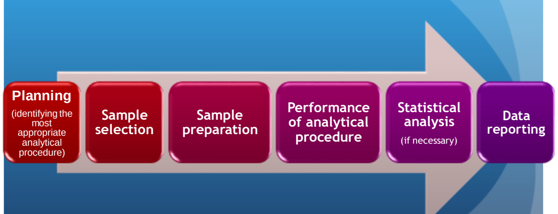
WASTE CHARACTERISATION, WASTE QUALITY AND WASTE PARAMETERS

WHY IS IT IMPORTANT???

- The needs for reliable data about what is in the waste stream - quantity and quality
- Has become paramount to the success of the waste treatment
- Determine the best or appropriate technology used for treating the waste stream
- Help in planning and sizing the waste treatment facilities
- Help in estimating the needs for transportation

Steps of waste characterisation



Level sophistication of analytical procedures

- Manual handling or extraction
  (oven drying, furnace burning, centrifuge, grinding, etc)
- Manual extraction and semi-sophisticated equipment
  (UV spectrophotometer, automatic titration, etc.)
- Simple, easy and fast test-kit
  (Hach reagent)
- Sophisticated equipment
  (FTIR, Raman, NMR, etc.)

WASTEWATER CHARACTERISATION

Approaches in wastewater characterisation

Traditional	*Modern*
Focus on point sources	Classification of receiving water based on use: • A - drinking, environmentally sensitive • B - bathing, fish-life • C - irrigation, fish-life, agricultural use
Mainly concerned with local effect	Definition of stream quality standards for specific use
Definition of maximum limits (BOD, SS, T, pH, nutrients etc.)	
Usually concentration limits and total flow rate limit	

Procedures of wastewater characterisation

What is (in) Wastewater?

1. Identify wastewater sources and flows
2. Specify likely key pollutants
3. Select suitable sampling strategies
4. Measure pollutant concentrations
5. Calculate pollutant loads
6. Identify main components to be removed

a. Sources and Flow Rates

- Essential step to identify problem area
- How to define sources & flows?
  1. Use "systems/mass balance" approach
  2. Utilize wastewater audits
  3. Anticipate future requirements
  4. **Reduce > Reuse > Recycle**
  5. Simple is better than complex
- Source reduction can drastically improve wastewater situation (tannery)

b. Types of Pollutants

- **Physical**: solids, temperature, color, turbidity, salinity, odor
- **Chemical**:
  - Organic : carbohydrates, fats, proteins, toxins...
  - Inorganic: alkalinity, N, P, S, pH, metals, salts...
  - Gaseous : H_2S, CH_4, O_2 ...
- **Biological**: plants (algae, grass, etc.), microorganisms (bacteria, viruses)

c. Sampling strategies

- Aim: to ensure that the sample *of waste* is a good representation of the true value of waste
- In this stage, needs to identify:
  1. Sampling time
  2. Sampling size
  3. Sampling location
  4. Method used to collect the sample
  5. Method used to preserve sample prior analysis

d. Measurement of pollutant concentration

- Sample preparation - MUST to be carefuly carried out to get accurate and precise measurements
- Know the properties of sample - liquid, solid or gas
- Making samples homogenous
- Reducing sample size - take an aliquot of homogenous sampe that representing the sample population
- Sample identification - labelling of the sample
- analytical equipments/instruments - manual or automatic

- Characterisation methods - analytical procedures
  - Proximate Analysis
  - Ultimate Analysis
  - Biochemical Analysis
  - Microbiological Analysis
  - Elemental Analysis

MUST follow standard for wastewater, examples:

- APHA (Standard Methods for the Examination of Water and Wastewater/APHA)
- HACH methods
- etc

e. Calculate pollutant loads

- depending on the analytical methods chosen
- Used the formula in the standard method selected
- Main wastewater parameters measured, include:
  - Total Suspended Solids
  - Suspended Solids
  - Volatile Suspended Solids
  - Temperature
  - pH
  - Salinity
  - Colour and Turbidity
  - BOD
  - COD

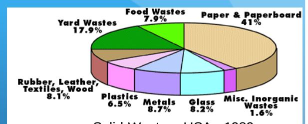
f. Identification of pollutant to be removed

- Based on the highest concentration of pollutants present in wastewater
- This will influence the selection of technology to be used in treating wastewater – physical, chemical, biological, enzyme, thermal, or combined treatment technology

SOLID WASTE CHARACTERISATION

What is Solid Waste?

- Municipal Solid Waste (MSW)
- AKA: "trash" or "garbage"
- Includes:
- Durable goods, e.g., tires, furniture
- Nondurable goods, e.g., newspapers, plastic plates/cups; containers and packaging, e.g., milk cartons, plastic wrap; and other wastes, e.g.,
- Yard waste, food.
- Common household waste, as well as office and retail wastes
- Excludes industrial, hazardous, and construction wastes



Solid Waste – USA - 1989

Characteristics of solid waste

- **Volume - quantity**
- **Physical**: Total solids, volatile solids, ash, moisture content
- **Chemical**:
  - Organic : carbohydrates, fats, proteins, toxins, phenols, oil…
  - Inorganic: Cyanides, Sulphates, Asbestos…
  - Elemental: C, H, O, N, S, P, K ..
  - Heavy metals: Cadmium, Mercury, Lead
- **Biological**: plants (algae, grass, etc.), microorganisms (bacteria, viruses)

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Solid waste characterisation methods - analytical procedures

GENERAL STEPS ARE SIMILAR TO WASTEWATER CHARACTERISATION

- Proximate Analysis
- Ultimate Analysis
- Biochemical Analysis
- Microbiological Analysis
- Elemental Analysis
- Calorific Value

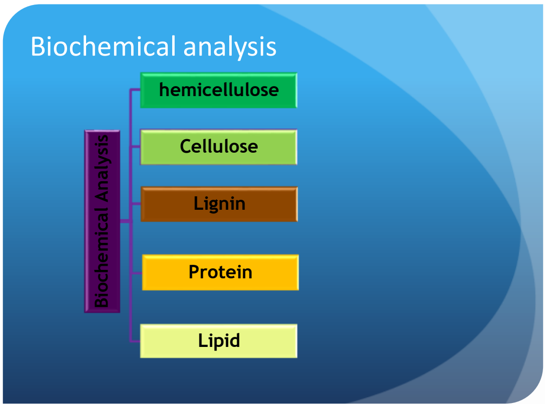
MUST follow standard:
e.g.
- APHA
- HACH methods
- Etc.

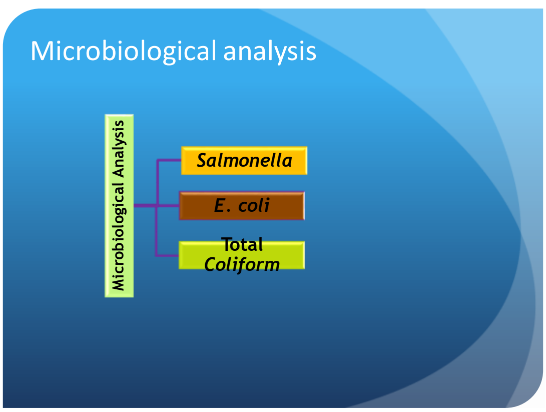
Proximate analysis

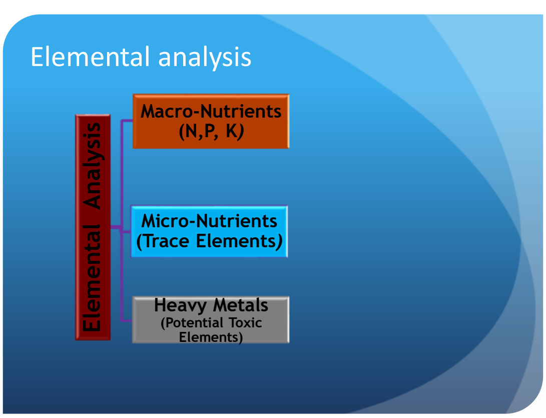
Proximate Analysis
- Moisture Content (MC)
- Total Solids (TS)
- Volatile Solids (VS)
- Ash
- Fixed Carbon Content

Ultimate analysis

Ultimate Analysis
- Carbon (C)
- Hydrogen (H)
- Nitrogen (N)
- Sulphur (S)
- Oxygen (O) (by difference)


Biochemical analysis
Biochemical Analysis
hemicellulose
Cellulose
Lignin
Protein
Lipid


Microbiological analysis
Microbiological Analysis
Salmonella
E. coli
Total Coliform


Elemental analysis
Elemental Analysis
Macro-Nutrients (N,P, K)
Micro-Nutrients (Trace Elements)
Heavy Metals (Potential Toxic Elements)

Calorific value of solid waste

- Use Bomb calorimeter
- Is the measurement of the heat generated on combustion
- Can be used to compare energy potential from solid waste
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EMISSIONS/AIR POLLUTANTS CHARACTERISATION

Typical of emissions/air pollutants

Classified into:

1. Primary pollutants
   - directly emmitted into the atmosphere from sources
   - to cause harm in high enough concentration

2. Secondary pollutants
   - not directly emitted from sources but instead from in the atmoshpere from primary pollutants (known as precursors)
   - also to cause harm in high enough concentration

Primary air pollutants

- Carbon compounds - CO, CO_2, CH_4 and VOCS
- Nitrogen compounds - NO, N_2O and NH_3
- Sulfur compounds - H_2S and SO_2
- Halogen compounds - chlorides fluorides and bromides
- Particulate matter (PM or aerosols) - either in solid or liquid

Secondary air pollutants

- NO_2 and HNO_3 are formed from NO
- Ozone (O_3) are formed from photochemical reaction of NO_2 and VOC
- Sulfuric acid droplets from SO_4
- Nitric acid droplets formed NO_{2+}
- Sulfates and nitrates aerosols formed from reaction of sulfuric acid droplet and nitric acid droplet with NH_3
- Organic aerosolcs formed from VOS in gas to particle reaction

Source of air pollution

1. Nature - e.g. From volcanoes (ashes, dust), land source (dust, soil particles), green plants (vapor, pollen), forest fire, etc.
2. Manmade source - e.g. thermal power plant, textile mills, nuclear reactions, ttransportation, Industrial and domestic fuel burning, Industrial processes. etc
3. Primary and secondary air pollutants

Measurement of air pollution

- **General steps are similar to wastewater or solid waste characterisation**
- Pollution can be measured in many ways, from simple physical and chemical measurements, to sophisticated electronic methods.
- The three main methods are:
  - Passive Sampling Methods
  - Active Sampler Methods
  - Automatic Sampler Methods

Passive Sampling Methods

- Diffusion Tubes:

  Simple, inexpensive, simple plastic tubes or discs open at one end to the atmosphere, with a chemical absorbent at the other.
- Give an indication of the average pollution over an area for a period of weeks or months.
- To indentify ‘hotspot’

Active Sampler Methods

- Collect Pollutant samples, physically or chemically and analyse in the Laboratory.
- Regular measurements are easier and faster at less cost than automatic sampling.
- Provide good baseline data for comparison

Automatic Methods

- Give hourly measurements at a particular point.
- For example :
  - spectroscopic techniques
  - filtration techniques, e.g. For particulate matter
  - gas chromatography, e.g. for hydrocarbons.
- Samples can be analysed on-line and in real-time, BUT expensive.
- Provide accurate, reliable data need to ensure good maintenance operational and quality assurance/control procedures.