Utilization of Vetiver System for Landfill Phytoremediation and Mine Reclamation

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Abstract

Through years' engineering practice, we have accomplished or will complete a series of VS engineering projects. Two of projects have attracted the attention of experts from ecological protection, landfill management and vetiver circle.

Datanshan Landfill.
This project successfully applies the VS into restoration engineering of large-scaled landfill, providing the following technological demonstration for scholars and owners.
--Slope Stabilization Of Landfill
--Leachate Purification

Rare-Earths Mine of Pinyan.
It is the first time in our VS engineering to combine the following three aspects together in just one project.
--Erosion control
--Phytoremediation of Soil And Water
--Development of Mixed Agriculture

1.Slope Stabilization and Leachate Purification in Landfill

Datianshan landfill, with an area over 200,000m^2 hitherto the largest one in South China prior to its close, locates in Huangpu district 20km east to Guangzhou.It was built in 1985 with 65m as the designed fill depth and 2500T as the garbage disposal per day; its east, south, and north sides are banks with 19,000 m^2, 10,000 m^2, and 7000 m^2 as slope areas separately while the west is a hill.

In 1999,the landfill administration began to plant Taiwan grass on the banks. Since the plant could not tolerate the higher level of leachate from the slope, most grass died (fig.1) and landslide often happened, a great amount of leachate flowed out (fig.2). In 2000, Rivers Co. formally signed a contract with the landfill administration on strengthening the slopes, and in November that year began to work at the site. South slope was under construction from November to December in 2000 (fig.3, fig.4). East slope was accomplished between March and May in 2001.(fig.5, fig.6). While North Slope was completed between March and May in 2002(fig.7, fig.8), in which there is a steep slope on a slant over 70°. After carrying out vetiver system slope protection project, no landslide or subsidence happened on the slopes even that on a slant over 70°. In our construction, the method of combining vetiver system with slope protection net is used. After one year's practice, still no landslide appears (fig.9, fig.10).

The purification of garbage leachate by Vetiver System is very obvious. On the east side of garbage

bank, there is no leachate collecting system (fig.5). The wastewater from the bank slope would flow directly into irrigation canal.

1) Leachate purification by vetiver hedgerow on the slope.

Three months after planting vetiver grass, we took water sample from the drainage outlet of east bank and the COD level achieved 3730 mg/L. Almost no plant could grow on the swamp site, except vetiver (fig.11). Within a short period of growing, it's hard for the vetiver hedgerow to purify the leachate water. But 12months after planting, the situation has changed. At the same place, vetiver was growing very well on the slope and the swamp (fig.12). We detected the water again from the outlet and found the COD level has reduced to 487mg/L, even the concentration of original leachate was rising higher (Table 1).

Meanwhile, there were over 20 indigenous species of plants were growing rapidly, mainly on the bottom and middle of the bank. It's hard to find them on the top of the bank, due to the seepage of toxic gasses (fig.6). The landfill closed in the end of 2002, but the vetiver grass will still work continually.

Table 1

Date / Water Sample Position	Items	CODcr (mg/L)	BOD_5 (mg/L)
8,08,2001	Inlet of Leachate pond	15390	1424
8,08,2001	Drainage outlet (3months after planting)	3730	110
5,20,2002	Inlet of Leachate pond	19915	2112
5,20,2002	Drainage outlet (12months after planting)	487	24

2) The role of vetiver wetland

After 12month's restoration, we analyzed the remaining leachate flows at the bottom of the bank. The level of COD changed frequently and the normal value was about 1800 mg/L. It represents the quality of wastewater before it flow into the inlet of wetland, which cover an area of 2000 m^2 (fig.13). The figure 14 shows the three water samples from leachate pond, bottom of bank and the drainage outlet separately. The figure 15 exhibits the water from east bank drainage outlet of landfill. It looks quite clear.

To improve the wetland, further research is needed.

- The appropriate species with vetiver in a wetland
- Design of smaller and higher effective VS wetland
- The effect and the stability of vetiver bank and vetiver wetland as an integrated system to purify the changeable leachate (fig. Pdw, next page).

This project has been watched with great interest by vetiver experts at home and abroad, Mr.Richard Grimshaw, Dr.Sumet Tantivejkul, Dr. Narong Chomchalow, Professor Liyu Xu and the others have made a visitation early or late.

2. Reclamation And Development of Rare-Earths Mine

1). General Introduction

Pinyan County is located in Meizhou, the northeast of Guangdong Province, being one of poorest counties in the province. The economic lag-behind forces people in the county to make a living by resource development. In recent 10 years, the demand to rare metals keeps rising in the market. The rare earths mine has been greatly developed; leaving large-scaled of waste mine areas. To extract rare earths, the mining earth shall be soaped with acidic solutions. Thus, even through over 10 years' natural recovery, the waste mine areas rarely have vegetation (fig.16). And the ph value of earth has unbalanced distribution, ranging from 3.8 to 5.3. The local people once had planting experiment on waste mine areas. But all grasses died (P17). What is more, the wastewater from mine areas frequently ruins the land and hurt crops (fig.18, fig.19). Besides serious earth acidification, the various metals content of the waste mine soil keep at an acceptable level (mg/kg).

C_u	Z_n	C_r	N_i	Li	Pb
9.10	50.4	40.6	4.98	26.8	38.6

Hg	As	Cd
0.0023	0.283	0.051

Mining causes serious water and soil erosion in the whole county, resulting in frequent natural disasters. In May 2003, heavy rain destroyed bridges and roads, involving economic lost of 120 million Yuan (fig.20, fig.21). The environment situation made the local government understood it's an appropriate time to apply VS technology.

Rivers Co. signed contract with local government in the end of 2002 to select a piece of waste mine area of 1300 mu (100mu=6.67ha) as the first stage of project (fig.22). In March 2003, we established vetiver nursery at hill-foot and in the waste mine area to reduce engineering cost (fig.23, fig.24). We applied lime powder to relieve acidity of soil and alkaline organic fertilizer to plant vetiver, realizing successful cases in various experimental areas (fig.25, fig.26, fig.27). So far, we stared to carry out slope stabilization engineering with an area of 200,000 m^2 (fig.28). This waste mine area possess 1300 mu, among which 200mu is applied to develop roads and 1100mu to explored as agricultural fields. Since the ingredients of the waste mine area are very complicated and there is much acidic soil, 30-50cm earth from outside shall be covered on the field. Then plum tree, orange tree and other crops will be planted on it (fig.29, fig.30). In this way, the whole project manages to create economic profits. More importantly, the project compensates the lost cultivated land in the possession of airport, highway, and other municipal installations.

2) A Planning Sino-Thailand Cooperative Project—Develop Mixed Agriculture

Slope stabilization and erosion control is the special advantage of VS. That's the reason why we

always apply it to large-scaled slope protective projects. Meanwhile, the capability of VS to improve soil in microenvironment is also worth being researching. Improving soil and developing mixed agriculture simultaneously is a new topic for us. For this, we will refer to the successful experience from Thailand in the “Vetiver Grass for Environment And Other Usage” summarized by Office of The Royal Development Projects Board. It includes:

- Vetiver hedgerow to segment the land into parts and obstruct dispersement and transfer of various ingredients.
- Circle and half circle vetiver hedgerow around fruit trees to protect the trees and earth from penetration of waste mine substances.
- Vetiver hedgerow on waterway to relieve water pressure and absorb acidic water.
- Vetiver hedgerow to protect embankment of ponds
- Vetiver leaves cut to mulch.
- Vetiver artificial wetland.
- Vetiver hedgerow separate water field for purification.

The above technology will effectively improve the mine areas. The further industrializations and analysis include:

- Vetiver oil extraction (bag planting root).
- Vetiver feed.
- Vetiver leaves to build houses for relaxation.
- Vetiver leaves to build livestock plant.
- Handicrafts from vetiver leaves.
- Chemical analysis and general assessment of soil, water and plants.

We are planning to invite Thailand technicists and professors to investigate the project in Pingyan (90km from Meizhou Airport), or assign our staff to Thailand for training.

3.Dissemination Program

Today, very few of the local people are familiar with VS technology in Pinyan. The implementation of the project would be the most typical VS waste mine reclamation project and vetiver nursery in south China. As a start point of dissemination, it would also make VS widely known in eastern of Guangdong and pay a special contribution to environmental improvement and economic development. In January 2003, Rivers Co. Printed a publication (photographed, edited by the author, totally 28 pages) mainly introduces various usages of VS. Since it is greatly applicable to the actual situation of south China, it has received great appreciation of officers and customers.

The King of Thailand Vetiver Award, as a symbol of VS, encourages peoples to accomplish the most suitable project for the most suitable demands. That’s what we need.

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