人工粘土层在枯水期对小清河氧化塘底质水盐运动的抑制模拟研究*

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摘要 利用实验室土柱模拟装置对枯水条件下盐渍地区氧化塘不同底质土壤结构的水盐运移状况进行了定性模拟研究。结果表明,原底质均质白汤土输水能力较大,蒸发较易发生,因而带动盐分在塘底表面大量累积,维持该水盐运移的最大吸力值为120cm水柱。而经人工改造后,表层有30cm粘土覆盖的土壤层结构对水盐运移有强烈的抑制作用,在模拟3个月的蒸发时间内表面没有盐分累积。

关键词 氧化塘底质,水盐运移,模拟试验。

小清河下游地处半干旱的气候环境,年蒸发量为110mm,河道、水塘经常干枯。地下水埋深1.5—2m,由于海水倒灌和周围盐分的影响,地下水矿化度为10—20g/L,地下水、盐在干旱季节是否可以上升到氧化塘底地面并发生积累,成为氧化塘运行和水资源综合利用的重要问题。

土壤中盐分累积作为农业土地盐碱化现象,前人已经进行了大量的工作(Hasson. F. H. 1977;贾大林,1985;李韵珠,1985和雷志栋,杨诗秀,1988等)。本工作作为水盐运动的一个特例,将前人所做土壤水盐运动理论及方法,运用于小清河氧化塘底质盐分入侵的研究工作,利用实验室土柱模拟的方法,模拟研究干旱条件下,盐分在该氧化塘底质白汤土结构下的运移情况,同时研究了经人工改造添加的粘土层结构对盐分运移的阻碍作用,为盐碱地带氧化塘的建立及改良提供科学依据。

1 实验装置和方法

1.1 装置

整个装置分别由土柱,供水系统和监测系统组成。

(1)实验土柱 土样装在高约2m和1m,内径为18.4cm的有机玻璃圆柱内。在圆柱两侧相隔一定位置上备有观测孔,分别安装盐分传感器(美国土壤水分仪器公司生产)和张力计。

(2)供水系统 自制。采用马利奥托瓶向土柱供水,能控制土柱中地下水位在实验过程中始终维持不变并能自动补水,同时可测定潜水蒸发量。

(3)监测系统 主要由盐分监测和水分监测2套系统组成,盐分变化由土壤盐分数据采集系统进行监测记录,水分变化则用水银负压计进行测量。

1.2 方法

分别设置2个水柱,实际土层结构和均质土层结构。实验分2个阶段。

(1)第一阶段 土样取自小清河氧化塘底质土壤剖面。经淡水淋洗后按原状土结构装填土柱,上层为30cm粘土,干容重1.3g/cm³,中层为20cm的粘土和白汤土的交接层,干容重1.35g/cm³,下层为150cm,干容重为1.4g/cm³,总柱长200cm,即地下水埋深度。模拟地下水的水溶液由氧化钠配制成的盐水,其浓度为15g/L。

(2)第2阶段 将原土柱的粘土层和交接层

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去掉，仅留下下层100cm高的均质白汤土，重新安装盐分传感器和张力计，模拟未经人工改造的原均质土壤的盐分运移规律，以作比较。实验的其它条件不变。

实验在室内进行，柱顶两侧用白炽灯烘烤，并用电风扇调节风力大小来模拟实际蒸发条件。土柱一侧安装与土柱蒸发面积相等的水面蒸发观测装置，由马氏瓶补水定量其蒸发量。

2　实验结果与讨论

2.1　层状土稳定蒸发条件下的盐分运移

实验共历时45d，水面蒸发量274mm。如果该地区的年平均蒸发量按1100mm计，相当于实际3个月蒸发时间。实验期间，定期采集土柱内各点盐 度分布数据，同时利用张力计测定吸力变化和由马氏瓶测定补给的地下水潜水蒸发量。

根据对整个实验过程和现象的观测，实验期间盐分传感器所采集的盐度数据基本没有变化，图1表示实验开始时土柱剖面的盐度分布(第1d)和结束时的盐度分布(第44d)。其分布仍为

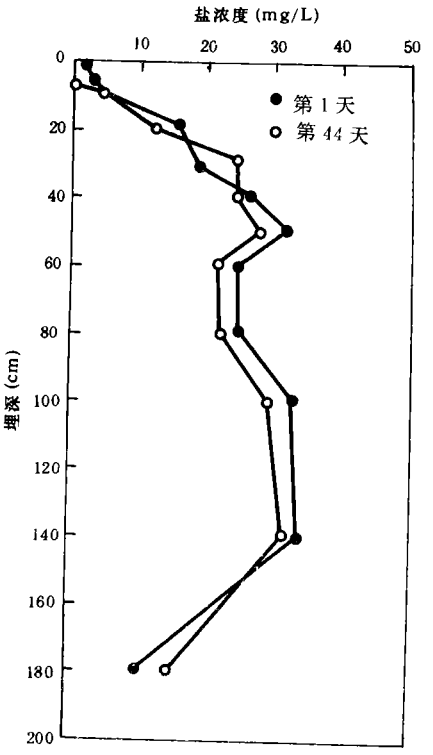

图1　开始和结束时非均质土壤的盐度分布

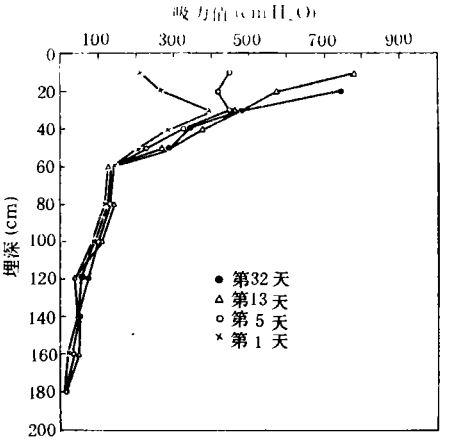

图2　非均质土壤的吸力值变化

装柱后为降低本底含盐量而淋洗后的浓度分布。根据土柱内吸力值的观测结果，选择绘制了第1d、5d、13d和32d土柱剖面吸力值变化，如图2所示。由图2表示的实验过程吸力值变化可看出，水柱吸力值在埋深为60cm以内时随蒸发的进行稍有增大，30cm以内其变化较为明显。在实验的后期其吸力值已增大到800cm水柱以上，超出水银负压计的测量限。这一过程中，随吸力值的增大粘土层内含水量减少，而在下层白汤土内吸力值和水势都没有变化，说明其含水量也没有变化，未发生蒸发及水盐运移作用，潜水蒸发为零。因而不难想象蒸发仅发生于表土30cm的粘土层内，即只有含水量的损失。从表土30cm处吸力值开始增大和60cm处吸力值开始变化，可清楚地说明3种不同性质土层的蒸发能力，供水能力的不同和相互抑制的存在。由于没有潜水蒸发，也就不可能发生水盐运移作用，这一结果与盐分传感器所监测的盐分运移结果是一致的。实验结果表明，蒸发过程由于受表层导水率较低的粘土隔绝作用的影响，使下层土壤水分和地下水分不能充分补给上层土壤蒸发所造成的水分损失，因而蒸发仅发生于上层土壤，一旦水分损失到一定程度，粘土便干结形成整块，使蒸发不能继续进行。这与刘有昌(1982)和李韵珠(1986)土壤隔绝层的厚度和位置的实验结果是一致的。因而可以得出初步结论，山东小清河氧化塘由于有粘土层覆盖，地下水位较深，在干枯

期蒸发的 3 个月或更长的时间内表土不会发生盐分累积现象。

2.2 均质土壤稳定蒸发条件下的盐分运移

均质土壤的盐分运移实验共进行 27d，控制水面蒸发约 85mm，土柱潜水蒸发为 28mm，平均相对蒸发率为 0.33。实验过程中定期观测各点盐度和吸力值变化，并选择绘制第 1d、9d、22d 和第 27d 的吸力值剖面变化，如图 3 所示。在实验

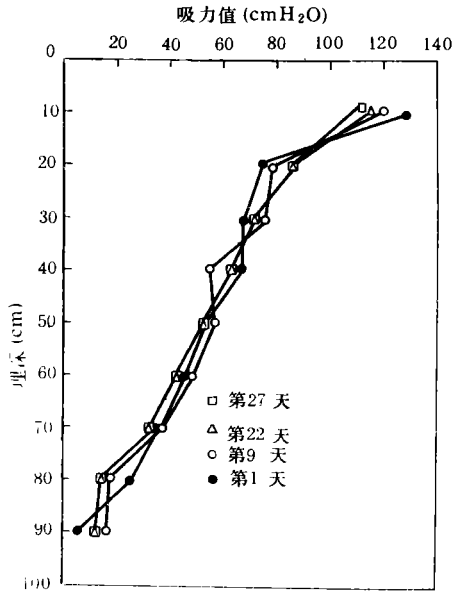

图 3 均质土壤吸力值分布

结束时，从观测孔采集不同埋深的土样，分别用烘干和滴定法分析其含水量和氯化钠浓度。图 3 所示，从实验开始到结束的吸力值变化不大，因而蒸发过程中的水气蒸发和供水较为稳定。而维持这一稳定蒸发的最大吸力值仅为 120cm 水柱左右，与第一阶段的实验相比，当表土吸力已大于 800cm 水柱以上时也未发生潜水蒸发现象。2 个阶段吸力值明显差别，除了说明第一阶段的潜水埋深较深和粘土的隔绝抑制作用外，也证实了均质白汤土输水能力较大，蒸发较易发生。与之相应，图 4 绘制了第 1d、17d、和第 26d 的盐分采集系统监测的土柱剖面盐度分布和实验结束时采集样品的盐度滴定值分布。从图 4 中可看出具有很好的盐分运移规律。开始时盐分从潜水开始上升，土面无盐分积累，下层的盐浓度高于表层的盐浓度；当盐分到达表土后，表层土盐分浓度不断增加。而表土 5cm 以下的土层内盐浓度基本保持不变，输入的水盐的通量与输出保持平衡，土柱内蒸发相对稳定。这与吸力值测定结果一致。

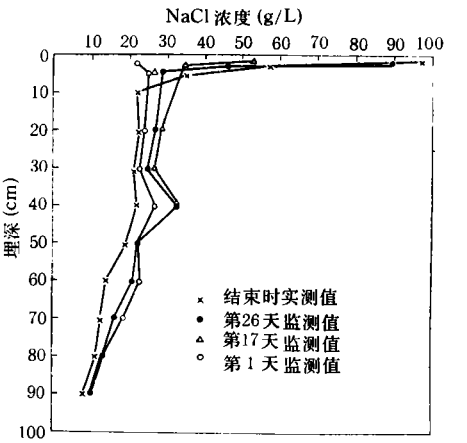

图 4 均质土壤的盐浓度分布

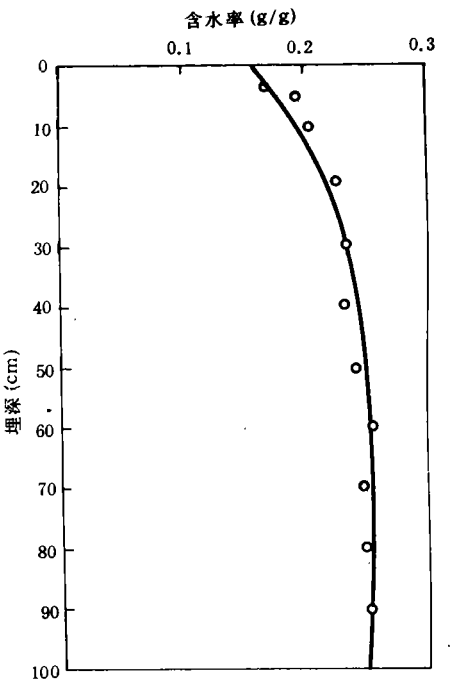

图 5 均质土壤土柱含水率分布

图 4 中给出的实验结束时滴定法测定的盐浓度，与监测值相吻合，证明了实验方法是可信

的。根据最终采样测定结果，土柱剖面的含水率分布和水分特征曲线分别绘制于图5和图6。两者与水盐运移的水分特征均有很好的一致性，含水率随埋深的增加而减少，吸力值随含水率的增大而减少。为便于比较，图6中同时引用绘制了文献中的粘土、壤土和砂土的水分特征曲线。由于水分特征曲线表示了土壤蒸发过程中水的能量和数量的关系，土壤含水率、吸力值与土壤颗粒度和该曲线都有较大的关系。一般来说，土壤颗粘愈大，同一吸力值条件下土壤的含水率愈大，或同一含水率下其吸力愈高。由图6可知，小清河氧化塘白汤土的水分特征曲线的变化间于

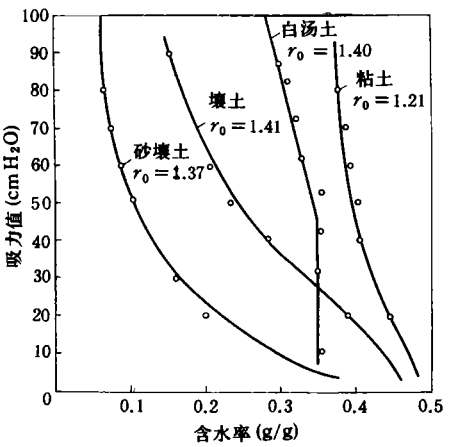

图6　均质土壤土柱和不同土质的水分特征曲线

粘土和壤土之间，说明白汤土的颗粒含量大于壤土而小于粘土；同一吸力值下其持水性比壤土和砂土大，而比粘土小，或维持蒸发同一含水率时白汤土所需的吸力值比壤土和砂壤土高，而比粘土低。

3　结论

潜水埋深为100cm的均质白汤土在吸力值为120cm水柱时，可维持正常的蒸发过程，因而其输水能力较大，蒸发较易发生，土壤表面有盐分累积。经人工改造后，表面有30cm粘土层覆盖的氧化塘底质土壤层结构对水盐运移有强烈的抑制作用，在潜水埋深200cm时，土壤表面不会发生盐分累积现象。

致谢　本工作在实验期间得到清华大学水利系杨诗秀教授和沈言琍同志的大力帮助和支持，在此表示感谢

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·环境信息·

工业化国家的环境性能比较

一项对工业化国家环境性能加以比较的研究，将澳大利亚列在榜首，并将美国排在末尾。这项涉及经济合作与发展组织(OECD)所有21个成员国的研究，是由位于伦敦的新经济基金会采用OECD数据来进行的。选择了11组数据，其中包括CO_2排放量、SO_2排放量、水提取、能效、城市固体废物产生量、保护区以及受威胁物种。对这些数据进行了标准化，以便适当得出每人、单位国内总产值(GDP)或单位土地面积的结果。就每项环境标准来说，最好的国家得100分，最差的得0分。简单地通过这些数字相加来计算总分；换句话说，这11项环境标准的权重相等。美国和加拿大之所以得分低是因为它们能耗高，几组环境数据反映这一点，其中包括CO_2和SO_2排放量、能效以及某种程度上的废物产生量。

淮海译自 ES&T，1994，**28**(3)：112A

Abstracts

Chinese Journal of Environmental Science

Characteristics in Mutagenicity of the Drinking Water from Representative Areas in China. Xu Fengdan et al. (Institute of Environmental Health Monitoring, CAPM, Beijing 100021): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 1—6

The tap waters, raw waters and chlorinated raw waters from the waterworks in Shanghai, Kunming, Harbin, Shengyang, Guangzhou, Wuhan and Shenzhen cities were studied for their characteristics in mutagenicity by using an Ames Test. All the tap waters were found to contain direct mutagens of frameshift, with strain TA98 to be the most sensitive strain for such a monitoring. The chlorinated raw waters from all the cities except for shenzhen were found to have significantly a stronger mutagenic activity than their raw waters in both strain TA98 and TA100, with and without S9, as evaluated in terms of relative activity by water volume (rev./L) or by weight of water concentrate (rev./mg), particularly in the case of Shanghai. The results provide a scientific basis for selecting representative cities to study the mechanism on the formation of toxic chlorinated organics during chlorination of drinking water.

Key words: drinking water, chlorination, mutagenicity Ames Test.

QSAR Model Paramters Research on Substituted Aromatic Compounds. Wang Lianshen, Liu Zhengtao et al. (Department of Environmental Science, Nanjing University, Nanjing 210008): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 7—10

The quantitative structure activity relationships (QSAR) between acute toxicities of 47 substituted aromatic compounds to *Daphnia magna* (48h, EC_{50}/LC_{50}) and seven classical parameters of molecules had been investigated. The biological effects were found to be mainly related to K_{ow} (octanol/water partition coefficient), π_x (hydrophobic bonding effects), $^1X^v$ (substituent molecular connectivity index). The contribution rank of the aromatics in quantitative relationships was: hydrophobity/hydrophilicity > electronic effects > steric effects.

Key words: aromatic derivative, toxicity effects, parameters analysis, QSAR.

Development of the Technology for Immobilizing Microorganism on a PVA Entrapped Activated Carbon and Its Application to Degradation of Isocarbophos. Chen Ming, Luo Qifang (Institute of Environmental Medicine, Tongji Medical University, Wuhan 430030): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 11—14

A technology has been developed for immobilizing microorganism on an activated carbon which has been entrapped by using polyvinyl alcohol (PVA) as an entrapping agent. The preferable preparation processes were given for such an immobilization. The trial study on application of this technology to degradation of isocarbophos, an organophosphorus pesticide, was conducted. The results show that the immobilized microorganism can be effective in a wider range of temperatures, pH values, and concentrations of isocarbophos in water. During a 3 month period of continuous operation, 55%—72% of the pesticide were removed from water if it had an initial concentration of 1300—2500mg/L by COD_{Cr} in water and was degraded in a thermostatic vibratile table (30℃, 150rpm) for 24 hours (HRT).

Key words: isocarbophos, immobilized microorganism, PVA, activated carbon, organophosphorus pesticides.

Characterization of the Ca-Fe-S-Si-O System as a Final Product of High Temperature Coal Briquet Sulfur Capture. Lin Guozhen, Xiao Peilin et al. (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 15—17

The ash from burning a coal briquet with an additive (Si, Fe) for sulfur capture was characterized by using a X-ray powder diffraction method and a X-ray fluorescent spectrometry, giving the same chemical composition as that derived from the elemental analysis data. The results also indicated that $CaSO_4$ was the major constituent of the ash; the content of sulfur in the ash was found to be 7.33% by weight; and the ash had a composition of Ca-Fe-S-Si-O showing a higher rate of sulfur capture.

Key words: coal briquet, sulfur capture, XRPD, XRFA.

Simulating Study on an Artificial Clay Layer Suppressed Movement of Waterborne Salt through the Sediments of Oxidative Ponds in Salinized Areas During Dry Seasons. Wang Hong, Ye Changming, Yin Chengqing (Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 18—21

The modelling studies have been qualitatively carried out on the movement of waterborne salt through different stratified structures of the sediment of oxidative ponds in a salinized Xiaoqinghe area during dry seasons by using simulated soil columns in laboratory. The results show that the homogenous earth of original sediment has a high ability to transport water and is prone to allow water to be evaporated, making the waterborne salt to be carried up and largely accumulated on the surface of pond bottom. The maximum suction head to maintain such

a waterborne salt movement was found to be 120 cm water column pressure. However, a 30 cm thick clay layer artificially covered on the top surface of the original sediment shows a strong suppression against the waterborne salt movement even if the suction head is over 800 cm water column prissure. No salt content was found to be accumulated on the surface during a 3 month period of simulated evaporation.

Key words: oxidative pond sediment, waterborne salt transport, simulation.

Application of GKS in National Water Quality Management Information System. Jiang Yong, Fu Guowei (Department of Environmental Engineering, Tsinghua University, Beijing 100084): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 22—25

GKS (Graphics Kernel System), the first ISO international standard for computer graphics, was used to construct a graphic application system with a higher efficiency of development and a stronger implantability of programs. This paper also deals briefly with the position of GKS in various applications, major functions and the principles of developing such a graphic system. The reasonable functions of graphics were arranged to closely meet the requirements of the national information system on water quality management. The software structures of the graphic system, and the schemes of designing a general graphics and a geographic graphics, were also described along with a general evaluation on the effectiveness of GKS application in developing graphic systems.

Key words: water quality management, graphics kernal system, National Water Quality Management Information System.

Research of the Separation and Recovery of PER Plastic Wastes. Zhang Zhongyan, Zhao Genmei et al. (Department of Chemistry and Chemical Engineering, Shanghai University of Technology, Shanghai 200072): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 26—29

The recycles of PET and high density polyethylene (HDPE) from the used plastic drinking bottles made of them were carried out by using a process comprising steps of: smashing the used bottles into pieces, air seperation, cleaning, and floating. With this process, PET, HDPE and other plastic wastes were effectively seperated and recovered at a rate of 97% for PET and a rate of 95% for HDPE. The recovered PET had a purity of above 95% and could be recycled as a raw material of plastics having a high quality.

Key words: PET, HDPE, separation and revovery of plastic wastes.

Use of Polymer Composite Materials for Vibration Damping and Noise Reduction. Zou Zongbai, Li Jun et al. (Southeast University, Nanjing 210018): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 30—33

A polymer composite material has been prepared by using an epoxy resin as binder, a low molecular weight polyamide as curing agent, and a mixture of powdered stone, quartz sand and glass fiber as filler, based on an optimized formulation designed to meet the requirements for the performance of material. The tests show that the composite material has a hardness of about 240 HB and an impact resistance of about 30kg • cm/cm^2, both of which are close to those for some metal materials. This material is also easy to shape and is cost-effective. All of these make the material having a value of wide application, particularly use as alternatives to replace those metal parts which may undergo a heavier impact on shuttled textile machines in textile factories, in order to minimize the vibration and noise.

Key words: polymer composite material, epoxy resin, vibration damping, noise reduction.

Method for Treating Exhaust Gases from Methanol Fueled Internal Combustion Engine (Ⅱ): A Deep Oxidation of Methanol over Multicomponent Catalysts. Wang Jin'an, Wang Ren (Institute of Industrial Catalysts, East China University of Science and Technology, Shanghai 200237): *Chin. J. Environ. Sci.*, **15**(3), 1994, pp. 34—37

Several kinds of multicomponent catalysts for a deep oxidation of methanol were studied for their activities and surface features by means of GC-MR, XRD, SEM, BET etc. The studies were also conducted on the effects of calcination temperature, oxygen level in the atmosphere and space-velocity on the activities of catalysts. The results show that the oxidation of methanol over all the catalysts studied produced formaldehyde (HCHO) and methyl formate ($HCOOCH_3$), and both the temperature ranges in which they could be produced and the maximum concentrations at which they could be produced varied for different catalysts. Catalysts No. 32—37 were found to have a significantly high activity than the bicompont catalysts. The addition of a rare earth metal oxide (CeO_2) and a noble metal (Pd) in a small amount to such catalysts could improve their activities to an extent. Increased calcination temperatures would cause the catalyst surfaces to be sintered, making the activities reduced. Increased space-velocities could give a slightly higher rate of methanol convertion. The oxygen level was found to be preferably at 5% and a level of over 10% would have only a small effect on methanol convertion.

Key words: methanol, formaldehyde, methyl