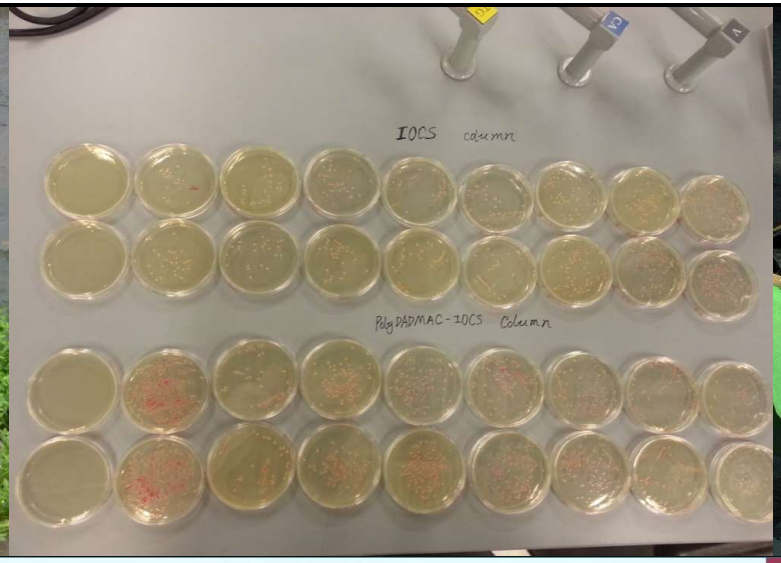

Water and Waste Laboratories

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Department of Civil and Environmental Engineering,
The Hong Kong Polytechnic University

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING
土木及環境工程學系

Opening Minds • Shaping the Future
啟迪思維 • 成就未來

Introduction

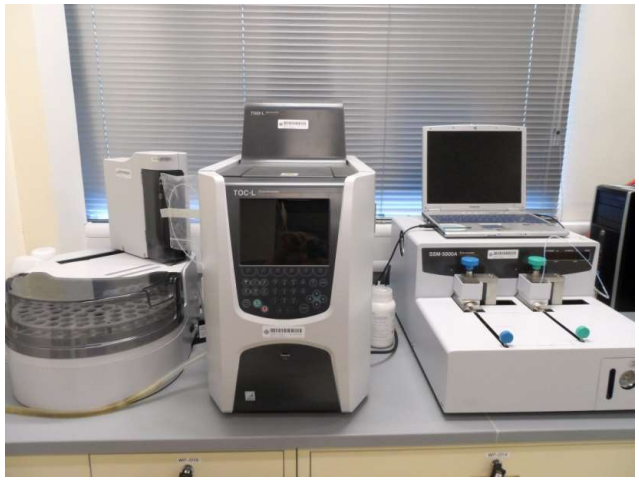
The Water and Waste Laboratories were established in 1976 with an important commitment to facilitate the application of research in environmental engineering and sciences to meet the needs of the industries. The present group of laboratories, comprising a teaching laboratory, a research laboratory, a microbiology laboratory, a chemical store, a sample storage cold room, and an instrument laboratory, are extensively equipped with advanced measuring and analytical instruments for complete physical, chemical and biological sample characterization.

Water Analysis Laboratory was well known for Prof. W. Chu's studies on the photo-degradation mechanisms of persistent organic pollutants (POPs) as well as the development of advance treatment process for POPs. The laboratory also hosted one of the renowned research team in Geo-chemistry in Hong Kong which was leaded by Prof. XD Li.

Water Analysis Laboratory was also named as a State Key Laboratory in Marine Pollution under the PolyU and IUE-CAS Joint Laboratory of Urban Environment and Health.

Major Equipment List

- Flame Atomic Absorption Spectrophotometer
- UV-Vis Spectrophotometers
- Water Baths and Steam Baths
- COD Digesters
- Dissolved Oxygen Meters
- BOD Incubator
- Liquid and Solid Total Organic Carbon Analyzer
- Total Nitrogen Analyzer
- Color and Turbidity Meters
- Salinity and Conductivity Meters
- pH Meters and Selective Ion Analyzers
- Electronic Desiccators
- Jar Test and Filterability Apparatus
- Centrifuges
- Vibration Mixers and Orbital Shakers
- TCLP Rotary Mixers
- Walk-in Cool Store



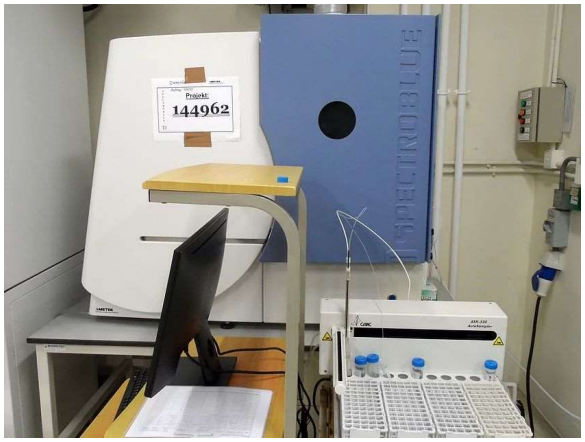
Major Equipment List

- Autoclave, CO2 Incubator and Coliform Incubators
- Drying Ovens and Muffle Furnaces
- Water and Soil Samplers
- Field Kits and Field Spectrophotometers
- Inverted Microscope
- Freezers
- Rotary Evaporators
- Semi-automatic Solvent Extractor
- Acid Digesters
- Optical Microscopes
- MicroTox Analyzer
- Laboratory Class I & II Water Generator
- Perchloric Acid Fume Hoods
- Ultrasonic Reactor and Ultrasonic Baths
- Photo-Reactors
- Vacuum Ovens
- Tube Furnace

Major Equipment List

- High Pressure Reactors
- Microwave Reactors
- Freeze-Dryers
- Various Desktop and Pilot Scale Reactors
- Fourier-transform infrared spectrometer
- Inductively Coupled Plasma Spectrometers with OES
- Inductively Coupled Plasma Spectrometers with MS
- Gas Chromatography with TCD
- Gas Chromatography with MSD
- Gas Chromatography with FID
- High Performance Liquid Chromatography
- Headspaces sampler

Main Equipment



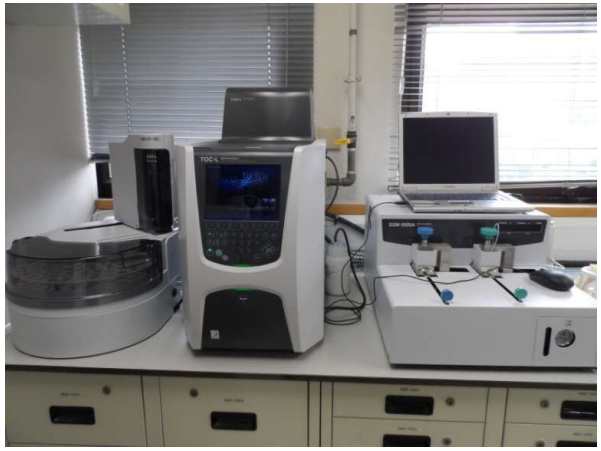
Inductively Coupled Plasma - Optical Emission Spectrometer

The SpectroBlue ICP-OES has automatic axial and radial plasma observation that eliminates the EIE (Easily Ionizable Elements) effect. It provides accurate determination of alkali / earth alkali elements in a complex alkali / earth alkali matrix and is ideal for such environmental applications as analyzing sodium, potassium, or calcium in wastewater or soil matrices.

Gas Chromatograph System with MSD

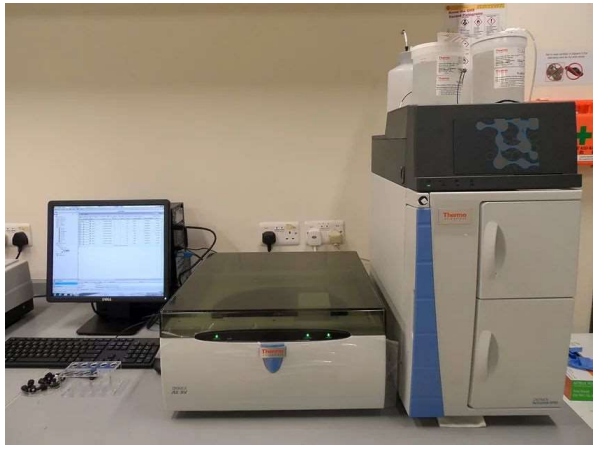
The Agilent 7890B is a state-of-the-art gas chromatograph with advanced electronic pneumatic control (EPC) modules and high performance GC oven temperature control. Each EPC unit is optimized for its intended use with a specific inlet and detector option. The GC system is coupled with a 5977B MSD to provide high sensitivity for trace analysis of volatile organic compounds in environmental samples.

Main Equipment



Total Organic Carbon Analyzer

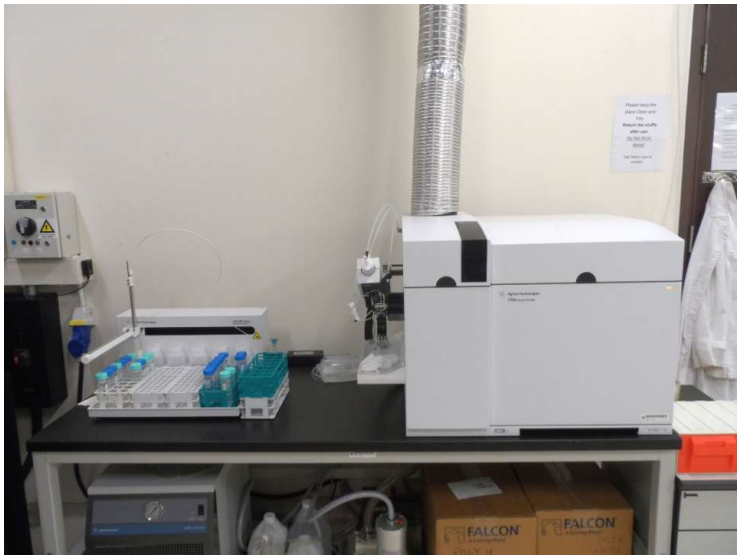
The TOC-L analyzer adopts the 680°C combustion catalytic oxidation method to determine the total carbon contents of samples. In addition, the combustion catalytic oxidation method makes it possible to efficiently oxidize not only easily-decomposed, low-molecular-weight organic compounds, but also hard-to-decompose insoluble and macromolecular organic compounds.



High Performance Ion Chromatography

The HPIC system performs all typical ion chromatography (IC) separations using conductivity or amperometric detection modes.

Main Equipment



Inductively Coupled Plasma Mass Spectrometer

The 7700x is configured for routine analysis of high matrix samples. With its high-temperature plasma (low oxides), matrix tolerant interface, and 9 orders dynamic range, the 7700x provides the analytical performance for routine as well as research applications. Many of the features expected of the highest specification ICP-MS systems are standard on the 7700x, making it suitable for most challenging analytical tasks.

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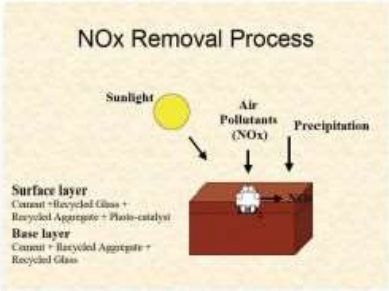
Research Spotlight

Environmentally friendly paving block that can keep the air clean

More than 300 tonnes of glass wastes and thousands of tonnes of construction material are generated daily in Hong Kong and are disposed to the landfill sites which are taking up much of HK's precious landfill resources. Eco-block is an environmentally friendly construction material which is made by a patented technology developed by PolyU. It effectively uses recycled glass and construction waste as major constituents in the production of concrete blocks to remove air pollutants, such as nitrogen oxides (NOx). It not only reduces the disposal of waste, but also conserves the use of natural resources, such as river sand.



NOx Removal Process

Different generations of Eco-Block

Special Features and Advantages
- Air pollutant removal capability
- Able to replace the natural substances by recycled materials as
- "Green" application
- Equivalent to conventional blocks in all performance requirements
- that has been fulfilled HKSAR's civil engineering work standards
- Has superiority over conventional blocks in terms of water
- absorption, hardness and aesthetic values
- Its physical life-span is comparable to the conventional blocks

Applications
Paving in:
- Pedestrian Areas
- Vehicular Areas

Awards
- Notable Mention, ECO-Products Award 2006, Hong Kong (2006)
- Merit Award, Green Building Award, Hong Kong (2006)
- Gold Award - The 6th International Exhibition of Inventions (2008)
- Best Invention Award from Macao Foundation (2008)

Photodegradation of Sulfamethoxazole with a Recyclable Catalyst

Introduction

Sulfamethoxazole (SMX) is a synthetic antimicrobial used for the prevention and the treatment of infections, as well as feed additives to promote growth of food animals. Owing to its low biodegradability, SMX can persist in the environment for a long time and thus was categorized as a persistent antibiotic. SMX has been detected frequently in many municipal sewage treatment plant effluents and surface water in many countries, usually at levels of ng/L. Due to its various potential risks, the degradation of SMX is a critical issue in the water treatment.

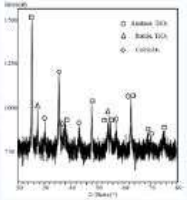


Figure 1. XRD pattern of $CoFe_2O_4/TiO_2$

Catalyst synthesis

The photocatalyst was synthesized by heterojunction of commercial $CoFe_2O_4$ with P25. The phase of magnetic photocatalysts $CoFe_2O_4/TiO_2$ was characterized by the X-ray diffraction technique.

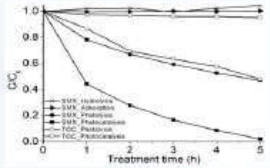


Fig. 2 Degradation of sulfamethoxazole (SMX) and reduction of TOC. Experimental Condition: [SMX]$_0$ = 100 μM, catalyst dose = 0.5 g/L, twelve 350 nm UV lamps were employed.

Photocatalytic activity

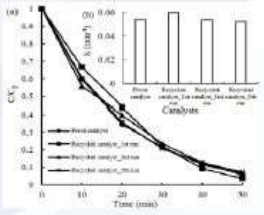
A considerable enhancement by the combined use of the UV radiation with the catalyst was observed at 100% and 50% removal of SMX and TOC, respectively, in 5 hours. The reaction was accelerated when the catalyst was introduced. The reaction rate constant of using UV/$CoFe_2O_4/TiO_2$ (0.70 h^{-1}) was four times of that using sole UV (0.18 h^{-1}). Judging from the TOC decay curves, the fraction of TOC/SMX removal (i.e. TOC removal per unit of SMX decay) at 5 hour of the direct photolysis and photo-catalysis was 0.07 and 0.59, respectively, indicating that photocatalysis plays a much more important role in the removal of TOC than that of direct photolysis.

Figure 3. Separation of $CoFe_2O_4/TiO_2$ from the treated SMX solution.

Recycle of the catalyst

The photocatalyst was proved to be easily separated and recycled, and the photocatalytic activity of the recycled catalyst remained intact after extensive reuses, which suggests the $CoFe_2O_4/TiO_2$ is a stable and highly efficient catalyst with good potential in real applications.

Fig. 4 (a) Degradation efficiency of recycled catalysts. (b) Decay rate constant of photodegradation under recycled catalysts. Experimental Condition: [SMX]$_0$ = 0.005 mM, Catalyst dosage=0.5 g/L, twelve 350 nm UV lamps were employed.



Research Spotlight

Valorization of Pre-Consumer Food Waste into Hydroxymethylfurfural

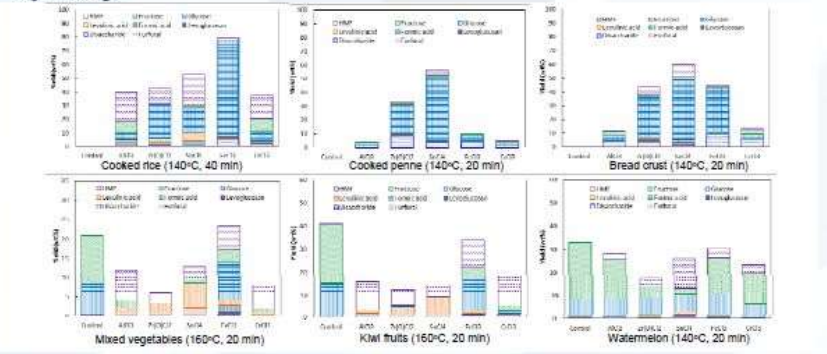
Motivation

- Over 3,600 tonnes of food waste disposed every day in Hong Kong
- Non-sustainable landfilling at the bottom of waste management hierarchy
- New treatment options needed to increase the capacity of the local recycling industry

Research Interest

- Develop novel thermo-chemical valorization technology as a new food waste treatment option
- Convert pre-consumer food waste to a value-added chemical, hydroxymethylfurfural (HMF)

Key Findings



A Holistic Approach to a Sustainable Eco-Flood Channel Design for Yuen Long Nullah

Project Title:

A Holistic Approach to a Sustainable Eco-Flood Channel Design for Yuen Long Nullah

Current engineering approaches attempt to incorporate knowledge from eco-hydraulics and fluvial geomorphology to produce designs that are in balance with natural processes as well as sustainable in the long term. However, ecological rehabilitation requires more spatiotemporal physical heterogeneity in the lotic system to trigger floral and faunal diversity; on the other hand, flood protection demands controllability and predictability in stormwater removal. The main purpose of this project is to use a holistic approach which includes ecological assessment and physical and numerical modeling methods to develop a near-natural and self-sustainable lotic system design in order to establish and restore river corridors with rich biodiversity as well as to meet the flood control requirement.

Since 2014, ecological assessment surveys have been conducted in 20 sites in Yuen Long including natural streams and concrete channels sections. One of the purposes is to record the existing ecological condition (e.g. hydraulics, water quality, and the diversity and abundance of riparian vegetation, birds, benthic macroinvertebrate and diatoms), which are important baseline information for future reference.

Map of 20 sampling sites
(natural stream sites: A1-10 ; concrete channel sites: D1-10)

Field survey photos

Preliminary Results

Ecological assessment surveys were conducted two times a year to represent the dry and the wet seasons. The collected water samples were analyzed in the Water and Waste Teaching Laboratory for parameters listed in Table1. From the results in 2014-2015, it was noticed that although in general the concrete channel sections suffer more from ecological degradation, some sites that are connected to good quality upstream (e.g. D8-D10) seem to support a variety of living organisms, such as dragonflies, fishes and birds. Also, over the period, these sites show evidence that the biota can recover after disturbances such as flooding and droughts, which is essential to make rehabilitation projects successful.

Field observation photos:
Little Egret (left) and Chinese Greenwing (right)

Macroinvertebrate sample photos:
Dragonfly nymph (left) and freshwater shrimp (right)

Average	A-sites	D-sites	Average	A-sites	D-sites
DO(mg/L)	7.64	5.99	Turbidity(NTU)	8.07	8.89
pH	7.26	7.38	Conductivity(μs/cm)	189.6	535.9
TS(mg/L)	15.7	336.9	TSS(mg/L)	20.39	27.95
NH_3-N(mg/L)	1.72	4.99	SO_4^{2-}(mg/L)	2.03	14.7
NO_2^--N(mg/L)	0.08	2.82	S^{2-}(mg/L)	0.03	0.05
NO_3^--N(mg/L)	1.19	3.39	PO_4^{3-}(mg/L)	2.57	4.40

Table 1. Water quality average results (2014-2015)

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