Closed Loop Water Filtration and Waterjet

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Introduction

Water is one of the most abundant natural resources on Earth and also one of the most critical resources to life and modern manufacturing. As material science research leads to advances in materials, new challenges arise on how to process these materials efficiently. At WARDJet, our waterjet systems rely heavily on water for operation, and the nature of waterjet cutting allows for virtually any material to be cut in unending shapes from simple to extremely complex. The versatility of the waterjet means that it will be a crucial tool for material processing during this rapid expansion of advanced materials. One concern with these new materials is the waste that comes from manufacturing and processing them and how that effects the water supply. WARDJet has a solution to these concerns with what is called a Closed Loop Filtration System or CLFS. In the following paragraphs, we'll lay out how it works, why it optimizes waterjet performance, and how it can solve issues related to local and federal water regulations.

How It Works

A closed loop filtration system (CLFS) takes a spent medium (in the case of waterjet that medium is water) and scrubs it to a level of cleanliness that allows it to be reused in the system it is running through. Figure 1 shows what a closed loop system on a WARDJet waterjet looks like. Water is plumbed into a high-pressure intensifier pump and boosted using hydraulic pressure from normal tap water pressure to 60,000 psi. The pressurized water then travels through a series of stainless-steel high-pressure lines until it exits the cutting head.

Figure 1

When cutting soft goods, such as materials that can be cut with a knife, the water itself does the cutting. When cutting hard goods such as metals, the water mixes with a garnet just before exiting the nozzle, transferring its energy to the garnet which then does the cutting. In both scenarios, material is removed from the stock sheet and enters the water tank below the cutting surface. This removed material is called the kerf. When garnet is used for the cut, the garnet will enter the water tank as well.

Figure 2

Eventually, water will fill the tank beyond the overflow drain located in every waterjet tank. This water, contaminated with kerf and garnet, then flows to a drain or to a filtration system. In order to reuse this water through the waterjet again, a series of filters must be utilized to scrub the kerf and garnet from the drain water before pumping it back into the intensifier pump. The CLFSs that WARDJet offers performs this incredible task.

The CLFS consists of three separate components: the settling weir, the filter unit (see Figure 2) and the chiller. When water overflows in the waterjet tank, it first enters into the settling weir. The settling weir allows heavy components in the water to fall to the bottom while the cleaner water is removed from the top and enters the filtration unit. The filtration unit consists of four filters. The first filter is a 1-micron filter bag, followed by a 0.35-micron filter cartridge. This flows into the third filter which is a DI resin bag before it finally flows through a final 0.35-micron filter cartridge.

The water from these four filters is then sent through the chiller to be cooled. From there, it either goes on to the intensifier pump to be used again, or is recirculated through a holding tank on the filter unit until it is needed. Some water will be lost due to evaporation, splash out or carry off. This water is replaced with tap water that we recommend be softened before it enters the closed loop system in order to further protect the high-pressure components.

Optimized Operation

All waterjet high-pressure pumps operate with tight tolerances and incredible forces that require clean, consistent water to operate. Introducing foreign debris into the water supply, such as kerf material and garnet from the waterjet cutting process, results in increased wear on the pump seals and other components of the pump. In extreme cases it can cause expensive pump failures after only a few hours of operation. Pumps require water cleaned to specified levels of total dissolvable solids (TDS) since pure water can be too acidic for the pump components and can cause premature failure as well. Most pump manufacturers recommend between 50 and 100 parts per million of TDS. In a closed loop water filtration system, the TDS levels are set by the operator at the

filter unit control to achieve the level required by the pump manufacturer. Once a CLFS is installed, the operator can rest assured that the water running through their high-pressure pump is cleaned to the manufacturers recommended levels.

In order to maximize the life of the seals on a pump, it is critical to have the inlet water into the pump maintained at operating temperatures at or below 70^{O}F. All CLFSs include a chiller to cool the filtered water coming out of the system. Chilled water along with consistent agitation of the water prevents bacterial growth in the water which would increase the cost of consumables on the CLFS if allowed to grow. An added benefit of this chiller is that it supplies water to the high-pressure pump under the required 70F. A larger chiller can be spec'd to cool the hydraulic circuit within the high-pressure pump as well. A well-maintained CLFS will provide clean, cool water for all the water needs of a high-pressure pump.

Environmental Impacts

Localities with tight water restrictions and high risk of drought can be prohibitive to the use of waterjet in a manufacturing process. A closed loop filtration system can remove this prohibition by significantly reducing the water consumed by the waterjet system. Reducing the amount of fresh water required for manufacturing also reduces the overall environmental impact of that manufacturing. A CLFS reduces the water consumption of a waterjet system by up to 98%.

To put that into perspective, a standard waterjet cutting continuously for more than 8 hours a day uses 500 gallons of water, not including water for cooling the intensifier pump hydraulics. As little as 2% of that water would need to be made up from evaporation, carry off and splash out during operation of the waterjet. A CLFS can take a waterjet from consuming 500 gallons per shift down to 10 gallons per shift (see Figure 3). Not only does this cut the water bill by up to 490 gallons per shift, it also reduces the environmental burden by up to 490 gallons per shift as well.

Waterjet System	Water Consumption (gpm)	8hr Shift (gal)	Yearly Total (gal)
50HP Pump	1	480	124800
50HP Pump w/ CLFS	0.02	9.6	2496

This chart is not meant to be a guarantee of water consumption and WARDJet, LLC cannot be held liable for any information herein

Figure 3

While a closed loop filtration system can substantially reduce the amount of water needed by a waterjet system, it eliminates the drain water entirely. With regulations tightening every day on drain water quality standards, a CLFS could be a necessity for future waterjet operation. Manufacturers cutting materials such as lead, aluminum and heavy metal containing products like solar panels are already required to filter or decontaminate their waterjet drain water to comply with local and federal restrictions.

Many adhesives, grease barriers and some inks are made using harmful chemicals that can leach into the drain water of a waterjet during the cutting process. Various plastics contain what are sometimes referred to as "forever chemicals" that can also leach into the waterjet drain water during the cut process. Some of the more well-known chemicals are BPA's and PFAS. As more materials are invented with unknown safety profiles, having a containment system to prevent known or unknown chemicals from entering local water supplies becomes more and more necessary. A CLFS removes this concern by eliminating the drain water entirely and instead cleaning it and returning it to the waterjet system for reuse.

Conclusion

The world of manufacturing materials advances further everyday requiring new manufacturing processes to create new products and new regulations to protect our resources. When considering a waterjet, combining it with a closed loop filtration system will optimize the life of the waterjet components, reduce the total water requirements and prevent toxic chemicals from entering the local water supply. At WARDJet, we will work with you to configure the right filtration system for your facility and make it easy for you to ensure long lasting, reliable WARDJet waterjet performance while staying ahead of local and federal water regulations.

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