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ICEEES2026 & ICCEE2026

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Preface

Abstract Book of ICEEES2026 & ICCEE2026 is composed of the abstracts of the 2026 13th International Conference on Energy, Environment and Earth Sciences (ICEEES2026) and 2026 12th International Conference on Civil and Environmental Engineering (ICCEE2026). According to the similarity among the topics of ICEEES2026 and ICCEE2026, ICEEES2026 is held in conjunction with ICCEE2026 on May 23-25, 2026.

ICEEES2026 and ICCEE2026 serve as an optimal platform for specialists, scholars and researchers in the field related to civil and environmental energy, environment, earth sciences, civil and environmental engineering to facilitate academic communications and exchange ideas. These abstracts demonstrate the richness of interdisciplinary approaches, theories, models and applied research presented.

Major themes of the conferences include:

Energy: Solar Energy, Kinetic Energy, Potential Energy, Mechanical Energy, Mechanical Wave Energy, Chemical Energy, Electric Energy, Magnetic Energy, Radiant Energy, Nuclear Energy, Ionization Energy, Elastic Energy, Gravitational Energy, Thermal Energy, Marine Energy, etc.

Environment: Geographical Environment, Geological Environment, Cosmic Environment, Regional Environment, Ecological Environment, Marine Environment, Investment Environment, Urban Environment, Native Environment, Secondary Environment, etc.

Earth Sciences: Geomorphology, Ancient Biology, Environmental Geology, Marine Geology, Hydrological Geology, Geophysics, Climate Change, Atmospheric Physics, Meteorology, Geography, etc.

Civil: Civil Engineering, Civil Engineering Practice, Adapting Civil Engineering Practice, Civil Engineering Planning, Civil Engineering Contracts, Civil Engineering Construction, Infrastructure Projects, Transport Systems and Water Supply Networks, etc.

Environmental Engineering: Environmental Protection, Health and the Environment, Environmental Economics, Environmental Science and Technology, Environmental Nanotechnology, Environmental Biology, Environmental Engineering, Environmental Chemistry, Environmental Microbiology, etc.

We thank all authors for their scientific contribution to ICEEES2026 and ICCEE2026 and look forward to having the opportunity to showcase and disseminate your research.

Sincerely,

ICEEES2026 and ICCEE2026 Organizing Committees

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AI-powered Intelligent Control and Assembly of Environmental Water Treatment Materials and Future Prospects

Wei Zhengwen*

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Abstract

The application of novel and functional organic composites for efficient removing polycyclic aromatic hydrocarbons (PAHs) from aquatic environments offers a promising strategy for mitigating their associated environmental and health risks. Nevertheless, the advancement of high-efficiency organic composites and the refinement of reaction parameters remain significantly constrained by time-consuming, costly experimental approaches and the inherent complexity of real wastewater systems. To address these challenges, a machine learning framework is established in this study to enable the targeted design of advanced adsorbent composites and the systematic adjustment of operational parameters. A comprehensive dataset (over 700 adsorption cases with 12 physicochemical descriptors) was constructed from literature reports on PAHs adsorption using organic composites. Multiple data-driven models were utilized to assess the influence of adsorbent physicochemical properties, PAHs characteristics, and reaction conditions on adsorption performance. The superior fitting performance of the XGBoost-CMAES model (R^2 = 0.9615) highlights the substantial benefits of customized hyperparameter tuning in enhancing the predictive accuracy. Model interpretability was enhanced using Shapley additive explanations values and partial dependence plots, which revealed the dominant roles of operational parameters and material features, including initial concentration, specific surface area, and contact time, and highlighted conditional dependencies related to molecular structure and environmental descriptors. Furthermore, density functional theory calculations were integrated to validate and strengthen the interpretability of the machine learning derived insights. This integrated, data-driven and theory-supported approach provides novel perspectives into the systematic development of organic composites and contributes to the broader advancement of adsorption technologies in complex environmental systems.

Keywords

Organic Composites, Machine Learning, PAHs Adsorption

Dielectric Engineering for Enhancing Triboelectric Performance of Nanogenerators

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Abstract

Triboelectric nanogenerators (TENGs) have emerged as promising sustainable energy technologies capable of providing environmentally friendly power sources for wearable electronics while contributing to the reduction of carbon emissions associated with modern communication networks. In this work, we developed a new class of TENGs based on electrospun nanofibres engineered with core–sheath architectures, functional nanofillers, and multilayer assemblies incorporating surface energy gradients. These structural innovations were designed to enhance triboelectric charge generation, mitigate the degradation commonly caused by humidity, and ultimately improve device robustness and performance. The resulting nanocomposite based TENGs demonstrated substantial improvements in electrical output. Specifically, the devices achieved an open circuit voltage of 1944 V and a short circuit current of 40.3 μA—corresponding to enhancements of 284% and 783%, respectively, compared with TENGs fabricated from pristine nanofibre materials [1]. Such significant gains confirm the effectiveness of combining nanofiller engineering with controlled microstructural design in triboelectric interfaces. Beyond energy harvesting, the engineered TENG platforms also show strong potential for human–machine interface (HMI) applications. The triboelectric signatures generated during user interactions were employed for user identification, achieving an average recognition accuracy of up to 86%. Additionally, bilayer Janus nanofibre based TENGs demonstrated reliable performance in monitoring fall events, highlighting their relevance for elder care and safety focused wearable systems. Taken together, these advancements illustrate the multifunctional potential of next generation triboelectric materials. By synergizing materials engineering, structural optimization, and advanced sensing capabilities, this work paves the way for machine learning assisted HMIs powered by TENGs. Such developments hold promise for future sustainable communication networks in which self powered, adaptive, and environmentally conscious devices play an increasingly central role.

Keywords

Energy Harvesting, Triboelectric Nanogenerator, Nanofibres

Optimization of Fuel Cell Catalytic Layer for Deep-Sea Carbon Sink Monitoring

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Abstract

The long-term continuous operation capability of deep-sea carbon sink monitoring equipment is fundamentally constrained by the technical bottlenecks of insufficient endurance and low energy conversion efficiency of its power supply system, which severely hinders the high-precision observation and mechanism elucidation of deep-sea carbon sink processes. This study proposes a technical solution based on proton exchange membrane fuel cells (PEMFCs), leveraging their inherent advantages of sustainable power generation and stable operation, with a focus on performance enhancement and adaptive optimization of the catalytic layer, the core component of PEMFCs. Using non-precious metal M-N-C catalysts (M=Fe, Co, Ni) as the core active materials, we regulate the interfacial interaction between the catalysts and ionomer side chains to optimize charge transport efficiency and reaction kinetics in fluid electrochemical processes, achieving a synergistic improvement in the fuel cell's energy density, deep-sea environmental adaptability, and long-term durability. Combined with in-situ electrochemical tests, molecular dynamics simulations, and advanced material characterization techniques, this study systematically reveals the intrinsic operation mechanism of the catalytic layer for efficient and stable performance under extreme deep-sea conditions. This work provides core technical support for the construction of a long-term stable energy supply system for deep-sea carbon sink monitoring equipment. This technical breakthrough can effectively enable multi-month continuous observation of carbon sink monitoring devices, accurately capture the spatiotemporal dynamic characteristics of key carbon sink parameters, and further provide critical technical underpinnings for marine resource development practices, including carbon sink assessment in deep-sea oil and gas development zones and blue carbon ecosystem conservation.

Keywords

Carbon Sink Monitoring, Energy Supply, PEMFC, Electrochemistry

Development of an Evaporator-Condenser Heat Exchanger for the Super-Long Gravity Heat Pipe Geothermal Systems

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Abstract

A shell-and-tube heat exchanger is widely used in many industrial areas due to its versatility and reliability. It serves as a critical interface between the heat pump and the recently proposed super-long gravity heat pipe (SLGHP) system, designed for deep geothermal heat extraction. By enabling substantial heat transport from the underground source, the SLGHP system offers notable benefits in effectiveness and economic viability; however, the limited capacity of the heat exchanger to transmit this energy constrains the heat pump's performance, thereby reducing overall system efficiency. To overcome this challenge, a two-phase flow heat exchanger is proposed, facilitating condensation on the shell side coupled with evaporation on the tube side, thereby enabling an integrated perspective on phase-change heat transfer. This study develops a model to examine the thermal performance of a coupled evaporation/condensation mechanism, which is validated against experimental data and shows good agreement. The results demonstrate that increasing the shell side mass flow rate enhances heat absorption in the heat pipe evaporator and strengthens heat transfer to the tube-side fluid, thereby reducing the temperature difference across the heat exchanger. Low tube-side mass flow rates result in a stratified flow with partial dry-out and increased evaporation; however, the associated high tube side thermal resistance limits the shell-side condensation. In contrast, higher tube-side mass flow rates promote annular flow, markedly reducing thermal resistance and enhancing condensation. Further increases in tube-side mass flow rate transition the flow into a bubble regime, providing only marginal gains. A lower tube count increases flow rate within tube side, significantly boosting both condensation and evaporation. Conversely, increasing the tube count decreases the mass flow rate per tube, causing tube-side thermal resistance to dominate, which suppresses the evaporation rate and constrains heat transfer. These findings underscore the need for a delicate balance of structural and operational conditions to optimize shell-side condensation in conjunction with tube-side evaporation, thereby enhancing the overall thermal performance of the SLGHP system.

Keywords

Geothermal Energy, Super-long Gravity Heat Pipe, Shell-and-tube Heat Exchanger, Condensation; Evaporation, Thermal Performance

Research Status and Prospects of Numerical Simulation of Hydrocarbon Source Rock Development Process

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Abstract

The numerical simulation of the development process of source rocks is a key technical means for the analysis of sedimentary basins and the evaluation of oil and gas resources. This paper systematically reviews the four core methods of this type of simulation: organic matter factory model, three-dimensional stratigraphic forward simulation, organic facies numerical simulation, and quantitative prediction model of source rocks. It deeply analyzes the technical principles, application examples, advantages and disadvantages of each method, and looks forward to future development directions. The organic matter factory model comprehensively analyzes the formation mechanism of source rocks from the "production - sedimentation - preservation - burial" entire chain, emphasizing the coupling control of paleo-productivity, redox conditions and sedimentation rates; the three-dimensional stratigraphic forward simulation (such as DionisosFlow) reconstructs the evolution and sediment filling process of the basin to achieve three-dimensional quantitative prediction of the spatial distribution of source rocks, and has successfully revealed the TOC enrichment patterns in applications such as the Natih Formation in Oman and the Paris Basin; the organic facies numerical simulation (such as OF-Mod) focuses on the detailed characterization of the quality of source rocks, through distinguishing the organic matter sources of marine and terrestrial, coupling preservation conditions with sequence stratigraphic background, to achieve three-dimensional prediction of TOC, hydrogen index and hydrocarbon generation potential, and has been verified in Norway's Barents Sea and Brazil's Camamu-Almada Basin; the quantitative prediction model of source rocks integrates geochemistry, basin simulation and re-deposition models to construct a forward prediction link from paleoenvironmental parameters to TOC calculation, effectively overcoming the fragmentation and strong experience nature of traditional methods. Current research still faces challenges such as paleo-productivity recovery, multi-scale process coupling, and model universality. Future development directions include high-resolution paleoenvironmental reconstruction, artificial intelligence-assisted parameter inversion, and multi-disciplinary integration, to promote the transition of source rock simulation from "form description" to "process analysis" and "quantitative prediction", providing theoretical support for deep and unconventional oil and gas exploration.

Keywords

Source Rock, Development Process Simulation, Three-dimensional Stratigraphic Forward Simulation, DionisosFlow, OF-Mod, Organic Facies Simulation

Effects of External Nutrient Inputs on Phytoplankton and Nutrient Dynamics in the Three Gorges Reservoir Under Extreme Heatwave Conditions

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Abstract

Summer algal blooms frequently occur in tributaries of the Three Gorges Reservoir, yet the relative contributions of external versus internal nutrient loads remain poorly understood under extreme climate events. This study investigated an intense heatwave from July 30 to August 5, 2025, with temperatures exceeding 34°C, using in situ incubation devices and natural water controls to assess the effects of external nutrient inputs on nutrient cycling and phytoplankton dynamics. Results indicated that: (1) under high temperatures, external inputs primarily controlled phosphorus dynamics. In natural waters, surface thermal accumulation led to a sharp decline in total phosphorus (TP) from 0.04 to 0.01 mg/L due to rapid assimilation by algal blooms. In contrast, TP in the enclosed systems, where external inputs were blocked, accumulated from 0.03 to 0.08 mg/L, highlighting sediment release and algal decomposition as dominant internal phosphorus sources. (2) Extreme heat accelerated organic nitrogen mineralization, with ammonium (NH_4^+) in natural water increasing from 0.02 to 0.18 mg/L, whereas NH_4^+ in the enclosures declined to 0.08 mg/L, indicating preferential uptake of high-efficiency nitrogen sources by phytoplankton under nutrient-limited conditions. (3) Prolonged heatwaves induced strong thermal stratification, with surface dissolved oxygen exceeding 20 mg/L, while pH dropped sharply from 9.66 to 6.54, suggesting a metabolic shift from photosynthesis-dominated to heterotrophic respiration-dominated processes. (4) Total algal biomass in natural water ranged from 3.28 to 20.45 mg/L, dominated by dinoflagellates and cyanobacteria, whereas enclosures lacking external inputs exhibited lower biomass (1.96–4.58 mg/L) and rapid succession toward diatom dominance.These findings demonstrate that extreme heat alters water column stability and reinforces the critical role of external nutrient inputs in promoting harmful algal blooms.

Keywords

Three Gorges Reservoir, Heatwave; External Nutrients, In Situ Incubation, Phytoplankton

The Driving Effect of Environmental Factors on the Succession of Dinoflagellate Blooms on the Time Scale

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Abstract

After the impoundment of the Three Gorges Reservoir area, the tributaries such as Pengxi River changed from flowing water type to still water type, and blooms from cyanobacteria to dinoflagellates often occurred in spring. In order to explore the driving mechanism of environmental factors on the succession of dinoflagellate blooms, this study carried out high-frequency day and night continuous sampling and in-situ device experiments in Gaoyangping Lake of Pengxi River in the spring bloom period of 2025, and analyzed the temporal variation characteristics of algae biomass, nutrients, water temperature and photosynthetically active radiation in different water layers. The study found that : (1) Dinoflagellates showed a significant diurnal vertical migration rhythm, and the biomass was negatively correlated with the surface light intensity ($R = -0.68$, $p < 0.01$). From night to early morning (22:00 ~ 8:00), a large number of dinoflagellates gathered in the surface layer, and the biomass could reach 3 ~ 5 times of that in the daytime. During the daytime (14:00), it migrates to the middle and lower levels. (2) The vertical structure of water temperature showed obvious diurnal variation. The temperature difference between the surface layer and the bottom layer reached 2.5°C during the day, and the water body formed a stable stratification. Nighttime stratification weakened. The weakening of stratification at night was synchronized with the disappearance of light, and a large number of dinoflagellates floated to the surface, indicating that stratification changes and light rhythms jointly regulated their vertical migration behavior. (3) The water temperature was low (< 22°C) in the early stage of water bloom, and cyanobacteria were dominant. After the water temperature rose to 24-26°C, the biomass of dinoflagellates increased rapidly and reached the peak at the most stable stage of stratification, indicating that the increase of water temperature and stratification strengthening were important conditions for triggering dinoflagellate blooms. In summary, dinoflagellates achieve the temporal and spatial coupling of light avoidance and nutrient acquisition through the vertical migration of day and night. The stratification of water temperature provides a physical basis for its migration, and the increase of water temperature directly drives the occurrence and succession of algal blooms.

Keywords

Three Gorges Reservoir Area, Pengxi River, Water Temperature Stratification, Algae Succession

Study on the Mechanism of Dinoflagellate Bloom and Water Browning in the Three Gorges Reservoir Area Based on Dinoflagellate Mobility

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Abstract

To investigate the effects of vertical migration on the dominance of dinoflagellate populations and water browning in the Pengxi River of the Three Gorges Reservoir Area, a comparative experiment was conducted using an in-situ culture device (Device 1) and a device with a 5 m depth barrier to block dinoflagellate vertical migration (Device 2). The effects of dinoflagellate vertical migration on algal bloom and water browning were analyzed. The results showed that: (1) Total Phosphorus (TP), Dissolved Total Phosphorus (DTP), Orthophosphate (PO_4^{3-}) and Ammonium (NH_4^+) in both Device 1 and Device 2 showed a gradual accumulation pattern in the lower layer. Compared with May 6, these parameters increased by 498%, 342.87%, 1955.14% and 247.81% on May 30, respectively. In contrast, Total Nitrogen (TN), Dissolved Total Nitrogen (DTN) and Nitrate (NO_3^-) showed a gradual consumption pattern in the upper layer, decreasing by 72.02%, 57.24% and 76.64%, respectively. This was mainly due to sufficient light in the upper layer for algae to absorb nitrogen, while hypoxia in the bottom layer led to anaerobic decomposition of settled organic matter, massive phosphorus release and accumulation of ammonium nitrogen. (2) In Device 1, the dinoflagellate density in the water column was significantly correlated with the vertical variations of DTN, DTP and PO_4^{3-}. Affected by the physical barrier, the dinoflagellate density in the lower layer of Device 2 decreased rapidly to an extremely low level, and the overall dinoflagellate density was significantly lower than that in Device 1. (3) In Device 2, the physical barrier reduced the dinoflagellate biomass in the lower layer, and cyanobacteria and green algae became the absolutely dominant group. The dinoflagellate biomass in the upper layer decreased with the reduction of DTN and NO_3^-, and the total dinoflagellate biomass on May 20 was 32% lower than that in Device 1. This was mainly because DTN, NO_3^- and other nutrients in the upper layer were continuously consumed, and the barrier in Device 2 restricted dinoflagellates from obtaining nutrients in the lower layer.In conclusion: compared with cyanobacteria and green algae, the vertical migration ability of dinoflagellates enables them to overcome the differences in water column density and access nutrients and organic matter in the lower layer, which is an important reason for them to become the dominant algae in algal blooms.

Keywords

Dinoflagellate Bloom, Vertical Migration, In-situ Culture, Three Gorges Reservoir Area

Metal-organic Framework-derived Iron Nitride Composites for Rapid Light-Driven Diclofenac Degradation via Persulfate Activation

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Abstract

The prevalence of pharmaceuticals and other organic micropollutants in surface and groundwater poses a serious environmental consequence. Here, metal–organic framework (MOF)–derived iron nitrides (FeN) carbon composites were designed as an efficient photochemical oxidation catalyst to degrade diclofenac (DCF) via persulfate (PS) activation. The carbon-supported FeN materials (FeN(w%)@C_x, with w and x representing the weight percentage and the pyrolysis temperature, respectively) were obtained by preparing iron-doped MOF precursors and subsequently subjecting them to high-temperature pyrolysis. The prepared FeN(w%)@C_xs were applied to remove DCF from aqueous media after thorough characterization. The FeN(w%)@C_xs efficiently activated PS under light condition (intensity 950 W m^{-2}), enabling rapid DCF degradation with high turnover frequencies. DCF removal efficiency reached nearly ~93% in 40 min using FeN(10%)@C_{950}/PS system under optimized parameters such as catalyst (0.05 g L^{-1}), PS dose (1 mM), and initial DCF concentration (10 mg L^{-1}), etc. The Fe–N–C structure of FeN(10%)@C_{950} enables the light–driven activation process involving radical species ($SO_4^{\bullet-}$ and $^{\bullet}OH$), as well as non-radical reactive oxygen species ($^1O_2$), proceeding via an electron-transfer mechanism, as confirmed by scavenger tests, ESR spectroscopy, and electrochemistry. DCF degradation rate was influenced with the addition of different anions, cations, and organic acids in FeN(10%)C_{950}/PS system under light. The optimum pH (5-9) showed higher degradation rate. Additionally, the reusability and stability of the FeN(10%)@C_{950} were confirmed over multiple cycles and DCF degradation products using LC-MS. Finally, the obtained results emphasize the potential of these catalysts in wastewater remediation.

Keywords

Iron Nitride Composites, Persulfate, Pharmaceuticals, Photochemical Oxidation, Wastewater Treatment

Early Detection of Hydrate-Induced Pipeline Blockage in Offshore Energy Systems Using LFM Acoustic Reflection Monitoring

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Abstract

Hydrate formation is a major flow assurance challenge in subsea oil and gas transportation systems and can pose significant risks to the safety, efficiency, and environmental sustainability of offshore energy infrastructure. Accumulation of hydrate particles may gradually restrict pipeline flow, potentially leading to severe blockages, operational interruptions, and increased environmental hazards. Therefore, reliable monitoring technologies capable of detecting hydrate-induced blockage at an early stage are essential for maintaining the stable operation of marine energy transportation systems. This study proposes an acoustic monitoring approach for pipeline blockage detection based on linear frequency modulated (LFM) reflection signals combined with an adaptive matched filtering algorithm. The method utilizes the propagation and reflection characteristics of LFM acoustic signals in pipelines to identify abnormal structural changes caused by partial or severe blockages. By analyzing the reflected acoustic signatures, the proposed technique enables accurate detection and localization of blockage regions along the pipeline. A series of controlled laboratory experiments were performed on a pipeline test platform to investigate acoustic responses under simulated hydrate-like blockage conditions. The experimental results demonstrate that the proposed approach can effectively identify blockage boundaries and accurately determine blockage locations along the pipeline. Compared with conventional acoustic detection approaches, the proposed method provides significantly improved localization performance. The results indicate that LFM acoustic reflection monitoring provides a reliable and efficient tool for early blockage detection in subsea pipeline systems. This technique offers significant potential for real-time monitoring, risk assessment, and preventive maintenance of offshore energy transportation infrastructure, contributing to improved operational safety and enhanced environmental protection in marine energy development.

Keywords

Gas Hydrate, Pipeline Blockage, Acoustic Reflection, Linear Frequency Modulated Signals,
Offshore Energy Infrastructure, Flow Assurance, Subsea Pipelines

Research on Factors Influencing the Acoustic Properties of Seafloor Sediments

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Abstract

The acoustic characteristics of seafloor sediments are crucial parameter in the fields of underwater acoustics, geoacoustics, and sedimentary acoustics. The factors such as environmental temperature and pressure, and the detecting frequency, influence the acoustic characteristics of seafloor sediments, necessitating a comprehensive study that combines theoretical analysis, laboratory measurements and in situ measurements. The influences of temperature and hydrostatic pressure were studied on the seafloor surficial sediment by theoretically and experimentally analyzing the sound speed ratio of the seafloor sediment to the bottom seawater in typical environmental conditions. Laboratory environment controlled experiments were conducted to examine the characteristics of the sound speed ratio influenced by temperature and pressure, with the results agreeing with the theoretical analysis using the effective density fluid model (EDFM) and the general model of seafloor sediment (GMSS). With respect to surficial sediments, pore water plays a key role in the sound speed ratio of sediment influenced by different environmental factors. The sound speeds of different types of sediments (sandy, silty, and clayey) change similarly with temperature, but change slightly differently with hydrostatic pressure. The influence of environmental factors on the sound speed ratio of seafloor sediment is independent of the detection frequency. The results show that the sound speed ratio can change up to 0.0008 per ℃ when the temperature ranges from 2℃ to 25℃ and up to 0.00064 per MPa when the seawater depth pressure ranges from 0MPa to 40MPa. The result reveals the sampling-transmitting process and existing-state variation of sediment samples have much greater impacts on the sound speed of sandy sediment in the East China Sea compared to muddy sediment. Overall, EDFM can predict the in situ sound velocity and sound attenuation coefficient under different temperatures and frequencies, with a lower prediction error for sound velocity compared to sound attenuation coefficient.

Keywords

Sound Speed, Porosity, Seafloor Sediment, In Situ Measurement, EDFM, GMSS

Experimental Investigation of Combustion and Emission Characteristics of a Heavy-duty Direct-injection Hydrogen Engine with Active and Passive Jet Ignition

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Abstract

Hydrogen internal combustion engines offer a promising pathway toward carbon-free transportation. Compared to conventional spark ignition systems, jet ignition technology can significantly improve combustion stability and thermal efficiency while reducing emissions. However, systematic experimental studies on jet-ignited hydrogen engines—especially those comparing active and passive pre-chamber configurations—remain scarce. This study aims to experimentally investigate the combustion and emission characteristics of a heavy-duty, direct-injection hydrogen engine equipped with a jet ignition system, operating under both active (fuel-supplied pre-chamber) and passive (non-fueled pre-chamber) modes.A single-cylinder heavy-duty hydrogen engine with a central pre-chamber jet ignition system was tested at a constant speed of 1000 rpm and an indicated mean effective pressure (IMEP) of 10 bar. Three key control parameters were varied: spark timing, excess air ratio (λ, ranging from 1.6 to 2.8), and pre-chamber fuel energy ratio (0–5%). Cylinder pressure, hydrogen flow rate, and exhaust emissions were measured over 200 consecutive cycles to evaluate combustion phasing (CA10, CA50, CA90), indicated thermal efficiency (ITE), cycle-to-cycle variation (COV IMEP), NOx, and unburned hydrogen emissions. Results show that spark timing primarily shifts combustion phasing in both modes, with negligible effect on combustion duration. Advancing spark timing leads to earlier CA50 and higher peak pressures. The maximum ITE is achieved when CA50 is near 7°CA ATDC for both modes, though active mode requires less spark advance due to stronger ignition energy. Increasing λ prolongs combustion duration but drastically reduces NOx emissions; at $\lambda \geq 2.4$, NOx approaches near-zero levels. However, active mode exhibits a higher risk of pre-ignition under ultra-lean conditions. The pre-chamber fuel energy ratio has a minor effect on combustion phasing but significantly increases NOx and reduces ITE, suggesting that minimal fueling of the pre-chamber is preferred.In conclusion, jet ignition effectively enhances combustion in heavy-duty direct-injection hydrogen engines. The active mode provides higher ignition energy and faster combustion but at the cost of increased NOx and abnormal combustion risk. For optimal trade-offs, $\lambda \approx 2.6$ and minimal pre-chamber fueling are recommended.

Keywords

Hydrogen Engine, Pre-chamber, Jet Ignition, Direct Injection, Combustion Characteristics

Soil Heavy Metal Source Tracing in Farmland Based on the Hybrid Model of APCS-MLR and Machine Learning SVR: A Case Study of Huayuan County, Hunan Province

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Abstract

Precisely apportioning the sources of heavy metal pollution in farmland soils is a critical foundation for implementing cultivated land safety management and source-oriented pollution control. Taking Huayuan County, Hunan Province, a typical mining–agriculture composite area, as a case study, this research explores a multi-source information fusion analysis method suitable for small soil sample datasets, with the aim of systematically revealing the multiple sources of heavy metals in farmland soils. The results indicate that heavy metals in farmland soils of the study area can be classified into three categories of pollution sources: natural sources include V, Cr, Fe, Mo, As, and Ni, whose concentrations are jointly controlled by soil parent materials and DEM-elevation-driven rainfall runoff deposition; anthropogenic sources include Cd, Pb, Zn, Cu, and Hg, among which Cd is dominated by fertilizer inputs, Pb by road traffic emissions, Zn and Cu by combined inputs from fertilizers and traffic emissions, and Hg by the joint influence of local point sources and rainfall runoff deposition; natural–anthropogenic mixed sources consist of Mn and Co, which are controlled by the superimposed effects of soil parent materials and minor agricultural activities. The multi-source information fusion analysis method proposed in this study effectively compensates for the insufficient accuracy of source apportionment of heavy metal pollution in farmland soils under small-sample conditions, providing a scientific basis and methodological reference for precise source tracing and cultivated land safety management in mining–agriculture composite areas.

Keywords

Machine Learning, Source Apportionment, Farmland Soil, Small Sample Size

Removal of Aldehydes and HCN from Cigarette Smoke Using Amino Acid Ionic Liquids

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Abstract

Small molecular aldehydes and hydrogen cyanide (HCN) are important harmful components in cigarette smoke, which also significantly contribute to its irritancy. Therefore, reducing the yield of aldehydes and HCN in cigarette smoke is of great significance for public health and the improvement of cigarette product. In this study, a series of tetrapropylammonium hydroxide-amino acid ionic liquids (TPAILs) were prepared via a simple acid-base neutralization reaction to selectively reduce the release of aldehydes and HCN in cigarette smoke. These TPAILs were systematically characterized by Fourier transform infrared spectroscopy (FTIR), nuclear magnetic resonance spectroscopy (NMR), and elemental analysis (EA); the thermal stability was further evaluated with thermogravimetric analysis (TG). The adsorption capacity of the prepared TPAILs toward aldehydes and HCN was assessed in a homemade simulated filtration device under controlled conditions. The adsorption performance was notably affected by both the type of amino acid used and the dosage of TPAILs applied. With the increasing of the pendent chain length of the amino acid, the removal efficiency of acetaldehyde and crotonaldehyde decreased significantly from 32%, 66% to 16%, 41%, respectively, which can be primarily attributed to the increased steric hindrance imposed by the longer side chains. Interestingly, TPAILs bearing pendant amino groups, such as [N3333][Lys], exhibited enhanced adsorption performance, reducing about 60% of crotonaldehyde and 39% of acetaldehyde due to the strong chemisorption interaction between the pendant amino groups and the aldehyde molecules. In addition, more than 90% of HCN, 80% of formaldehyde, and 50% of acrolein could be efficiently removed by these TPAILs under the optimized conditions. Collectively, these results clearly demonstrate the significant filtration performance of TPAILs as effective absorbents for removing harmful aldehydes and HCN from cigarette smoke.

Keywords

Amino Acid Ionic Liquid, Cigarette Smoke, Adsorption, Aldehydes, Hydrogen Cyanide

Functionalized Carbon Adsorbents via Ball Milling for Enhanced Removal of Toluene

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Abstract

With the continuous advancement of industrialization and urbanization, atmospheric environmental issues have become increasingly prominent. Among them, the emission of volatile organic compounds (VOCs) poses a serious threat to the ecological environment and human health. As a typical aromatic VOCs pollutant, the efficient removal of toluene is of great significance. In this work, functionalized carbon materials (FG-BM) were prepared using flake graphite as the raw material via a one-step ball milling process. The effects of ball size, ball-to-material ratio, rotation speed, and number of milling cycles on the material structure and catalytic performance were systematically investigated, and various types of commercial carbon materials were selected for comparative validation. The results indicate that the material exhibits optimal catalytic performance under the following conditions: a ball size of 15 mm, a rotation speed of 700 rpm, a ball-to-material ratio of 100:1, and eight milling cycles. Characterization results show that ball milling significantly increased the specific surface area of the material (from 6.0 m^2/g to 448.3 m^2/g), created a hierarchical porous structure, and introduced a large number of structural defects as well as nitrogen- and oxygen-containing functional groups on the surface, effectively increasing the number of active sites. Performance test results indicate that the toluene removal efficiency of the as-prepared FG-BM increased from 67.3% to 99.8%, demonstrating a substantial enhancement. This ball milling modification strategy exhibits good general applicability for enhancing the catalytic oxidation performance of various carbon materials. Mechanistic analysis reveals that the defect structures induced by ball milling and the surface-enriched pyridinic nitrogen and oxygen-containing functional groups (C=O and O-C=O) serve as key active sites. By promoting the formation of oxygen-containing intermediate species, these sites accelerate the adsorption, activation, and oxidation of toluene molecules, thereby significantly improving the catalytic performance. This work provides a scalable, solvent-free route to high-performance functionalized carbon adsorbents for efficient toluene removal.

Keywords

Functionalized Carbon, Toluene Removal, Ball Milling, Adsorption, Catalytic Oxidation

Identification of Aerosol Types over Changchun Using AERONET and Low-Cost Sensor Data

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Abstract

Aerosols play an important role in the Earth's climate system by interacting with solar radiation and influencing atmospheric processes. Their properties and variability are especially relevant in urban regions, where natural and anthropogenic sources are combined. Understanding the distribution and characteristics of aerosols is therefore essential for improving our knowledge of atmospheric composition and its impact on climate and environmental conditions, particularly in rapidly developing and industrialized areas. In this study, we investigate aerosol types and variations in particulate matter ($PM_{2.5}$) concentrations in Changchun, a city in northeast China. The region is strongly influenced by industrial emissions, frequent dust storms, open waste burning, and biomass burning. To better characterize urban air quality, data from recently developed low-cost sensor networks are analyzed under a range of atmospheric conditions, including clear days, dust events, smoke episodes, and fireworks during holiday periods. $PM_{2.5}$ observations from the IQAir, PurpleAir, and AirGradient networks are used. More than ten sensors deployed across different parts of the city enable the evaluation of sensor performance and support the development of an improved city-wide monitoring system. In addition, data from the AERONET Changchun_JLU site, equipped with a sun-lunar-sky photometer, are used to analyze aerosol optical and microphysical properties and to identify aerosol types. Aerosol classification is first conducted using the conventional AOD-AE method, followed by a more advanced approach that combines AERONET-based clustering with a nearest-center matching algorithm based on single scattering albedo at 440 nm and the extinction Ångström exponent (440–870 nm). In summary, this integrated framework provides a comprehensive characterization of aerosol types and $PM_{2.5}$ pollution in Changchun. The results offer valuable insights for air quality monitoring and contribute to more effective pollution management strategies in complex urban environments.

Keywords

Aerosol Types, $PM_{2.5}$, AERONET, Low-cost Sensors, Aerosol Optical Properties

Dust Storm Events in Northeast China by Ground Based, Satellite and GEOS-Chem Modeling Data

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Abstract

We present the results of an analysis of dust storm events in Northeast China using a multi-platform, model-based approach covering 2015-2025. The study integrates data from ground-based sensors (AERONET, low-cost PM monitors), satellite observations, and model simulations (GEOS-Chem). Key findings reveal that dust aerosols are mainly transported from the Gobi and Taklimakan deserts and significantly impact air quality in the region. The western part of Northeast China is experiencing the highest dust concentrations. Analysis of aerosol optical properties during dust events shows sharp increases in AOD and decreases in the Ångström exponent, indicating a dominance of coarse-mode particles. Cluster analysis effectively reveals the dust events from other aerosol types produced by smoke outbreaks. GEOS-Chem simulations and back-trajectory analysis confirm the prevailing northwest origin of dust transport. The study also identifies seasonal patterns in dust distribution and transport pathways across five sub-areas of the Northeast China region. The dust fractional distribution, averaged over sub-areas and 2015–2023, shows a greater proportion of larger dust particles in the western part of the region than in the northern part (22% versus 6%). We compared dust aerosol concentrations simulated by GEOS-Chem with observed PM_{10} concentrations. Both results show increasing dust/PM_{10} concentrations up to 300 μg m^{-3} during the most significant dust storm events.

Keywords

AERONET, Back-trajectory, Cluster Analysis, Dust Aerosol, PM_{10}, Seasonal Pattern

Deep Ground•Collaboration•Integration and Intelligence: Development Trends and Strategic Reflections on China's Unconventional Natural Gas

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Abstract

Under the "dual carbon" goal, unconventional natural gas (shale gas, coal-rock gas, tight gas) has transformed from a "substitute" for conventional natural gas to a "main force" for China's energy security and green transformation. By using methods such as literature research, data statistics, and case analysis, a systematic summary of China's unconventional natural gas resource foundation and its deep breakthroughs, theoretical and technological revolutions, and new patterns of coordinated development was conducted. The results show that unconventional natural gas resources in China account for 66.5% of the total natural gas resources in the country, with a proven rate of less than 10%, indicating huge potential for increasing reserves and production. In recent years, historic breakthroughs have been made in the deep field, with breakthroughs in multi-layered marine shale gas formations in the southern Sichuan Basin and the implementation of the first trillion cubic meter large-scale gas production area in China for deep coal-rock gas in the Ordos Basin. The position of tight gas as a stable production "ballast stone" continues to consolidate. Theoretical and technological innovation profoundly drives industrial transformation, forming geological theories such as "binary enrichment", "ternary accumulation", and "three-field controlling accumulation" as well as intelligent development technology based on geological engineering integration. In response to challenges such as resource degradation and high cost, a four-dimensional integrated strategy of "deep breakthrough, stereoscopic collaboration, integrated development, and intelligent production" is proposed: implementing four major paths of strategy development which are resource collaboration, nonconventional gas-conventional gas collaboration, nonconventional gas-new energy integration, and intelligent upgrading, constructing an intelligent dynamic evaluation model of "economy-technology-policy", promoting intelligent development and institutional mechanism reform. It is expected that the proportion of unconventional gas production will exceed 50% by 2030, and the peak in 2045 will reach over $1500\times10^{8}m^{3}$. This article provides strategic reference for the high-quality development of unconventional natural gas and national energy security guarantee.

Keywords

Deep Breakthrough, Stereoscopic Collaboration, Integrated Development, Unconventional Natural Gas, Shale Gas, Coal-rock Gas, Tight Gas, Intelligentization, Development Strategy

Effect of Modified Waste Rubber Particles on the Properties of 3D-Printed Concrete

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Abstract

To address the high-value utilization challenge of construction waste and waste tires, this study prepared low-carbon 3D-printed recycled fine aggregate (RFA) concrete (3DP-MRRC) by partially replacing RFA with surface-modified rubber aggregates (MRA). The effects of MRA dosage (0–15%) on the rheological properties, setting time, mechanical performance, and mechanical anisotropy of 3DP-MRRC were systematically investigated, with the micro-mechanism revealed via scanning electron microscopy (SEM) and mercury intrusion porosimetry (MIP). Results indicate that the active modified layer on MRA accelerates cement hydration, shortens setting time, and linearly increases static yield stress, satisfying the buildability requirement for 3D printing. With increasing MRA dosage, the compressive strength of 3DP-MRRC decreases continuously, while the flexural strength first increases and then decreases, peaking at 10% MRA dosage. Microscopic analysis confirms that 10% MRA dosage induces needle-like AFt crystals, which split the original macropores of RFA to form a complex ink-bottle pore structure, significantly enhancing crack propagation resistance and flexural toughness. However, MRA agglomeration at 15% dosage shields the modified layer, leading to a sharp increase in median pore diameter and deteriorated mechanical properties. Additionally, the high elasticity of MRA effectively alleviates inter-layer and inter-filament stress concentration, homogenizing flexural anisotropy, while compressive anisotropy increases linearly with MRA dosage. This study provides a feasible strategy for the synergistic resource utilization of construction waste and waste tires in 3D-printed concrete, and recommends 10% MRA as the optimal dosage to balance printability, mechanical performance, and low-carbon benefits.

Keywords

3D-printed Concrete, Modified Rubber Aggregate, Recycled Fine Aggregate, Pore Structure, Mechanical Anisotropy, Low-carbon Building Materials

Enhanced Nitrogen Removal Performance of Nitrogen-Containing Domestic Wastewater Using Tourmaline/Biochar Synergistically Modified Fillers

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Abstract

The prior art often has the problem of poor nitrogen removal effect when treating domestic sewage. Based on this, a kind of tourmaline/biochar modified fillers were prepared in this study. By putting the fillers into the fixed-bed biofilm reactor and comparing with the fillers modified by high-density polyethylene (HDPE) and biochar, the effect of enhanced denitrification was explored, the removal mechanism was analyzed by surface roughness, Zeta potential and high-throughput sequencing.The results showed that in the simulated domestic sewage with C/N = 3 and HRT = 8, the removal rate of NO_3 -N can be significantly improved by tourmaline/biochar synergistic modification fillers, which is 27% higher than that of HDPE fillers, and 21% higher than that of biochar fillers. On the one hand, the tourmaline in the modified fillers improved the electron transfer efficiency through the piezoelectric effect. On the other hand, the higher surface roughness and bioelectrophilicity of the fillers are conducive to the attachment and proliferation of microorganisms, especially denitrifiers Kinetobacter and unclassified Comamonadaceae. The research shows that the modified filler of tourmaline/biochar has great potential for nitrogen removal, which can provide theoretical basis and technical support for the engineering application of low carbon ratio nitrogen removal technology for nitrogen-containing domestic sewage.

Keywords

Tourmaline/Biochar-modified Fillers, Diomembrane Technology, Domestic Wastewater, Enhanced Denitrification, Microbial Community Structure Differences

Effect of Polyvinyl Alcohol Fiber Content on the Frost Resistance of Recycled High-Ductility Cementitious Composites

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Abstract

Freeze–thaw damage poses a significant durability risk for recycled high-ductility cementitious composites (R-HDCC) in cold regions. This study investigated the influence of polyvinyl alcohol (PVA) fiber content (ranging from 0.306% to 1.512%) on the frost resistance of R-HDCC. After 300 freeze–thaw cycles, the mass change, relative dynamic modulus of elasticity (RDEM), residual compressive and flexural strength, and direct tensile stress-strain behaviour of R-HDCC were tested. Scanning electron microscopy observations of the fracture surfaces were conducted to elucidate cracking characteristics and interfacial damage mechanisms. Results showed that all mixtures exhibited an apparent mass gain during the early exposure stage due to water absorption. With prolonged testing, surface scaling and progressive degradation became dominant, leading to measurable mass loss. Relative dynamic modulus of elasticity (RDME) was more sensitive than mass change in detecting internal freeze-thaw damage. Mixtures with 1.0-1.5% PVA showed the best freeze-thaw resistance, with lower mass loss and higher RDME retention. The 28-day compressive and flexural strengths increased with PVA fiber content up to 2.0% and slightly decreased at 2.5%. The 2.0% PVA mixture also exhibited the highest tensile strain capacity and strain energy density. Moderate PVA contents improved crack bridging and fiber pull-out resistance, while excessive fiber addition increased local heterogeneity and interfacial defects.

Keywords

Frost Resistance, Recycled High-ductility Cementitious Composites, Freeze-Thaw Cycles, Polyvinyl Alcohol Fiber

Influence of Fluid Compressibility on Pore Water Pressure Response in Shanghai Soils Under Complex Stress Paths

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Abstract

Fluid compressibility is a critical parameter that plays an important role in the generation of excess pore water pressure and is significantly influenced by soil saturation. A slight decrease in saturation leads to a marked increase in fluid compressibility. Strata characterized by high groundwater levels present a high degree of saturation, referred to as quasi-saturated strata. However, previous studies have typically considered engineering practices involving complex stress paths, such as pile driving and CPTU testing, within the framework of full saturation. The influence of fluid compressibility on the pore water pressure response in Shanghai soils under such complex stress paths remains unexplored. This study characterizes the complex stress path as a combination of compression and shear, approximating the triaxial shear state, and accounts for fluid compressibility via the fluid bulk modulus. Building on previous work on Ningbo clay, this study extends the investigation to the pore water pressure response of Shanghai soft clay and sand through undrained triaxial shear tests. Complementary numerical analyses are performed to assess the influence of fluid compressibility on the pressure response under complex stress paths. The results indicate that when the fluid compressibility is 2×10^6 Pa, the resulting pore water pressure response is markedly lower than that under low-compressibility conditions. For compressibility values ranging from 2×10^7 Pa to 2×10^9 Pa, the effect on the pressure response becomes negligible, which is consistent with earlier observations in Ningbo clay. Moreover, the fluid compressibility of clay in quasi-saturated strata is considered to range from 2×10^7 Pa to 2×10^8 Pa. Consequently, the influence of quasi-saturated characteristics on the pressure response under complex stress paths can be reasonably disregarded, and the fully saturated assumption remains valid for engineering practices in Shanghai areas subjected to complex compression–shear stress states. This abstract presents a further extension of a portion of the work from a separate manuscript that is currently under review.

Keywords

Fluid Compressibility, CPTU, Excess Pore Water Pressure, Shanghai Soil, Quasi-saturated Strata

High Entropy LDH Catalyst Derived from Electroplating Wastewater for Durable H_2O_2 Activation and Organic Pollutant Degradation

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Abstract

Transition metal-based catalysts are effective for advanced oxidation processes (AOPs), but their practical application is often limited by structural degradation and catalytic deactivation caused by metal leaching. Herein, we report a high entropy layered double hydroxide catalyst (MgAlCrFeCuNi-LDH, HE-LDH) directly synthesized from heavy metal containing electroplating wastewater through a simple coprecipitation method. The HE-LDH exhibits a high configurational entropy of 1.67R (13.91 J mol^{-1} K^{-1}). Combined characterizations confirm the formation of a structurally stable LDH framework based on Mg and Al, enabling the effective stabilization of multiple transition metals. The HE-LDH exhibits high catalytic activity for H_2O_2 activation toward bisphenol A (BPA) degradation, achieving >97% removal of 46 mg L^{-1} BPA within 1 h under acidic conditions, with an apparent rate constant of 3.40 h^{-1}. The catalyst shows negligible metal leaching and retains >95% BPA removal efficiency after five consecutive cycles. It also maintains high activity in natural water matrices, indicating strong resistance to water chemistry interference. In contrast, the MgAl-free counterpart, CrFeCuNi-LDH, exhibited a lower initial BPA removal efficiency (<93%), significant metal leaching, and rapid deactivation, with the BPA removal efficiency declining to below 70% after five cycles. The superior catalytic activity and durability of HE-LDH are most likely attributed to the synergistic stabilization of multimetal active centers by the brucite-like Mg-Al host layers and the structural confinement of the LDH framework, which together suppress metal leaching and sustain efficient H_2O_2 activation. This work provides a feasible wastewater to catalyst strategy for transforming electroplating wastewater into stable AOP catalysts, enabling heavy metal resource utilization and organic pollutant remediation.

Keywords

Layered Double Hydroxides, Electroplating Wastewater, Advanced Oxidation Processes, Hydrogen Peroxide Activation, Resource Recovery, Pollutant Degradation

Traffic Flow Prediction Based on a Deep Spatiotemporal Convolutional Hybrid Network

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Abstract

Traffic flow prediction is a core component of intelligent transportation systems (ITS) that aims to alleviate urban congestion, reduce energy consumption, and improve travel efficiency. However, the highly nonlinear, dynamic, and spatiotemporally correlated nature of traffic data, along with external factors such as weather and incidents, poses significant challenges to conventional models like historical average, ARIMA, and support vector regression. To address these limitations, this study proposes a hybrid deep learning framework that jointly captures temporal dependencies and spatial correlations for short-term traffic flow prediction. The method leverages long short-term memory (LSTM) networks to model sequential time dependencies and graph convolutional networks (GCN) to directly operate on the non-Euclidean road network topology, where sensors are nodes and roads are edges. To further integrate spatiotemporal features, a spatiotemporal graph convolutional network (STGCN) is constructed by alternately stacking graph convolution and gated temporal convolution layers. Additionally, a self-attention mechanism is incorporated to capture long-range dependencies across different time steps and spatial locations, and a dynamic graph learning module adaptively adjusts adjacency weights based on real-time traffic states. The model is evaluated on three public benchmark datasets: PeMSD4 (29 road segments), PeMSD8 (8 segments), and METR-LA (207 loop detectors), all aggregated at 5-minute intervals. Prediction horizons of 15, 30, and 60 minutes are tested using mean absolute error (MAE) and mean absolute percentage error (MAPE). Experimental results show that the proposed model achieves a MAPE of 13.8% on PeMSD4 for the next-step prediction, outperforming the best baseline LSTM (21.6% MAPE). On METR-LA, the MAE for 60-minute prediction is 275, which is 12.5% lower than that of Diffusion Convolutional Recurrent Neural Network (DCRNN). In conclusion, the proposed deep learning approach, integrating dynamic graph learning and attention mechanisms, outperforms traditional and baseline deep models, offering a robust and accurate solution for traffic flow prediction in real-world ITS applications

Keywords

Traffic Flow Prediction, Deep Learning, Spatiotemporal Graph Convolutional Networks, Attention Mechanism, Dynamic Graph Learning

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