DESIGN AND IMPLEMENT OF WASTE WATER HEAT RECOVERY UNIT FOR GLOVEMANUFACTURING INDUSTRY

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***Abstract*—High-Pressure Hot Water (HPHW) is used for variety of applications glove manufacturing industry, including leaching, curing, and drying. During leaching process, HPHW is used to heat up liquids inside process tanks and majority of this thermal energy is lost to the drain and considered as an industrial waste.**

In glove manufactrurig, there are two types of leaching called pre leaching and post leaching in each dip machine. Both processes involves increasing the temperature of fresh water or other chemical in an open tank upto 90 C using HPHW and heat exchangers.
The heated content inside these leaching tanks are continously replaced with new liuids and the excess is drained out and transfered to the efluent treatment plant. The drained content usually consist a temperature between 55C to 90C and considered as waste thermal energy lost in the industrial process.

The implemented tank is designed based on recovering heat from drain water and preheating incoming fresh water. In addition, special considerations was taken to minimize fouling which may contribute to the loss of efficiency in the WWHRU.

Keywords-component; Waster Water Hear Recovery System ,Energy Management, Centrifugal pumps energy conservation, VFD Flow Control, Valve Throttling.

I. INTRODUCTION *(WASTE WATER HEAT RECOVERY)*

Wastewater is defined as "used water from any combination of domestic, industrial, commercial, or agricultural activities, surface runoff/stormwater, and any sewer inflow/infiltration". Depending on the quantity of heat available, it contains a sizeable amount of thermal energy that can be recovered and utilised to warm up the cold water supply in a leach tank. The temperature and flow rate of wastewater affect the amount of heat it contains. The heat transfer equation can be used to determine the amount of available heat for wastewater recovery:

$$Q = \dot{m}\, C_p \Delta T \qquad [1]$$

where:
Q = Recovered heat content for unit time (kW)
$\dot{m}$ = Mass flowrate of wastewater
C_p = Specific heat capacity
ΔT = Temperature change of wastewater due to heat recovery

According to the equation, the possibility for heat recovery increases with increasing wastewater flow and temperature. A heat exchanger that is resistant to fouling is the main element of WWHR. Although a heat pump may be used to recover heat in some circumstances, it is often used when the average temperature of wastewater is less than 50C [1]. Using a heat exchanger prevents the mixing of two fluids while facilitating the passage of internal thermal energy between them. Becauseit uses passive technology, no outside energy source is needed. Indirect contact heat exchangers and direct-contact heat exchangers are the two types of heat exchangers that can be categorised.

a) Indirect-contact heat exchangers

Heat is continuously transmitted over an impermeable separating wall or temporarily into and out of a wall while fluid streams stay separate. However, in a perfect world, thermally interacting fluids don't immediately interact with one another. This form of heat exchanger, which is also known as a surface heat exchanger, can be further divided into direct transfer type, storage type, Fluid-bed exchangers, and direct-contact heat exchangers [2].

b) Direct -contact heat exchangers

Two fluid streams directly contact one another in a direct-contact exchanger, exchange heat, and are subsequently separated. In addition to heat transfer, direct-contact exchangers are frequently used for mass transfer processes including rectification and evaporative cooling. Applications requiring simply sensible heat transfer are uncommon. Additionally, a significant amount of the total energy transfer in such an exchanger is made up of the enthalpy of phase shift. The rate of heat transfer typically increases when a process is changed [2].

c) *Efficiency of heat exchanger*

There are various ways to characterise heat exchanger efficiency, and there are several key aspects of thermal performance to take into account:

Temperature differential: The separation between hot fluid and coolant is crucial when building a heat exchanger, as mentioned in paragraph 3 (temperature cross-over). Still, the coolant needs to be warmer than the hot substance. More heat can be extracted from the hot fluid at higher coolant temperatures than at warmer ones. The same principle holds true for heat exchangers: if you have a glass of room temperature cold water, for instance, it is much more convenient to chill off with ice than it is with just cool water.

Fluid flow rates on the heat exchanger's primary and secondary sides are another important factor. Although a larger flow rate frequently entails a higher density, which may make it harder to remove the energy, as well as an increase in velocity and pressure loss, it can enhance the exchanger's ability to transfer heat.

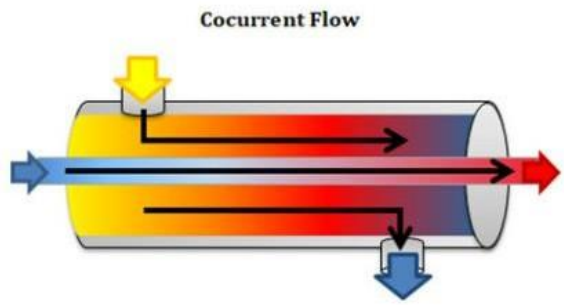
Installation: The heat exchanger can always be fitted in accordance with the guidelines provided by the manufacturer. The coolant can reach the lowest inlet location (as seen in the diagrams above) to ensure that the heat exchanger is still full of water. Generally speaking, the most effective way to build a heat exchanger is for the fluids circulating in a counter current configuration (so if the coolant flows from left to right, the hot fluid travels from right to left).

d) *Flow configuration*

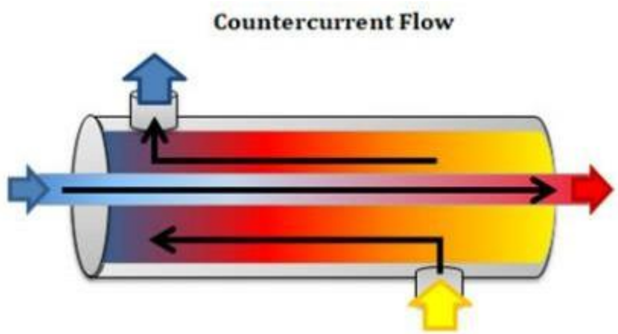
A heat exchanger's flow configuration, also known as the flow arrangement, describes how the fluids travel in relation to one another inside the heat exchanger. The four main flow configurations used by heat exchangers are as follows.

- Cocurrent flow
- Countercurrent flow
- Crossflow
- Hybrid flow

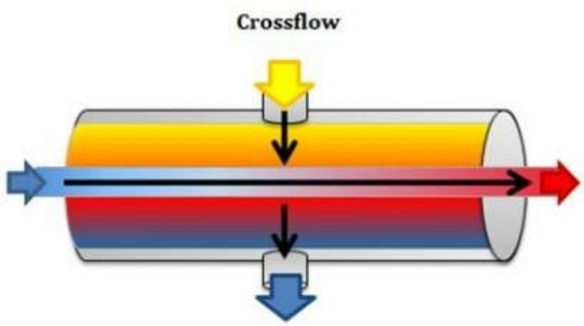
The fluids of cocurrent flow heat exchangers, also known as parallel flow heat exchangers, move parallel to and in the same direction as one another. Even while this configuration often yields lower efficiency than a counter flow setup, it also permits the maximum degree of thermal uniformity throughout the heat exchanger's walls.



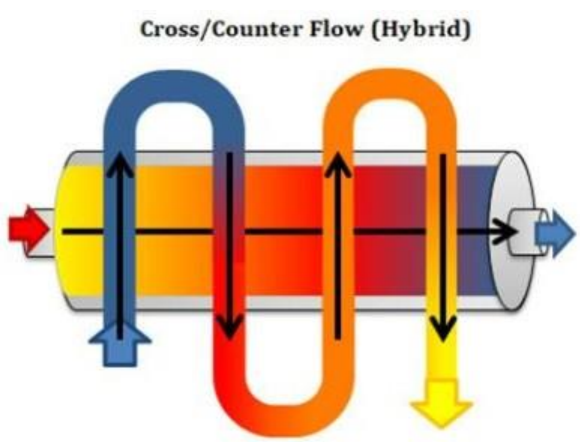
The fluids within countercurrent flow heat exchangers, also referred to as counter flow heat exchangers, move antiparallelto one another within the heat exchanger (i.e., parallel but inthe other direction). A counter flow arrangement, the most widely used flow design, typically has the highest efficiency levels because it enables the most heat transfer between fluids and, as a result, the biggest change in temperature [3].



Fluids flow perpendicular to one another in crossflow heat exchangers. Heat exchangers that use this flow design have efficiency that fall between countercurrent and cocurrent heat exchangers.



The characteristics of the aforementioned flow topologies are combined in hybrid flow heat exchangers. For instance, different flow passages and configurations (such as crossflow and counterflow arrangements) can be used by different heat exchanger designs within a single heat exchanger. These kinds of heat exchangers are frequently employed to overcome the constraints of an application, such as available space, financial constraints, or temperature and pressure specifications.



II. Benefits of the Proposed Heat Exchanger Design in Waste Water Heat Recovery

The most common types of heat exchangers in industrial applications are the "shell and tube" and "plate and frame" types. In all cases where the liquid streams are clear and free of waste like lint, resins and other pollutants, these exchangers work adequately. However, when pollutants are contained in the waste stream, they foul and eventually plug up the heat exchanger.
This means that valuable time is needed for maintenance and cleaning of the heat exchanger, which can get rather messy as well as costly.

Key benefits of implemented heat exchanger

- Less space requirement
- Piping modification requirement is less (Since installed tank wise)
- Easy Installation
- Easy to clean
- Low cost (Compared to RCR and other commercially available heat exchangers)
- Possibility of fabricating in-house
- No electricity requirement

III. Conclusion

Heat recovery from dirty water is challenging due to its nature and will create some clogging issues for heat recovery systems. However, from this research, it shows it is possible and work continue till further improve the efficiency of the heat recovery system.

IV. References

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