**— University of Mosul —**

**College of Petroleum & Mining Engineering**

# Analytical Chemistry

**Lecture …(2)….**

**Petroleum and Refining Engineering Department**

# Lec -2- Analytical Chemistry Applications in Petroleum Engineering:
## Quantitative and Qualitative Techniques with Practical Calculations

## Part 1: Quantitative Analytical Chemistry

### 1. API Gravity

As mentioned in the first lecture, **API gravity** is a measure of how heavy or light crude oil is. The formula used for calculating API gravity is:

**Formula:**

$$\text{API Gravity} = \frac{141.5}{SG} - 131.5$$

**Example Question 1:**

Crude oil specific gravity = **0.82**.

Step 1: Plug into formula:

$$\text{API} = \frac{141.5}{0.82} - 131.5$$

Step 2: Calculate:

$$\frac{141.5}{0.82} = 172.56$$

$$172.56 - 131.5 = 41.06$$

✅ **API Gravity = 41.1°**

✅ Conclusion: **Light crude oil** (very valuable).

## Example Question 2:

Crude oil SG = **0.93**. Find API gravity.

**Solution:**

$$\text{API} = \frac{141.5}{0.93} - 131.5$$

$$= 152.15 - 131.5$$

$$= 20.65$$

## Table 2: Key Analytical Methods in Refinery Operations

| Analytical Technique | Measured Parameter | Petroleum Application |
|---|---|---|
| Gas Chromatography (GC) | Hydrocarbon composition | Reformate analysis |
| UV-Vis Spectroscopy | Aromatic content | Gasoline quality |
| X-Ray Fluorescence (XRF) | Sulfur content | Diesel sulfur testing |
| Titration | Acid/Base number | Lube oil stability |
| ICP-OES | Trace metals (e.g., V, Ni, Fe) | Crude oil corrosion control |

✅ **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).

**Common ASTM Tests for Petroleum Products:**

These are **important tests** used to measure the quality of petroleum products:

1. **D86 – Distillation Curve (Boiling Points):**
   - This test checks the **boiling points** of different parts of the petroleum product. It helps determine the best way to separate the **gasoline**, **diesel**, and other products during refining.

   **Numerical Example:**

   - If gasoline boils at temperatures between **40°C to 200°C**, this helps the refinery know at what temperature to separate it from other products.
2. **D445 – Kinematic Viscosity:**
   - This measures how **thick** or **thin** the product is. If it's too thick, it won't flow well, and if it's too thin, it won't lubricate the engine properly.

   **Numerical Example:**

   - A **diesel fuel** might have a **viscosity of 2.5 cSt (centistokes)**. This tells us how thick or thin it is. For reference, **thicker** oils have a viscosity higher than **3.0 cSt**, and **thinner oils** have a viscosity **lower than 1.0 cSt**.
3. **D4294 – Sulfur by XRF (X-Ray Fluorescence):**
   - This test measures how much **sulfur** is in the product. Too much sulfur in fuel is bad for the environment.