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APPENDICES

APPENDIX A

Properties of heavy metal

Copper (Cu)

Atomic number	: 29
Atomic weight	: 63.546
Periodic Table	: group IB
Valences	: 1, 2; two stable isotopes
Oxidation states	: +2, +4
Properties	: Distinctive reddish color, specific gravity 8.96, melting point 1083 °C , boiling point 2595° C, dissolves in nitric acid and hot concentrated sulfuric acid, dissolves slowly in hydrochloric and dilute sulfuric acid but only when exposed to the atmosphere.
Hazard	: The toxicity of metallic copper is very low. However, inhalation of duxts, fumes, mist or salt can cause adverse health effects. Many copper (II) salts are toxic.
Uses	: Copper is used in electric cables and wires, switches, plumbing, heating: roofing and building construction; chemical and pharmaceutical machinery; alloys (brass, bronze, and new alloy with 3% beryllium that is particularly vibration resistant); alloy castingss; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc.. cooking utensils.
Exposure limits	: TLV-TWA 1 mg (Cu) /m^3 (dust and mists) ACGIH and MSHA; 0.2 mg/m^3 (fumes) (ACGIH).
Method	: The Atomic Absorption Spectrometic, The Inductively Coupled Plasma and the neuocuproine method are recommended because of their freedom from interference.
Sampling and Storage	: Copper ions tends to be adsorbed on the surface of sample containers. Therefore, analyze sample as soon as possible after collection. To store sample, use 0.5 ml 1+1 HCl/ 100 ml samples to prevent this adsorption.

Cadmium (Cd)

Atomic number	: 48
Atomic weight	: 112.4
Periodic Table	: group IIB
Valences	: 2
Oxidation states	: +2
Properties	: Soft, blue-white, malleable metal or grayish-white powder. Tarnishes in moist air; corrorsion resistance poor in industrial atmospheres. B ecomes b rittle at 80 °C. Resistant to alkalies; high neutron absorber. Specific gravity 8.642, melting point 320.9 °C, boiling point 767 °C, soluble in acids, especially nitric and ammonium nitrate solutions.
Hazard	: Highly toxic, especially by inhalation of dust or fumes. It is a known carcinogen (OSHA)
Uses	: Electrodeposites and dipped coating on metals; bearing and low-melting alloys; brazing alloys; fire-protection systems; nickel-cadmium storage batteries; powder tramission wire; TV phosphors; bisis of pigments used in ceramic glazes.
Exposure limits	: TLV-TWA 0.15 mg/m^3 (ACGIH and MSHA); 0.05 mg/m^3 (OSHA).
Method	: The Atomic Absorption Spectrometic, The Inductively Coupled Plasma and the neuocuproine method are recommended because of their freedom from interference.
Sampling and Storage	: Cadmium ions tends to be adsorbed on the surface of sample containers. Therefore, analyze sample as soon as possible after collection. To store sample, use 0.5 ml 1+1 HCl/ 100 ml samples to prevent this adsorption.

Lead *(Pb)*

Atomic number	: 82
Atomic weight	: 207.2
Periodic Table	: group IVA
Valences	: 2,4
Oxidation states	: +2
Properties	: Heavy, ductile, soft gray solid. Specific gravity 11.35, melting point 327.4 °C, boiling point 1755 °C, soluble in dilute nitric acids; insoluble in water but dissolves slowly in water containing a weak acid; resists corrosion.
Hazard	: Toxic by ingestion and inhalation of dust or fumes.
Uses	: Storage batteries; tetraethyllead (gasoline additive); radiation shielding; cable covering; ammunition; chemical reaction equipment (piping, tank linings, etc.); solder and fusible alloys; type metal; vibration damping in heavy metal construction; foil; and other bearing alloys.
Exposure limits	: TLV 0.05 mg/m^3 (OSHA); 10 hr TWA 0.1 mg(inorganic lead)/m^3 (NIOSH).
Method	: The Atomic Absorption Spectrometic, The Inductively Coupled Plasma and the neuocuproine method are recommended because of their freedom from interference.
Sampling and Storage	: lead ions tends to be adsorbed on the surface of sample containers. Therefore, analyze sample as soon as possible after collection. To store sample, use 0.5 ml 1+1 HCl/ 100 ml samples to prevent this adsorption.

Zinc *(Zn)*

Atomic number	: 30
Atomic weight	: 65.37
Periodic Table	: group IIB
Valences	: 2
Oxidation states	: +2
Properties	: Shining white metal with bluish gray luster (called spelter). Not found native. Specific gravity 7.14, melting points 419 °C, boiling point 907 °C. It is soluble in alkalies and acids, especially nitric and ammonium nitrate solutions but insoluble in water.
Hazard	: Low toxicity, zinc dust is flammable, dangerous fire and explosion risk.
Uses	: Alloy (brass, bronze, and die-casting alloys); galvanizing iron and other metals; electroplating; metal spraying; automotive parts ; electrical fuses, storage and dry cell batteries.
Exposure limits	: TLV-TWA 0.15 mg/m^3 (ACGIH and MSHA); 0.05 mg/m^3 (OSHA).
Method	: The Atomic Absorption Spectrometic, The Inductively Coupled Plasma and the neuocuproine method are recommended because of their freedom from interference.
Sampling and Storage	: Zinc ions tends to be adsorbed on the surface of sample containers. Therefore, analyze sample as soon as possible after collection. To store sample, use 0.5 ml 1+1 HCl/ 100 ml samples to prevent this adsorption.

Source: Sungkhum, 2002

APPENDIX B

Linearization of Langmuir isotherm and Freundlich isotherm for single component system

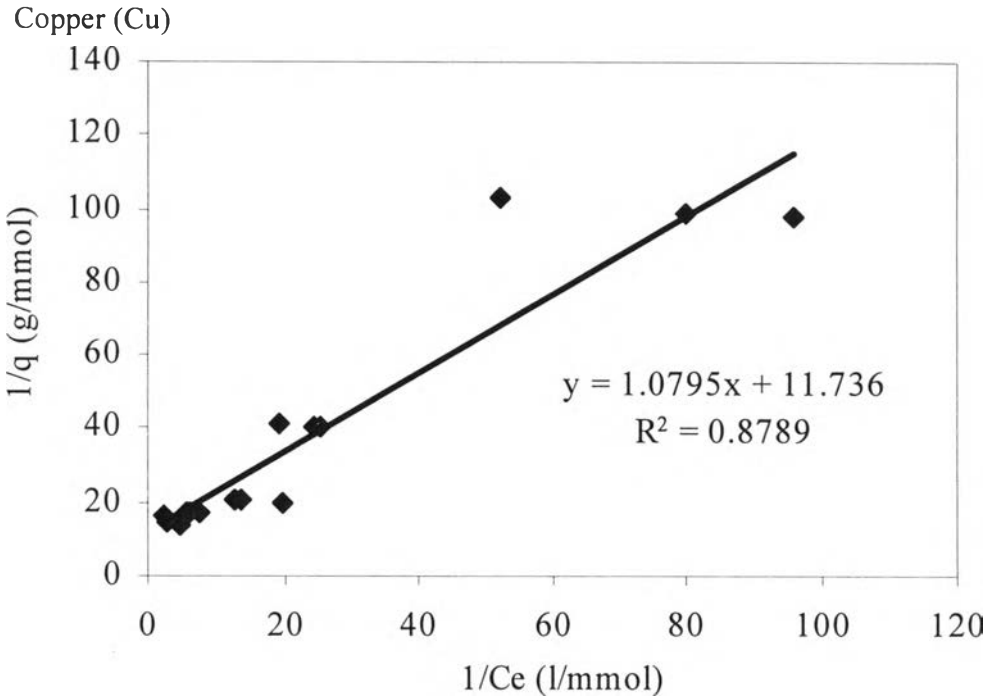

Figure B-1 Linearization of Langmuir isotherm model

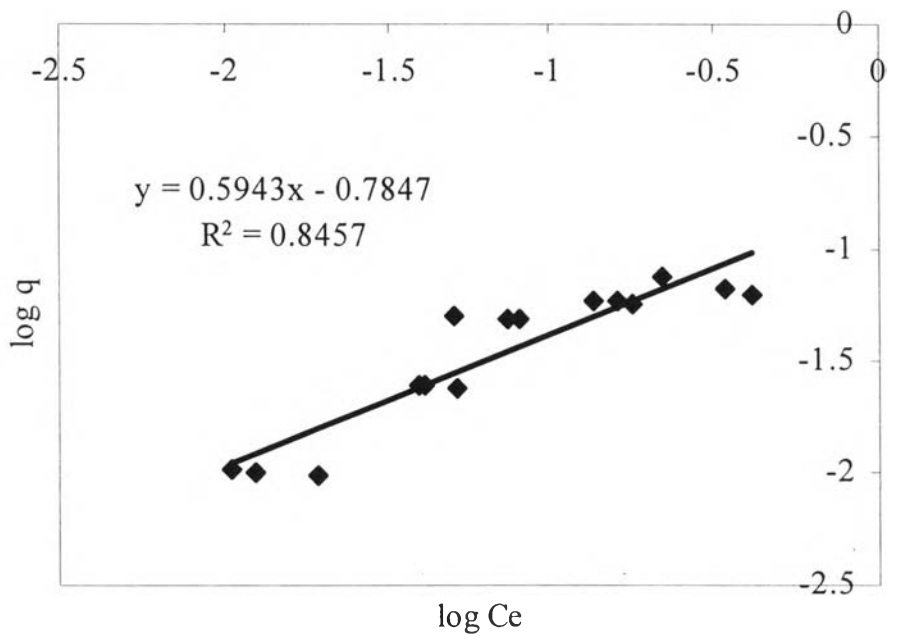

Figure B-2 Linearization of Freundlich isotherm model

Cadmium (Cd)

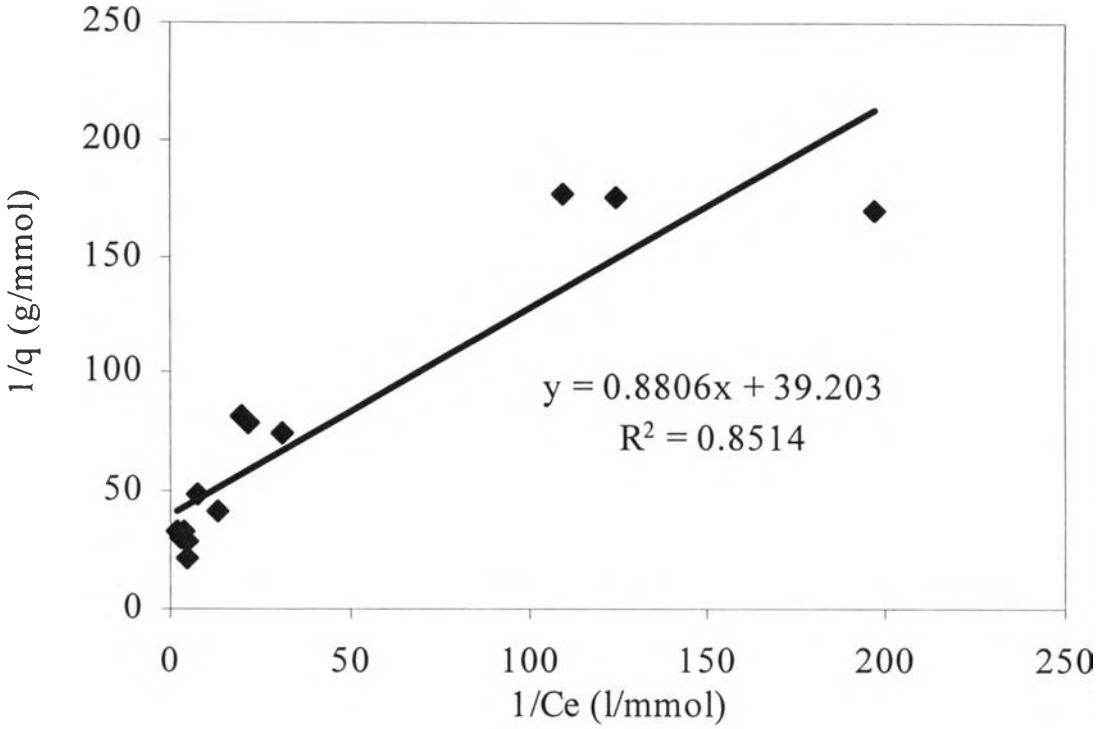

Figure B-3 Linearization of Langmuir isotherm model

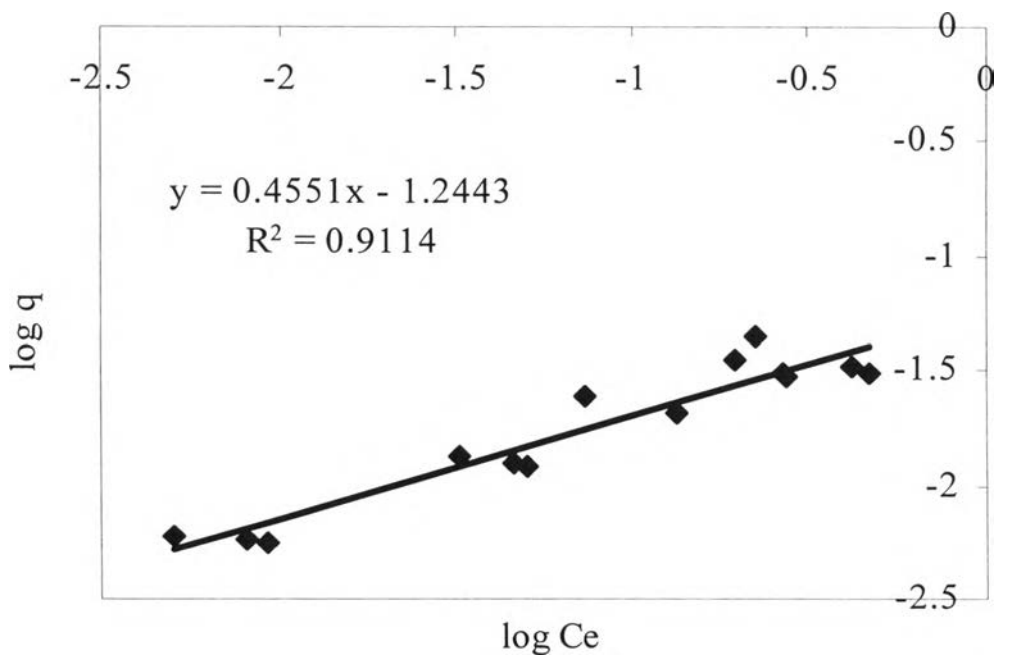

Figure B-4 Linearization of Freundlich isotherm model

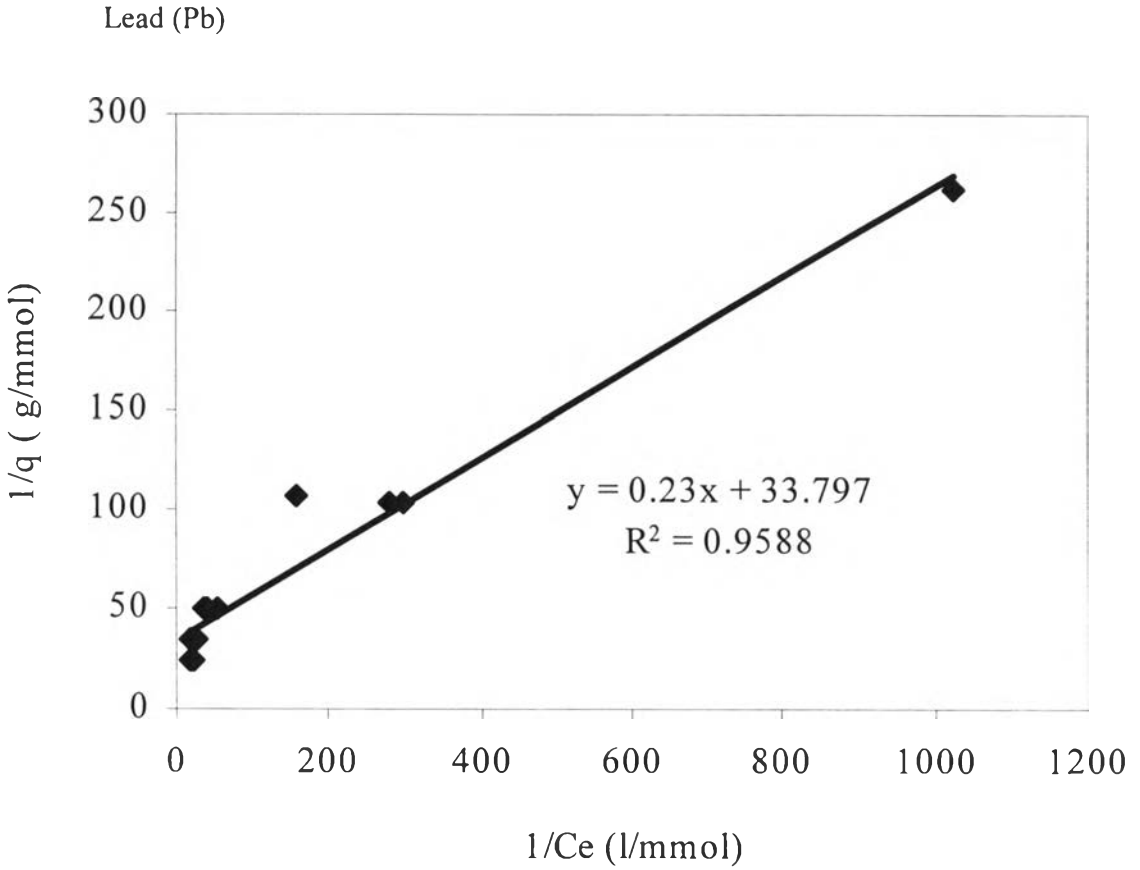

Figure B-5 Linearization of Langmuir isotherm model

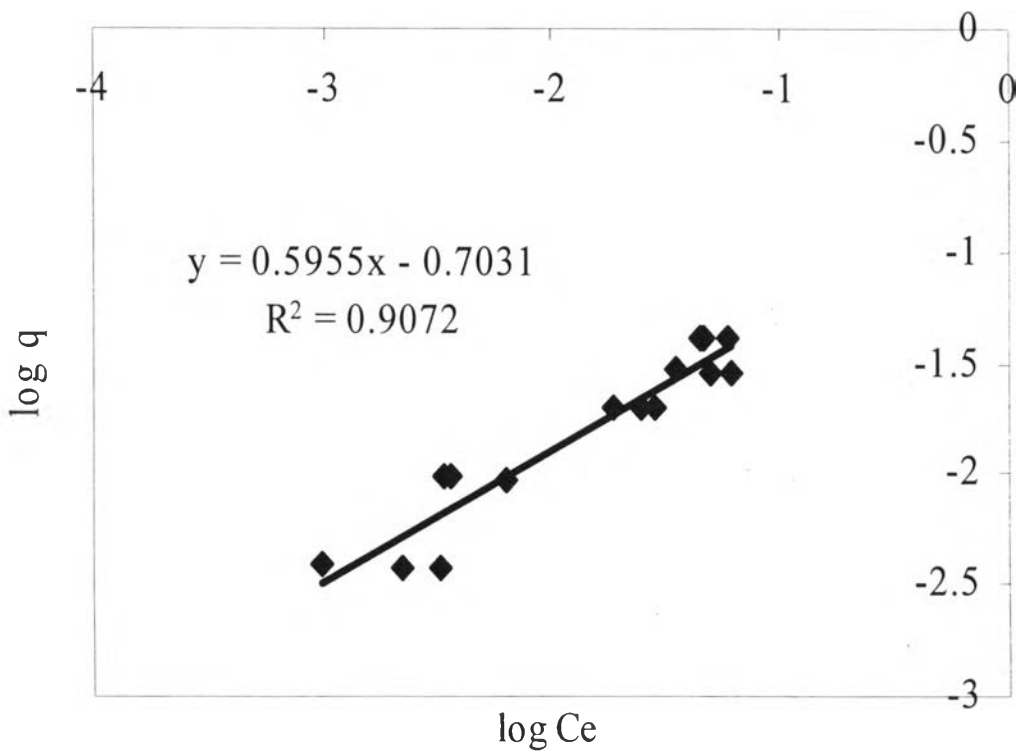

Figure B-6 Linearization of Freundlich isotherm model

Zinc (Zn)

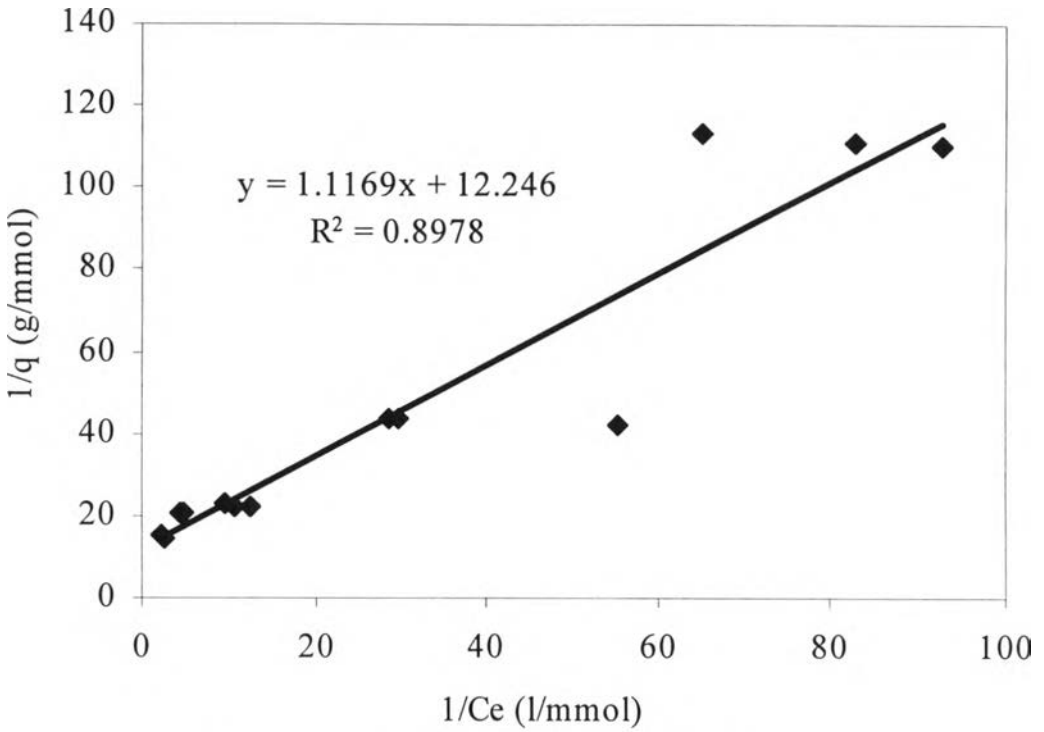

Figure B-7 Linearization of Langmuir isotherm model

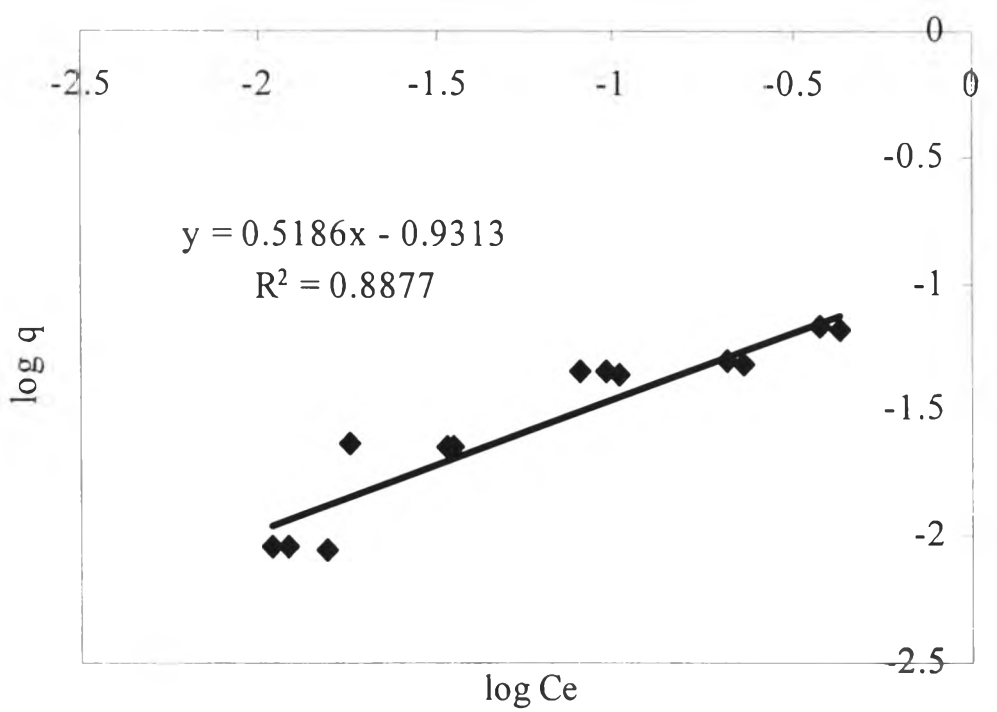

Figure B-8 Linearization of Freundlich isotherm model

BIOGRAPHY

Mr. Ronbanchob Apiratikul was born on 27th October 1980 in Bangkok, Thailand. He finished his higher secondary courses from Triam udom suksa high school (Bangkok) in March 1998. After that he studied in the major of Environmental Engineering, Faculty of Engineering at Chulalongkorn University and received his bachelor's degree in 2002. He continued his further study for Master's degree in International Environmental Management Science at Chulalongkorn University and Achived his Master's degree in April 2004.