The 227th ACS National Meeting, Anaheim, CA, March 28, 2004

Comparative Study of Gas Phase Adsorption of Volatile Organic Compounds on Two Types of Activated Carbon

Daekeun Kim, George A Sorial

Department of Civil and Environmental Engineering
University of Cincinnati

OUTLINE

- Introduction
- Objective
- Adsorption of Single Compounds
  - Experimental Method
  - Results
- Ternary Adsorption
  - Experimental Method
  - Results
- Conclusion

INTRODUCTION

- **Volatile Organic Compounds (VOCs) :**

  Typical air pollutants

- **VOC Control Technology :**

  Carbon adsorption,

  Liquid scrubbing,

  Condensation,

  Catalytic incineration,

  Biological treatment.

INTRODUCTION (cont'd)

- **Biofiltration: Typical Biological Treatment Process**
  Contaminants or odor are removed through a biologically active media (soil, compost, inorganic material)

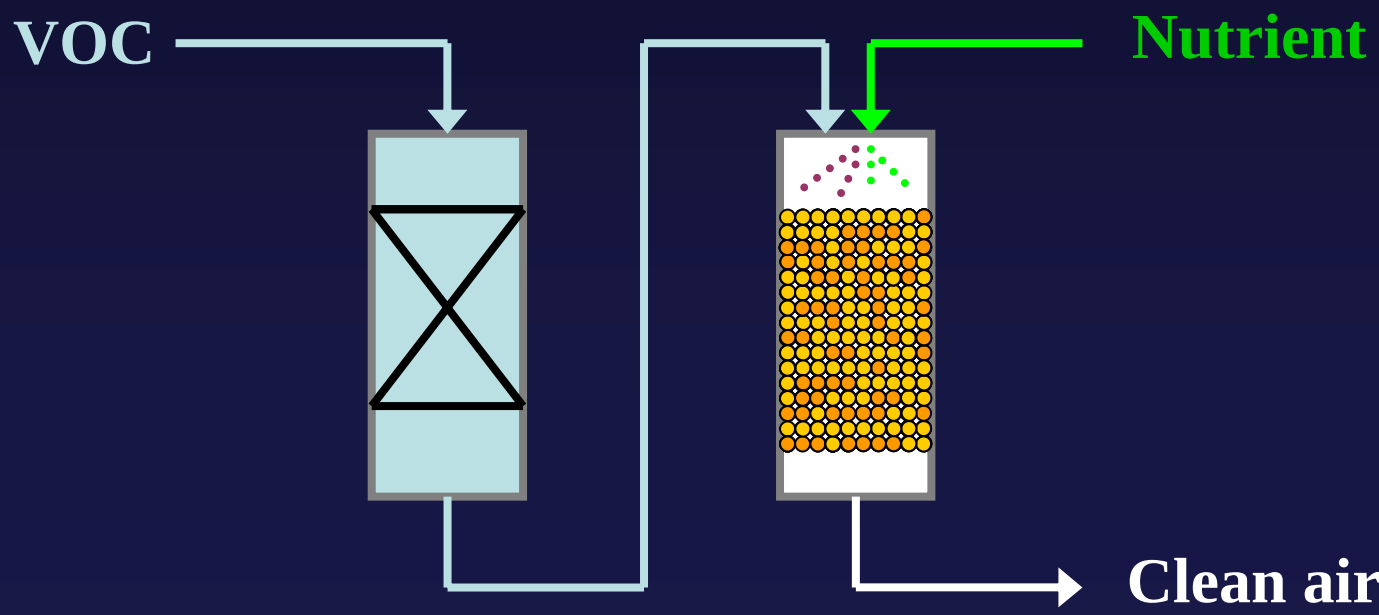
- **Advantages of Biofiltration**
  - ✓ **Environmental friendly**
  - ✓ **Economical viable**

- **Disadvantages of Biofiltration**
  - ✓ **Unfavorable performance due to shock load & load fluctuations**
  - ✓ **Clogging of bed due to accumulation of biomass**

INTRODUCTION (cont'd)

- **For yielding consistently high VOC removal efficiency, a novel combined treatment technology is proposed**

Adsorption unit + Biofiltration



INTRODUCTION (cont'd)

- **Adsorption Unit : as a buffer against unexpected operating condition**

  Required design capacity for this unit mainly depend on the results of the adsorption experiment.

- **Experimental Method of Adsorption**
  - ✓ **Dynamic adsorption column**
  - ✓ **Gravimetric method**
  - ✓ **Constant volume method**

OBJECTIVE

- **To obtain basic experimental adsorption data of VOCs for designing an adsorption unit.**

- **For this purpose, gas phase VOC adsorption on two different adsorbents is carried out by using constant volume method**

ADSORPTION OF

SINGLE COMPOUNDS

EXPERIMENTAL METHOD

- **Adsorbate**
  - **Toluene**
  - **Methyl ethyl ketone (MEK)**
  - **Methyl isobutyl ketone (MIBK)**
- **Adsorbent: two types of activated carbon**
  - **BPL - bituminous base**
  - **OVC - coconut base**
- **Method : Constant volume method**
- **Analysis : Myers adsorption equation**

EXPERIMENTAL METHOD (cont'd)

- **Experimental Apparatus**

Sampling Bag (Tedlar® bag)

6-L Canister

EXPERIMENTAL METHOD (cont'd)

Experimental Procedure

1. **Carbons are inserted into sampling bag**

EXPERIMENTAL METHOD (cont'd)

Experimental Procedure

2. Introduce 6-L pure air by using 6-L canister

EXPERIMENTAL METHOD (cont'd)

Experimental Procedure

3. Inject gas phase VOC

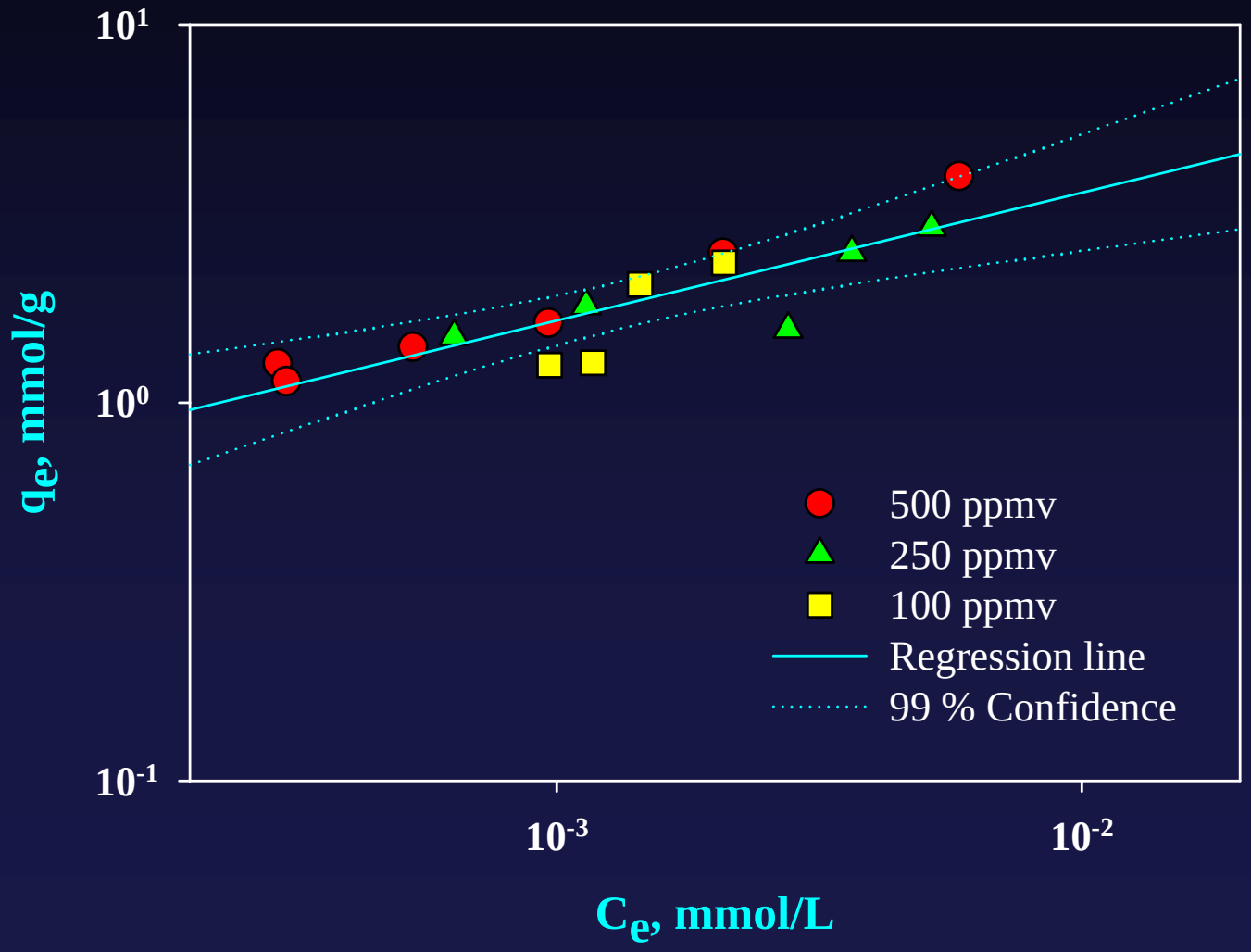
EXPERIMENTAL METHOD (cont'd)

Experimental Procedure

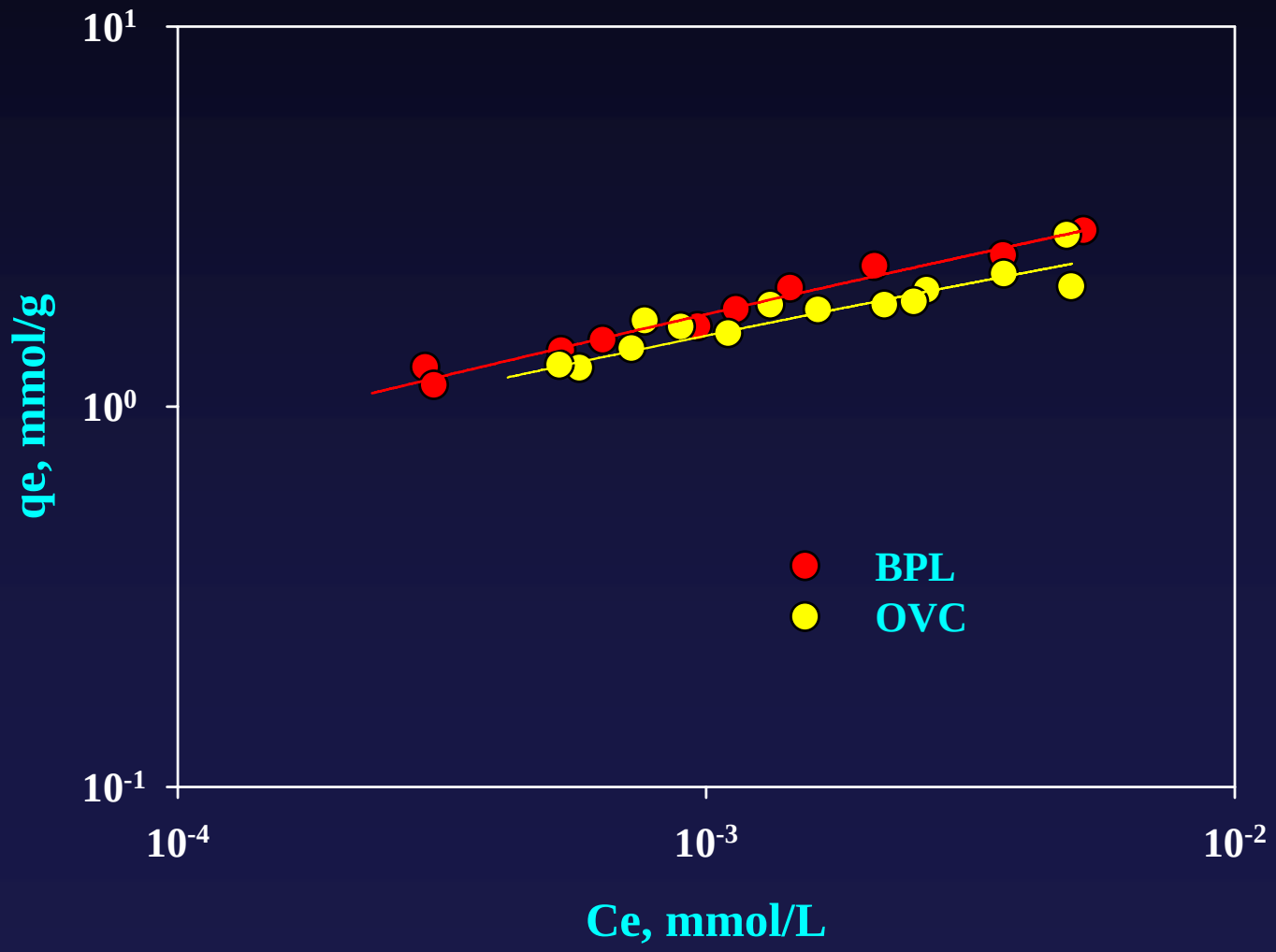
4. GC measurement

RESULTS

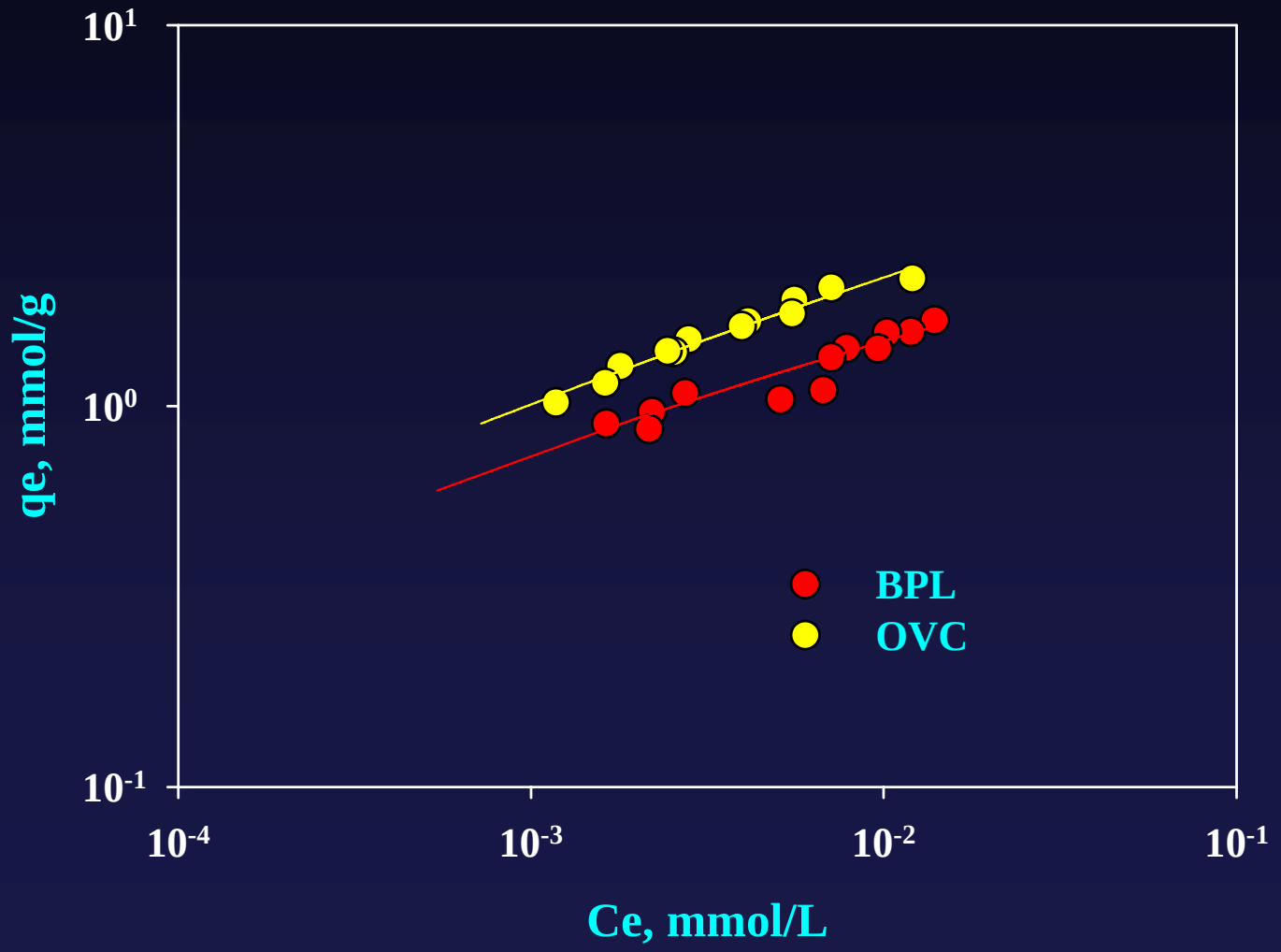
Toluene adsorption on BPL



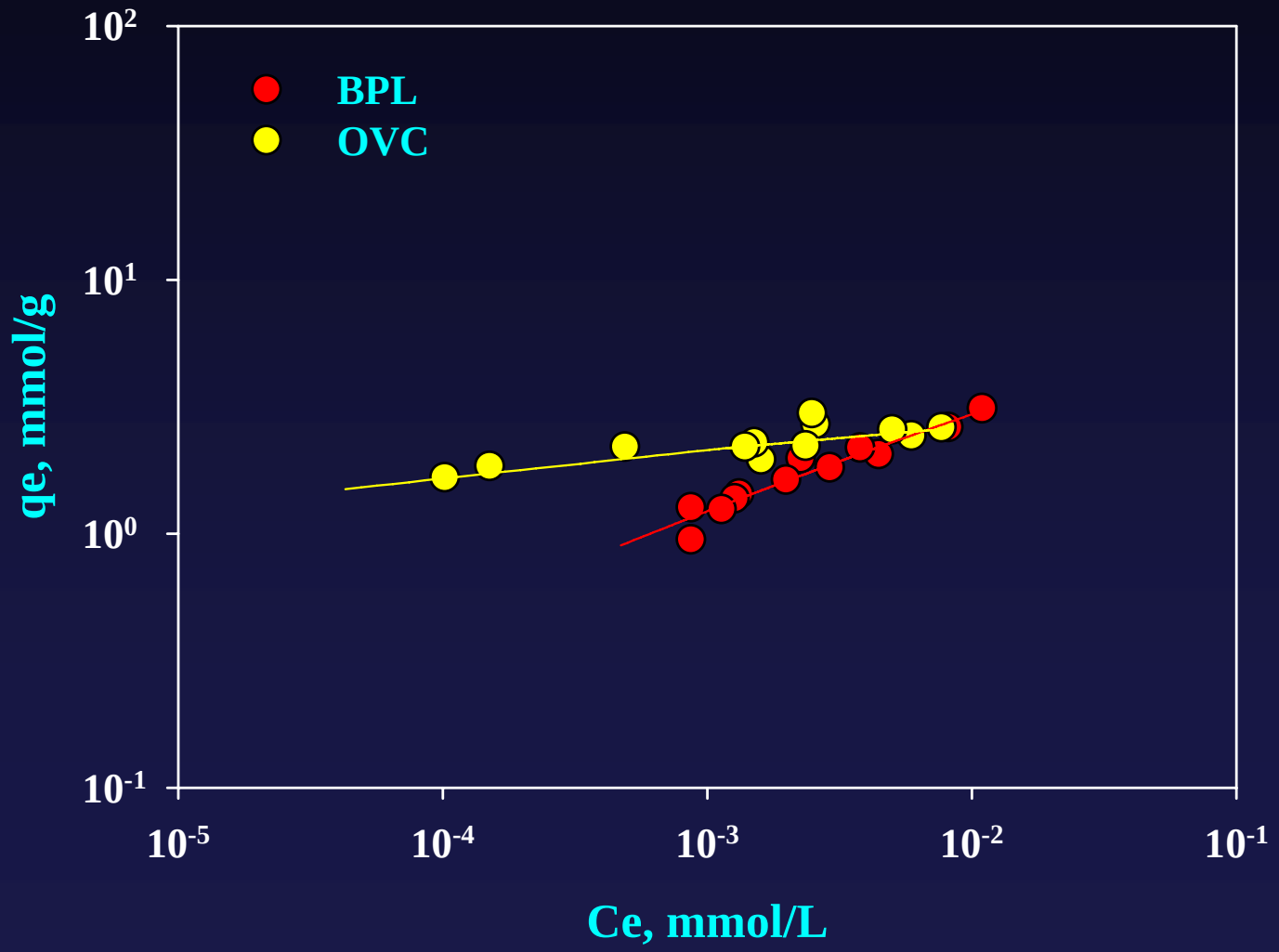
RESULTS – TOLUENE



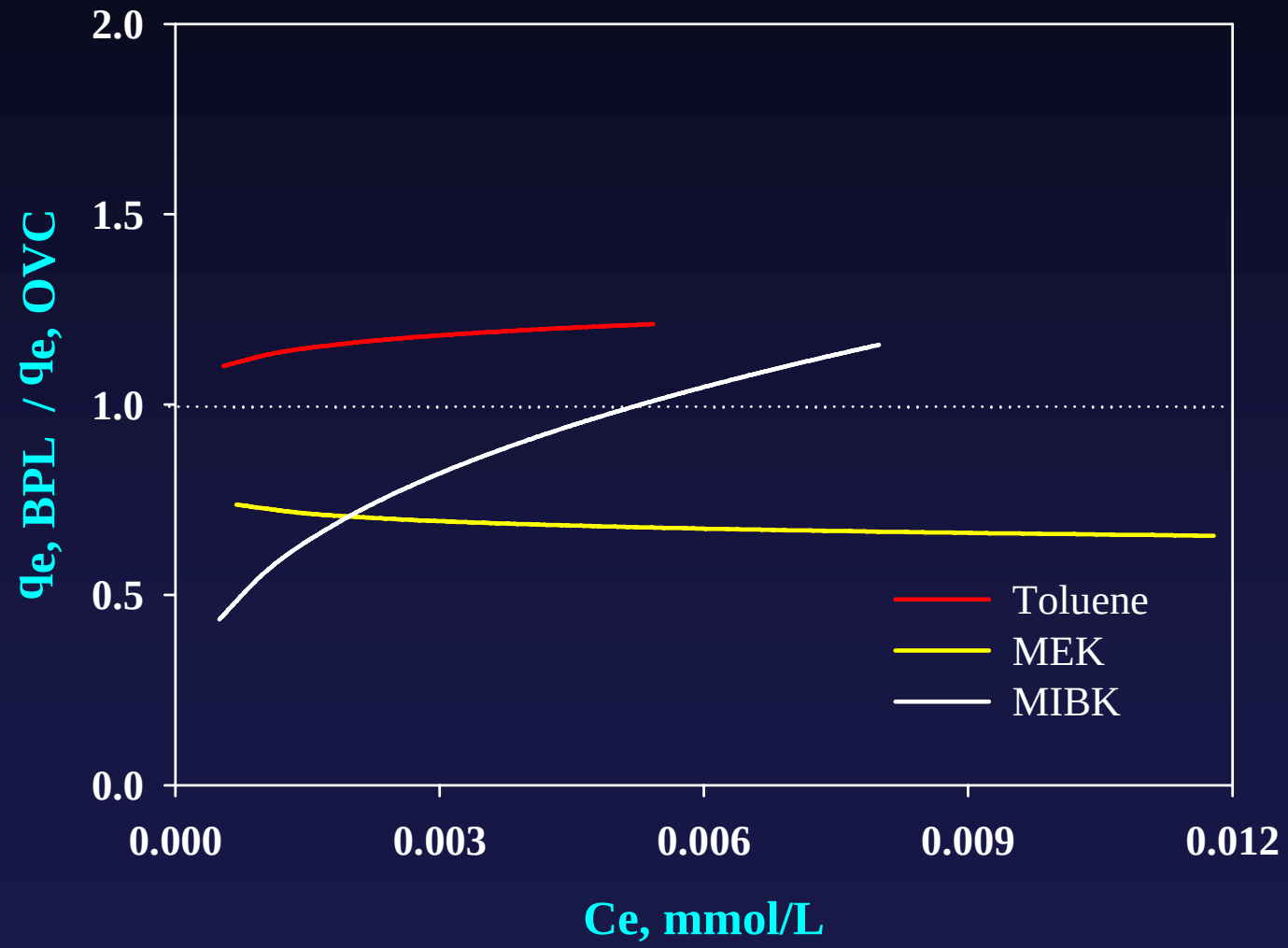
RESULTS - MEK



RESULTS - MIBK



RESULTS - Comparison



TERNARY ADSORPTION

EXPERIMENTAL METHOD

- **Composition of adsorbate**

  Using public data of industrial VOCs air emission (U.S.EPA Toxic Release Inventories),

  Toluene: MEK: MIBK ≈ 6 : 3 : 1 (Toluene is majority)

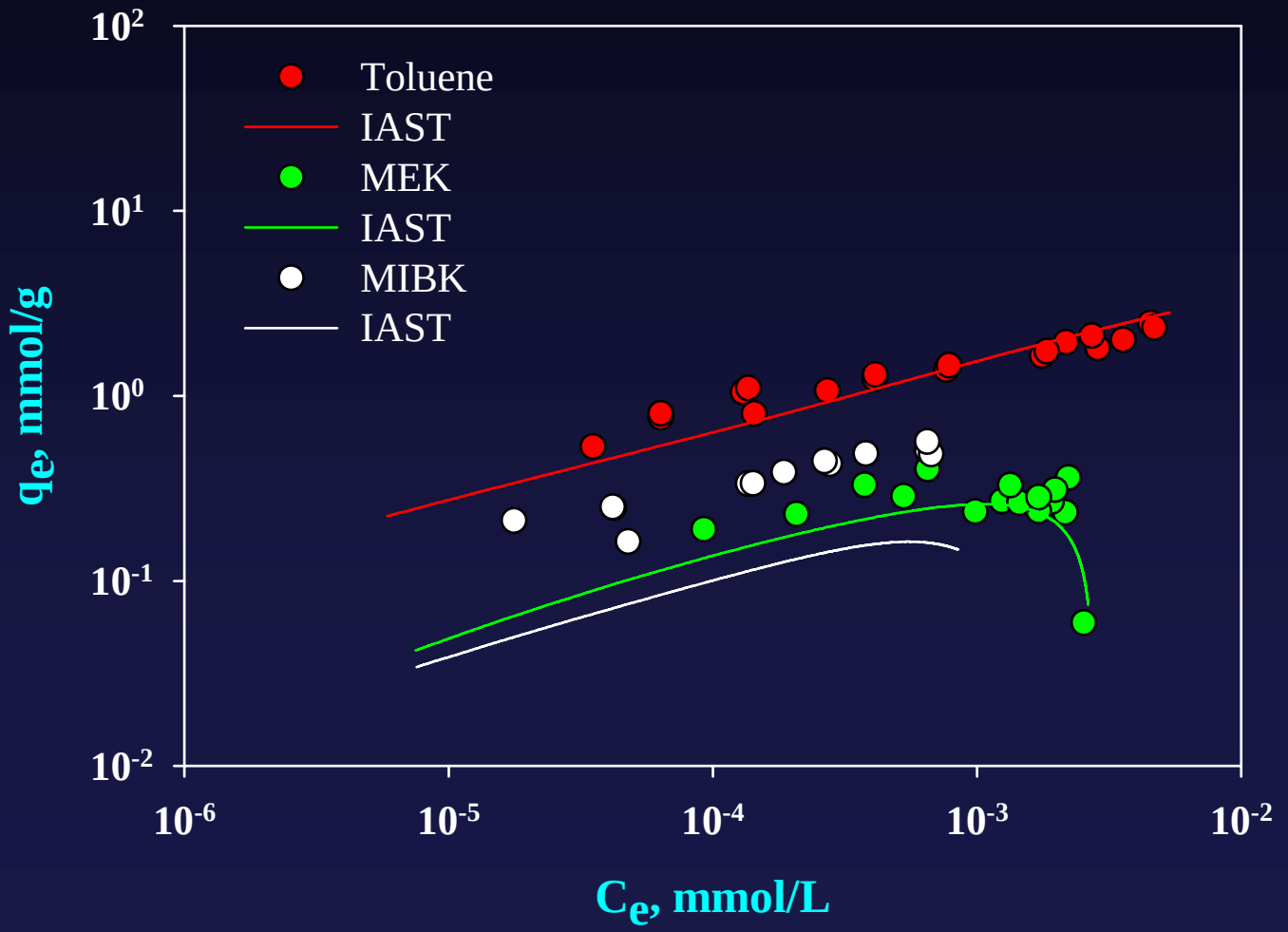
- **Adsorbent of concern**

  BPL (BPL is superior to OVC for toluene adsorption)

- **Experimental Method : Constant Volume Method**

- **Prediction : IAST (Ideal Adsorption Solution Theory)**

Results - Ternary Adsorption



CONCLUSION

- Activated carbon **BPL and OVC can effectively adsorb Toluene, MEK, and MIBK** as single solute and mixture-compounds.
- However, **BPL was superior to OVC** for adsorption of toluene
- **Myers adsorption equation** was found to reliably represent single solute equilibrium data

CONCLUSION (cont'd)

- **IAST predicted well ternary adsorption on activated carbon BPL, but minor compound (MIBK) was underestimated.**

- **Constant volume method is a simple & accurate experimental method for gas phase VOC adsorption for the low concentrations.**

ACKNOWLEGEMENTS

This research study was supported financially by National Science Foundation (BES-0229135)

Special thanks is given to Dr. George A. Sorial

and is extended to my colleagues at Environmental Chemistry Laboratory at University of Cincinnati.

Comparative Study of Gas Phase Adsorption of Volatile Organic Compounds on Two Types of Activated Carbon

Thank you !

Question ?

Daekeun Kim
Department of Civil and Environmental Engineering
University of Cincinnati