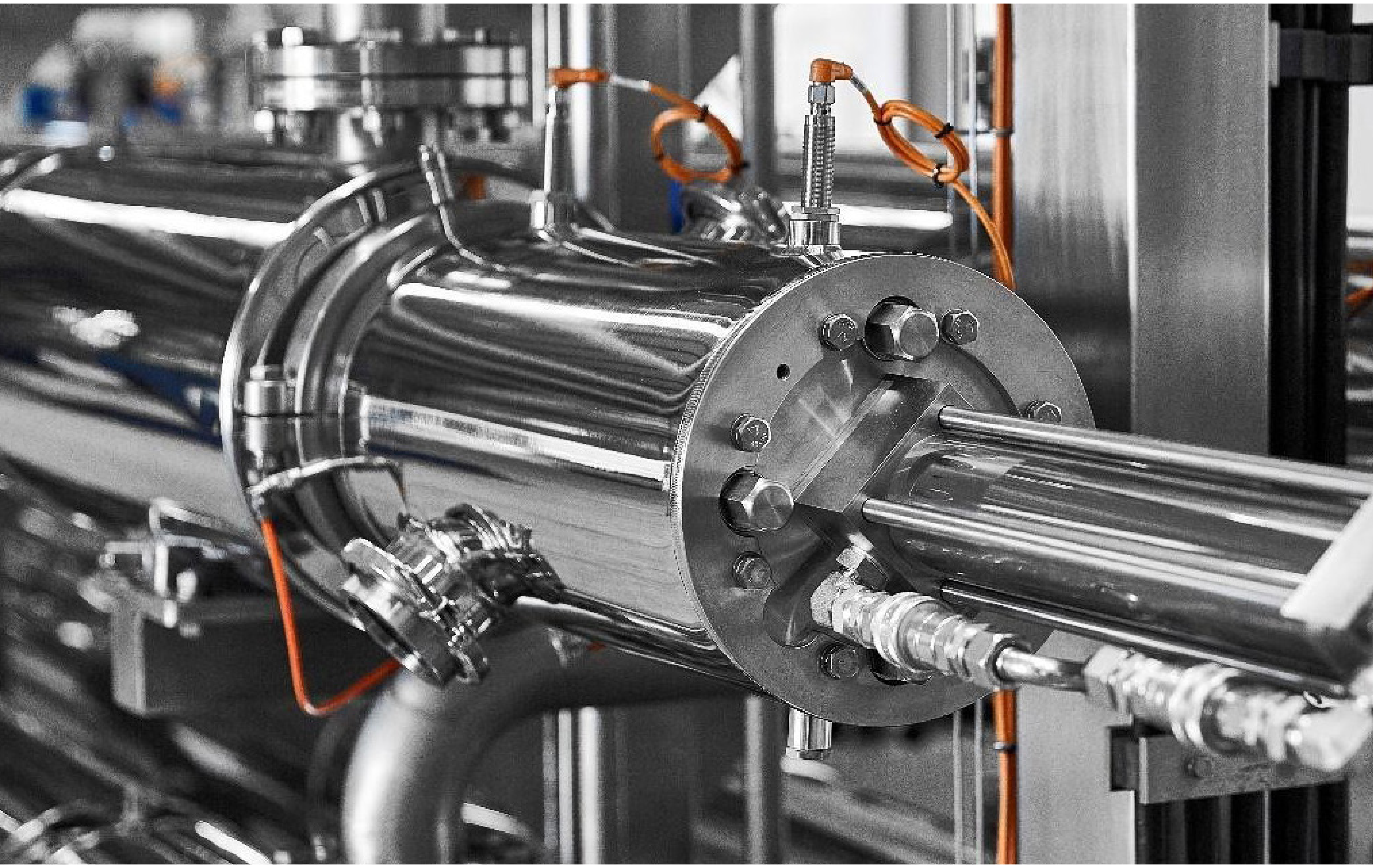
CHOOSING THE RIGHT HEAT EXCHAN



The world faces unprecedented challenges in terms of water security. These include population growth, increasing urbanisation, a decline in traditional sources of freshwater, and water scarcity driven by climate change. It is important to remember that for every litre of freshwater put into the public system, there is an extra litre of wastewater which needs treating.

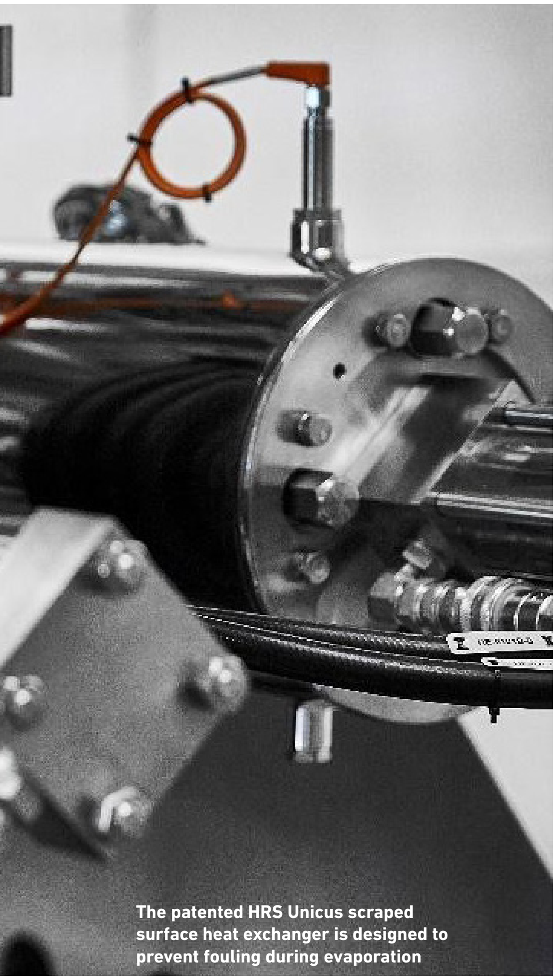
There are a number of applications for heat exchangers in wastewater treatment. They can be used to recover heat from raw or treated sewage, to preheat sludge prior to anaerobic digestion, or to remove water from wastes and sludges through evaporation. Pasteurisation of waste streams may be required to meet environmental rules, or water or effluent may need cooling before it is discharged to the environment in order to meet local legislation. Each process will place different demands on the heat exchanger being used, and some processes may be combined (e.g., recovering heat from treated sludge and using it to pre-heat untreated sludge before digestion).

The basic practical considerations when choosing a heat exchanger for wastewater treatment are the same as for any other application and include factors such as the physical space available, the available temperature of the product and process materials and the required temperatures after processing, acceptable pressure drop, and the service materials being employed. However, there are also other considerations which while not unique, are particularly relevant to wastewater and sludges. These include the physical nature of the material and the potential for fouling in the heat exchanger, ease of maintenance and the ability to operate reliably for long periods of time. Finally, general considerations include energy efficiency, capital and operating costs, which are also crucial

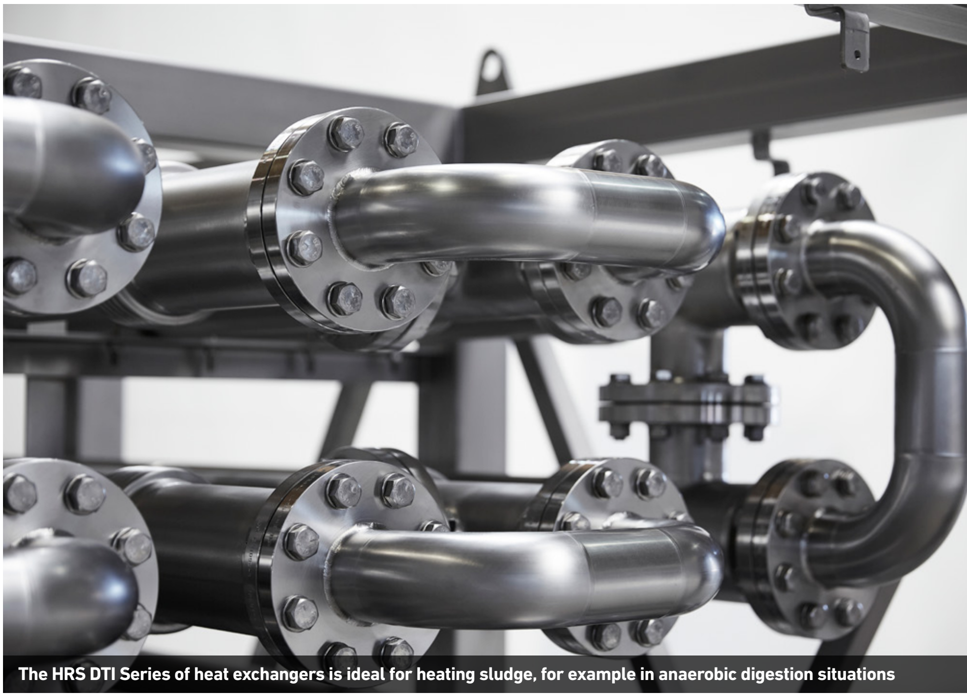
GER FOR WASTEWATER APPLICATIONS

Heat exchangers often play an important role in wastewater treatment systems, but given the nature of wastewater streams and the processes involved, including evaporation and anaerobic digestion, it is important that the right technologies are selected to maximise process and energy efficiency.

Matt Hale, International Sales & Marketing Director, HRS Heat Exchangers



The patented HRS Unicus scraped surface heat exchanger is designed to prevent fouling during evaporation



The HRS DTI Series of heat exchangers is ideal for heating sludge, for example in anaerobic digestion situations

to the final choice of the heat exchanger. The total cost of ownership should be considered, as units that are cheap to purchase often have higher running costs or lower operational efficiencies.

Obviously, the biggest factor when choosing a heat exchanger is the nature of the material itself. Some wastewater streams will be relatively clean, containing only a few dissolved chemicals, while others will be a mixture of dissolved and suspended materials. At the other extreme, the thickest most viscous semi-solid sludges will need significant power to move them through the exchanger, and the risks of fouling and the importance of the pressure drop will therefore be much greater.

Several types of exchanger are utilised in wastewater treatment with differing levels of success, according to the type, the actual design of individual units, and the processes they are used for. In essence, the four types of heat exchangers encountered in wastewater treatment are: spiral heat exchangers; plate heat exchangers; tubular heat exchangers; and scraped surface heat exchangers.

Spiral heat exchangers (SHEs), which are sometimes known as shell and coil heat exchangers, are commonly used in wastewater and sludge applications. They consist of a single channel formed into a spiral or coil, creating a compact design. Various options such as wider spacing

The biggest factor when choosing a heat exchanger is the material, from relatively clean wastewater streams to viscous semi-solid sludges

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and the removal of baffles are employed to try to reduce fouling and the design's large surface area and true counter-current flow result in high thermal efficiency. However, they require regular cleaning (which is both time-consuming and costly) and are often unsuitable for sludge-to-sludge heat transfer.

Plate heat exchangers (PHEs) are one of the most common types of heat exchangers and they have a compact design with good thermal efficiency. However, they are highly prone to fouling and are often only suitable for relatively clean, non-viscous materials. Their maintenance schedules also often require regular replacement of the gaskets that separate the plates.

Tubular heat exchangers, also known as shell and tube, comprise a tube or tubes within another tube or vessel. Because of the various designs and geometries available, they are better able to cope with more viscous materials and suspended solids. Depending on their design, they can require more space than some other designs, and can be susceptible to fouling. These issues are greatly reduced by using corrugated tube designs, and HRS produces a range of efficient and cost-effective corrugated tube heat exchangers for wastewater and environmental use, depending on the viscosity and physical characteristics of the product. These include the DTI and DTR Series of Double Tube designs for more viscous products, and the C & K Series of Multi-Tube designs for lower viscosity fluids which may contain small particles.

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Scraped surface heat exchangers (SSHEs) are used where materials are very viscous or have a high fouling potential, so they are particularly suited for treating thick sludges and for use in evaporation systems. The use of a scraper keeps the tube surface clean and maintains high thermal efficiency, while the individual design may provide other benefits, such as controlling product viscosity during processing. HRS offer two different types of scraped surface heat exchanger, but the most suitable for wastewater applications is the patented Unicus Series that uses a reciprocating action with a choice of scraper geometries, making it ideal for applications such as effluent evaporation, where fouling or low heat transfer is a problem.

As well as effective and efficient water treatment and heat transfer, another consideration for managers in the wastewater treatment sector is the overall energy and environmental footprint of their operations. Operational efficiency is of utmost importance in wastewater treatment facilities, and this has traditionally been the driving factor for innovation in the sector. Reducing energy consumption is not only good for the bottom line, but also for the planet.

In many parts of the world, wastewater treatment plants (WWTPs) are being challenged to become net zero in terms of carbon by 2030. Achieving such challenging targets will require recovery of the energy contained in the incoming wastewater streams and using this to provide the heat and power necessary for wastewater treatment and solids handling.

Anaerobic digestion is widely used as a wastewater treatment mechanism, and so it makes sense for the technology to produce usable energy via biogas (whether in the form of heat, electrical power or biomethane fuel). At the current time, most of the biogas generated in the wastewater sector is used onsite for digester heating, while other uses include heating buildings, power generation, or driving process machinery.

One recent example saw the installation of an improved heating system as part of a larger upgrade to one of Tasmania's most important wastewater treatment plants in Australia. HRS supplied the contractor, Aquatec Maxcon, with a corrugated tube heat exchanger to warm the recirculating sludge and maintain optimum operating temperatures in the main digester.

The supplied unit consists of a six-module HRS DTI Series heat exchanger to raise the sludge temperature from 33 °C to 36 °C, with a capacity to process 72,000 litres of sludge every hour using hot water supplied by a separate boiler. To facilitate routine maintenance and cleaning, the heating unit has been installed outside the digester; a design which is rapidly becoming the norm for biogas plants due to the benefits it provides over internal designs.

Spiral heat exchangers can be difficult to clean and maintain

The energy created by anaerobic digestion also has the potential to be used for improved sludge management, and digestate and sludge concentration using equipment based on heat exchangers is a more efficient and sustainable alternative to traditional drying methods.

Some such systems reduce the overall quantity of digestate or sludge by 60-80%, greatly reducing associated storage requirements and transport costs. They also include measures to retain the valuable nutrients while the evaporated water can be condensed and reused. In many cases, the captured water is added back to the feedstock making the entire process almost self-sufficient in terms of water use and eliminating liquid discharges from the plant. After concentration, the treated digestate can contain up to 20% dry solids, making it much easier to transport and handle, and as much heat as possible is recaptured and reused in the process, making it more energy efficient than alternative treatments.

Where sludge or digestate requires pasteurisation, for example, so that it can be used as an agricultural biofertiliser and soil conditioner, heat exchanger-based pasteurizer systems use up to 70% less energy than traditional technologies. Again, heat and energy recovery should be maximized to increase the overall process efficiency.

Choosing such systems again depends largely on the nature of the material being treated (for example, viscosity or solids content), but also the source/s of energy available. Is waste heat available, or will you need to install a boiler or CHP unit? Will such a unit be powered by biogas produced by onsite anaerobic digestion? These questions not only affect the economics of sludge treatment, but also the type of system and the exact nature of the heat exchangers employed within it.

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