FACTSHEET

September 2015 # 010

HYDROCYCLONES & CENTRIFUGES

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Introduction

Hydrocyclones and centrifuges are two water treatment technologies that utilize centrifugal force to separate substances with different densities from suspension. In wastewater treatment they are often used as a primary treatment step to separate solids from liquids. In both systems water spins around inside a container, which causes the solid particles to separate from the water to then be collected and removed.

Description

Centrifugal force occurs when an object is rotating in a circular motion. The rotation of the object causes outward movement from the center of a circle (US Centrifuge, 2015), similar to swinging a ball attached to string in a circular motion around a center pivot (Figure 1). When wastewater containing substances with different densities is rotated at high enough speeds the denser substances are pushed outwards from the center of the circle the same way the ball attached to the string does. In this way the solids can be separated from solution (US Centrifuge, 2015). The separated solids are collected and removed and the clarified water can be reused or undergo further treatment.

Both hydrocyclones and centrifuges operate on this same basic principle, but the mechanics of how they operate are slightly different. For hydrocyclones the force is applied passively and there are no mechanical components except for the pump that feeds the system (Chemindustrial Systems, 2009). The

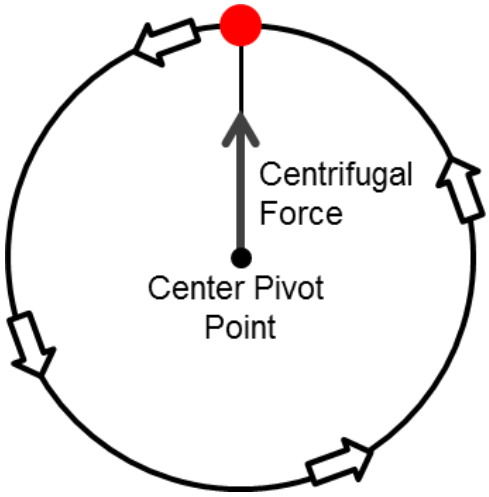

Figure 1: Centrifugal force: the rotation of an object in a circular motion causes an outward force to act on the object (HMGA Water Project).

influent wastewater is pumped into a chamber that has grooves on the interior surface to help make the water rotate in the proper circular motion. As the wastewater spins around the chamber the solids are separated and captured and the water flows out of the system (Fig. 2). Some hydrocyclone systems contain multiple hydroclyclones in parallel within one treatment system (Fig. 2).

Centrifuges are more complex systems in which the rotation is achieved by rotating the entire chamber that contains the wastewater (US Centrifuge, 2015; Fig. 3). These systems are able to apply larger forces to the wastewater resulting in higher solid load separation. A motor rotates the reservoir or bowl. This rotational motion produces the

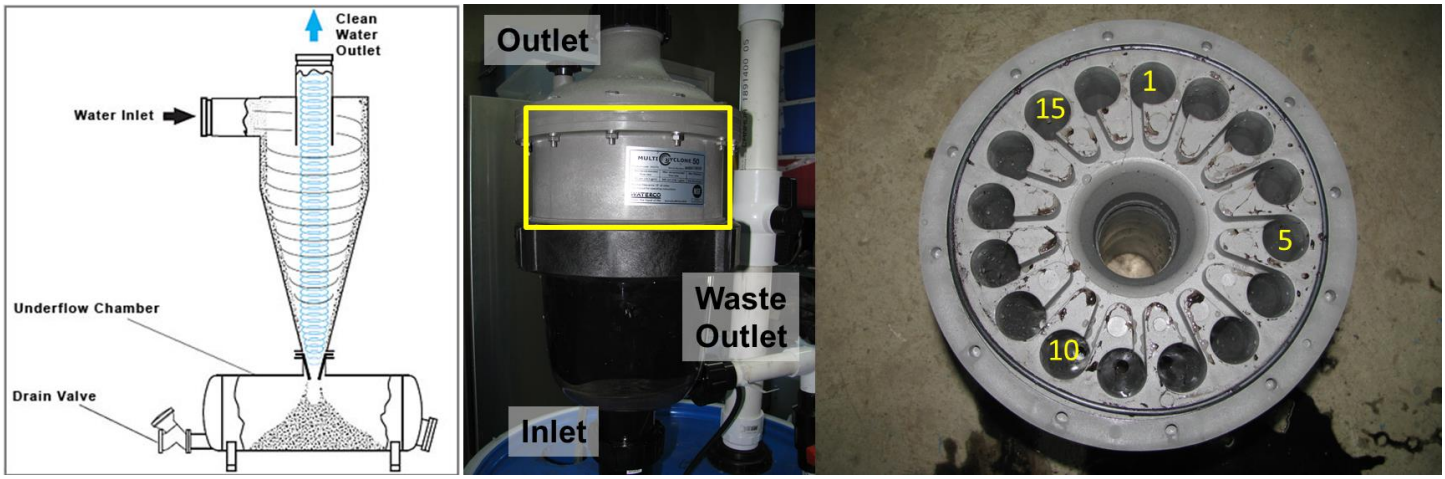

Figure 2: Schematic diagram of a hydrocyclone and the process by which it separates solids from liquids (left; Water Renewal Technologies, 2011), hydrocyclone unit that contains 16 hydrocyclones within, demonstrated by the yellow box (centre; HMGA Water Project), and top view of the 16 hydrocyclones (right; HMGA Water Project)

centrifugal force that separates solids from water. The removed solids are collected and the treated water flows out of the system in a separate stream. The removal efficiency of these systems is dependent on the mass of solids in different size ranges. The removal efficiency of large particles found in wastewater is much more efficient than the smaller particles. Chemical pretreatment with coagulants and flocculants will increase the performance of these technologies (Gurvinder, 2013) and could make these technologies more desirable options.

System Placement

Hydrocyclones and centrifuges are used for the removal of coarser solids from wastewater. Therefore, they would be used in the primary stages of a water treatment system. If treating vegetable washwater and the goal is to meet discharge standards or to reuse the washwater further treatment steps will be required to meet these goals.

Considerations

When considering these technologies for the treatment of vegetable washwater it is important to understand that they will only target larger solid particles. The small particle size and low densities of muck soil make it difficult to remove via centrifugal force. The density of muck soil is only slightly higher than water, meaning it will not easily separate from solution. However, centrifuges will be more effective than hydrocyclones. Another consideration, as with any solids removal technologies, is the need for the disposal of the removed solids. Depending on the source and contents of the removed solid load, different options are available. For example, land application or disposal at a landfill may be considered. Additional regulatory requirements may impact the method of disposal.

Performance

The HMGA Water Project evaluated the treatment efficiency of a hydrocyclone for treating vegetable washwater. The results showed that the hydrocyclone was effective for the removal of larger mineral soil particles but was unable to remove the smaller muck soil from solution. Therefore, a hydrocyclone may not be a suited for the treatment of vegetable washwater containing fine particles, especially if there is already a coarse solid removal system in place like settling tanks as they can generally achieve the same results as the hydrocyclone. However, if space is limited hydrocyclones may be a viable alternative to

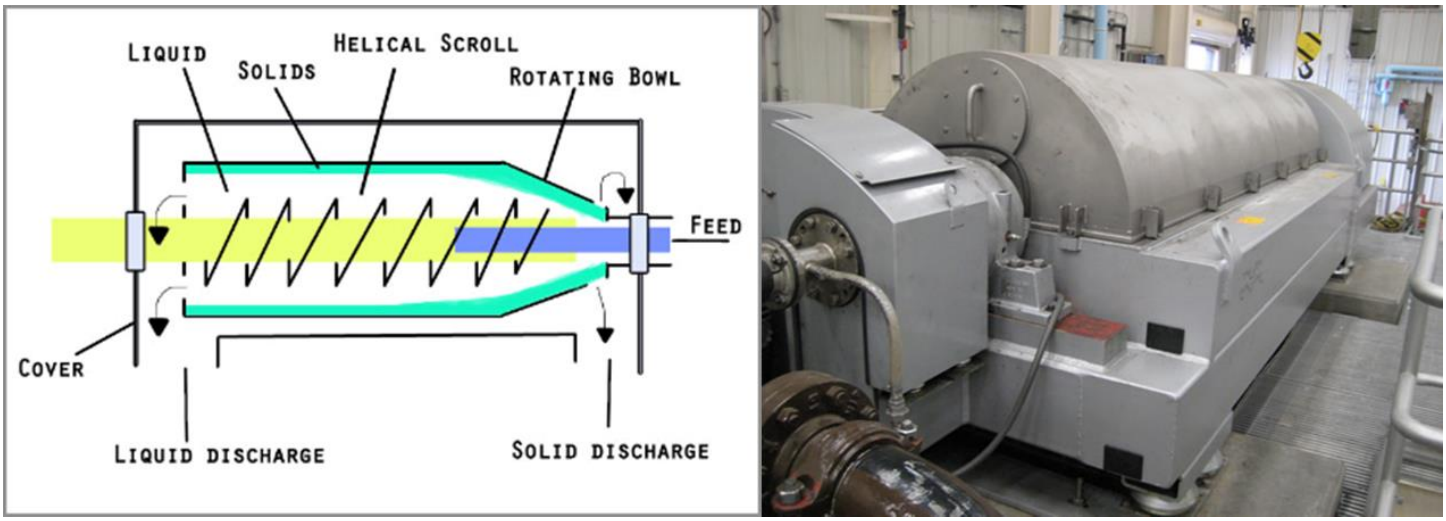

Figure 3: Schematic diagram of a centrifuge system for the removal of solids from wastewater (left; Odiliasugita, 2013) and centrifuge unit (right; City of Yakima, 2012)

settling systems for the removal of larger soil particles.

Cost

Hydrocyclones are less expensive in regards to capital costs than centrifuges due to their less complex design. A small hydrocylcone can cost a couple hundred dollars.

Centrifuges are able to treat more concentrated wastewaters and this is reflected in the cost. A unit designed to treat 100,000 - 150,000 L/day can cost in the hundred thousand dollar range (Gurvinder, 2013). Additionally, if a system requires chemical additions to increase efficiency, there will be on-going costs associated.

Conclusion

Hydrocyclones and centrifuges are two similar technologies that operate using the same basic principal. Both are effective for the removal of larger and denser solid material from wastewater but are not able to remove small and low-density soil particles. They can be of use where space is limited, but the cost can be prohibitive.

References

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This factsheet was prepared by Eric Rozema on behalf of the Holland Marsh Growers' Association Water Project. This project was undertaken with the financial support of the Government of Canada through the federal Department of the Environment. Ce projet a été réalisé avec l'appui financier du gouvernement du Canada agissant par l'entremise du ministère fédéral de l'Environnement.