8th demonstration: KINETICS OF THE BENZENEDIAZONIUM CHLORIDE HYDROLYSIS REACTION

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AIMS

- To monitor the **kinetics** by measuring the volume of gas released.
- To check that the reaction rate is of **first order**.
- To study the effect of **temperature**.

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- Aims
- **Theoretical background**
- Experimental procedure

THEORETICAL BACKGROUND

$$C_6H_5N_2Cl + H_2O \rightarrow C_6H_5OH + HCl + N_2\,(g)\uparrow$$

- Kinetics of the reaction → **Volume of N_2** released.
- Reaction speed:

$$v = k\left[C_6H_5N_2Cl\right]^a\left[H_2O\right]^b$$

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- We will suppose:
  - a = 1
  - $[H_2O]^b$ = constant

$$v = k'\left[C_6H_5N_2Cl\right]$$

- Definition of the speed of a reaction:

$$v = -\frac{d\left[C_6H_5N_2Cl\right]}{dt}$$

- Equalling both equations:

$$-\frac{d\left[C_6H_5N_2Cl\right]}{\left[C_6H_5N_2Cl\right]} = k'dt$$

- By integrating:

$$\ln \frac{\left[C_6H_5N_2Cl\right]_0}{\left[C_6H_5N_2Cl\right]} = k't$$

- As a function of the volume of N_2 formed:

$$k't = \ln \frac{V_\infty - V_0}{V_\infty - V_t}$$

- $\mathbf{V_\infty}$, $\mathbf{V_0}$ and $\mathbf{V_t}$ → **Experimentally**

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Preparation of the benzenediazonium chloride solution

5,4 cm^3 **HCl 12N** (250 cm^3 volumetric flask) → Cool in a bath (**0°C**)

\+ 1,65 cm^3 **aniline**

\+ 1,22 g **$NaNO_2$** diluted in 20 cm^3 of water

- **Dilute** with water and **stir** it → Inside the bath!
- When it is **perfectly clear** at 0°C → Level it off (250 cm^3)
- Keep it in a **topaz flask** in the fridge.

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Experimental method for kinetic monitoring

1. Heat the **thermostatic bath** → Working temperature

2. 25 cm^3 $C_6H_5N_2Cl$ solution → 100 cm^3 Büchner flask

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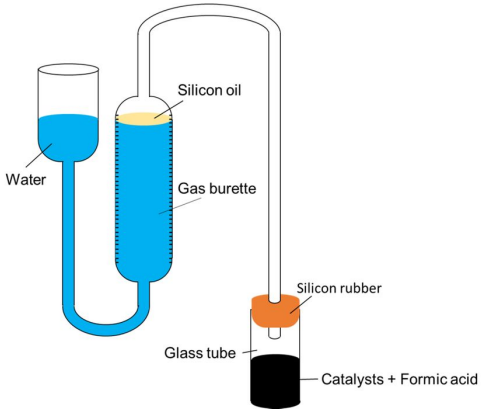
Put the lid and the cable-tie

3. **Heat** the solution in the bath → Temperature

4. Connect the flask outlet to the **gas burette**



When the **liquid level** is **equal** in both branches

↓

Read the $\mathbf{V_0}$ (burette)

↓

Start the clock

The working temperature

50°C

- Leave the flask heating for 5 min.
- Read **V_t** every **3 min** for 1h.

40°C

- Keep it at 40°C for 7 min.
- Read **V_t** every **5 min** for 1h.

30°C

- Keep it at 30°C for 10 min.
- Read **V_t** every **10 min** for 1h.

Each group will carry out the experiment at **two temperatures**

Always equal out the level of water before reading the V_t value

Measurement of V_∞

Accelerate the reaction → **Heat** the flask (water bath close to boiling)

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Put it back in the **thermostatic bath**

Check the liquid level

↓

Take the V_∞ value

Repeat this process until the value does not change.

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