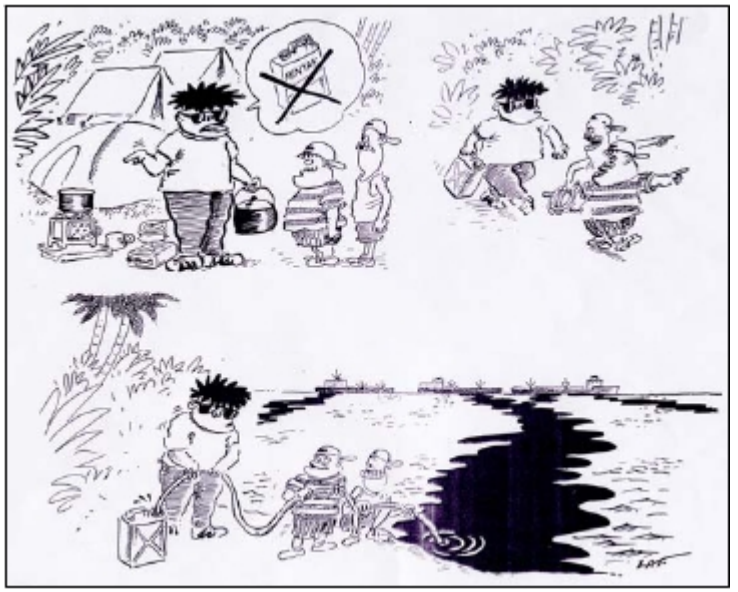
Lecture 3: Environmental chemicals (1 hr)

- Chemicals in environment
- Detection and measurement
- The atmosphere
- Water
- Soils
- Biota



Chemicals in environment

- We are surrounded by natural and synthetic chemicals that can become hazardous upon sufficient exposure
- Synthetic chemicals received more attention – chemical pollution by manufacturing sector
- Toxic Release Inventory (TRI) – attempt to identify & locate the release of chemical wastes into water, air and soils

Applications of chemicals:

- Cyclic & acyclic chemicals
- Plastics & resins
- Cyclic intermediates
- Miscellaneous products
- Surfactants
- Elastomers
- Plasticizers
- Pesticides
- Rubber processing chemicals
- Dyes
- Medicinals
- Flavours & fragrances
- Organic pigments

Detection and measurement

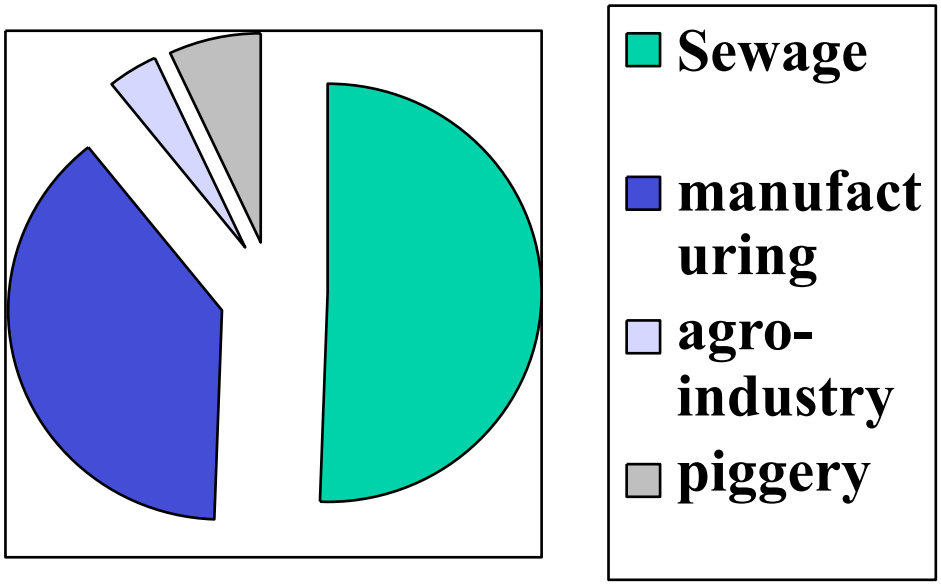
- Concentrations, fate of each chemical, exposure levels are determined by analysis
- Analytical measurements are inherently erroneous, but the degree of error can be estimated and minimized

Chemical analysis:

- Sampling
- Purification
- Detection
- Measurement
- Data interpretation

Number of water pollution sources by sector to Malaysian rivers (DOE, 2001)

- Sewage plants (6,693)
- Manufacturing industries (5,086)
- Pig farming (909)
- Agro-based industry (472)



Number of industrial water pollution sources (agro-based and manufacturing industry) (DOE, 2002)

Food and beverage	1,410
Chemical-based	800
Paper	532
Rubber-based	435
Textile	408
Electric and electronic	358
Palm oil mill	355
Metal fabrication	296
Non metallic mineral	207
Metal finishing and electroplating	185
Transport equipment	132
Rubber mill	117

Estimated organic pollution loading (BOD) by industrial sectors, 2001

Industry	Number	BOD (ton/d)
Rubber	117	2.1
Palm oil	355	19.9
Rubber-based	435	1.6
Paper	435	5.1
Chemical-based	800	2.2
Food and beverage	1410	12.9

Number of industrial pollution sources by states (DOE, 2002)

Johor	1,597
Selangor	1,486
Perak	572
Sabah	420
Sarawak	326
Melaka	279
Kedah	210
Negeri Sembilan	186
Pahang	122
Kelantan	102
Pulau Pinang	89
Kuala Lumpur, Federal Territory	89

Interim National River Water Quality Standards

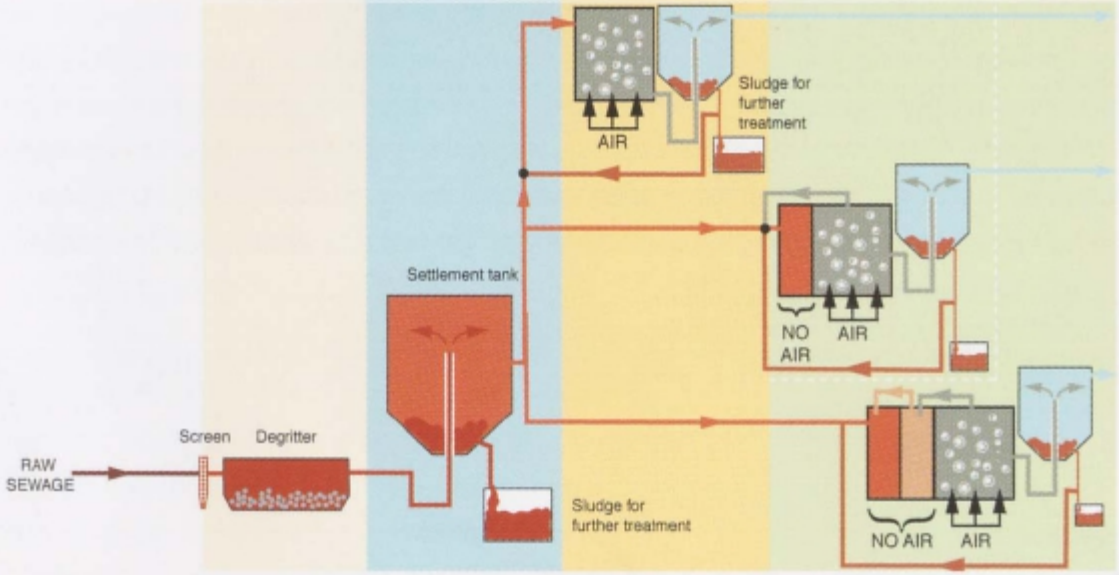
Paremeters	I	IIA	IIB	III	IV	V
Amm-N	0.1	0.3	0.3	0.9	2.7	>2.7
BOD	1	3	3	6	12	>12
COD	10	25	25	50	100	>100
DO	7	5-7	5-7	3-5	<3	<1
pH	6.5-8.5	6-9	6-9	5-9	5-9	-
Color (TCU)	15	150	150	-	-	-
TDS	500	1000	-	-	4000	-
TSS	25	50	50	150	300	>300
Turbidity (NTU)	5	50	50	-	-	-
FC(per 100ml)	10	100	400	5000	5000	-
TC(per 100ml)	100	5000	5000	20,000	50000	>

Effluent quality standards in Malaysia
(1974-2002)

Parameters (24)	Standard A	Standard B
BOD (mg/L)	20	50
COD (mg/L)	50	100
SS (mg/L)	50	100
TN (mg/L)	- (5?)	- (10?)
TP (mg/L)	- (0.5?)	- (3?)

Principles

Amount of main pollutants removed	PRELIMINARY	PRIMARY	SECONDARY	TERTIARY	
Organic Material (BOD)	0%	30%	85%	85%	85%
Suspended Solids	5%	40%	96%	96%	96%
Nitrogen	0%	2%	5%	97%	97%
Phosphorus	0%	0%	2%	5%	95%
			Basic BOD removal only	BOD & Nitrogen Removal	BOD, Nitrogen & Phosphorus Removal



The main pollutants in sewage - solids, oxygen demand (BOD), nitrogen and phosphorus - are removed by successive treatment stages.

Point Source Pollution Control

Environmental sampling & analysis

- Sample must be representative
- Samples should be collected at several sites several times
- Replicate samples
- What to analyze?
- Surrogate?

Analysis:

- On-site analysis
- Conventional laboratory analysis
- Advanced lab analysis

Environmental sampling & analysis

Example

- Treatment of sewage using conventional extended aeration activated sludge, followed by membrane bioreactor and reverse osmosis membrane
- Objective: Production of treated wastewater suitable to be used for industrial process water

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Environmental sampling & analysis

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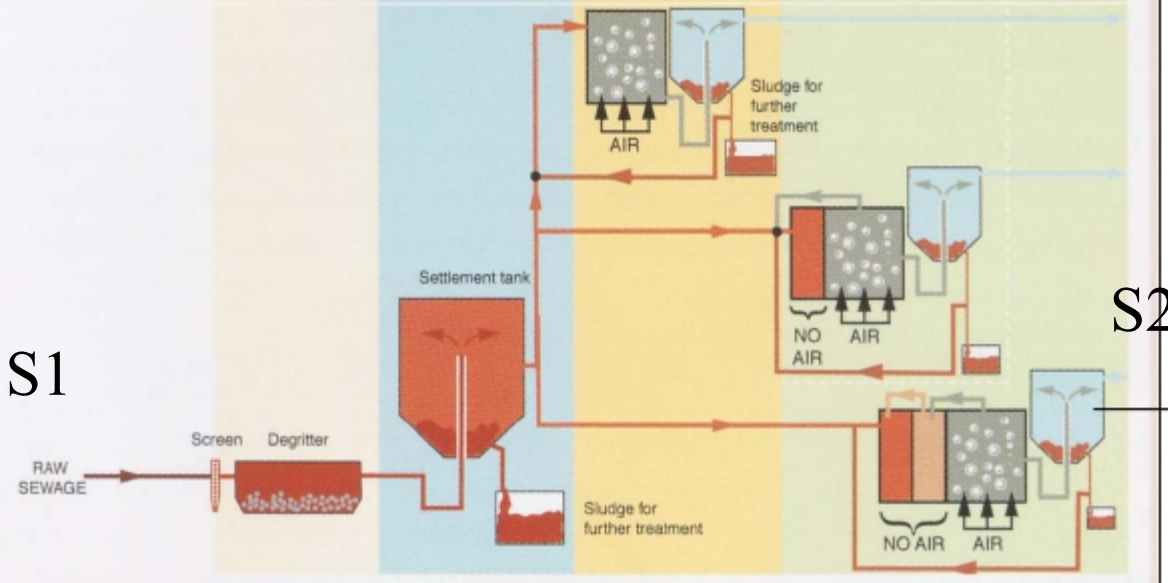

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Environmental sampling & analysis

Parameters	S1	S2	S3	S4
BOD or COD	daily	daily	daily	daily
SS or TSS	daily	daily	daily	daily
TOC	2/week	2/week	2/week	2/week
Faecal Coliform	-	-	2/week	2/week
Metals (??)	-	-	1/week	1/week
pH, hardness, conductivity	4/day	4/day	4/day	continuous
Flux	-	-	continuous	continuous

Some modern analytical detectors

Type	Separation	Specificity	Sensitivity
Alkali flame inonization	GLC	N, P	1
Electron capture	GLC	E-rich	0.1
Flame photometric	GLC	P, S, Sn	1
Hall conductivity	GLC	Cl	0.1
Ultraviolet absorption	LC	UV-absorbing	50
Fluorescence	LC	Fluorescent	5
Color reagent	TLC	Varies	> 1000

GLC = gas liquid chromatography; LC = liquid chromatography; TLC = thin-layer chromatography

Environmental concentration equivalents

Unit	Water	Air	Soil & biota
1 ppm	1 mg/L	40.9 MW ∝g/m3	1 mg/kg
1 ppb	1 ∝g/L	40.9 MW ∝g/m3	1 ∝g/kg
1 ppt	1 ng/L	40.9 MW ∝g/m3	1ng/kg

The atmosphere

- Atmosphere is principal recipient and transporter of pollutants, mostly in troposphere (surface to 10 km)
- Environmental chemistry is concerned with the sources, identity, levels, reactions, transport and fate of chemical species in water, soil and air environments – provide exposure information for evaluation of toxicity and risk.

Toxicity

- Intoxication is the scientific terms for poisoning
- Dose-response relationship
- The dose makes the poison
- Selective toxicity – one species can be affected by a poison while another seemingly is not
- Selectivity is a necessary feature of medicines and pesticides, and many weed killers, e.g. are almost non-toxic to mammals because they kill plants by such non-animal processes as photosynthesis
- Intoxication is common to all living organisms, from bacteria to people

References

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