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第四十六卷 第十期 二〇一四年十月
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《哈尔滨工业大学学报》征稿简则

《哈尔滨工业大学学报》主要报道自然科学领域的基础理论、工程技术与应用方面的最新研究成果,欢迎省(部)级以上政府基金资助项目(国家自然科学基金、863、973、博士点基金等)相关论文。报道方向包括航天、机械、能源、动力、材料、电气、电子、信息与控制、计算机、化工、生物工程、土木工程、市政环境、暖通空调、道路、桥梁、交通工程、工程力学及有关交叉性学科。

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活性粉末混凝土基本力学性能指标取值

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摘 要：为促进活性粉末混凝土在工程中的应用，收集整理与活性粉末混凝土相关的文献.提出以边长 70.7 mm 立方体抗压强度标准值为依据的活性粉末混凝土强度等级划分方法.对活性粉末混凝土立方体抗压强度尺寸效应、轴心抗压强度、轴心抗拉强度、弹性模量、峰值压应变和极限压应变等基本力学性能指标进行分析，获得了活性粉末混凝土相关力学性能指标之间的换算关系，并基于一次二阶矩法推导得出活性粉末混凝土的材料分项系数.

关键词：活性粉末混凝土；强度等级；基本力学指标；一次二阶矩法；材料分项系数

中图分类号：TU528 **文献标志码**：A **文章编号**：0367-6234(2014)10-0001-09

Basic mechanical property indexes of reactive powder concrete

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Abstract: To promote engineering application of reactive powder concrete, relative research literatures published are summarized and studied. The method of classifying strength grade of reactive powder concrete is proposed according to characteristic value of 70.7 mm side length cube compressive strength. Reactive powder concrete mechanical property indexes on size effect of compressive strength, axial compressive strength, axial tensile strength, elastic modulus, peek compressive strain and ultimate compressive strain are analyzed, and the conversion relation of these mechanical property indexes are obtained. The material partial factor of reactive powder concrete is calculated based on first-order second-moment theory.

Keywords: reactive powder concrete; strength grade; basic mechanical property index; first-order second-moment theory; material partial factor

三类薄钢板剪力墙滞回性能及选型

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摘 要: 为研究四边连接、两边连接及开竖缝薄钢板剪力墙的滞回性能并对其设计选型提出建议,利用 ANSYS 有限元软件对三类薄钢板剪力墙的滞回性能进行数值模拟研究,对比分析了三类薄钢板剪力墙在低周往复荷载作用下的初始刚度、峰值承载力、耗能性能以及延性.分析结果表明:三类薄钢板剪力墙均具有良好的延性和耗能能力;四边连接和两边连接薄钢板剪力墙的滞回曲线有一定程度的捏缩,但其初始刚度和峰值承载力较高,可用作高层或高烈度区的多层钢结构住宅的抗侧构件;开竖缝薄钢板剪力墙的滞回曲线呈饱满的梭形,但其初始刚度和峰值承载力较低,可用作低层或低烈度区的多层钢结构住宅的抗侧构件.

关键词: 四边连接;两边连接;开缝;薄钢板剪力墙;滞回性能
中图分类号: TU392.5 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0010-07

Hysteretic performance study and lectotype suggestion for three types of thin steel plate shear walls

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Abstract: To study the hysteretic performance and lectotype suggestion of the thin steel plate shear walls with four-side connections, two-side connections and silts, the hysteretic performance of those thin steel plate shear walls were systematically investigated utilizing the ANSYS software package. Comparisons of the initial stiffness, peak load, ductility and energy dissipation capacity of those steel plate shear walls were carried out base on the numerical results. Results showed that those three types of steel plate shear walls had proper ductility and energy dissipation capacity. The hysteretic curves of the thin steel plate shear walls with four-side connections and two-side connections had pinch phenomenon, while their initial stiffness and peak load were relatively high. They could be used in the multistory steel structure residences in high intensive seismic region or high-rise steel structure residences. The hysteretic curves of the thin steel plate shear walls with silts exhibited plump loops, but its initial stiffness and peak load were low. This kind of shear walls could be applied on the multistory steel structure residences in low intensive seismic region or low-rise steel structure residences.

Keywords: four-side connections; two-side connections; silts; steel plate shear walls; hysteretic performance

近断层方向性效应地震动双规准组合反应谱

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摘 要: 为了给近断层设计谱的确定提供新的方法和参考依据,考虑场地条件的影响,分析了53条具有典型近断层方向性效应特征的地震动记录的双规准组合反应谱的特征.相比传统的地震动加速度、速度和位移反应谱,组合反应谱的谱值与地震动的幅值相关性更强;双规准组合谱具有更低的统计变异性.最后,给出了基于双规准组合谱特征的近断层区场地相关设计谱模型.

关键词: 近断层地震动;方向性效应;双规准组合反应谱;抗震设计谱

中图分类号: P315.9 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0017-06

Bi-normalized combined response spectra of directivity effect ground motions in near-fault region

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Abstract: Aiming at providing new method and reference for the construction of near-fault design spectra, characteristics of bi-normalized combined spectra of 53 typical near-fault directivity effect ground motions are analyzed by considering the influence of site condition. Results show that the bi-normalized combined spectrum exhibits the highest correlation with the amplitudes of ground motions, and the lowest statistical variability, compared with those of acceleration spectrum, velocity spectrum and displacement spectrum. Finally, site-depended design spectral models for near-fault region are suggested based on features of bi-normalized combined response spectra.

Keywords: near-fault ground motion; directivity effect, bi-normalized combined response spectrum; seismic design spectrum

大型浮顶储油罐爆炸动力响应及破坏机理

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摘 要: 为研究大型浮顶储油罐结构在可燃气体爆炸作用下的变形破坏机理,根据 Von Mises 屈服条件和强度理论,建立了储油罐结构在爆炸荷载作用下的广义屈服函数和失效破坏准则,利用显示非线性动力有限元软件 LS-DYNA,采用 ALE 流固耦合算法,对爆炸作用下容积为 15×10^4 m^3 的大型浮顶储油罐结构的罐壁位移、加速度、应力、应变等动态力学响应进行了数值模拟,计算结果表明:浮顶油罐的失效破坏模式为迎爆面顶部罐壁产生内凹塌陷和屈曲变形,迎爆面中部驻点区首先屈服并带动相邻部分达到屈服状态,同时在变形区周围明显形成不规则的塑性铰环,导致罐壁产生内凹屈曲.爆炸作用下,罐内液体既对罐壁产生一定的冲击作用,也能吸收和耗散部分爆炸能,储罐内液面较高时能提高油罐结构的抗爆能力.

关键词: 浮顶储油罐;可燃气体;爆炸冲击;失效准则;动力响应

中图分类号: X937; X932 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0023-08

Dynamic response and failure mechanism of the large floating roof oil tanks under blast loading

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Abstract: To investigate the damage and deformation mechanism of large scale steel floating roof oil tank under the combustible gas explosion, according to the Von Mises yield condition and strength theory, the generalized yield function and failure criterion of tank wall under blast loading is established. A finite element model of 15×10^4 m^3 floating roof tanks has been established by explicit package ANSYS/LS-DYNA, and the dynamic responding processes such as displacements, acceleration, stress and strain of the tank walls structures under blast loading have been simulated. The results show that the failure mode of the floating roof tank is collapse and buckling on top of the impact surface tank walls. The yield range first appears at the stagnation area and then propagates to the neighboring parts, and the irregular plastic hinge circle obviously appears around the deformation area, which results in the concaved bucking of the tank inner surface. During the whole process, the inner liquid not only impacts on the structures, but also absorbs and consumes part of the blast energy.

Keywords: floating roof oil tank; combustible gas; blast and impact; failure criteria; dynamic response

管材和流速对供水管道生物膜形成的影响

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摘 要: 针对供水管网中不断变换的管材和水力条件,运用异养菌计数和PCR-DGGE技术研究了特定余氯质量浓度下管材和流速对水质和管道生物膜形成的影响.结果表明:管材对主体水余氯、TOC、细菌总数和生物膜群落结构影响均较大,而流速只对主体水余氯和生物膜细菌总数影响较大;同一时期,PE管道附着细菌总数显著大于不锈钢;同类管材中0.2和0.4 m/s流速下生长的生物膜细菌总数差异不显著,但均显著大于0.8 m/s流速下生长的生物膜细菌总数;生物膜成熟时鞘氨醇单胞菌属(*Sphingomonas*)和芽孢杆菌属(*Bacillus*)占优势且广泛存在,而某些疏水性细菌则较难在不锈钢管材上聚集,特别是在流速增大时更难聚集.

关键词: 管材;流速;生物膜;微生物群落结构
中图分类号: TU991.21 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0031-06

Interaction of flow velocities and pipe materials on biofilm formation

ZHU Zebing[1,2], WU Chenguang[1,2], ZHONG Dan[1,2], YUAN Yixing[1,2], SHAN Lili[1,2], ZHANG Jie[1,2], YUAN Yuan[1,2]

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Abstract: The flow velocities and pipe materials may be variable in drinking water distribution system, and their interaction on the water quality and biofilm formation under a certain chlorine level have been investigated. Heterotrophic plate counts and denaturing gradient gel electrophoresis were employed to analyze biofilm formation, and the results showed that the chlorine, TOC of bulk water, total bacteria counts and microbial community structure were all varied in pipe materials, while flow velocities only affected the chlorine of bulk water and biofilm biomass. In the same time, PE pipes attached significantly greater biofilm biomass than stainless steel. The biofilm biomass grown under flow velocities 0.2 and 0.4 m/s were significantly greater than that under 0.8 m/s, but the biofilm growth between 0.2 and 0.4 m/s were not significant. In the mature biofilm microbial community, *Sphingomonas* sp. and *Bacillus* sp. were dominant in all biofilms, while the hydrophobic bacteria were difficult to grow on the stainless steel pipe, especially under high flow velocities.

Keywords: pipe materials; flow velocities; biofilm; microbial community structure

基于分区模型的城市供水管网压力监测点布置

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摘 要: 为掌握整个城市供水管网的压力分布情况,提出基于供水管网分区模型的压力监测点布置方法.首先采用欧氏距离度量供水管网中任意两两节点在一个运行周期内水压波动的相似度;然后按照给定的分区内最大允许欧氏距离限定要求,依次对每根管段上两个端节点的子区归属进行判断,从而实现对管网的分区;最后在各子区内选择一个最能代表本子区节点水压波动情况的节点作为压力监测点.将该分区布置模型应用于东北某市开发区的供水管网,分区结果表明,各子区内的所有节点是连通的,任意两两节点间的欧氏距离均在给定的最大允许值范围内,并且不同的最大允许欧氏距离形成不同精度的分区方案.在各子区内布置一个压力监测点,当压力监测点布置数目为4时,平均相对误差为4.53%,此时基本能反映供水管网的压力分布情况.

关键词: 供水管网;压力监测点;分区模型;欧氏距离

中图分类号: TU991.33 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0037-05

Layout of pressure monitoring points in urban water distribution system based on district model

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Abstract: To monitor the pressure distribution in urban water distribution system (WDS), a method of locating pressure monitoring points is proposed based on district model of WDS. First, Euclidean distance is introduced to measure the pressure fluctuation similarity between two nodes within a running cycle. Whether a node in a pipe is classified as one sub-district depends on that the Euclidean distance values between the node and other nodes of this sub-district is within a given maximum allowable Euclidean distance. Finally, a node with minimum average Euclidean distance in a sub-district is chosen as its pressure monitoring point location. This district method is applied to monitoring point layout of a practical WDS. The analysis results show that different district solutions are obtained by changing the maximum allowable Euclidean distance. All the nodes in each sub-district are connected and the Euclidean distance between any two nodes is within a given maximum allowable value. After placing one pressure monitoring point in each sub-district, the results show that the pressure distribution in WDS can be effectively reflected, when average relative error is 4.53% and the number of pressure monitoring point is four.

Keywords: water distribution system; pressure monitoring points; district model; Euclidean distance

污泥发酵液对 A^2O 脱氮除磷和微生物的影响

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摘 要: 为研究剩余污泥发酵液作碳源对微生物群落结构的影响,将发酵液与市政污水按流量比1∶35回用于厌氧-缺氧-好氧反应器,在室温下运行90 d.聚类分析表明,发酵液明显改变了微生物群落结构,5~30 d和45~90 d的微生物属于不同的聚集区; 微生物多样性分析表明,发酵液使Shannon-Wiener指数从2.6升高到3.1,系统运行稳定性增强; PCR-DGGE分析表明,发酵液对微生物群落具有一定的选择性,氨氧化菌 *Nitrosomonas* sp.、硝化菌 *Betaproteobacteria* 和 *Nitrospira* sp.、反硝化菌 *Comamonas* sp.和聚磷菌 *Gammaproteobacteria* 得到富集,TN和TP去除率从64.5%和52.4%提高到84.7%和94.3%.

关键词: 剩余污泥;脱氮除磷;碳源;生物群落;聚合酶链式反应-变性梯度凝胶电泳技术

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The effect of sludge fermentation liquid on nutrient removal performances and microbial community structure in A^2O process

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Abstract: To analyze the effect of sludge fermentation liquid, using as internal carbon source, on microbial community structure in anaerobic-anoxic-aerobic process, three-month-long operational experiment was conducted at flow ratio of fermentation liquid and domestic wastewater 1 ∶ 35 at room temperature. The clustering analysis indicated that the microbial community structure was changed significantly by fermentation liquid, and the microbes of 5-30 d and 45-90 d had quite different homology. The microbial diversity analysis demonstrated that the Shannon-Wiener index increased from 2.6 to 3.1, resulting in the enhancement of operational stability. Meanwhile, fermentation liquid appeared to be selective for ammonia-oxidizing bacteria *Nitrosomonas* sp., nitrifying bacteria *Betaproteobacteria* and *Nitrospira* sp., denitrifying bacteria *Comamonas* sp. and phosphorus-accumulating bacteria *Gammaproteobacteria*, which led to the TN and TP removal efficiency improved from 64.5% and 52.4% to 84.7% and 94.3%, respectively.

Keywords: waste activated sludge; nutrient removal; carbon source; bacterial community; PCR-DGGE

陶瓷平板膜处理采油废水性能

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摘 要:为实现二次采油废水处理后水质达到低渗透率地层回注标准,以油田采油废水为处理对象,建立一套以陶瓷平板膜为核心的实验装置.通过监测陶瓷平板膜跨膜压差的变化,重点考察膜通量、反应温度、曝气量等因素对处理效果的影响.结果表明:最佳膜通量为22.5 L/(m^2·h),反应温度为50 ℃,曝气量为1 L/min;经0.05 mol/L HCl或HNO_3溶液浸泡12 h后,膜通量的恢复率保持在96%以上,膜片过滤性能恢复较好;采油废水经陶瓷平板膜处理后出水含油量及SS均小于1 mg/L,各项指标均优于SY5329—94《碎屑岩油藏注水水质推荐指标及分析方法》中回注水水质A1级标准.利用陶瓷平板膜处理采油废水可以取代传统采油废水处理流程中的浮选、粗滤、精滤步骤.

关键词:采油废水;陶瓷平板膜;膜通量;跨膜压差;恢复率

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Treatment of the oil extractionwastewater by plate ceramic membranes

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Abstract: To achieve the water standard of low-permeability reinjection for secondary oil wastewater treatment, this experiment took the oil-field wastewater as the processing object, and an experimental device which took plate ceramic membranes as the core processing unit in the production site was set up. The study mainly focused on the effects of the membrane flux, reaction temperature and aeration rate on treatment by monitoring the changes in transmembrane pressure difference. On the premise of normal operation of the experimental device, the optimum membrane, reaction temperature flux and aeration rate was set as 22.5 L/(m^2·h), 50 ℃ and 1 L/min, respectively. Filtration performance of membrane could be better recovered after immersing the membrane in 0.05 mol/L HCl or HNO_3 solution for 12 h, and membrane flux recovery rate reached above 96%. As the results show, oil content and SS of effluenttreated by plate ceramic membrane are less than 1 mg/L, and all indexes of injection water are better than the A1 class standards in SY5329—94. It demonstrates that plate ceramic membranes can replace traditional steps in the oily wastewater treatment, such as flotation, rough filtration and fine filtration.

Keywords: oil extraction wastewater; plate ceramic membrane; membrane flux; transmembrane pressure difference; recovery rate

$CaCO_3$ 型生物滤料曝气生物滤池生物诱导强化除磷特性

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摘 要: 为提高普通曝气生物滤池除磷效果,以水渣为主要原料开发了一种 $CaCO_3$ 型生物滤料,并以陶粒为参比滤料,通过改变水力停留时间考察 $CaCO_3$ 型生物滤料和陶粒两种填料的曝气生物滤池除磷特性.结果表明,与陶粒填料相比,$CaCO_3$ 型生物滤料曝气生物滤池对磷具有较好的去除效果,在水温为 20~25 ℃、COD 负荷为 3.55~3.62 kg·$(m^3·d)^{-1}$、氨氮负荷为 0.76~0.78 kg·$(m^3·d)^{-1}$条件下,$CaCO_3$ 型生物滤料曝气生物滤池在 HRT 为 5, 3 和 1 h 时,磷去除率分别为 65.20%~71.07%、40.49%~48.02%和 26.10%~33.11%.$CaCO_3$ 型生物滤料曝气生物滤池对磷的去除主要是通过生物诱导化学沉淀来实现,且磷酸钙盐沉淀对出水浊度几乎没有影响.

关键词: $CaCO_3$ 型生物滤料;曝气生物滤池;生物诱导;化学沉淀;除磷

中图分类号: X703.1 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0053-05

Study on biologically-induced enhanced phosphorus removal of $CaCO_3$-biofilter media in a biological aerated filter

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Abstract: By comparative studies on BAF between $CaCO_3$-biofilter media which is a new-style filter material made of grain-slag and ceramisite filter material, the performance of phosphorus removal was discussed at different HRT and phosphorus concentrations. The results indicated that compared with ceramisite filter material, $CaCO_3$-biofilter media had a higher removal rate of phosphorus in BAF. Under the condition of water temperature of 20-25 ℃, ammonia nitrogen load rates of 0.76-0.78 kg·$(m^3·d)^{-1}$and organic load rates of 3.55-3.62 kg·$(m^3·d)^{-1}$, the phosphorus removals of $CaCO_3$-biofilter media biological aerated filter with HRT 5, 3 and 1 h were in the range of 65.20%-71.07%, 40.49%-48.02% and 26.10%-33.11% respectively. It was evidenced that $CaCO_3$-biofilter media biological aerated filter could remove phosphorus effectively by biologically-induced chemical precipitation and the settling matters had no effect on the effluent turbidity.

Keywords: $CaCO_3$-biofilter media; biological aerated filter; biologically-induced; chemical precipitation; phosphorus removal

金属-石墨烯复合物吸附活化 CO_2 的第一性原理

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摘 要: 在光催化 CO_2 的反应体系中,CO_2 的吸附活化是一个关键步骤;不同的活化方式和 CO_2 的活化态决定了其反应路线和最终产物.以金属-石墨烯体系为研究对象,采用密度泛函理论方法,结合局域密度近似(LDA)和 PWC 泛函,计算该体系在 CO_2 吸附前后的几何结构、能量、电荷分布和态密度等的变化.结果表明:电子从金属-石墨烯体系转移到 CO_2,使 CO_2 带负电并活化;其中 Cu-G 体系对 CO_2 的活化效果最好,C—O 键长分别增加 6 和 14 pm,O—C—O 键角减小为 122°;金属原子簇和石墨烯的第一电离能和电子亲和势对电子的转移起决定性作用,金属原子簇电子亲和势比石墨烯第一电离能越大,电荷越易从石墨烯转移到金属原子簇.

关键词: 二氧化碳;石墨烯;金属;催化剂;第一性原理计算

中图分类号: O641.12 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0058-07

First-principle theory calculations of CO_2 adsorption and activation by metal-graphene composite

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Abstract: Metal-graphene system was taken as the research object. Density functional theory (DFT), combined with local density approximation (LDA) and PWC functional, was employed to study the changes in the geometry structure, energy, charge distribution and density of states (DOS) of the systems before and after absorption of CO_2 on them. The results show that the electrons are transferred from the M-graphene system to CO_2, which is eventually activated by negative charge. The Cu-G system is most effective to activate CO_2 in these three complexes. The bond length of CO_2 increases by 6 and 14 pm, respectively, and the bond angle of O—C—O decreases to 122°. Furthermore, the first ionization energy and electron affinity of metal clusters and graphene play a decisive role in the electron transfer. Compared with the first ionization energy of graphene, the larger the electron affinity of metal clusters, the more the electrons transferred from graphene to metal cluster.

Keywords: carbon dioxide; graphene; metal; catalyst; first-principle theory calculation

阀控密封铅酸电池正极板栅在不同硫酸电解液中的电化学行为

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摘 要: 为研究正极板栅的腐蚀对阀控密封铅酸(VRLA)蓄电池失效的影响,分别采用循环伏安(CV)、电化学阻抗谱(EIS)和塔菲尔曲线研究了VRLA电池正极板栅在不同硫酸密度电解液的电化学行为.结果表明: 氧化峰和还原峰的峰值电势均随硫酸密度的降低发生正移,说明Pb向$PbSO_4$转化变困难,而$PbSO_4$还原为Pb变得更容易;峰电流值随着硫酸密度的降低而增大,说明硫酸密度越小转化速率越快.酸密度影响正极板栅腐蚀膜的导电性,硫酸密度在1.30 g·cm^{-3}左右时,板栅腐蚀膜的导电性较好.适当降低酸密度对提高板栅腐蚀膜的导电性有利.

关键词: 阀控密封铅酸电池;正极板栅;硫酸;电化学行为
中图分类号: TM912.1 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0065-04

Electrochemical behavior of positive-electrode grid for VRLA battery in different density sulfuric acid electrolyte

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Abstract: To investigate the effect of positive-electrode grid on the failure of valve-regulated lead acid (VRLA) battery, the electrochemical behavior of positive-electrode grid for VRLA battery in the different density sulfuric acid electrolyte is studied by cyclic voltammetry (CV), electrochemical impedance spectroscopy (EIS) and Tafel curves, respectively. The result shows that the peak potential of oxidation and reduction peaks move to positive direction with the decrease of sulfuric acid density, indicating that lead can difficultly convert into lead sulfate, but lead sulfate easily convert into lead. The peak current increases with the decrease of sulfuric acid density, revealing that the lower sulfuric acid density is, the faster rate of conversion is. The acid density affects the conductivity of positive grid corrosion film, and the conductivity of positive grid corrosion film is good when the sulfuric acid density is about 1.30 g·cm^{-3}. It is beneficial to improve the conductivity of grid corrosion film by decreasing the acid concentration.

Keywords: VRLA battery; positive-electrode grid; sulfuric acid; electrochemical behavior

甜菜雄性不育系及保持系花期蛋白差异分析

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摘 要: 为揭示甜菜雄性不育的原因,从蛋白质组学角度对甜菜细胞质雄性不育进行研究,利用双向电泳与MALDI-TOF-MS方法,对Owen型甜菜质核互作型雄性不育系DY5-CMS及同型保持系DY5-O花粉发育3个阶段(雄蕊原基分化期、四分体时期和单核时期)的花蕾蛋白差异表达进行研究.结果表明: 在雄蕊原基分化期花蕾中鉴定出6个差异蛋白,在四分体时期鉴定出4个差异蛋白,这些蛋白多数与呼吸和能量代谢有关,推测甜菜细胞质雄性不育可能是花粉发育早期(雄蕊原基分化期和四分体时期)与能量和呼吸代谢有关的蛋白表达上调导致呼吸和能量代谢紊乱造成的;在花粉发育的单核时期鉴定出6个差异蛋白,这些蛋白主要与植物的光合作用有关,推测到花粉发育后期雄性不育性状已形成,雄性不育导致植物光合机能下降.

关键词: 甜菜;花蕾;细胞质雄性不育;2-DE;蛋白质组学

中图分类号: S566.3;Q753 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0069-06

Proteomic analysis of florescence differentiation between cytoplasmic male sterile line and maintainer in sugar beet

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Abstract: To explore the molecular genetic mechanisms of cytoplasmic male sterility in sugar beet, the differential proteins between the CMS line and its maintainer line were studied. Immobilized pH gradient two-dimensional gel electrophoresis (2-DE) technique and MALDI-TOF-MS were used to identify differentially expressed proteins in the three pollen development stages (stamen primordium differentiation stage, metaphase and uninucleate stage) between the Owen sugar beet male-sterile line (DY5-CMS) and its maintainer line (DY5-O). Six distinct proteins were identified in the stamen primordium differentiation stage and four distinct proteins were identified in the metaphase. In addition, all those proteins were related to the energy and respiratory metabolism. It was inferred that cytoplasmic male sterility of sugar beet might take place at the prophase of pollen development (contain stamen primordium differentiation stage and metaphase). The over-expression of energy and respiratory metabolism related proteins leads to metabolism disorder. Six distinct proteins are identified in the uninucleate stage of pollen development, and most of the proteins are related to photosynthesis of plants. It is speculated that the male sterility trait has formed at the late stages of pollen development and male sterility leads to the decreasing of photosynthetic.

Keywords: sugar beet; bud; cytoplasmic male sterility; 2-DE; proteomic

开挖卸荷桩土界面荷载传递模型的修正与验证

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摘 要: 为了准确预测深开挖条件下桩基的承载变形性状,在桩土界面荷载传递计算模型中考虑了卸荷效应.基于快速拉格朗日法(FLAC^{3D}),将线弹性-完全塑性的桩土界面荷载传递模型修正为双曲线计算模型,修正后的模型可以考虑开挖卸荷后桩周土体法向应力减小对桩土界面剪切刚度的影响,也可以考虑开挖深度、面积和桩长对桩端阻力的影响.利用修正模型对开挖条件下砂土地基中的单桩进行了足尺数值试验,分析计算了开挖后桩基的承载性能,并将修正后模型的计算值与软件内嵌的线弹性-完全塑性模型的计算值及试验值进行对比分析.结果表明:修正后计算模型和传统计算模型都能够较准确地预测开挖条件下桩基总极限承载力,但是,修正计算模型考虑了支护结构外围土体对桩端承载力的贡献,能更准确地预测桩身下部侧摩阻力与桩端阻力.因此,修正计算模型更适合开挖条件下的桩基承载力计算.

关键词: 深开挖;荷载传递;剪切刚度;有限差分法

中图分类号: TU473 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0075-06

Improved hyperbolic model of load-transfer for pile-soil interface and its verification considering deep excavation

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Abstract: An improved hyperbolic model of load-transfer for the pile-soil interface under deep excavation conditions was developed. It not only considered the influence on the initial shear stiffness because of excavation which decrease the normal stress of the surrounding soil, but also considered the influence of excavation depth, width and length of pile. A full-scale numerical experiment was completed on a single pile in sandy soil after excavation and the bearing capacity of pile foundation was analyzed using this model, and then the results was compared with the measurement and the calculating values, which were calculated from the traditional model. It was shown that the ultimate bearing capacity of pile foundation after excavation, which was calculated from both model, are closed to measurement. The tip resistance and shaft friction on the bottom of pile calculating from traditional model which cannot consider the contribution of soil for the pile tip behind the supporting structure, however, have significant differences compared with the measurement. So, the improved model is better to estimate the shaft friction and tip resistance for the pile foundation after excavation.

Keywords: deep excavation; load-transfer model; shear stiffness; finite difference method

PHC 管桩劈裂试验裂缝开展特征

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摘 要: 为研究预应力高强度混凝土管桩(PHC)受环向压力时裂缝开展特征,针对 PHC300 型管桩,设计一种裂缝生成劈裂试验方法,该方法能够在钢筋附近生成裂缝,为该型管桩最不利裂缝生成方式,通过对该型号 PHC 管桩进行劈裂试验,研究其裂缝开展特征.结果表明:PHC 管桩受劈裂产生裂缝时,外表面混凝土层裂缝呈现较好的 V 型特征,裂缝深度随裂缝宽度增大而增大,当裂缝宽度达到 0.18 mm 时,即形成贯穿裂缝;内表面水泥浆层和砂浆层则易发生整层断裂,裂缝延伸性较好,当裂缝宽度达到 0.1 mm 时,裂缝贯穿管壁;与实心混凝土相比,PHC 管桩空心结构造成混凝土之间有效粘结面积较小,裂缝恢复能力较低,外表面裂缝恢复值随裂缝宽度增大而增大,但裂缝恢复率随裂缝宽度增大而减小,PHC 管桩外表面裂缝宽度(COD)恢复率一般在 50%以下.

关键词: PHC 管桩;劈裂;裂缝;裂缝恢复

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Crack development characteristic of PHC pipe pile in splitting test

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Abstract: A special splitting test method has been introduced for PHC300 (prestress high concrete) pipe pile to research the characteristics of crack development due to the toroidal pressure. This crack generation method is considered to be the most negative situation for PHC300 pipe pile since the crack around steels can often be observed. The results show that crack depth increases with crack width in outer surface of PHC. The crack runs through the wall thickness of PHC as the measured crack width reach to 0.18 mm in outer concrete surface and 0.1 mm in inner surface, respectively. This is probably due to the crack extensibility, i.e., inner surface has a better extensibility than outer surface because cement paste layer and mortar layer tend to integral fracture in inner surface. Compared with a solid concrete structure, the crack in PHC is seemly difficult to recovery due to a relatively small bonding area in outer concrete surface contributed by the hollow structure. Crack recovery values increase with the increase of crack widths in outer surface, while crack recovery rates is opposite. The recovery rates of crack open displacement (COD) in outer surface are generally below 50%.

Keywords: PHC pipe pile; splitting test; crack; crack recovery

环境和荷载对 RC 柱滞回性能和氯质量分数的影响

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摘 要: 为研究不同持续荷载比例(持续偏压荷载占极限偏压荷载的比例)和不同环境对 RC(reinforced concrete)柱的滞回性能和氯质量分数影响,试验室模拟了沿海地区 RC 结构的工作条件. 持续荷载比例分别为 0、0.2 和 0.35 的 RC 柱试件, 经历 100 次海水干湿循环或置于大气环境 100 d 后,进行低周水平反复加载试验并测试受拉区混凝土的氯离子质量分数. 结果表明,持续偏压荷载使海水干湿循环柱和大气环境柱的滞回曲线均呈现明显的不对称性,且前者的不对称性甚于后者. 当水平荷载产生的截面应力分布与持续偏压荷载的同向且持续荷载比例为 0.35 时,海水干湿循环柱的峰值荷载和耗能能力分别是大气环境柱的 0.89 和 0.57 倍;反之,前者分别是后者的 1.04 和 1.08 倍. 持续偏压荷载耦合海水干湿循环作用后,距受拉表面 20 mm 和 40 mm 深处,受拉混凝土的氯离子质量分数均是持续偏压荷载单独作用(即大气环境柱)的 3 倍以上. 可见,持续偏压荷载耦合海水干湿循环作用加速了氯离子的渗透和滞回性能的劣化.

关键词: 持续荷载;海水干湿循环;大气环境;滞回性能;氯离子质量分数

中图分类号: TU375.3;TU317.1 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0087-07

Impact of environment and load on the hysteretic behavior and chloride mass fraction of RC columns

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Abstract: To investigate the impact of different sustained load ratios (the ratio of sustained eccentric compressive load to ultimate eccentric compressive load) and different environments on hysteretic behavior and chloride mass fraction of RC(reinforced concrete) columns, the working conditions of RC structures in coastal region were simulated in laboratory. The sustained load ratios were 0, 0.2 and 0.35, respectively. After the RC columns with sustained load had undergone 100 cycles of seawater dry-wet or 100 days in atmospheric environment, low cyclic horizontal loading test was conducted and chloride mass fraction in tensile concrete was tested. Results show that sustained eccentric compressive load lead to the apparent asymmetric pattern of the hysteretic curves of RC columns in seawater dry-wet environment or in atmospheric environment. And the asymmetric pattern of former is more apparent than that of latter. While the stress distribution of cross-section under horizontal cyclic loading is the same as that of sustained eccentric compressive load and the sustained load ratio is 0.35, the peak load and the energy dissipation of RC columns in seawater dry-wet environment are 0.89 and 0.57 times of that in atmospheric environment, respectively. But the former are 1.04 and 1.08 times of the latter if reverse cyclic load is applied. In the depth of 20 mm and 40 mm from tensile surface, chloride mass fraction of tensile concrete in the columns subjected the coupled actions of sustained load and seawater dry-wet cycles are more than 3 times of that only subjected to sustained load (the RC columns in atmospheric environment). These clearly imply that the coupled action of sustained eccentric compressive load and seawater dry-wet cycles could facilitate the chloride penetration and hysteretic behavior degradation.

Keywords: sustained load; dry-wet cycle of sea water; atmospheric environment; hysteretic behavior; chloride mass fraction

震源深度对地震动方向性特征的影响

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摘 要: 为了定量分析地震震源深度对近断层地震动及其在地表的空间展布特征的影响,本文采用一个典型的走滑地震震源模型,基于离散波数有限元方法计算了5种不同震源深度工况下的地震动及其分布场,对地震动幅值、频谱和持时的方向性特征进行分析,结果表明:随着震源深度的增加,地震动的幅值降低,并且在破裂前方和破裂后方存在明显差异;震源深度不同,地震动的空间分布特征也不同;在地震动场中存在一个明显受到方向性效应影响和控制的区域,此区域的位置和面积随着震源深度变化而改变;在地震工程中预测地震动时,特别是当工程中需要考虑地震的近场效应时,震源深度参数是一个不可忽略的因素.

关键词: 地震动;数值模拟;震源深度;影响区域
中图分类号: P315.3 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0094-05

Effect of fault depth on directivity of ground motions

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Abstract: Earthquake source parameters have important impact on the near-fault ground motions and their spatial distribution characteristics. Using a discrete wavenumber finite element method, we simulate the ground motion fields, and then study the effect of fault depth on ground motion amplitude, spectra and duration from the directivity point of view. Numerical results show that: with increasing fault depths, the amplitude decreases but the difference between forward and backward direction still exists; the significantly affected areas is getting closer to the fault; and the radiation angle of directivity effect gradually extends to both sides of the fault strike. This phenomenon indicates that the source depth not only affect the amplitude of ground motion but also the significantly affected areas and locations. Therefore, the source depth parameter should be considered in the prediction of ground motion in engineering, especially in near-fault region.

Keywords: ground motion; numerical simulation; fault depth; affected areas

城市热岛对热舒适度的景观格局影响演化分析

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摘 要: 为明确城市热岛对热舒适度的空间格局过程的影响规律,给城市空间的合理规划布局提供理论支持,以1992—2011年天津市主城区为例,采用同季同时相的TM遥感数据和地面实测数据,基于人体舒适度和高温生理反应构建地表热岛对热舒适度的影响等级划分标准,划分成5个强度不同的影响区,进而利用景观格局指数评价方法进行分析.研究结果表明:热岛对热舒适度的影响区面积和强度都不断增大;二级影响区斑块破碎化,最大斑块面积减小,但其总面积却在升高,热岛影响无实质改善;引起人体不适应的三、四级影响区,斑块的数量与密度不断增大,总面积和最大斑块面积也迅速增加;热岛景观斑块的破碎化、斑块类型的混合、强热岛区的斑块连通度降低,都会改善热岛对热舒适度的影响;高层小区建设虽然节约用地,却增加了热舒适度的恶化总面积,并使局部热舒适度受影响等级异常增高.

关键词: 热舒适度;地表热岛;划分标准;景观格局;演化

中图分类号: TU984 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0099-07

An analysis of landscape evolution for the thermal comfort degree affected by urban heat island effect

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Abstract: To clear the influence rule that the spatial pattern process of thermal comfort degree affected by urban heat island, and to provide theoretical support to the reasonable layout of city space, this paper constructed the criteria for the classification of thermal comfort degree affected by surface heat island effect, adopted the same phase of TM remote sensing data and ground measured data at the same time based on human comfort and human physiological reaction for the environment temperature. Utilizing the landscape pattern index evaluation method, this paper analyzed the urban heat island effect in downtown Tianjin from 1992 to 2011. The results show that, first, the space area is expanding of the thermal comfort degree affected, and the impact intensity is rising; second, for the secondary thermal comfort degree affected regions, the largest patch area is decreasing, but the total area is increasing; third, for the third and fourth thermal comfort degree affected regions which cause people feel discomfortable, patch classes area, the largest patch area, patch density are rising, indicating the heat island effect on the thermal comfort in the continuing deterioration; fourth, the fragmentation of heat island landscape patch, the mixture of patch types, the reduction of connectivity among strong heat island areas can weaken the impact of the urban heat island effect on thermal comfort; fifth, although saving land, high-rise residential building will increase the total area of deteriorating thermal comfort and make the local thermal comfort affected by super grade.

Keywords: thermal comfort degree; surface heat island; classification criteria; landscape; evolution

原水输送管道生物净水效能

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摘 要：为提高长距离输水管道输送水质，研究原水输送管道生物净水效能的形成过程，采用实验室配水，利用管道模拟反应器模拟原水输送管道，连续检测进、出水水质以及生物膜中微生物的数量随时间的变化.结果表明：原水输送管道生物净水效能的形成过程中，氨氮（NH_4^+-N）和有机物等的去除均是先逐渐增大后趋于稳定，且稳定值相比最大值稍有下降；管道模拟反应器在运行45 d后生物膜达到稳定，对NH_4^+-N的去除率稳定在75%左右，出水亚硝酸氮（NO_2^--N）质量浓度稳定在0.02 mg/L左右；输水管道中，氨氧化菌（AOB）相比亚硝化细菌（NOB）是优势菌种；管道模拟反应器对UV_{254}和浊度的去除率均稳定在30%左右；管道模拟反应器对正磷酸盐（PO_4^{3-}）的去除率维持在13.64%～38.78%.

关键词：原水；输水管道；生物膜；净水效能

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Biological purification efficiency in raw water delivery pipelines

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Abstract: Study on formation process of biological purification efficiency in raw water delivery pipelines was beneficial to improve water quality in long distance raw water delivery pipes. Using simulated pipeline reactors to simulate water situation in raw water delivery pipelines, and water samples were prepared in laboratory. The influent and effluent water quality, the microorganisms in the biofilm is continuously monitored. Results show that the ammonia nitrogen (NH_4^+-N) and organic matter removal are stabilized after a gradual increase in first, and stable value decreases slightly compared to the maximum in the formation process of biological purification efficiency. Biofilm grow on polyethylene slides in simulated pipeline reactor and then harvest within 45 days, the removal rate of NH_4^+-N remains stable at 75%. Nitrite nitrogen (NO_2^--N) effluent concentration remains stable at 0.02 mg/L. Ammonia oxidizing bacteria (AOB) is dominant strain compared to nitrite oxidizing bacteria (NOB) in raw water delivery pipes. Removal rate of UV_{254} and turbidity are about 30%, and orthophosphate (PO_4^{3-}) removal rate ranges from 13.64% to 38.78%.

Keywords: raw water; water delivery pipes; biofilm; purification

具有未知死区的SISO非仿射非线性系统间接自适应模糊控制

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摘 要: 为了解决含有未知死区输入特性的SISO非仿射非线性系统的跟踪控制问题,提出了基于模糊自适应方法的控制器设计方案,把未知死区分解为一个线性项和一个扰动类似项,当系统状态可测时,利用模糊逻辑系统设计间接自适应模糊控制器,并结合跟踪误差信息设计自适应律;系统状态不可测时,通过引入误差观测器估计的状态变量,设计了间接自适应模糊输出反馈控制器.理论论证过程说明两种控制器能使系统的跟踪误差最终收敛到零的某一邻域,且闭环系统所有信号均有界. 仿真实验结果表明利用所设计控制方案可以使系统完成跟踪控制任务.

关键词: 未知死区;非仿射非线性系统;自适应模糊控制;误差观测器; 输出反馈

中图分类号: TP273 **文献标志码**: A **文章编号**: 0367-6234(2014)10-0110-07

Indirect adaptive fuzzy control for SISO nonaffine nonlinear system with unknown dead-zone input

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Abstract: To cope with the controller design problem that the control input of single-input single-output (SISO) nonaffine nonlinear system is with an unknown dead-zone character, a controller design strategy based on fuzzy adaptive technique is proposed. Within this scheme, the unknown dead-zone is treated as a combination of a linear and a bounded disturbance-like term. For the case that the system states are measurable, an indirect adaptive fuzzy controller is constructed by using fuzzy logic systems and adaptive laws are given out according to the information of tracking error. On basis of the above controller design method, another indirect adaptive fuzzy output-feedback controller for immeasurable system states is designed based on the estimated states which are generated by an error observer. The theoretic prove process indicates that the two controllers can guarantee that the tracking errors converge to a small neighbourhood of the origin and all signals in closed-loop system are bounded. Simulation results demonstrate that the constructed controllers can make the system achieve the tracking control objective.

Keywords: unknown dead-zone; nonaffine nonlinear system; adaptive fuzzy control; error observer; output-feedback

一种改进的群目标自适应跟踪算法

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摘 要: 为提高对群目标在机动情况下的跟踪性能,提出一种改进的群目标自适应跟踪算法.在群质心状态估计中,在修正"当前"统计模型的基础上,利用群质心的速度预测和速度估计的偏差进行过程噪声方差自适应调整,并引入强跟踪滤波中的渐消因子,实时调节群质心的状态预测协方差.在扩展状态估计中,将其对应的椭圆面积预测值和估计值的偏差以及偏差变化率作为模糊输入量,采用模糊推理法自适应输出扩展状态的预测参数.此外,提供了群目标分裂机动的判决方法.仿真结果表明,与现有方法相比,本文算法增强了对群目标在突发机动时的自适应跟踪能力,并能有效检测出群的分裂机动.

关键词: 群目标;质心状态;扩展状态;强跟踪滤波;模糊推理;分裂机动

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An improved adaptive tracking algorithm for group targets

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Abstract: In order to improve tracking performance of the approach, a new adaptive tracking algorithm of group maneuvering targets was presented. In the estimation of group centroid kinematic state, the deviation between the prediction value and estimation value of centroid speed was used to adjust the covariance matrix of process noise based on modified current statistical model, and a fading factor of strong tracking filter was used to adjust the state-estimation error covariance adaptively. In the estimation of group extension state, the prediction parameter of extension was calculated by using a fuzzy reasoning method, which had taken the deviation between the prediction value and estimation value of the corresponding elliptical area and the change ratio of deviation as the input of the fuzzy controller. Lastly, a method to judge split-off maneuvering of group targets was offered. Simulation results show that, compared with the existing methods, the proposed algorithm can obtain a better adaptive tracking performance in maneuvering scenarios, and detect the split-off maneuvering effectively.

Keywords: group targets; centroid kinematic state; extension state; strong tracking filter; fuzzy reasoning; split-off maneuvering

PEO基聚合物电解质的制备

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摘 要: 为采用蒸馏水替代有机溶剂溶解PEO,减轻对空气的污染,改善由于有机溶剂挥发较快使得聚合物膜易裂的缺点,采用溶液浇铸法,首次以蒸馏水为溶剂溶解PEO,以纳米SiO_2为填料,锂盐采用$LiClO_4$,制备出复合聚氧化乙烯基电解质PEO-$LiClO_4$-SiO_2,并对纳米SiO_2的作用进行分析.采用SEM、XRD和交流阻抗法等测试方法对PEO基复合电解质的微观形貌、晶体结构和相关电化学性能等进行表征.结果表明:添加纳米填料后,PEO聚合物电解质的结晶度下降,拉伸强度增加.PEO-$LiClO_4$-SiO_2(6%)聚合物电解质的电化学稳定窗口为4.8 V,离子电导率(25 ℃)为3.95×10^{-5} S·cm^{-1},离子迁移数为0.29.

关键词: 聚合物电解质; 电化学性能; 纳米SiO_2; 聚氧化乙烯

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Preparation of PEO matrix polymer electrolyte

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Abstract: The method by using distilled water to replace organic solvents to dissolve PEO is simple and the air pollution caused by organic solvents volatilizing will be avoided. The PEO-$LiClO_4$-SiO_2 polymer electrolyte is prepared by solution-casting method, in which the water is as solvent, the nanometer $SiO_2$is inorganic filler and the lithium salt is $LiClO_4$. The effect of nano SiO_2 particles is analyzed. The micro-morphology, crystal structure and electrochemical properties of the electrolyte are characterized by scanning electron microscope (SEM), X-ray diffraction (XRD) and electrochemical impedance spectra (EIS). The results show that the crystallinity of PEO polymer electrolyte is decreased and the tensile intensity is increased when nanometer SiO_2particles are doped in the polymer electrolyte. The electrochemical stability window is 4.8 V, the highest ionic conductivities (25 ℃) of PEO-$LiClO_4$-SiO_2(6%) polymer electrolyte is 3.95×10^{-5} S·$cm^{-1}$and the ionic transference number is 0.29.

Keywords: polymer electrolyte; electrochemical property; nanometer SiO_2; PEO