SWWS & ROS 2018

Small bioreactor system for the treatment of rural sewage driven by wind-solar hybrid power

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Outline

1. Background
2. Purpose & Significance
3. Research Content
4. Conclusion

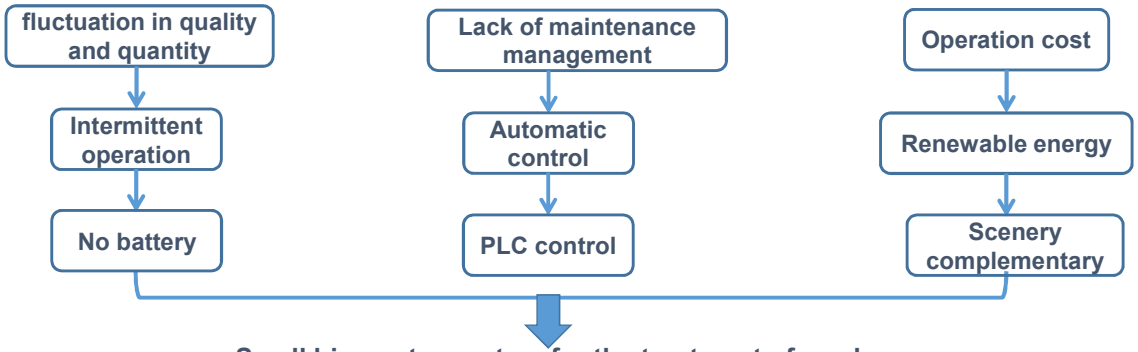
Background

Three Major Questions?

- Unstable wastewater quality and quantity in rural areas (day and night).
- Lack of professionals for the maintenance and management of sewage treatment facilities in rural areas.
- Operational cost for rural sewage treatment equipment cannot be guaranteed.

In China, the sewage treatment rate in rural areas only reached 22% until 2016.

Background



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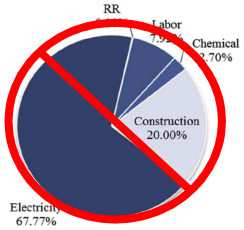


Purpose & Significance

Purpose

- Based on the rural sewage treatment system with low cost of operation and maintenance is established through automatic control system by utilizing the battery-free wind-solar complementary power generation method.

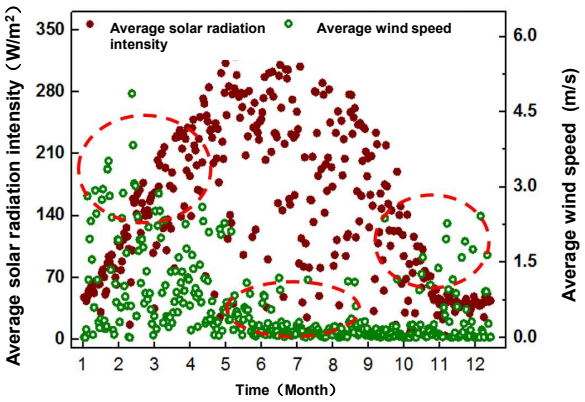
Significance

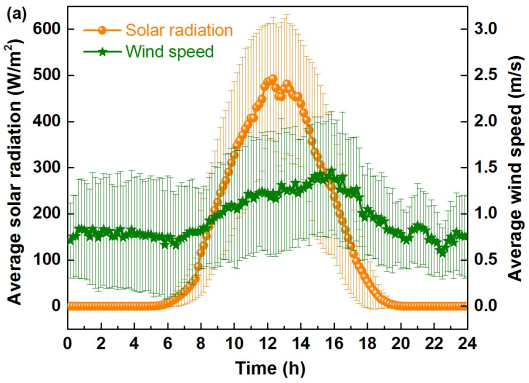
- It provides theoretical and technical support for developing environment-friendly sewage treatment model and new ideas for decentralized sewage treatment.

Research Content

1. Characteristics of solar and wind energy of the study sites.
2. Wind-solar hybrid power generation and PLC construction without battery
3. The efficiency of the multi-influent biological contact oxidation process for the sewage treatment.

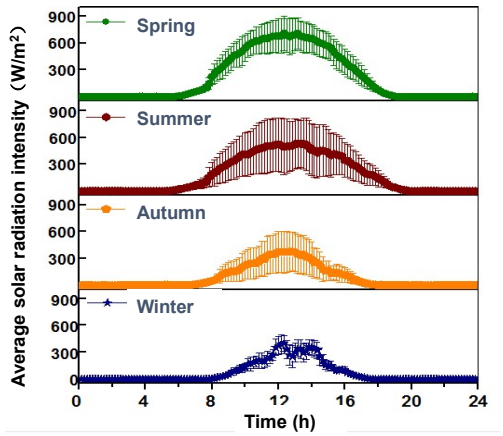
1. Characteristics of solar and wind energy of the study sites

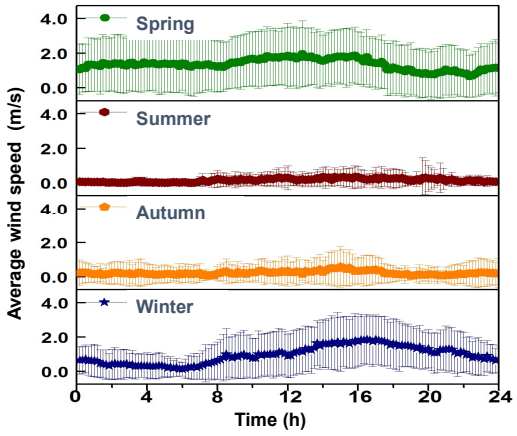




- The average daily solar radiation intensity and wind speed have a good complementarity in the study sites of Beijing in 2016.
- The onsite seasonal climate characteristics efficiently provide the energy consumption in the experimental area.

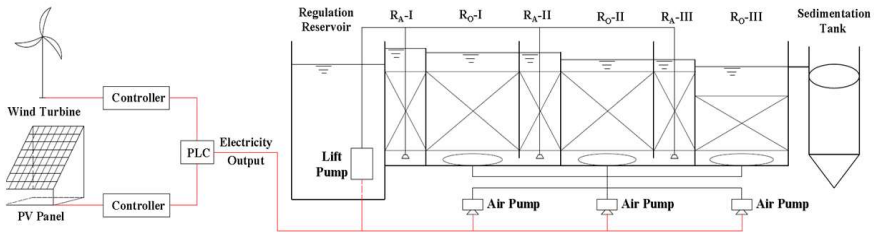
1. Characteristics of solar and wind energy of the study sites





- Solar energy is abundant and can guarantee 9 hours of sunshine even in winter.
- Wind resources will appear randomly in each season, with strong winds in spring and winter.

2. Wind-solar power generation and PLC construction without battery



Parameter	COD_{cr}	NH_4-N	TN	TP	pH
Range of values (mg/L)	77-1062	16-93	22.5-130	3.5-127.7	6.1-7.6
Average value ± S.D.	352.3 ± 239.2	35.4 ± 13.4	43.4 ± 20.3	25.9 ± 16.9	7.2 ± 0.9

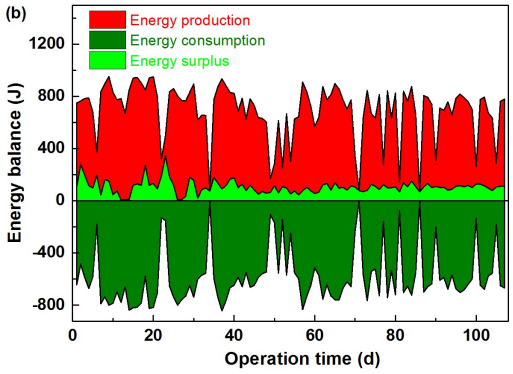
Parameter

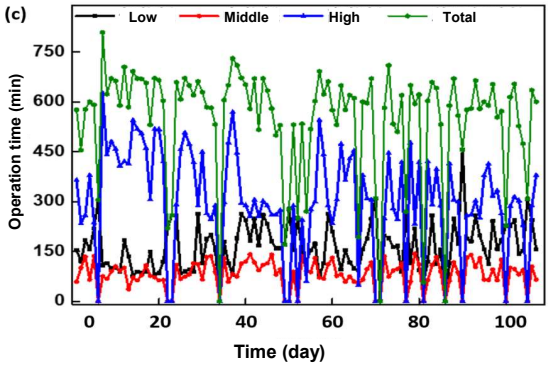
Model	Power (W)	Flux (mL/min)	HRT (hrs)	Voltage variation (V)
Low	45	45	14	15~20
Middle	85	53	12	20~24
High	105	63	10	24~29

Main Parameters

- Three stage A/O, total efficient volume of 39 L;
- V-I, V-II, V-III are 14, 14, and 11 L;
- V_A-I: V_O-I, V_A-II: V_O-II, V_A-III: V_O-III are 1:3, 1:3, and 1:2.75;
- Influent ratio: V-I: V-II: V-III=5:3:2
- Temperature : 8-29 ℃
- DO in anaerobic and aerobic area are about 0.2 mg/L and 4.0 mg/L;

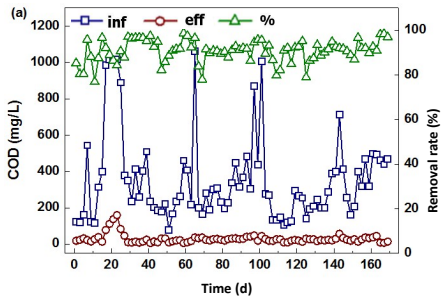
2. Wind-solar power generation and PLC construction without battery

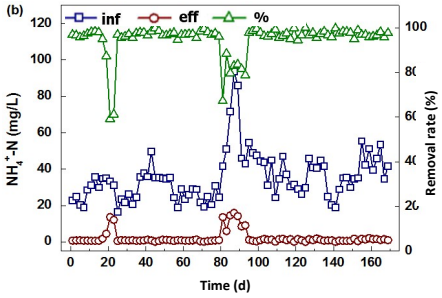


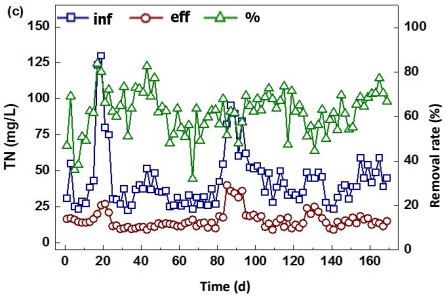


- **Without a few days of extreme weather, the energy production is always bigger than the energy consumption of the wind-solar hybrid power, which clearly revealed the energy supply was enough.**
- **Further, the energy utilization rate of wind-solar hybrid power keep at about 80% during more than 100 days stable operation.**

3. Efficiency of the multi-influent biological contact oxidation process

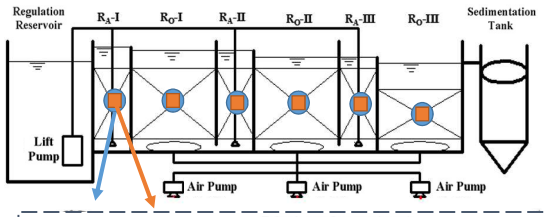


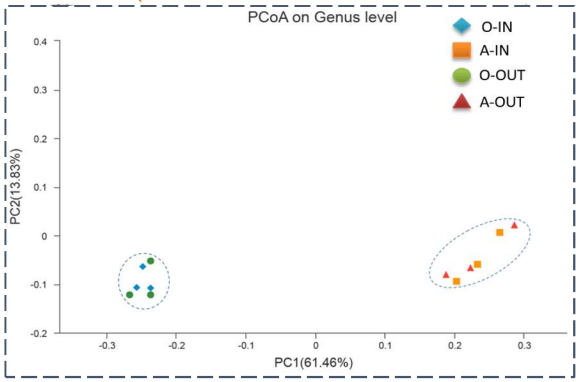


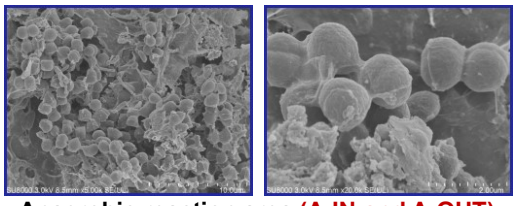


- More than 160 days stable operation, the removal rate of COD, NH_4^+-N and TN could reach 90.6%, 94.7% and 61.7%, and the effluent concentrations are 29.1 mg/L, 2.2 mg/L and 15.7 mg/L.
- The outlier and bad point might be caused by the extreme weather.

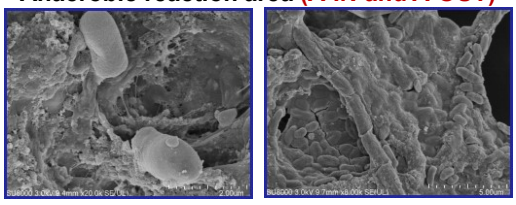
3. Efficiency of the multi-influent biological contact oxidation process







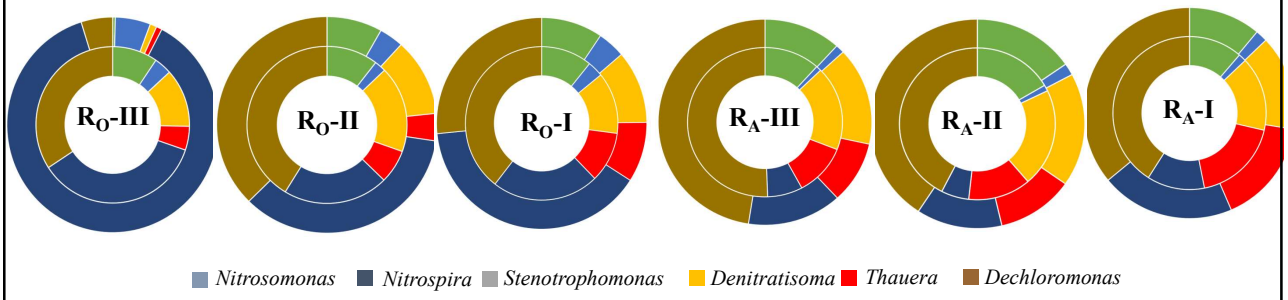
Anaerobic reaction area (A-IN and A-OUT)



Aerobic reaction area (O-IN and O-OUT)

- The anaerobic/aerobic situation decide the similarity of the genus level during different samples

3. Efficiency of the multi-influent biological contact oxidation process



- During the aerobic reaction area, the abundance of nitrifying bacteria inside of the fillers was obviously lower than that of inside the, while the abundance of denitrifying bacteria inside of fillers was higher than that of outside.
- During the anaerobic reaction area, the abundance of nitrifying bacteria was lower both inside and outside of fillers, while the abundance of denitrifying bacteria was significantly higher than that outside the packing ball.

Conclusions

- The average daily solar radiation intensity and wind speed have a good complementarity, where the onsite seasonal climate feature could also provide enough wind-solar hybrid power for the energy consumption during the experimental area.
- The PLC system was stable during the last 100 days stable operation, where the energy utilization rate of wind-solar hybrid keep at a level of 80%.
- During the stable operation of more than 160 days, the removal efficiencies of the COD, NH_4^+-N, and TN are as high as 90.6%, 94.7% and 61.7% respectively when the corresponding effluent concentrations are 29.1, 2.2 and 15.7 mg/L.

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Thanks for your kind attention

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