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Study on the Construction of Garden Green Space in Petrochemical Enterprises

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In order to study the landscaping of petrochemical enterprises, combined with the characteristics of petrochemical enterprises, the ecological concept of landscape construction of petrochemical enterprises was put forward. It focuses on the green quantity, plant diversity and the application of native plants. At the same time, it is pointed out that the important goal of the construction of landscape green space in petrochemical enterprises is to control and weaken the environmental pollution. In terms of pollution control and reduction, water pollution control, soil pollution control and noise pollution control are analyzed. Based on the latest phytoremediation theory and related techniques, the specific methods of phytoremediation were proposed. The results showed that the removal rates of TN (total nitrogen) and TP (total phosphorus) were 63.12% and 40.74%, respectively. Therefore, green plants can effectively improve water pollution, soil pollution and noise pollution.

1. Introduction

The raw materials of petrochemical enterprises are crude oil or liquefied petroleum gas. Through different production processes and processing methods, a variety of petroleum products, organic chemical raw materials, chemical fiber and fertilizer production enterprises are produced (Mohammad et al., 2016). In the process of processing, storage, handling and transportation, various ingredients of chemical raw materials will inevitably lead to water, gas, soil and other environmental pollution. Gases, dust, dust, sewage and other substances that are harmful to human health and plant growth are expelled. The surrounding air, water and soil are infected and damaged in varying degrees (Enzo, 2017). The living environment of humans and other creatures is polluted. Under the current level of science and technology and management conditions, this infringement and pollution cannot be completely eliminated (Ying et al., 2015). In order to improve this situation and the surrounding environment, to minimize the harm to the human body and the surrounding crops and damage, it must be through the green plants to improve the surrounding environment (Testiati et al., 2013). The construction of garden green space has become an important task in the environmental construction of petrochemical enterprises. According to the basic requirements of landscaping and natural law, combined with the characteristics of petrochemical enterprises, the construction of garden green space has become an important problem that we must study and solve (Srivastava and Singh, 2016).

2. Ecological concept in landscape construction of petrochemical enterprises

Green quantity: Green is the most important ecological indicator of landscaping (Sessitsch et al., 2013). The ecological benefits of greening are measured by the amount of leaves, rather than simply counting the number of trees (Xiaomin et al., 2017). The amount of green leaves is the first factor to determine the greening effect and ecological benefits. Therefore, leaf area index (LAE) is a key indicator to evaluate the ecological benefits of landscaping (Prapagdee et al., 2013). The construction of plant community is the basis for realizing high leaf area index and high ecological benefit green space.
Plant diversity: Plant diversity is the basis and important component of biodiversity, which is an important condition and basis for realizing the ecological effect of garden green space. In the planning of garden green space, plant diversity is not only reflected in the diversity of plant species, but also should be diversified in the

aspects of plant ecology, specifications, configuration techniques, and shrubs (Pérez-López et al., 2014). Through the rich species composition of vegetation, reasonable collocation of plant communities in the upper, middle and lower vegetation, and improve the heterogeneity of green space, which takes into account the continuity and integrity of the green space. It creates a space conducive to the growth, development and reproduction of individual plants. Through rational plant cultivation, a closely related plant community is formed (Muhammad et al., 2014). In a good plant community, it is bound to naturally adapt to the animal and microbial groups, so that the species and number of organisms in the entire ecosystem increases gradually. The system stability and anti-interference ability are improved, so as to realize the virtuous cycle of ecosystem.
Application of native plants: The native plant is the core of the ecological function of the green space, and it is also the basis of the composition of the garden greenbelt. In the ecological standard of the ecological garden city, the application of the local native species has the clear requirement of the basic index. However, there are still some phenomena of ignoring native tree species, over appreciating and relying on exotic species, especially foreign ornamental varieties. These phenomena are particularly prominent in the landscape as the main goal of the green space. As a result, the landscape effect was not achieved, although a large amount of money and manpower were spent.
The main goal of the greening of petrochemical enterprises is not the landscape, so it is more important to use native plants in the construction of green space. Native plants have unique natural advantages such as low cost, strong adaptability and obvious local characteristics (Chibuike and Obiora, 2014). In addition, the adsorption of dust, water conservation, manufacturing oxygen, purification of air and other aspects of the effect is significant. At the same time, the adaptability of native plants to climate, environment and soil is very strong, and the disease and insect pests are few, which can greatly reduce the cost of fertilizer, plant protection and other maintenance costs. More importantly, it has reliable ecological safety (Chodak et al., 2012).

3. Study on pollution control of landscape construction in petrochemical enterprises

3.1 Water pollution control

Artificial wetland is a new type of sewage treatment model. Its design and construction are carried out through the optimal combination of physical, chemical and biological effects in wetland natural ecosystems (Tobias et al., 2015). Plants are the core of constructed wetlands. It can not only remove pollutants, but also promote the recycling and reuse of nutrients in sewage, and promote the virtuous cycle of the ecosystem. The construction of constructed wetland can take into account the two aspects of pollutant purification and landscape effect. The process flow chart is shown in Figure 1.

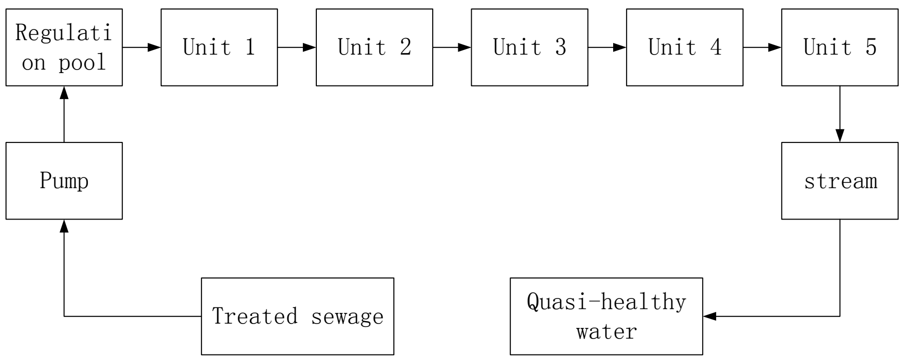

Figure 1: Technological process chart of artificial wetland

The study of artificial wetland in a petrochemical plant shows that the water quality has improved obviously after the treatment of constructed wetland. The results showed that the removal rates of TN (total nitrogen) and TP (total phosphorus) were 63.12% and 40.74%, respectively. The removal of organic matter and SS (suspended matter) is particularly obvious, and the removal rate of organic matter is more than 70% (Albert et al., 2014). SS was not detected in water, indicating that artificial wetlands can effectively remove organic matter and SS. The specific treatment effect of constructed wetland is shown in Table 1.

Table 1: The specific treatment effect of constructed wetland

Index	Influent(mg/l)	Effluent(mg/l)	Removal rate (%)
Nitrate nitrogen	1.536±0.341	0.605±0.043	60.57
Ammonium nitrogen	0.026±0.005	0.013±0.001	51.26
TN	2.412±0.866	0.889±0.133	63.12
TS	0.067±0.003	0.040±0.014	40.74
SS	27.000±4.240	Not detected	100.00
Permanganate	4.369±1.126	1.282±0.055	70.67
BOD_5	2.810±0.795	0.746±0.029	73.45
COD	29.572±3.217	5.005±1.930	83.07

In the selection of artificial wetland plants, we should first consider the selection of local plants. Exotic plants should be carefully introduced to avoid causing biosafety problems. Wetland plant roots are long-term soaked in water and exposure to higher concentrations of pollutants. Therefore, aquatic plants not only have strong ability to resist pollution, but also have good adaptability to local climate conditions, soil conditions and surrounding animal and plant environment (Bruce et al., 2012). Second, the decontamination capacity of plants should be considered. The decontamination capacity of the plant depends mainly on its biomass. It should choose the roots of developed, lush foliage plants. In terms of plant selection, the resistance should also be considered, that is, resistance to pollution, cold and heat resistance and resistance to pests and diseases. Finally, it should be noted that try to use a certain landscape effects and economic value of plants, such as Japan's Hakone wet garden (Francesc et al., 2017). It was built in Japan for the protection of wetlands and for the popularization of wetland science knowledge. There are more than 2,700 kinds of wet plants and other plants in the park. In the collocation of plant species, multi species rational collocation is adopted. By using the relationship among different plant species, a good and stable natural water ecosystem can be formed so that it can develop itself and self-cycle, and realize the control of water pollution for a long time.

3.2 Soil pollution control

With the increase of oil production and utilization, a large amount of oil and its products enter the environment. At present, physical and chemical methods cannot solve this problem completely, so it inevitably causes pollution to the surrounding environment, especially the soil. Compared with chemical and physical methods, bioremediation is an efficient, economical and environmentally friendly cleaning technology. Bioremediation technology is mainly used for soil, groundwater and marine pollution control. It is mainly based on the original repair (Berta et al., 2017).

Plant-microbial co-repair is achieved by synergistic action of plants with specific mycorrhizal fungi or rhizosphere bacteria, which increases the absorption and degradation of contaminants. This is a very valuable research direction, but the current research on this area is still relatively rare. Medicago sativa and microbes are used to repair oil contaminated soil. The results showed that soil microbial degradation was significantly enhanced under plant growth conditions. Salix myrtillacea is used to repair diesel contaminated soil. The results show that the repair mechanism mainly uses the rhizosphere microorganisms of the roots of trees to promote the degradation of petroleum hydrocarbons. Highly efficient oil degrading bacteria and plants such as Glycinemax and Trifoliumrepens were combined to treat petroleum contaminated soil. The results show that the degradation rate of petroleum hydrocarbons is 63.65-83.26%. At the same time, it was found that the content of petroleum hydrocarbon in the rhizosphere soil was significantly lower than that in the non - rhizosphere soil, which indicated that the plant could promote the propagation of rhizosphere microorganisms and the decomposition and transformation of pollutants. Sketch chart of microbial-phytoremediation system is shown in Figure 2.

Phytoremediation technology is an ecological technology developed in recent years to remove heavy metal pollution from soil. Heavy metal contaminated soil bioremediation refers to the cultivation of a particular plant on heavy metal contaminated soil, which has a special absorption and adsorption capacity for toxic heavy metal elements in the soil. After the plant is harvested and properly treated, the heavy metal can be removed from the soil, so as to achieve the purpose of heavy metal pollution control and ecological restoration (Cheng et al., 2017). There are three aspects to the main mechanism of soil heavy metal pollution by phytoremediation. Firstly, by using the special ecological conditions of plant rhizosphere, the forms of heavy metals in soil can be changed so as to fix them. Secondly, the migration of heavy metals in the soil is reduced by ecological processes such as oxidation-reduction or precipitation. Third, plants have the ability to accumulate heavy metals by using contaminants and conversion contaminants. These plants are hyper accumulators. When heavy metals enter the plant body, they accumulate and increase in a certain period, forming enrichment or hyper enrichment. Through repeated planting and repeated harvest of plants, the purpose of reducing heavy metal concentration in soil was achieved. It is an easy, economical and effective method to strengthen phytoremediation by planting measures. The specific process is shown in Figure 3.

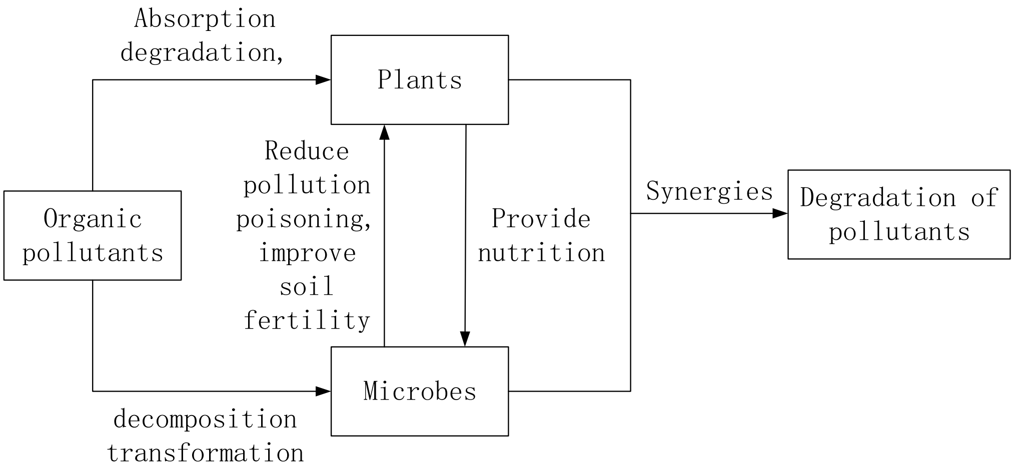

Figure 2: Sketch chart of microbial-phytoremediation system

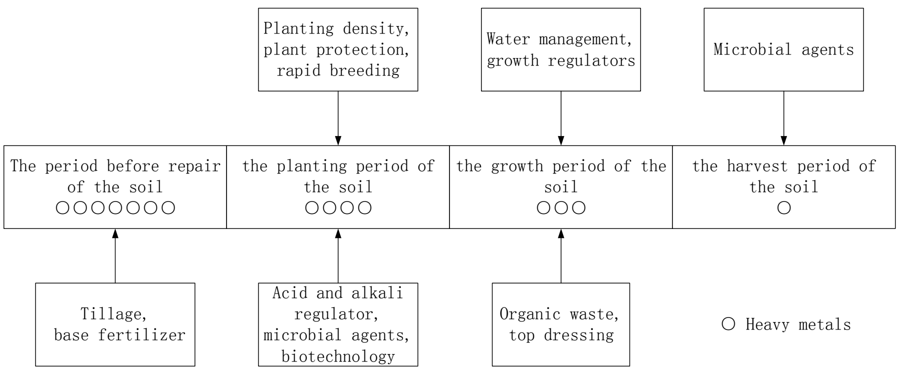

Figure 3: Application of enhancing technology for phytoremediation

3.3 Noise pollution control

Plants can reflect and absorb sound waves, and the effect of noise reduction can be achieved. Single or sparse plants have little effect on the reflection and absorption of sound waves. When plants form closed canopy communities, they can effectively reflect sound waves (Chao et al., 2017). The composition and species of plant community are different, and the structure of community is different. Therefore, the effect of noise reduction is different. The results showed that the effect of different plant community types on noise was as follows: coniferous forest, evergreen broad-leaved forest, evergreen and deciduous broad-leaved forest, deciduous broad-leaved forest, scattered bamboo, evergreen shrubs, deciduous shrubs. The noise reduction effects of common plants are shown in Table 2 and Table 3.

Table 2: Afforest the effect that forest belt either hedge abate the buzz

Forest type	Sound source to forest belt	Forest width(m)	Noise attenuation through forest	Noise attenuation through corresponding space	Net attenuation of forest
Blackberry pure forest	8	34	16	11	5
Cedar, cypress forest belt	6	18	16	6	10
Trees, Pittite Green Fence	11	4	8.5	2.5	6

Table 3: Noise reduction effect of different Qiao undergrowth

Noise reduction	Tree species
4-6dB	Papyrus, European birch, European red Swiss wood, Caucasian red maple leaf, Western elderberry, Gold and silver wood, Honeysuckle, Maple, Canadian poplar, European hazel,
6-8dB	Mao Ye Shan plum, Western clove, European beech, Larch leaves holly, Rhododendron
8-10dB	Chrysanthemum pheasant, Loquat, Larch
10-12dB	Aceraceae

4. Conclusions

The construction of garden green space in petrochemical enterprises is a new subject. It involves not only the landscape design, but also the resources, environment, ecology and other macro issues. In addition, it also involves phytoremediation and other hot research areas. Ecological concept has become the consensus of garden green design industry. The ecological concept is embodied in the design of green space in petrochemical enterprises. The application of green biomass, plant diversity and native plants is presented. According to the production characteristics of petrochemical enterprises, the ability to control and reduce the environmental pollution in factories is put forward. It is not only an important goal of petrochemical enterprises in the construction of garden green space, but also the focus of the research on the construction of garden green space in petrochemical enterprises. The pollution control is divided into three aspects: water pollution control, soil pollution control and noise pollution control. Based on the latest phytoremediation theory and related techniques, the specific methods of phytoremediation were proposed.

Reference

Albert C., Aronson J., Fürst C., Paul O., 2014, Integrating ecosystem services in landscape planning: requirements, approaches, and impacts, Landscape Ecology, 29(8), 1277-1285, DOI: 10.1007/s10980-014-0085-0

Berta M.L., Ignacio P., García-Llorentec M., Iniesta-Arandiac I., Antonio J.C., David G.A., Gómez-Baggethun E., 2017, Delineating boundaries of social-ecological systems for landscape planning: A comprehensive spatial approach, Land Use Policy, 66, 90-104, DOI: 10.1016/j.landusepol.2017.04.040

Bruce K.J., Zurlini G., Kienast F., Petrosillo I., Edwards T., Timothy G.W., Bai-lian L., Nicola Z., 2012, Informing landscape planning and design for sustaining ecosystem services from existing spatial patterns and knowledge, Landscape Ecology, 28(6), 1175-1192, DOI: 10.1007/s10980-012-9794-4

Chao J., Jun X., Xiaohu W., Fengshou D., Xingang L., Chunyan T., 2017, Effects of hexaconazole application on soil microbe's community and nitrogen transformations in paddy soils, Science of The Total Environment, 609, 655-663, DOI: 10.1016/j.scitotenv.2017.07.146

Cheng Z., Jun W., Lusheng Z., Zhongkun D., Jinhua W., Xi S., Tongtong Z., 2017, Effects of 1-octyl-3-methylimidazolium nitrate on the microbes in brown soil, Journal of Environmental Sciences, In Press, DOI: 10.1016/j.jes.2017.09.002

Chibuike G.U., Obiora S.C., 2014, Heavy Metal Polluted Soils: Effect on Plants and Bioremediation Methods, Applied and Environmental Soil Science, 708-752, DOI: 10.1155/2014/752708

Chodak M., Gołębiewski M., Morawska-Płoskonka J., Kuduk K., Niklińska M., 2012, Diversity of microorganisms from forest soils differently polluted with heavy metals, Applied Soil Ecology, 64, 7-14, DOI: 10.1016/j.apsoil.2012.11.004

Dhal B., Thatoi H.N., Das N.N., Pandey B.D., 2013, Chemical and microbial remediation of hexavalent chromium from contaminated soil and mining/metallurgical solid waste: A review, Journal of Hazardous Materials, 250, 272-291, DOI: 10.1016/j.jhazmat.2013.01.048

Enzo F., 2017, Protection of coastal areas in Italy: Where do national landscape and urban planning legislation fail? Land Use Policy, 66, 80-89, DOI: 10.1016/j.landusepol.2017.04.038

Francesc B., Erik G.B., Dagmar H., 2017, Ecosystem service bundles along the urban-rural gradient: Insights for landscape planning and management, Ecosystem Services, 24, 147-159, DOI: 10.1016/j.ecoser.2017.02.021

Mohammad R.M., Neda A., Ali A., 2016, Ecological Landscape Planning and Design Strategies for Mangrove Communities (Hara Forests) in South-Pars Special Economic Energy Zone, Environment and Natural Resources Research, 6(3), DOI: 10.5539/enrr.v6n3p44

Muhammad A., Qaiser M.K., Angela S., 2014, Endophytic bacteria: Prospects and applications for the phytoremediation of organic pollutants, Chemosphere, 117, 232-242, DOI: 10.1016/j.chemosphere.2014.06.078

Pérez-López R., Márquez-García B., Abreu M.M., Nieto J.M., Córdoba F., 2014, Erica andevalensis and Erica australis growing in the same extreme environments: phytostabilization potential of mining areas. Geoderma, 230(231), 194–203, DOI: 10.1016/j.geoderma.2014.04.004

Prapagdee B., Chanprasert M., Mongkolsuk S., 2013, Bioaugmentation with cadmium-resistant plant growth-promoting rhizobacteria to assist cadmium phytoextraction by Helianthus annuus, Chemosphere, 92, 659-666, DOI: 10.1016/j.chemosphere.2013.01.082

Sessitsch A., Kuffner M., Kidd P., Vangronsveld J., Wenzel W.W., Fallmann, K., 2013, The role of plant-associated bacteria in the mobilization and phytoextraction of trace elements in contaminated soils, Soil Biology & Biochemistry, 60, 182–194, DOI: 10.1016/j.soilbio.2013.01.012

Srivastava S., Singh N., 2014, Mitigation approach of arsenic toxicity in chickpea grown in arsenic amended soil with arsenic tolerant plant growth promoting, Acinetobacter sp. Ecol. Eng., 70, 146–153, DOI: 10.1016/j.ecoleng.2014.05.008

Testiati E., Parinet J., Massiani C., Laffont-Schwob I., Rabier J., Pfeifer H.R., 2013, Trace metal and metalloid contamination levels in soils and in two native plant species of a former industrial site: evaluation of the phytostabilization potential, Hazard Mater, 248(249), 131–141, DOI: 10.1016/j.jhazmat.2012.12.039

Tobias P., Claudia B., Nora F., Anja B., Tibor H., Patrick H., 2015, The role of cultural ecosystem services in landscape management and planning, Current Opinion in Environmental Sustainability, 14, 28-33, DOI: 10.1016/j.cosust.2015.02.006

Xiaomin Z., Baoliang C., Lizhong Z., Baoshan X., 2017, Effects and mechanisms of biochar-microbe interactions in soil improvement and pollution remediation: A review, Environmental Pollution, 227, 98-115, DOI: 10.1016/j.envpol.2017.04.032

Ying M., Mani R., Inês R., Rui S.O., 2015, Helena F., Serpentine bacteria influence metal translocation and bioconcentration of Brassica juncea and Ricinus communis grown in multi-metal polluted soils, Front Plant Sci, 5, 757, DOI: 10.3389/fpls.2014.00757