## Contents

### Aquatic environment

**Investigation of low-molecular weight organic acids and their spatiotemporal variation characteristics in Hongfeng Lake, China**  
Min Xiao, Fengchang Wu, Liying Wang, Xingqin Li, Rongsheng Huang ................................................................. 237

**Investigation of acetylated kapok fibers on the sorption of oil in water**  
Jintao Wang, Yuan Zheng, Aiqin Wang ......................................................................................................................... 246

**Growth characteristics of algae during early stages of phytoplankton bloom in Lake Taihu, China**  
Yuhong Jia, Johnson Dan, Min Zhang, Fanxiang Kong ................................................................................................. 254

**Immobilization of nitrite oxidizing bacteria using biopolymeric chitosan media**  
Pranee Lertsutthiwong, Duangcheewan Boonpuak, Wiboonluk Pungrasmi, Sarawit Powtongsook ................................. 262

**Preliminary studies on occurrence of monensin antibiotic in Bosque River Watershed**  
Sudarshan Kurwadkar, Victoria Sicking, Barry Lambert, Anne McFarland, Forrest Mitchell ........................................... 268

**An innovative integrated system utilizing solar energy as power for the treatment of decentralized wastewater**  
Changfu Han, Junxin Liu, Hanwen Liang, Xuesong Guo, Lin Li ................................................................................... 274

**Sedimentting and dewatering characteristics of granulated methane-oxidizing bacteria**  
Kwang Ho Ahn, Kwang Soo Kim, Sung Won Kang, Chul Yong Um, Won Tae Lee, Kwang Baik Ko ................................. 280

**Quantification, morphology and source of humic acid, kerogen and black carbon in offshore marine sediments from Xiamen Gulf, China**  
Yanting Chen, Jiping Zhao, Lijian Yin, Jinsheng Chen, Dongxing Yuan ........................................................................ 287

**Evaluation of oxygen transfer parameters of fine-bubble aeration system in plug flow aeration tank of wastewater treatment plant**  
Xiaohong Zhou, Yuanyuan Wu, Hanchang Shi, Yanqing Song ....................................................................................... 295

**Effects of ion concentration and natural organic matter on arsenic(V) removal by nanofiltration under different transmembrane pressures**  
Yang Yu, Changwei Zhao, Yangui Wang, Weihong Fan, Zhaokun Luan ........................................................................ 302

**Characterization of cake layer structure on the microfiltration membrane permeability by iron pre-coagulation**  
Jun Wang, Siru Pan, Dongping Luo ................................................................................................................................ 308

**Spatial distribution and pollution assessment of mercury in sediments of Lake Taihu, China**  
Chunxiao Chen, Benghui Zheng, Xia Jiang, Zheng Zhao, Yuzhu Zhan, Fengjiao Yi, Jiaying Ren ........................................ 316

### Atmospheric environment

**Review of heterogeneous photochemical reactions of NOy on aerosol – A possible daytime source of nitrous acid (HONO) in the atmosphere**  
Jinzhu Ma, Yongchun Liu, Chong Han, Qingxin Ma, Chang Liu, Hong He ........................................................................ 326

**Pollutant emission characteristics of rice husk combustion in a vortexing fluidized bed incinerator**  
Feng Duan, Chensong Chyang, Yucheng Chin, Jim Tso ..................................................................................................... 335

**Hylomerium splendens (Hedw.) B.S.G. and Pleurozium schreberi (Brid.) Mitt. as trace element bioindicators: Statistical comparison of bioaccumulative properties**  
Sabina Dolgoszewska, Zdzislaw M. Migaszewski, Artur Michalik ................................................................................... 340

**BTX pollution caused by motorcycles in the megacity of HoChiMinh**  
Tran Thi Ngoc Lan, Pham Anh Minh ............................................................................................................................. 348

### Environmental biology

**Profile of the culturable microbiome capable of producing acyl-homoserine lactone in the tobacco phyllosphere**  
Di Lv, Anzhou Ma, Xuanming Tang, Zhihui Bai, Hongyan Qian, Guoqiang Zhuang ......................................................... 357

**Tolerance of Chrysanthemum maximum to heavy metals: The potential for its use in the revegetation of tailings heaps**  
Ma. del Carmen A. González-Chávez, Rogelio Carrillo-González ..................................................................................... 367

**Effects of nitrogen and phosphorus concentrations on the bioaccumulation of polybrominated diphenyl ethers by Prorocentrum donghaiense**  
Chao Chai, Xundong Yin, Wei Ge, Jinye Wang ................................................................................................................. 376

### Environmental health and toxicology

**Umbilical cord blood mercury levels in China**  
Meiqin Wu, Chonghui Yan, Jian Xu, Wei Wu, Hui Li, Xin Zhou .................................................................................. 386

### Environmental catalysis and materials

**Mercury removal from coal combustion flue gas by modified fly ash**  
Wenqing Xu, Hairui Wang, Tingyu Zhu, Junyan Kuang, Pengfei Jing ............................................................................. 393

**Influence of supports on photocatalytic degradation of phenol and 4-chlorophenol in aqueous suspensions of titanium dioxide**  
Kashif Naeem, Feng Ouyang ............................................................................................................................................ 399

**Effect of biomass addition on the surface and adsorption characterization of carbon-based adsorbents from sewage sludge**  
Changzi Wu, Min Song, Baosheng Jin, Yumin Wu, Yai Huang ....................................................................................... 405

**La-EDTA coated FeO nanoparticle: Preparation and application in removal of phosphate from water**  
Jiao Yang, Qingru Zeng, Liang Peng, Ming Lei, Huijuan Song, Boqing Tie, Jidong Gu ....................................................... 413

Serial parameter: CN 11-2629/X*1989*m*184*en*P*24*2013-2
La-EDTA coated Fe$_3$O$_4$ nanomaterial: Preparation and application in removal of phosphate from water

Jiao Yang$^1$, Qingru Zeng$^1$, Liang Peng$^{1,2,*}$, Ming Lei$^1$, Huijuan Song$^3$, Boqing Tie$^1$, Jidong Gu$^1$

1. Department of Environmental Science & Engineering, Hunan Agricultural University, Changsha 410128, China. E-mail: pengliang2004@126.com
2. School of Metallurgical Science and Technology, Central South University, Changsha 410083, China
3. Hunan Perochemical Vocational Technology College, Yueyang 414012, China

Received 14 March 2012; revised 24 May 2012; accepted 14 June 2012

Abstract
La-EDTA-Fe$_3$O$_4$ was prepared by a chemical co-precipitation method. The magnetic composite was characterized by transmission electron microscopy (TEM), X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FT-IR). Furthermore, the adsorption properties of La-EDTA-Fe$_3$O$_4$ toward phosphate in water were investigated. The uptake rate of phosphate in water by La-EDTA-Fe$_3$O$_4$ was 3–1000 times than that of EDTA-Fe$_3$O$_4$, and reached 97.8% at 7 hr. The adsorption process agreed well with the Freundlich model and kinetics studies showed that the adsorption of phosphate proceeds according to pseudo second-order adsorption kinetics. The maximum removal rate was achieved at pH 6.0–7.0. The La-EDTA-Fe$_3$O$_4$ had good adsorption properties and could be separated well from aqueous solution by a permanent magnet. Therefore, this nanomaterial has potential application for the removal of phosphate from large water bodies.

Key words: La-EDTA-Fe$_3$O$_4$; phosphate; magnetic materials
DOI: 10.1016/S1001-0742(12)60014-X

Introduction
Excess phosphate in bodies of water can lead to significant eutrophication and water quality problems. The eutrophication can result in the overgrowth of aquatic plants, including harmful algal blooms, as well as depletion of dissolved oxygen, which subsequently results in the decline of aquatic life. The amount of phosphate pollution has been increasing as a result of wastes generated from industrial, agricultural, and household sources. Therefore, to achieve levels below the limits set by Environmental Protection Agency of China, various techniques, including chemical precipitation, biological treatment, and adsorption, have been used and studied for phosphate removal. Since chemical precipitation is best suited for the higher phosphate concentrations encountered in some industrial waste streams, the development of adsorbents for phosphate capture has been most widely studied due to their high efficiency at low phosphate concentrations (Zhang et al., 2009).

Adsorption provides a higher removal rate of phosphate than biologically-based phosphate treatments (Chouyyo, 2010). Therefore, a variety of adsorbents have been developed recently and evaluated for phosphate removal, such as slag (Xue et al., 2009; Xiong, 2008), red mud (Huang, 2008), polgyorskite (Gan, 2009), iron-based components (Namavisoym and Prathup, 2005), zirconium (Yeon, 2008), coal fly ash (Guan, 2009), crab shells (Jeon, 2009), lithium-intercalated gibbsite (Wang, 2007), and Mg-Mn-layered double hydroxides (Chitrakar, 2005). Among these materials, lanthanum(III) plays an important role in the field of phosphate removal because it is a moderately hard trivalent Lewis acid, and has a high affinity for phosphate, which is a hard base (Wu, 2007). The maximum adsorption capacity for La(III)-based sorbents for phosphate was reported to be about 25 mg phosphorus/g (Ning, 2008).

Magnetic nanomaterials are appropriate for the removal of phosphate from lakes and rivers, because they can be easily re-collected from water conveniently. Bare magnetite nanoparticles are quite susceptible to air oxidation (Maity et al., 2003) and are easily aggregated in aqueous systems, which weakens their removal efficiency (Lee, 2004). Recent research indicated that EDTA has high affinity toward Fe$_3$O$_4$ nanoparticles, and an EDTA coating on Fe$_3$O$_4$ nanoparticles enhanced the stability of nanodispersions by preventing their aggregation (Warner et al.,...
In this study, a novel low-cost magnetic sorbent material prepared by modifying Fe$_3$O$_4$ magnetic nanoparticles with EDTA and La(III) was developed for the removal of phosphate from water. The physical and chemical characterization of the synthesized La-EDTA-modified Fe$_3$O$_4$ nanoparticles (La-EDTA-Fe$_3$O$_4$) was conducted, and the applicability of La-EDTA-Fe$_3$O$_4$ for phosphate removal was evaluated in view of the sorption kinetics and capacity, effects of pH, as well as the adsorbent dosage.

1 Materials and methods

1.1 Preparation and characterization of sorbents

The ethylenediamine tetraacetic acid (EDTA)-coated Fe$_3$O$_4$ magnetic nanoparticles were synthesized following the work by Warner (2010) with some modification. Briefly, 6.1 g of FeCl$_3$·6H$_2$O and 4.2 g of FeSO$_4$·7H$_2$O were dissolved in 100 mL water and heated to 90°C, respectively. Then these two solutions, 10 mL of ammonium hydroxide (25%) and 0.615 g of EDTA dissolved in 50 mL of water, were added rapidly and sequentially. The mixture was stirred at 90°C for 30 min and then cooled to room temperature. The black precipitate was collected by filtration and washed to neutral pH with water. The obtained black precipitate was EDTA-Fe$_3$O$_4$ nanoparticles and was ready for use. Incorporation of lanthanum (La(III)) ions was accomplished by stirring the EDTA-Fe$_3$O$_4$ in an 100 mL 0.016 g/L lanthanum nitrate aqueous solution for a few hours to produce La-EDTA-Fe$_3$O$_4$. The metalized adduct was collected by filtration, and washed with water. The prepared method of bare EDTA-Fe$_3$O$_4$ was the same as that of La-EDTA-Fe$_3$O$_4$, except that no La was added.

Transmission electron microscopy (TEM) was carried out with a JSM-6380LV instrument (JEOL, Japan). The crystal forms of materials were measured with a Rigaku-TTRIII Diffractometer (Japan). The IR-spectrum was measured with a PerkinElmer Spectrum 65 FT-IR spectrometer (USA).

1.2 Effect of pH and coexisting anions on phosphate removal

The adsorption of phosphate was measured in batch experiments. The 1.5 mL sorbent (0.21 g/mL) and 250 mL phosphate aqueous solution were shaken in a triangular flask for 24 hr at room temperature. After 24 hr, the suspending sorbent was collected with an iron magnet. The concentrations of phosphate were analyzed with the Mo-Sb anti spectrophotometric method. All batch experiments were performed in triplicate and the averaged values are reported. The phosphate removal efficiency (R, %) was calculated as in Eq. (1) (Ou, 2007):

$$R = \frac{C_0 - C_f}{C_0} \times 100\%$$

where, $C_0$ (mol/L) and $C_f$ (mol/L) are the initial and final concentrations of the phosphate, respectively.

The influence of pH on the phosphate removal experiment was determined using the previous process except the pH was adjusted with HCl or NaOH to the desired pH.

The effect of common coexisting anions in wastewater (chloride, nitrate, bicarbonate, sulfate and citrate) on the phosphate removal efficiency of La-EDTA-Fe$_3$O$_4$ was investigated. All the processes were the same as previously described, except that 0.01 mol/L chloride, nitrate, bicarbonate, sulfate, citrate (all in sodium form) were added to the phosphate solutions, respectively. The pH of the solutions was kept at 6.5 and all the experiments were carried out at room temperature.

1.3 Sorption capacity and kinetics

The sorption capacity of La-EDTA-Fe$_3$O$_4$ for phosphate was measured in the same process as the above experiment, except that the initial phosphate concentration was varied to 2, 3, 4, and 5 mg/L.

The kinetics of metal sorption was performed as described above. The 1.5 mL (0.21 g/mL) La-EDTA-Fe$_3$O$_4$ was added into a 250-mL aqueous solution with 1 mg/L phosphate, and then 1 mL solution was extracted to analyze the phosphate concentration for sorption times of 10, 30, 60, 90, 150, 180, 210, 240 min and 7, 12, 22, 32, and 34 hr.

1.4 Regeneration and reuse

In order to regenerate and reuse the La-EDTA-Fe$_3$O$_4$ after adsorbing phosphate, 0.6 mol/L NaOH solution was selected as the regeneration agent. Three cycles of adsorption-desorption studies were accordingly carried out.

2 Results and discussion

2.1 Characterization of La-EDTA-Fe$_3$O$_4$

A powder X-ray diffraction (XRD) pattern of the resulting product is shown in Fig. 1. All of the diffraction peaks can be readily indexed to a cubic inverse spinel, and are in accordance with the pattern of bulk Fe$_3$O$_4$ crystals (JCPDS 75-0566). In addition, the crystal form of Fe$_3$O$_4$ did not change and no other compound of La(III) was formed during the production of La-EDTA-Fe$_3$O$_4$.

Figure 2 shows the TEM images of the La-EDTA-Fe$_3$O$_4$. It shows that the particles are irregular, and the diameter of particles is 10–25 nm. Some nanoparticles are aggregated as the result of some La-EDTA compounds being adsorbed on the surface layer.

The product was further investigated using Fourier transform infrared spectroscopy (FT-IR). As shown in Fig. 3, the –OH vibration is at 3400 to 3500 cm$^{-1}$ and that of C=O is at 1617 cm$^{-1}$. Comparing the FT-IR spectra of La-EDTA-Fe$_3$O$_4$ and EDTA-Fe$_3$O$_4$, the C–H stretch of
EDTA-Fe$_3$O$_4$ at 1400 cm$^{-1}$ is stronger than that of La-EDTA-Fe$_3$O$_4$, which indicates that the La anion interacts with the EDTA and weakens the C–H vibration. The bands at 706, 803 and 891 cm$^{-1}$ can be ascribed to NO$_3^-$, due to NO$_3^-$ combined with La. The 586 cm$^{-1}$ peak is ascribed to the Fe–O stretch of EDTA-Fe$_3$O$_4$; however, complex stretches (586 cm$^{-1}$ for Fe–O and 564 cm$^{-1}$ for La–O) are observed for La-EDTA-Fe$_3$O$_4$. This indicates the formation of a –COO–La bond.

Zeta potentials of the as-prepared La-EDTA-Fe$_3$O$_4$ and EDTA-Fe$_3$O$_4$ were measured over a varied pH range (Fig. 4). The pH$_{PZC}$ of EDTA-Fe$_3$O$_4$ is 2.5 since the EDTA had negative charge. The zeta potential of La-EDTA-Fe$_3$O$_4$ is positively charged in the pH range 2.0–6.5. The pH$_{PZC}$ of La-EDTA-Fe$_3$O$_4$ is higher than that of EDTA-Fe$_3$O$_4$, which indicates that the sorption ability of La-EDTA-Fe$_3$O$_4$ toward phosphate group ions is stronger in weakly acidic and neutral pH conditions.

The separation magnetization of La-EDTA-Fe$_3$O$_4$ was 55.6 emu/g (Fig. 5). The separation of La-EDTA-Fe$_3$O$_4$ from its aqueous dispersions could be easily completed in a few minutes with a handheld permanent magnet. Figure 5 shows that the dispersed La-EDTA-Fe$_3$O$_4$ was aggregated under the influence of the handheld magnet and then was re-dispersed in solution.

2.2 Phosphate removal

In order to compare phosphate removal between La-EDTA-Fe$_3$O$_4$ and EDTA-Fe$_3$O$_4$, the sorption capacity of La-EDTA-Fe$_3$O$_4$ and EDTA-Fe$_3$O$_4$ for phosphate was measured in the same process. As shown in Table 1, the phosphate removal capacity of La-EDTA-Fe$_3$O$_4$ was 910 times than that of EDTA-Fe$_3$O$_4$.

2.3 Effect of pH

The pH of solution has an impact on the speciation of phosphate ions in solution. At pH lower than 2.1, the predominant species is neutral H$_3$PO$_4$. Between pH of 2.2 and 7.2, the predominant species is H$_2$PO$_4^-$, whereas at pH between 7.2 and 12.3 the main species is HPO$_4^{2-}$. To assess the influence of pH on phosphate removal by La-EDTA-Fe$_3$O$_4$, batch adsorption were investigated in solutions containing 1 mg/L of phosphate over the pH range of 1.0–10.0. The results are summarized in Fig. 6. Phosphate removal increased with pH increasing from 1.0.
Fig. 5 (a) Dispersed La-EDTA-Fe$_3$O$_4$ solution, (b) La-EDTA-Fe$_3$O$_4$ solution in magnetic field of hand-held magnets, (c) aggregated La-EDTA-Fe$_3$O$_4$, (d) magnetization curves of La-EDTA-Fe$_3$O$_4$ nanoparticles.

![Figure 5](image)

Table 1 Comparison of phosphate removal of La-EDTA-Fe$_3$O$_4$ and EDTA-Fe$_3$O$_4$

<table>
<thead>
<tr>
<th>Sorbent</th>
<th>Initial phosphate concentration (mg/L)</th>
<th>Sorbent dose (mL)</th>
<th>Phosphate removal (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDTA-Fe$_3$O$_4$</td>
<td>0.2</td>
<td>2.0</td>
<td>49.0</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>2.0</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>2.0</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td>2.0</td>
<td>0.0</td>
</tr>
<tr>
<td>La-EDTA-Fe$_3$O$_4$</td>
<td>0.2</td>
<td>2.0</td>
<td>96.6</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>2.0</td>
<td>91.0</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td>2.0</td>
<td>56.8</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td>2.0</td>
<td>44.3</td>
</tr>
</tbody>
</table>

Fig. 6 Effect of pH on phosphate removal efficiency. Condition: adsorption time 7 hr, sorbents 1.5 mL, initial phosphate concentration 1 mg/L, room temperature.

![Figure 6](image)

to 7.0, and then dropped sharply as pH increased from 7.0 to 10.0. The maximum removal of > 90% was achieved from pH 1.0 to 7.0. This result is in accordance with the Zeta potential of the material, where the positive potential of La-EDTA-Fe$_3$O$_4$ at pH lower than 7.0 presents a stronger binding ability to the negatively charged phosphate ions.

2.4 Effect of coexisting anions

Natural waters and waste waters normally contain coexisting ions, which could potentially interfere with the sorption of phosphate. Thus, the competitive sorption of the coexisting anions, including (0.01 mol/L) chloride, nitrate, bicarbonate, sulfate, and citrate, was studied in DI water containing 2 mg/L phosphate (the competing anions were equivalent to a 1000-fold molar excess of the phosphate). The phosphate removal was 99.7%, 96.9%, 59.0%, 73.2%, 10.2% and 93.4% in the presence of chloride, nitrate, sulfate, bicarbonate and citrate, respectively. The results demonstrated that there was only little interference for the phosphate adsorption in the presence of chloride and citrate anions, while the bicarbonate anions strongly affected the phosphate binding. Moreover, the effect of nitrate on phosphate binding was stronger than the sulfate anions.

2.5 Adsorption kinetics

The adsorption kinetics of La-EDTA-Fe$_3$O$_4$ for phosphate removal was studied. Figure 7 shows the reduction of phosphate concentration in the solution as a function of contact time. The concentration was reduced from 1.00 to 0.026 mg/L (97% reduction) within 12 hr and remained relatively constant until 34 hr of contact time. The data was fitted with pseudo first- and second-order kinetics (Eqs. (2) and (3)) (Gad, 2009):

\[
\ln(\phi_e - \phi_t) = \ln \phi_e - \frac{k_1}{t}
\]  
(2)

\[
\frac{t}{\phi_t} = \frac{1}{k_2 \phi_e^2} + \frac{t}{\phi_e}
\]  
(3)

where, $\phi_e$ (mg/g) and $\phi_t$ (mg/g) are the sorption capacities at equilibrium and at time $t$, respectively and $k_1$ and $k_2$ are the rate constants of pseudo first- and second-order sorption, respectively. As can be found in Fig. 7, the
adsorption of phosphate can be described well by pseudo second-order kinetics with $k_2 = 3.2 \times 10^{-4}$ hr$^{-1}$, removal rate 97%, and $R^2 = 0.869$.

### 2.6 Adsorption isotherm

In order to determine the maximum adsorption capacity of La-EDTA-Fe$_3$O$_4$ for phosphate, the adsorption isotherms were measured in solutions containing different phosphate concentrations at pH 6. The adsorption isotherm data fit the Freundlich model (Eq. (4)) well.

$$q_e = K_F C_e^{1/n}$$  \hspace{1cm} (4)

where, $K_F$ (mg/g) and $1/n$ are the Freundlich constant and exponent, respectively. The Freundlich isotherm is empirical for heterogeneous surface energy. It assumes that the adsorption energy of an adsorbate binding to a site on an adsorbent depends on whether or not the adjacent sites are already occupied. The characteristics constants of the Freundlich isotherm $K_F$ and $1/n$ were 2.48 and 0.42, respectively. The $R^2$ value for the Freundlich isotherm fitting result was 0.96. The results are shown in Fig. 8, indicating that the adsorption of phosphate anions takes place in a complicated mode. The adsorption mechanism is not monolayer chemisorption as in the Langmuir model. The adsorption capacity of phosphate increased with increasing equilibrium phosphate concentration; in our experiment, the maximum adsorption capacity of phosphate was 4.19 mg/g.

### 2.7 Regeneration

The reusability of adsorbents is of great importance in a cost-effective process for water treatment. For the environmental sustainability of an adsorbent, a high regeneration capacity would add value to the water treatment. As shown in Fig. 9, the removal rate was 94% at the first cycle. For the second cycle, the adsorption capacity of phosphate was reduced by 2%, which was due to the incomplete desorption of phosphate. After three consecutive adsorption-desorption cycles, over 68% recovery ratio was attained, indicating the regeneration capacity of La-EDTA-Fe$_3$O$_4$ is not very good, which was due to the strong bond between La and phosphate.

### 3 Conclusions

La-EDTA-Fe$_3$O$_4$ was prepared by a chemical co-precipitation method with iron salts, EDTA and lanthanum, and its properties in the removal of phosphate from aqueous solution were investigated. TEM images revealed the La-EDTA-Fe$_3$O$_4$ aggregated in aqueous suspensions to form aggregates. The La-EDTA-Fe$_3$O$_4$ can be simply recovered from water using magnetic separation at low magnetic field gradients within a few minutes. The maximum removal of phosphate was observed at pH 1.0–6.5. Sorption of the phosphate to La-EDTA-Fe$_3$O$_4$ reached equilibrium in 12 hr, and agreed well with the Freundlich
model with maximum adsorption capacities 4.19 mg/g (at initial concentration of phosphate 5 mg/L). The La-EDTA-Fe$_3$O$_4$ was able to remove 99% of phosphate in water at optimized pH. This adsorbent was found to be both effective and economical for the removal of phosphate with low concentration in water bodies.

Acknowledgments

This work was supported by the National Natural Science Foundation of China (No. 21007014, 21107024), the Start Foundation of Hunan Agricultural University (No. 10YJ01), the National Science and Technology Major Projects (No. 2009ZX07212-001-05), the National Environmental Protection Public Welfare Program (No. 201009047) and the Scientific Research Fund of Hunan Provincial Education Department (No. 11C0650).

References


Aims and scope

Journal of Environmental Sciences is an international academic journal supervised by Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences. The journal publishes original, peer-reviewed innovative research and valuable findings in environmental sciences. The types of articles published are research article, critical review, rapid communications, and special issues.

The scope of the journal embraces the treatment processes for natural groundwater, municipal, agricultural and industrial water and wastewaters; physical and chemical methods for limitation of pollutants emission into the atmospheric environment; chemical and biological and phytoremediation of contaminated soil; fate and transport of pollutants in environments; toxicological effects of terrorist chemical release on the natural environment and human health; development of environmental catalysts and materials.

For subscription to electronic edition

Elsevier is responsible for subscription of the journal. Please subscribe to the journal via http://www.elsevier.com/locate/jes.

For subscription to print edition

China: Please contact the customer service, Science Press, 16 Donghuangchenggen North Street, Beijing 100717, China. Tel: +86-10-64017032; E-mail: journal@mail.sciencep.com, or the local post office throughout China (domestic postcode: 2-580).

Outside China: Please order the journal from the Elsevier Customer Service Department at the Regional Sales Office nearest you.

Submission declaration

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere. The submission should be approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out. If the manuscript accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder.

Submission declaration

Submission of the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere. The publication should be approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out. If the manuscript accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder.

Editorial

Authors should submit manuscript online at http://www.jesc.ac.cn. In case of queries, please contact editorial office, Tel: +86-10-62920553, E-mail: jesc@263.net, jesc@rcees.ac.cn. Instruction to authors is available at http://www.jesc.ac.cn.