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In this paper we use the term sludge. Sludge meaning all kind of viscous fluids that:
- are viscous, but pumpable.
- that contain a number of different defined and dissolved substances (Drymatter).
- that might also contain unwanted, undissolved or undisolveable substances. (Contaminants)

Purpose-targeted design.

As most heat exchangers for viscous fluids has their design roots as heat exchangers for low viscosity fluids, like water, the Westcome heat exchanger has been designed from day one as a heatexchanger for sludge from wastewater and biogas plants.
Sludge is one the most difficult masses to handle and heat exchange. Not only because it is viscous, but also because it contains a number of different substanses, often reacting to temperature and pressure and therefore causing problems, typically fouling, in the equipment.

Heat exchanging water or heat exchanging viscous, often inhomogeneous, fluids are 2 very different tasks, requiring 2 different approaches to designs.


We find it reasonable therefore to issue this background paper to explain, to our customers and other interested parties, why we did design the Westcome heat exchanger as we did, and based on field experience, the development of the design through the years.

Some challenges of heat exchanging sludge .

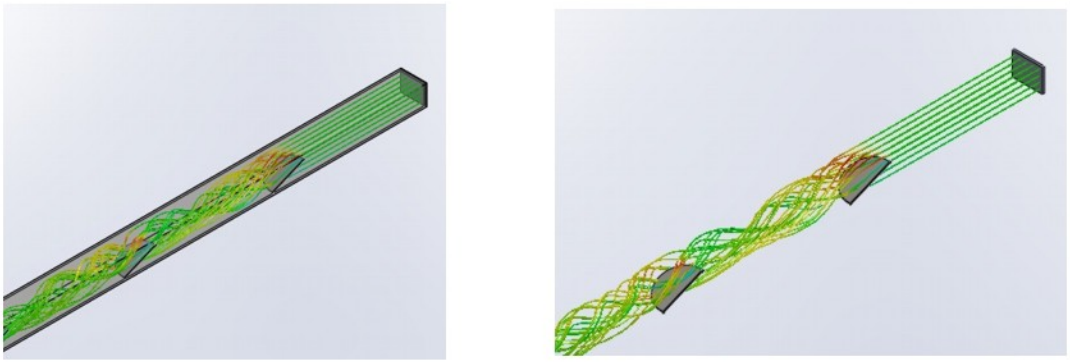
- the high viscosity.

The high viscosity of sludge is a challenge in itself to heat exchange. To transfer heat from one circuit to another, the sludge must be brought into contact with a heat transferring wall.
As sludge have a poor heat transferring factor, it is therefore vital that the sludge is constantly stirred to bring it into contact with the heattransferring wall and to equilize the temperature throughout the ”cross section”.
As sludge in different compositions has very different viscocity numbers and as the viscocity is changing with temperature, the Westcome heat exchanger uses forced stirring to secure that the sludge in question are properly stirred.

- low flow rate versus high flow rate. (Forced stirring versus random stirring)

As high flow rate rate is a recognized principle to secure turbulent flow for low viscosity fluids (like water) in heat exchangers designed for such, it is, to our knowledge and experience, not an option for sludge, because the flow rate would have to be very high to secure stirring under all conditions: variation in the sludge´s drymatter content, variation in contaminnants and variation in temperature occuring in a working heat exchanger.

Further, as high flow rate equals high pressure loss by the square figure, when doubling the flow rate, the much higher flow rate, that would be requirred for the ”random stirring”, would, aside from the much increased power requirement and wear to the equipment, result in a pressure drop so high, that the pressure drop in it self could easily result in additional problems.
Therefore Westcome heat exchangers uses forced stirring, which has proven itself as an efficient stirring method for flow rates as low as 0,3 m/s .for e.g wastewater sludge with a drymatter content of 8% at temperatures as low as 6° C.
Knowing the viscosity of the sludge in an actual installation, Westcome heat exchanger can simulate the best flow rate / stirring/ pressure drop relationship for the heatexchanger in question.



Forced stirring. (Software simulation situation using sludge and design data).

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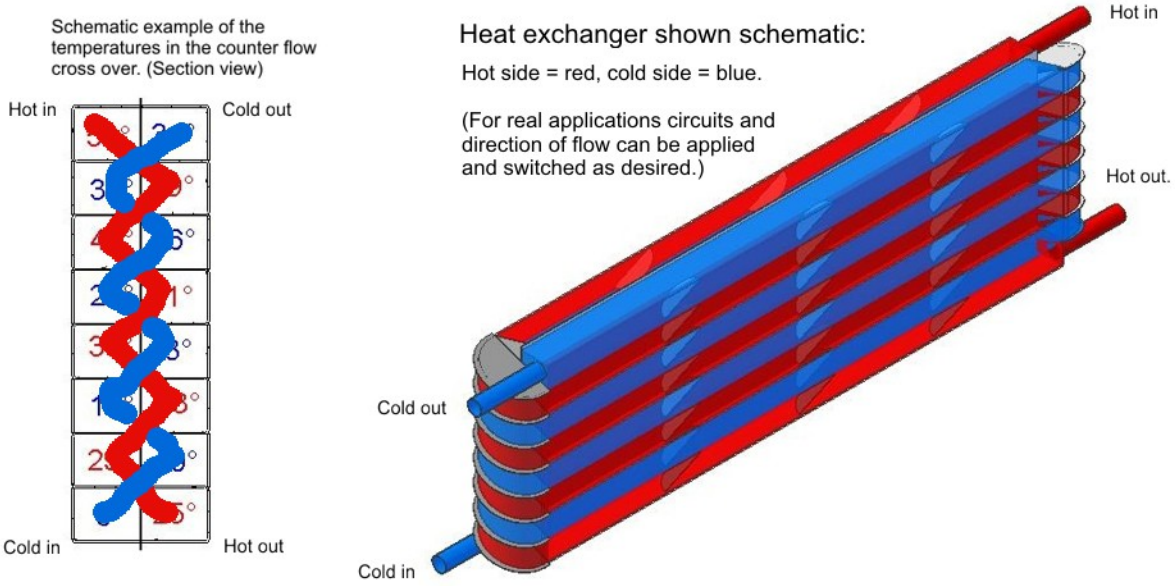
The cross over, counter flow principle:



The counter flow principle is the heat exchanging principle that have the highest temperature effiency of the static heat exchanging principles.

For biomass, wastewater and many other industries, this is desirable, not only to renew as much energy as possible, but also to save on additional heating equipment.
In many processes flow rate in and out are equal, and therefore direct energy transfer between the 2 flows are preferred to achieve as high a “cold out” temperature as possible.
A Westcome heat exchanger is therefore of the counter flow type, with the patented cross over principle added.

As seen on the figure, using counter flow + cross-over flow from side to side, results in the lowest temperature difference in the heatexchanger, that can possibly be achieved. This results in low risk of fouling by ”baking”.

Fouling, no matter the cause, is a heavy penalty to any heat or cooling equipment. When heat exchanging high viscous fluids, often with many different substances involved, any unwanted effect, like too high temperature diffference (hot spots) or too high pressure (caused by high flow rate and thereby high pressure loss in the heatexchanger) must be avoided as much as possible, as they easily results in unwanted effects like fouling and baking, or seperation of certain substances due to high pressure and/or temperature difference.

Design and manufacturing:

Apart from using a heat exchange principle as suitable as possible, it is equally important to design carefully to avoid hot spots, by-pass areas, dead zones etc.
This is especially important for a heat exchanger working sludge, because of the often complex and varying contents. Design and ”design flaws” not impacting the effiency in a heat exchanger working in a less demanding enviroment, can easily prove to be fatal in a sludge enviroment.

- no gaskets:
From the very first prototype the Westcome heatexchanger has been designed as a fully welded unit, without any gaskets whatsoever. From the first prototype and the first production units manufactured from prefabricated pipes to the present design, manufactured from high grade cold rolled plate, the basics are the same: Fully welded and no gaskets.

- low pressure drop:
Designed with forced stirring the flow rate can be kept as low as 0,3 m/s. As the flow is, basicly, directed through a pipe with the same cross section from the very start to the very end, it is possible to maintain a low flow rate without any risk of dead zones or hot spots. There are no “corners” and no areas internally where stirring has to be forced by a high flow rate.

- made of sheet metal:
Westcome heat exchangers are made of sheet metal thoughout. As the heat exchangers are dimensioned for each specific task, the use of sheet metal to manufacture the parts means very free design possibilities to further adress space limitations, as the heat exchanger can be “long and low” or “high and short”.

As the standard material AISI316L do have excellent anti corrosion properties to a wide range of different substances and working conditions, the heatexchanger can be delivered in all grades of steel to target special conditions/cleaning requirements and high temperatures.

The use of sheet metal also includes the benefit of a smooth surface. As fouling both starts easier and is harder to clean from a rough surface, a smooth surface in a sludge heatexchanger is a must.

Maintenance and cleaning.

Even scheduled manual cleaning can very often be avoided in a Westcome heatexchanger, the heatexchanger is as standard delivered with a plug at each end of each ”pipe”.
The interior of the heatexchanger can be fully inspected by means of a cabled video camera and in case cleaning is needed, the threaded fittings can be used for cleaning and draining, wheryby both the surroundings and the operator is protected from contamination.

For suitable processes, which are usually processes involving the same type of sludge in both circuits, and where fouling is unvoidable due to separation caused by temperature decreasing or increasing (for example struvite), a valve arrangement can be fitted to change circuits and flow direction at regular intervals.
This greatly reduces or eliminates fouling caused by soluble substances and since both circuits in a Westcome heat exchanger are similar, the process will not be affected at all .

The valve arrangement are fitted between the pumps and the heatexchanger.

Valve arrangement fitted on a heat exchanger to shift circuits and flow direction at regular intervals.

This facility is treating wastewater sludge with a very high content of fat from waste of the seafood processing industry in the area.

Fat being an example of a substance separating when cooled and soluble a higher temperatures.
In such cases the valve arrangement eliminates the need for cleaning by other means and the heatexchanger works
constantly efficient.

More information.

Please refer to our website www.westcome.com for more materials or feel free call /mail us.

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