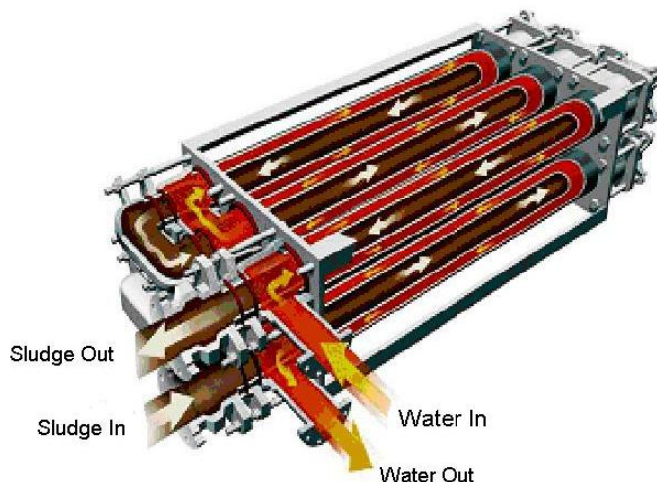


HEAT EXCHANGERS AND BOILERS

The external heat exchanger is a common method of heating sludge for an anaerobic digester. Raw sludge can be pumped through the heat exchanger before it enters the digester or, as in most cases, re-circulated through the exchanger from the digester to maintain a digester temperature of ± 95 degrees F.

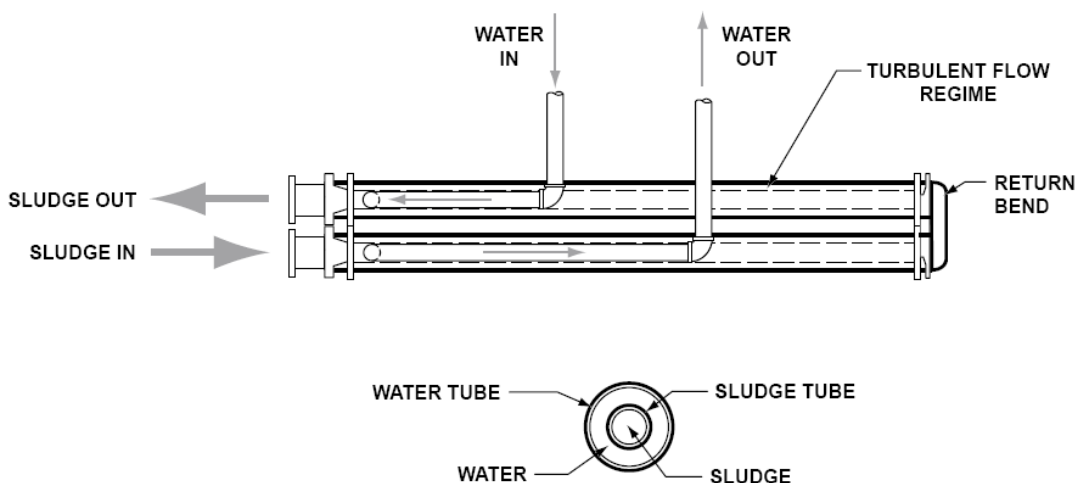
Heat Exchanger:

The figure below illustrates a *tube-in-tube* type heat exchanger.



Tube-In-Tube

The Walker Process uses the *tube-in-tube* type that operates by forced circulation. The exchanger unit consists of a bundle of sludge tubes that are concentric with and located inside of larger diameter water tubes. (The hot water tubes surround the sludge tubes).



Tube-In-Tube Exchanger with Counterflow Circulation

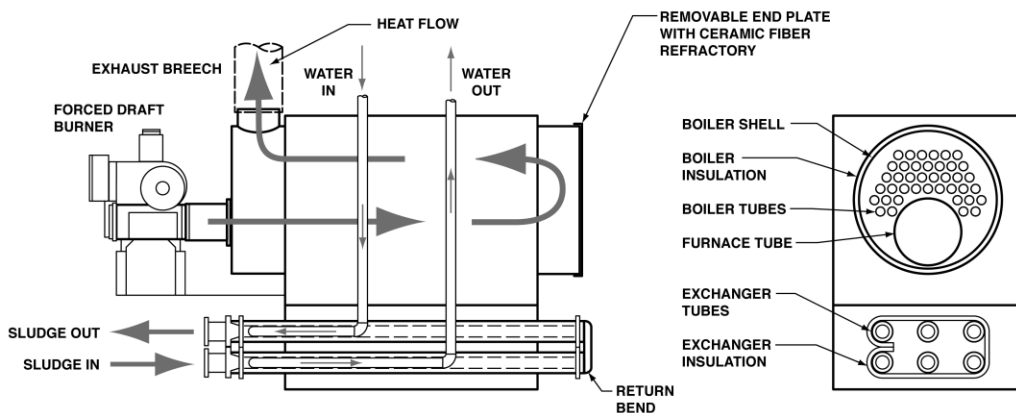
Hot water at 150 degrees F is pumped from the boiler to the exchanger. A temperature differential of about 45 degrees F between the sludge and water is common with a maximum hot water temperature of 150 degrees F maintained to avoid sludge baking on the tubes. The boiler

HEAT EXCHANGERS AND BOILERS

temperature is maintained at 180 degrees F to provide sufficient heat and to prevent damaging corrosion that may result from condensation that occurs at lower boiler temperatures.

When heat transfer is desired, the exchanger water pump is energized to produce positive, counter flow circulation of the water to the sludge flow. Sludge flows through the smaller center tube, while water flows in the annular space formed by the outside of the smaller pipe and the inside of the larger pipe. With the counterflow piping arrangement, the mean temperature differential between the two fluids is maximized, which results in the most efficient transfer of heat from the water to the sludge. The high turbulence of the flow in a tube-in-tube exchanger further improves the transfer characteristics by reducing the film coefficients between the fluids and the exchanger tubes. Further enhancement of heat transfer characteristics is obtained in the tube-in-tube by providing rifling in the sludge return bends. This rifling tends to "spin" the sludge as it travels within the exchanger, which promotes even heating due to the increased turbulence. Scaling or "sludge baking" is reduced by the scouring action of the flow.

BOILERS



DRYBACK-FORCED DRAFT BURNER

Boilers can be provided separately or in combination with the exchanger making a space saving arrangement. The combination unit, as illustrated above, is commonly supplied.

Boiler Construction:

Walker Process uses a double pass, dryback type boiler that heats water to approximately 180 degrees F within a compact vessel by burning either sludge gas or an auxiliary fuel (natural gas, LP gas or fuel oil).

The dryback boiler uses a refractory lining to protect the boiler end plate where the heated gases turn back and enter the boiler tubes. A major advantage of dryback construction is that it allows for removal of the back plate without having to drain the water from the boiler. This feature permits routine inspection and cleaning of the boiler tubes to maintain peak boiler efficiency. It should be noted that dryback boilers, due to their design and reliability, are favored by the commercial boiler industry as well.

HEAT EXCHANGERS AND BOILERS

Boiler construction also directly affects the ratings that manufacturers apply to their units. Equipped with a forced draft burner, the Walker Process boiler uses a nominal rating guide of 10,000 input BTU/Hr/Ft². Output heat is conservatively based on 80% efficiency. The conservative nature of these ratings is proven by both a long list of successful installations, as well as by Shop verification tests.

Some manufacturers attempt to directly relate boiler surface area with heat output. Surface area, however, is just one of many variables that influence heat transfer characteristics. Of equal importance are the firing rate of the boiler, the temperature differential between the combustion products and the water, the velocity of the gases through the fire tubes, and the recirculation rate of the water. A more practical approach to specifying boiler size is to avoid the use of surface area requirements and simply specify Shop verification of the manufacturer's rating instead.

Burner Types:

There are two basic types of burners that are used to fire sludge heating boilers: induced draft and forced draft. Walker Process selected the forced draft burner many years ago as the preferred burner type due to the many design advantages that it offers:

1. **Combustion control** - Mounted upstream of the furnace, the forced draft fan is in contact with only cool ambient air of constant density. The uniformity of the intake air ensures accurate control of the air-fuel mixture.
2. **Maintenance Requirements** - Blower reliability and longevity is another area where the forced draft fan is favored. Again, since the forced draft fan sees only cool, clean air, it is less prone to maintenance problems than an induced draft fan. Also, because the forced draft fan is directly coupled to the blower, there are no V-belts to adjust or replace.
3. **Energy Savings** - Due to the location of an induced draft fan in the exhaust stream, extra air must be admitted to the breaching to keep stack temperatures low. Therefore, electricity savings can also be realized with a forced draft fan because of their smaller horsepower requirements.

Burner Safety Controls:

Walker Process Equipment boilers use the most current, state-of-the-art, burner control system to ensure safe operation and utilize a microprocessor based burner management system that monitors the operation and performance of all electro-mechanical safety devices.

IN SUMMARY:

- Counter-Flow Tube-in-Tube type heat exchangers are the most efficient means of safely transferring heat to sludge without the risk of overheating and baking sludge to the inside of the tubes.
- Walker Process heat exchangers are designed with end castings with sufficient pressure capacity for use with high-head applications such as in systems utilizing "Egg" digesters.
- The Walker Process forced-draft type dry-back burner/boiler combination provides the most efficient means of combustion control that also provides the additional benefits of lower blower maintenance and less energy usage than induced draft type blowers.

HEAT EXCHANGERS AND BOILERS

Heat Exchangers

BELOW:

One of a pair of the smallest heat exchangers we make, a four (4)-tube unit that is undergoing assembly and destined for an installation in the Southeast United States.

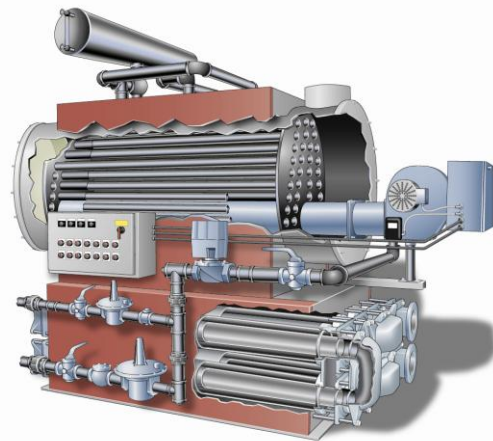
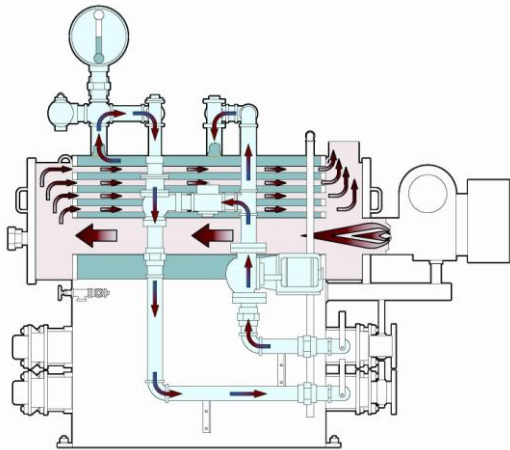


BELOW:

One of the largest heat exchangers we make, shown are two (2) out of a total of eight (8) thirty-two (32) tube units destined for an installation in the Northeast United States.



Combination Boiler and Heat Exchanger



* * * * *

In stationary service, boilers are either of the **Dry-Back** or **Wet-Back** type.

SOME DEFINITIONS:

DRY-BACK – The baffle provided in a firetube boiler joining the furnace to the second-pass to direct the products of combustion that is so constructed to be separate from the pressure vessel and constructed of heat resistant material.

WET-BACK – A baffle provided in a firetube boiler of water leg construction covering the rear end of the furnace and tubes and is completely water cooled. The products of combustion leaving the furnace are turned in this area and enter the tube bank.

SCOTCH BOILER – A cylindrical steel shell with one or more cylindrical internal steel furnaces located (generally) in the lower portion and with a bank or banks (passes) of tubes attached to both end closures.