

Design and Calculation of Sewage Heat Exchanger Based on SCILAB

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Abstract

The sewage source heat pump system has undergone considerable development for several years. At present, because of the bad water quality of sewage, it isn't allowed to enter directly into the heat pump unit. Instead the sewage is first passed through intermediary water which absorbs the sewage heat. Then the heat in the intermediary water was transferred to heat pump unit. Because the heat transfer performance and flow parameters of sewage and that of clear water are very different when compared, the past design parameters can not be applied in the design of sewage source heat pump, and so the design departments are faced with a lot of new problems. As far as we know, many designers have a lack of understanding of the specificity of heat transfer between the sewage and clear water. They still employ the methods and design parameters for clear water to design the sewage system, which is a very dangerous engineering practice.

What are the characteristics of sewage heat exchanger? (1) Because of the high sewage viscosity and serious heat exchanger surface pollution, the resistance of sewage is higher than that of clear water, and the heat transfer coefficient of sewage is smaller than that of clear water. (2) Due to the risk of blockage and pollution, it is impossible to adopt bellows inner fins used for enhancing the heat exchange of the sewage as the clear water does. (3) The sewage heat exchanger can only transfer heat by a small difference in temperature under limited condition. For example, in north China, it is very cold in winter, and the temperature in the channel is less than 10°C. With the limit of evaporation temperature control of the heat pump unit, the intermediary water temperature cannot be too low. As a result, the biggest sewage temperature drop can only be 3-4°C, and difference in temperature between any two heat exchangers can be lower than 3°C. (4) By virtue of the small difference in temperature and low coefficient of heat transfer the flow required for

cooling sewage temperature will take longer, usually about 30 meters, A new design such as tube regulation arrangement and shell space structural design for internal structure are needed for the shell and tube heat exchanger. Thus, making sure the current of the heat exchanger is countercurrent in the entire journey, and each place in the heat exchanger has an ideal heat transfer temperature difference.

According to experimental research and engineering practice in recent years on flow resistance and the characteristics of sewage heat exchanger, these three key targets namely: material consumption, volume and pump consumption have to do not only with the structural parameters such as diameter, tube length, tube pitch and the number of tube passes, but also the operational parameters such as flow velocity, flux, pressure drop, inlet and outlet temperature, circulation and heat outputs. These essential parameters of sewage heat exchanger (SHE) are divided into three kinds such as fixed parameters, computed values, parameters to be determined which is calculated using SCILAB. However, the structure of the shell side with the back plate is very complex, and it is difficult to calculate the exact results using simple formulas. Especially for the sewage heat exchanger which needs more vertical or horizontal back plates added to the shell side. Considering that, the shell side heat exchanger is thought of as external to the pipe with heat exchange flowing outside the pipe. From experience, this conversion coefficient is selected as 0.7 and the minimum flow speed on the shell side makes up 33.3% of the speed of that in tube side, after some approximation. Finally, the design method of the sewage heat exchanger is introduced with an engineering example. When the sewage flux in the channel is approximately equal to $4000\text{m}^3/\text{h}$, the required heating outputs Q is 20MW, and the sewage temperature in the channel is 12°C . We can obtain different operating conditions design parameters using SCILAB program. Moreover, the structural design of the sewage heat exchanger is established. In conclusion, to ensure ideal temperature difference within the whole the heat exchanger and counter-current from structural design perspective, there are two ways to achieve. One is adding vertical partitions into the shell space, and the other one is to have multiple heat exchangers in parallel.

Key words: sewage source heat pump; sewage heat exchanger; SCILAB