— University of Mosul —
College of Petroleum & Mining Engineering

Analytical Chemistry

Lecture …(4)….

Petroleum and Refining Engineering Department

Concentration Expressions and Analytical Interpretation in Petroleum Industry

II. Common Expressions of Concentration

Expression	Unit	What It Means	Where Used	Example from Industry
Percentage	% (v/v or w/w)	Parts per hundred (volume or weight based)	GC, titration	Gasoline with 5% benzene means 5 liters of benzene in 100 liters of fuel
Parts per million	ppm (mg/kg)	One part in a million parts	XRF, ICP-OES, GC	Sulfur in diesel = 10 ppm → 10 mg in 1 kg of fuel
Parts per billion	ppb (ug/kg)	One part in a billion parts	ICP-OES	Lead in fuel = 25 ppb → 25 micrograms in 1 kg
Molarity	mol/L	Moles of substance in one liter	UV-Vis spectroscopy	Not commonly used in refinery, mostly in lab-based chemical testing
Normality	eq/L	Reactive equivalents per liter	Titration (acid/base)	Used in determining acid number using KOH or other bases
mg KOH/g	-	mg of KOH needed to neutralize 1 gram of oil	Titration	Used engine oil = 6.73 mg KOH/g → Needs replacement

✅ **Sulfur content = 60 ppm**

✅ Interpretation: Too high if limit is 15 ppm (must be reduced).

Example Question 4:

Gasoline contains **150 ppm** sulfur.
Convert to % weight.

Solution:

$$\text{Weight \%} = \frac{\text{ppm}}{10,000}$$

$$\text{Weight \%} = \frac{150}{10,000} = 0.015\%$$

✅ **Sulfur content = 0.015%**

✅ Interpretation: Acceptable for regular gasoline (limit varies by country).

A. Weight Percent (%)

- **Formula**:

$$\text{Weight Percent (w/w)} = \left(\frac{\text{Mass of Solute}}{\text{Mass of Solution}} \right) \times 100$$

Mass of Solute = the substance being measured (e.g., acid, salt, fatty acid)

Mass of Solution = the total mass of the oil, fuel, or sample

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Summery :

Term	Meaning	Example from Petroleum
% w/w	Grams per 100 g of product	5% salt in 100 g crude = 5 g
% v/v	mL per 100 mL of liquid	10% ethanol in gasoline = 10 mL
GC use	% of each compound in fuel	60% isooctane in gasoline

✅ Formula (for liquids or solids):

$$\text{ppm} = \frac{\text{Mass of Solute (mg)}}{\text{Mass of Solution (kg)}}$$

- **Solute** = what you are measuring (e.g., sulfur, nickel, vanadium)
- **Solution** = the sample (e.g., crude oil, diesel, lubricant)

□ Example 1: Sulfur in Crude Oil (XRF Technique)

Let's say:

- Sulfur content = **200 mg**
- Crude oil sample = **1 kg**

$$\text{ppm} = \frac{200\ \text{mg}}{1\ \text{kg}} = 200\ \text{ppm}$$

Example Question:

GC shows:

- Hexane = 40%
- Benzene = 6%

Regulation says benzene must be < 1%.

Is the sample acceptable?