



9th International Conference on Applied Energy, ICAE2017, 21-24 August 2017, Cardiff, UK

Analysis of Typical Energy Saving Technology in the Sewage Treatment Plant

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Abstract

There are a large amount of low-grade waste thermal energy in the sewage and abundant organic substances in the sludge. By making full use of the energy in these resources, which can complement or offset the energy consumed in the sewage treatment process, the sewage treatment plants can significantly reduce the amount of carbon dioxide indirect emissions. The goal of “carbon neutrality” in the sewage treatment plant can be achieved. The sewage source heat pump using sewage thermal energy can supply cooling and heating in the buildings; The sludge anaerobic digestion process can produce a lot of biogas for generating electricity; The photovoltaic power generation modules can compensate the heat and the electric consumption of the sewage treatment plant. Comparing and analyzing the differences of three technologies in aspects of energy saving, economic feasibility and carbon neutral, the research result shows that the best treatment method is the SSHP technology, which have energy saving potential by using low-grade waste thermal energy and is contributed to achieve “carbon neutrality” of the sewage treatment plant.

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Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.

Keywords: Sewage treatment plant, Low grade heat source, Sewage source heat pump, Heating, Carbon neutral;

1. Introduction

Urban sewage treatment plant is to be characterized by high energy consumption, sewage treatment need to consume large amounts of energy, reagent, and other resources. The unit energy consumption of sewage treatment in China is still equivalent to energy consumption in the developed countries in the 1990s or even earlier. China's recent sewage treatment in annual power consumption is about $100 \times 10^8 \text{ kW} \cdot \text{h}$. The average energy consumption of water processing is about $0.29 \text{ kW} \cdot \text{h} / \text{m}^3$ in the sewage treatment plant. However, the United States of the sewage treatment

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plant in 1999s the average power consumption is $0.20 \text{ kW}\cdot\text{h} / \text{m}^3$ ^[1]. In the context of increasing popularization rate and processing degree of sewage treatment, high energy consumption of sewage treatment methods not only improve the operating costs of sewage treatment plants, while indirectly increasing the greenhouse gas emissions of carbon dioxide. Thus reducing the sewage treatment plant carbon emissions has important significance.

Sustainable sewage treatment technology concept originated in the 1990s, the early 21st century Europe and America, researchers proposed that 2030 urban sewage treatment plants need to achieve "carbon neutral" operational objectives^[2]. Urban sewage treatment plant is not only the carrier of sewage treatment process, but also sewage heat, sludge resources enrichment area. The urban sewage treatment plant makes full use of the SSHP technology, SADT and the PPG, to offset the energy consumed by the sewage treatment, is an effective way to realize the "carbon neutral" operation of the sewage treatment plant. In this paper, the three typical energy-saving technologies of sewage treatment plants are compared and analyzed. These three energy-saving technologies in the energy-saving, economic and "carbon neutral" and other aspects of the difference was compared.

Nomenclature

Q_g	the SSHP system heating load, kW;
ε	the SSHP system heating efficiency ratio (COP), this paper takes 3.5;
Q_w	the heat load from the sewage, kW;
F	the heating area of the sewage source heat pump system, m^2 ;
q	the building heat load index, this paper takes $40 \text{ W} / \text{m}^2$.
E_{hp}	the SSHP system power consumption equivalent to primary energy (converted to standard coal), t;
η_1	the power network efficiency, take 0.92;
η_2	the power plant efficiency, take 0.33;
τ	the design of heating load under the full load of heating time, h.
E_b	the coal-fired boiler heat output (converted to standard coal), t;
η_3	the coal-fired boiler heating efficiency, take 0.65;
η_4	the heating efficiency of heating network, take 0.80.
ΔE_2	the primary energy consumption difference (converted to standard coal), t.

2. Typical energy saving technology in the sewage treatment plant

Sewage contains a large number of low-grade thermal energy resources, the use of SSHP technology can recycle this part of low-grade heat. Sewage treatment plants in the treatment of sewage will produce a lot of sludge at the same time, it can produce biogas after thermophilic anaerobic digestion. If the biogas used for electricity generation, can provide electricity for sewage treatment plant. Because the sewage treatment plants usually have a large area, these space resources can be used to install photovoltaic power generation components, to achieve photovoltaic power generation for the plant to provide electricity. Fig.1 indicated the energy use model of sewage treatment plant.

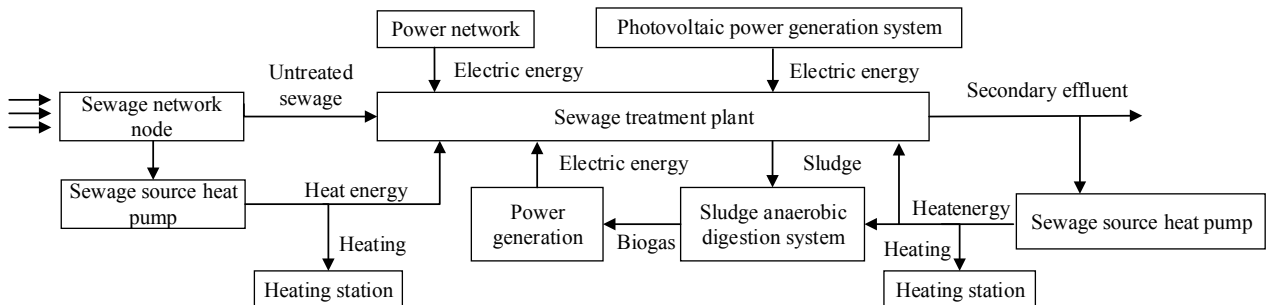


Fig.1. Energy use model of sewage treatment plant

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