Introduction to A Sewage Treatment Pilot Project with VGT in Caixin Village, Puding County, Guizhou Province, Southwest China

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June 2016

Project organizer: Agriculture Commission of Guizhou Province

Project co-organizer: Agriculture Commission of Anshun City, Guizhou Province

Project supervision unit: Agricultural Bureau of Puding Country, Guizhou Province

Project construction unit : Guangzhou Vetiver Industry Science and Technology Co. Ltd.

Project contents: 1. Integrated wastewater treatment system (60 m^3/d)

2. Sewage pipe network collection system with a total length of 3000 m

3. Total project investment: 1.5 million Yuan

Project completion date: November 2015

Project Profile

- Caixin village is located in the Shawan Development Zone, Chengguan Town, Puding County, belonging to an economic tourism development demonstration site of municipal orchards;
- The village is 6 kilometers away from the county town and 1.5 kilometers away from the drinking water source, "Yelang Lake" reservoir of Anshun City;
- The whole village has a total of 129 households, of which 400 people are permanent residents; about 20 mu of fishing pond, 1000 mu (15 mu = 1 ha) of vineyard and 5 peasant-restaurants are built nearby. This village is one place of vacationlands for country or town residents;
- Sewage treatment capacity of this project is 60 m^3/day, and “biochemical reaction integrated system of ecological three-dimensional micro-circulation” is adopted in this project;
- The project was funded by Agriculture Commission of Guizhou Province and Mayor’s Foundation of Anshun City.

Introduction of "Biochemical Reaction Integrated System of Ecological Three-dimensional Micro-circulation"

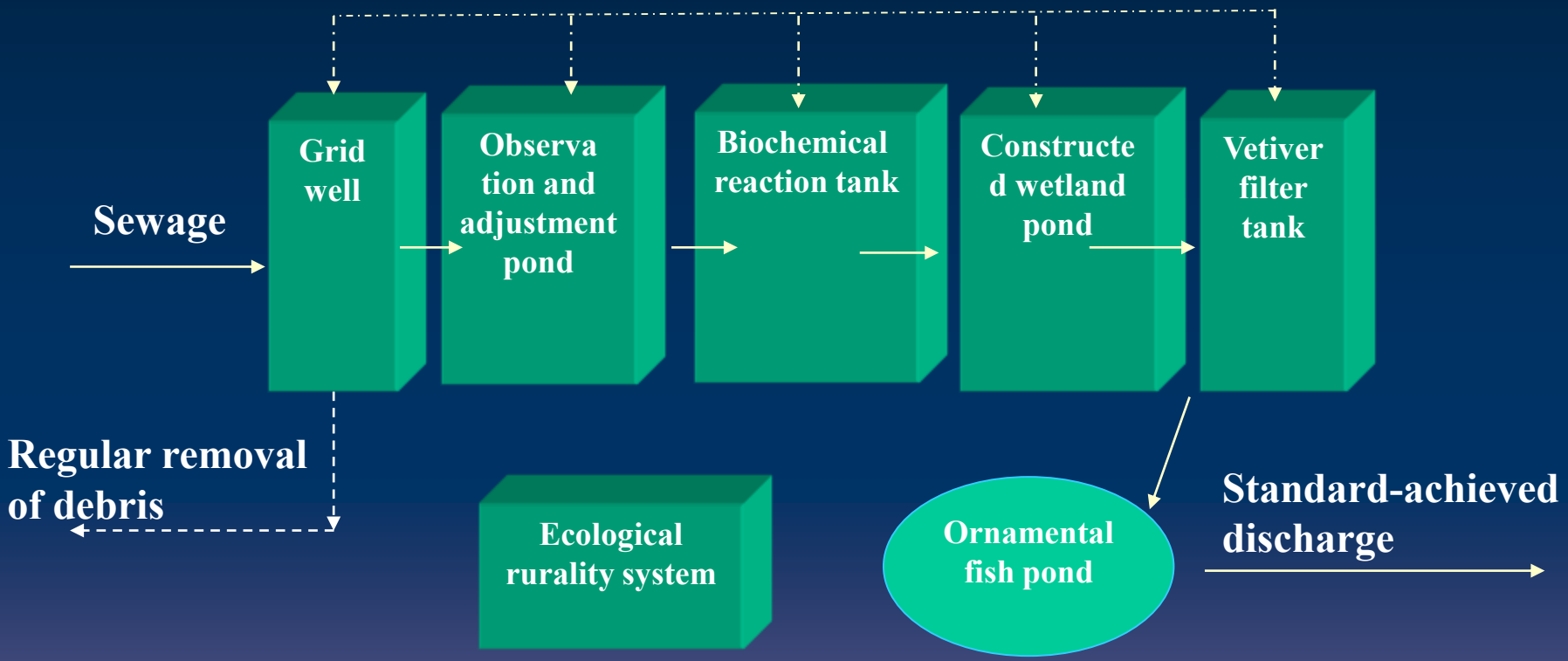
The technical scheme is composed of six major systems:

- 1. Sewage pipe network collection system；
- 2. Three-dimensional micro-circulation biochemical reaction system；
- 3. Constructed wetland system;
- 4. Vetiver filter tank system;
- 5. Ecological rurality system;
- 6. Micro power system (It can be normally operated with only 560W energy consumption);
- Among them above, the sewage pipe network collection system, the constructed wetland system and the vetiver filter tank system are the important components of sewage treatment.
- As many as 10 or more professions are involved, including water supply & drainage, civil engineering, electromechanics, microbiology, biochemistry, automatic control, artificial wetland, vetiver technology, new energy, ecology, landscape, flora & fauna, environmental protection and other professional disciplines.

Characteristics of "Biochemical Reaction Integrated System of Ecological Three-dimensional Micro-circulation"

- 1. Specialization and strong technology: a collection of multiple techniques and combination of eco-design concepts, to achieve discharge standards for sewage treatment;
- 2. Buried and open design: facilities and control system can be buried underground, to achieve the re-use and development of land;
- 3. Low energy consumption and less maintenance: daily energy consumption of electricity is only 6-8 kwh. After adopting wind and solar power, the running cost is only 0.02-0.05 Yuan/m^3;
- 4. High efficiency and long use period: high volume load and flexible operation, with use period up to 25 years;
- 5. Strong decontamination and wide range: more than 98% of the contaminants can be processed, more effective to degrade organic macromolecules of animal and plant oils;
- 6. No smell and no noise: NH_4-N, CH_4 and H_2S can be eliminated during system operation. The reactor motor can be run in water without noise;
- 7. Ecological and environmental friendship: a combination of a variety of plants and recycling use of wastes with multiple ecological and environmental effects;
- 8. Integration of rurality and landscape: irregular structure of gardens and landscape ponds form a harmonious rural scenery.

Flow Chart of "Biochemical Reaction Integrated System of Ecological Three-dimensional Micro-circulation"



Characteristics of “Biochemical Reaction System”

- 1. Small coverage: segregate large material only, no need of sludge returning tank. High volume load, and fully automatic operation;
- 2. Short time of sewage biochemical reaction: about 12-16 hours only. Primary biochemical metabolites are CH_4, CO_2, H_2 and H_2S, and the cleanout cycle of anaerobic sludge is 2-3 years;
- 3. Low cost: when the system is activated and after debugging is finished, energy consumption of per ton sewage treatment is between 0.10-0.16 kwh. When the conditions meet the requirements of wind and illumination, the system can achieve off-grid power supply operation and automatic control, without professionals on duty;
- 4. Strong decontamination: in the case of normal operation, sewage treatment can achieve the National Urban Sewage Comprehensive Discharge Standard G18918-2002 (first class A standard);
- 5. Processing ranges: CODcr 2000 mg/L, SS 50 mg/L, BOD_5 1000 mg/L, $NH4^+$-N 30 mg/L, TP 8 mg/L, TN 100 mg/L, LAS 10 mg/L, and organic animal and plant oil 5 mg/L.

Functions of "Constructed Wetland Pond"

- 1. Via the secondary treatment of effluent from biochemical reaction effluent tank, it guarantees to implement double assurance on effluent quality;
- 2. With a reasonable collocation of various aquatic plants, to achieve a natural combination of ecology and landscape.

Functions of "Vetiver Filter Tank"

- 1. Via the third treatment of effluent from constructed wetland pond (including excessive N and P coming from the death of aquatic organisms), to implement treble assurance on effluent quality
- 2. Using the latest research product about vetiver cultivar-"Huaxiang NO.1", with not only well-developed root system and strong adsorption capacity, but also evergreen and simple maintenance only;
- 3. Vetiver has a powerful and huge root system, which can decrease NH_4-N, COD, BOD and grease in wastewater by 97.1%, 71.5%, 73.7% and 89.8%, respectively.

Comparison with Traditional Scheme

- 1. Biochemical conversion reaction is mainly anaerobic, and it transforms organic contaminants into energy and gas (CO_2, CH_4, H_2S and H_2) after reactor processing. N, P and S ions are discharged after vetiver and aquatic plant adsorption. Therefore, no sludge is produced and no need for sludge cleanout and stack processing equipment;
- 2. The metabolites of organic contaminants after anaerobic reaction are CH_4, CO_2, H_2 and a little H_2S, therefore, no smelly odor is produced;
- 3. The entire system use only 560 W of special non-standard electrical equipment to operate, daily electricity consumption is 5-8 kwh. And then adopting the wind and solar complementary power supply, the actual electricity consumption to operate is an average of 2 kwh per day, and the annual operating cost is only 800 Yuan;
- 4. Maintenance of the entire system requires only one time of trim to dead plants in winter. Therefore, the annual maintenance cost can be controlled less than 2,000 Yuan, which is only 1/5-1/10 of traditional schemes;
- 5. Small coverage of biochemical reaction tank (about 50-150 m^2), which can be buried underground. Vetiver filter tank and wetland plants can take advantage of various ponds and rivers. Therefore, the design is not restricted, and land resources are saved.

PROJECT EXECUTING PROCESSES
—— The original apperance of construction site

Construction measurement by technicians

Biochemical reaction tank construction

The built biochemical reaction tank

Constructed wetland pond construction

Vetiver filter tank construction

General layout of construction site

Sewage effluent pipe installation

The installed sewage pipes

Breeding vetiver seedlings in advance

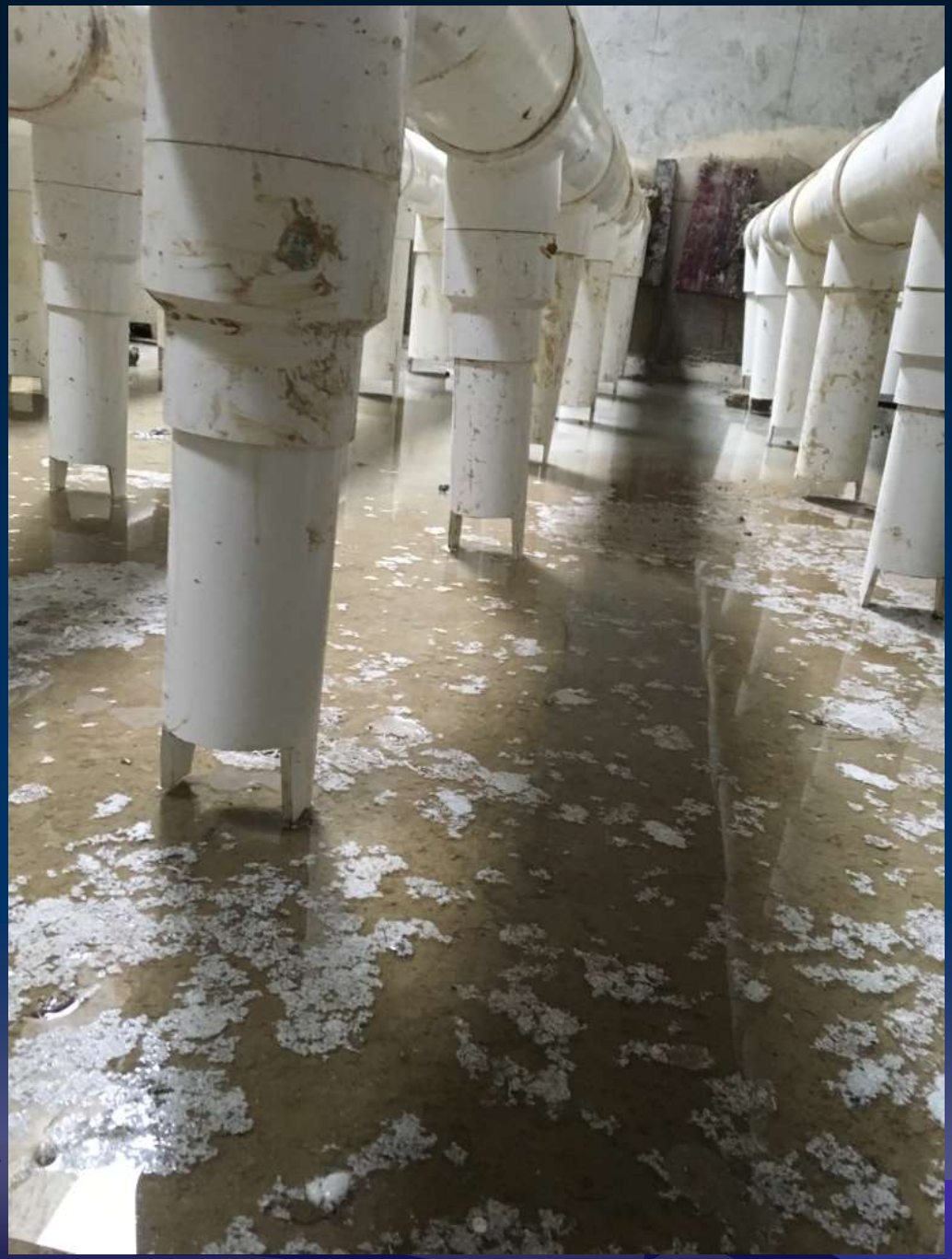
Vetiver seedlings transplanted to floating island

Grill of biochemical reaction tank installation

Equipment-1 of biochemical reaction tank installation

Equipment-2 of biochemical reaction tank installation

Biochemical reactor installation



Wind and solar power supply system installation

Photovoltaic system (solar panel) installation

Automatic control system

Microorganism strains and the reaction substrates activation

Microorganisms and the reaction substrates put into the observation pond, to conduct debugging

The main system after completing construction

One part of the panorama after project completion

The other part of the panorama after project completion

Biochemical reaction system buried underground

Combined artificial wetland system

Floated vetiver filtering system

Water body view after construction completion

Landscape after construction completion

Sewage inlet—observation pond

Sewage containing animal and plant oils

A test of oxygen reaction process in the Biochemical reaction pool

Water condition in biochemical reaction tank in the process of debugging: quite transparent, and suspended solids removed basically

Vetiver filter tank discharge treated wastewater

LEADERSHIP INSPECTIONS

——Kunyuan Liu, Vice-governor of Guizhou Province was on site inspection (5 March 2016)

Jiapei Huang, Vice-governor of Guizhou Province was leading the inspection (8 March 2016)

Xiaoqi Jin, director of Forestry Bureau of Guizhou Province was listening to the introduction of the project (8 March 2016)

Yuan Xiong, deputy mayor of Anshun City was on site inspection (construction stage, September 2015)

Yuan Xiong, deputy mayor of Anshun City was on site inspection again (25 March 2016)

Shangbin Gao, director of Station of Ecological Resource and Environmental Protection, Ministry of Agriculture on site inspection (11 May 2016)

Zhihong Zhang, Director of Department of Ecology and Energy, Guizhou Provincial Agricultural Commission was on site inspection (24 March 2016)

Erxun Pan, deputy director of Resource and Environmental Protection Station, Guizhou Provincial Agricultural Commission was on site inspection (4 January 2016)

Yuqi Zhao, an official of Housing and Building Department of Guizhou Province was on site inspection (8 December 2015)

A group of ecological and environmental protection experts from Guizhou Provincial Agriculture Commission were listening to the site report (18 March 2016)

Xing Liu, deputy director of Agriculture Commission of Anshun City (second from left) and Hong Yang, deputy magistrate of Puding Country (second from right) were on site inspection (25 March 2016)

Representatives of Guizhou Province Economic Conference were visiting the site (15 January 2016)

A delegation of Hebei Province was on site visit (21 January 2016)

Hai Lu, director of Station of Resource and Environmental Protection of Guiyang City, was leading to visit the site (8 June 2016)

Yuehua Zheng, deputy chief engineer of Water Conservancy and Electric Power Design Institute of Guangdong Province was on site visit (9 December 2015)

Dr. Chun Zhu, Party Secretary of Guangzhou Landscape Construction Company and Yongzhong Lu, general manager of the Company were on site inspection (2 April 2016)

Need to Be Perfected

- Parts of techniques of the project is the first application of miniature sewage treatment at home and abroad. So, in order to facilitate the dissemination of the technique, portions of surface structure are chosen in design. In the future, complete buried construction can be applied;
- Since the project was the first combined application of multidisciplinary and interdisciplinary, considerable many flaws still existed. The design and construction will be more delicate and completed in future；
- Specific data and indexes on wastewater treatment, will be provided after monitoring and debugging completion;
- The first sample self-test was conducted on April 15, 2016, fully meeting the national first level A standard.

1st sampling test on 14 April 2016
Achieved the National First Class Standard

No.	Testing items \ Testing sections and No.	Entrance FS16041501	Exit FS16041502	Unit	National Urban Sewage Comprehensive Discharge Standard (G18918-2002) First Class Standard	Achieved or excessive situation
1	pH	6. 45	7. 02	—	6—9	Achieved
2	Dissolved oxygen	0. 28	3. 6	mg/L	—	—
3	BOD-5	30. 2	9. 7	mg/L	10	Achieved
4	COD	56	23	mg/L	50	Achieved
5	NH_3-N	4. 463	2. 674	mg/L	5	Achieved
6	Total P	0. 97	0. 42	mg/L	0. 5	Achieved
7	Total N	7. 24	1. 75	mg/L	15	Achieved
8	Oils	1.54	0. 47	mg/L	1	Achieved
9	Anionic surfactants	0. 76	0. 08	mg/L	0. 5	Achieved
10	Fecal coliform	2400	700	numbers/L	1000	Achieved
11	Suspended Matters	33	5	mg/L	10	Achieved

Note: The results were expressed as testing limits plus "L“ when the resluts were lower than the testing limits.

2nd sampling test on 15 September 2016
Achieved the National First Class Standard

No.	Testing items \ Testing sections and No.	Entrance FS16041501	Exit FS16041502	unit	National Urban Sewage Comprehensive Discharge Standard (G18918-2002) First Class Standard	Achieved or excessive situation
1	pH	7.98	8.01	—	6—9	Achieved
2	Dissolved oxygen	8.02	7.46	mg/L	—	—
3	BOD-5	28	3.5	mg/L	10	Achieved
4	COD	40	5	mg/L	50	Achieved
5	NH_3-N	32.761	0.207	mg/L	5	Achieved
6	Total P	1.47	0.01	mg/L	0.5	Achieved
7	Total N	19.83	0.69	mg/L	15	Achieved
8	Oils	1.03	0.58	mg/L	1	Achieved
9	Anionic surfactants	0.4	0.1	mg/L	0.5	Achieved
10	Fecal coliform	1400	340	numbers/L	1000	Achieved
11	Suspended matters	37	8	mg/L	10	Achieved

Note: The results were expressed as testing limits plus "L“ when the results were lower than the testing limits.

Technical Group of Guangzhou Vetiver Grass Industry Science and Technology Co. Ltd.

- Overall project designer: Ziyuan Feng (senior engineer)
- Project chief engineer: Bo Huang (senior engineer)
- Designer of biochemical system: Kun Tian (senior engineer)
- Designer of vetiver technique: Ziyuan Feng (international expert on Vetiver)
- Designer of constructed wetland: Ruigui Zhang (landscape engineer)
- Project manager： Yunsheng Yang (senior engineer)
- Project construction： Youkun Ma (civil engineer)
- Technical advisor: Hanping Xia (research professor of South China Botanical Garden, Chinese Academy of Sciences, and internationally celebrated expert on Vetiver)

June 2016

Thank you
for your attention!