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基于地下水源热泵的寒区沼气工程加热模式的探讨

Heating mode of biogas plant in alpine region based on underground water source heat pump

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中文摘要:

合理选择节能环保型沼气发酵料液加热增温的模式和设备，是北方高寒地区发展大中型沼气工程必须解决的问题。该文提出了利用地下水源热泵对沼气发酵系统进行热的模式，通过沼气工程应用实例与现场测试，验证了地下水源热泵加热系统对保持沼气中温发酵系统稳定运行的作用；获得了热泵机组的平均能效比为4.39，加热系统均能效比为2.71；热泵机组一次能源利用系数为1.27，高于燃煤锅炉直接供热方式近1倍。同时通过对加热系统在2010-09-29—2011-02-25供热期内的实时跟踪监测，获得其的实际能耗为4.79×108 kJ，与燃煤锅炉直接供热方式相比，可节约标准煤10.8 t，节约标准煤44 %，减少二氧化碳排放量25.9 t。结果证明地下水源热泵加热系统应用于沼工程中是可行的，具有高效节能，运行稳定可靠，环境效益显著等优点，可为热泵技术在寒区沼气工程中的应用提供参考。

英文摘要:

Temperature is one of the key factors affecting anaerobic fermentation。In the alpine region of China，due to the cold weather in winter, it is necessary to strictly control the temperature of the anaerobic fermentation, taking appropriate heating and insulation measures to ensure that biogas plants are perennial and stable and that they maintain a const and efficient rate of gas production. However, it requires energy consumption and associated environmental pollution to heat the anaerobic fermentation liquid. An energy saving equipment with better heating mode was needed to solve that problem in the alpine region. Due to the energy-saving and environmental-protection characteristics of heat pump technology, this research used a groundwater source heat pump to heat the anaerobic fermentation system. It used the heat source method, the anaerobic fermentation liquid temperature within the reactor, ambient temperature, water temperature difference and flow between supply and return water heating pipelines, as well as measurements of various electricity consumption parameters, to test the running performance and the effect of groundwater source heat pump system. The experimental site was in Jixi City, Heilongjiang Province, and the biogas plant handled 20 t a day of manure. The test from January 1, 2010 to January 1, 2012 showed that fermentation liquid temperature in the reactor can be maintained between 33 ~ 35℃, even in the coldest weather. It validated that a groundwater source heat pump system cloud maintained the stable operation of an anaerobic fermentation system. The average energy efficiency ratio (EER) of the heat pump unit was 4.39, its primary energy ratio (PER) was 1.27, and the average energy efficiency of the he system was 2.71 by calculating the heat pump unit energy consumption, almost doubled compared to the direct coal-fired boiler heating mode. Meanwhile, through the real-time tracking and monitoring of the heating system from September 29, 2010 to February 25, 2011, the actual energy consumption of the system was 4.79 × 108 kJ, primary energy 44% Total savings in standard coal consumption was 10.8 t, and carbon dioxide emissions were reduced 25.9 t compared with the direct heating method using coal-fired boilers. The re indicated that the heating system with groundwater source heat pump was feasible as a heating mode for the biogas plants, and it had many advantages, such as high effectivene and energy savings, stable working ability, and reduced CO2 emissions.

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