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Apparent Specific Surface Area of Charcoal by Acetic-Acid Adsorption

Experiment 14 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To measure acid adsorption and estimate a model-dependent apparent surface area.

Principle

The drop in equilibrium acid concentration gives adsorbed amount per gram. A suitable Langmuir analysis can estimate monolayer capacity. Conversion to surface area assumes a molecular cross-sectional area and monolayer adsorption; this liquid-phase estimate is not a direct BET measurement.

Requirements

- Assigned activated charcoal batch, acetic-acid concentration series and standardised sodium hydroxide.
- Closed mixing vessels, filters, volumetric glassware, balance and prescribed titration endpoint method.

Procedure

1. Prepare controls

Prepare known initial acid concentrations C_0 and liquid volume V. Run no-charcoal and charcoal/leachate blanks as prescribed.

2. Adsorb

Add equal accurately weighed dry charcoal mass m to each solution, mix for the validated equilibration period and control temperature.

3. Separate

Remove charcoal by a validated method and retain clear equilibrium liquid without further adsorption loss.

4. Titrate

Determine Ce from a known aliquot using standardised base and blank correction. Acetic acid and NaOH react in a 1:1 molar ratio.

5. Calculate q

Use $q = (C_0\text{-}Ce)V/m$ with C in mol/L, V in L and m in g. Plot the isotherm and check whether the selected model is appropriate.

6. Estimate area

For an acceptable Langmuir representation, plot Ce/q against Ce: slope = 1/qm. Use S = qm NA a with the explicitly assumed molecular area a. Report the model and limitations.

Observations and Record

C_0 / Ce (mol/L)	Charcoal m (g) / V (L)	q (mol/g) / Ce/q
_____	_____	_____
_____	_____	_____
_____	_____	_____

Worked Example

The numbers below are illustrative; enter your own observations in the record.

- A 10.0 mL equilibrium aliquot consuming 2.00 mL of 0.0500 mol/L NaOH gives Ce = 0.0100 mol/L after applicable blank correction.
- For C_0 = 0.0200, Ce = 0.0100, V = 0.0500 L and m = 0.500 g, q = 0.00100 mol/g.
- An illustrative fitted slope of 500 g/mol gives qm = 0.00200 mol/g.
- With an explicitly assumed a = 0.21 nm^2 = 0.21×10^(-18) m^2 per molecule, S = 0.00200 × 6.02214076×10^23 × a = 252.9 m^2/g. The assumed a and model control this estimate.

Result

Record the observed outcome and calculated value, with units. State whether the stated laboratory specification was met; do not copy the worked example as your result.

Precautions

- Use the instructor's assigned material and apparatus; record actual temperature and units with every measured property.
- Check instrument calibration and use repeat readings rather than a single convenient result.
- Compare a marketed teaching formulation only under the same method and conditions; its excipients can change the property.
- Do not accept an adsorption curve without checking blank effects, equilibrium and appropriate model behaviour.

Viva Questions and Answers

1. Why distinguish this from BET surface area?

The experiment uses aqueous adsorption with model assumptions, not gas adsorption under BET conditions.

2. Why determine Ce rather than use C_0?

Adsorption is related to the concentration remaining at equilibrium.

3. What if the Langmuir fit is unsuitable?

Report measured adsorption and the failed model assumption rather than forcing a surface-area value.

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