Material Choices for Mechanized Effluent Irrigation Systems

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Introduction

The challenge of feeding, clothing and fueling the needs of the global population is one that continues to escalate in complexity. According to the latest UN projections, world population will rise from around 7 billion today to 9.1 billion in 2050.[1] According to the World Health Organization, today, water scarcity affects one in three people on every continent of the globe.[2] In the face of these and other trends, some groups are projecting a need to fully double agricultural outputs between now and 2050.[3] The role of irrigated agriculture in surmounting this challenge is clearly illustrated by the fact that while less than 20% of global cropland is irrigated, this land produces 40% of total agricultural output.[4] By using irrigation to facilitate plant vigor and productivity, yields can be as much as 230% higher than non-irrigated land.[5] Water is finite in nature and competition for access to water in sufficient quantity and quality for agriculture is escalating. It is important to maximize water productivity and limit impacts on water quality. This requires the reinsertion of some basic understanding in the way we use water on the farm and in other places. Instead of treating water in a linear fashion, where water enters one end of the farm and exits on the other, there is a need to get back to the basic understanding that water is in fact cyclical in nature. By deploying water reuse strategies with the goal of limiting physical, chemical and biological load on return flows, net inputs can be reduced and off-farm impacts can be lessened or negated entirely.

The modern farm is in fact, poised to become a much more prolific tool in the realm of water treatment as many constituents found in various effluent sources provide nutrition or other benefits to vegetation. Sources of reuse or reclaimed water are quite diverse. Depending upon the types of on-farm activities, as well as associated uses in the general vicinity of the operation, a wide variety of sources may be available. With nearly every primary use of water, there exists a potential for safe reuse. With some creativity and applied science, sources may be derived from but not limited to rain/stormwater, animal feeding operations, food processing, cooling/chilling, condensate recovery, industrial processes and/or municipal effluent. Of course, each of these sources require analysis of the various physical, chemical and biological properties to determine how best to safely apply such resources and to ascertain if some form of treatment may be necessary prior to such reuse. Such analysis is also important to determine the nutrient content of the reuse water as the target crop will benefit from and process constituents such as nitrogen, limiting the need for additional application of nitrogen while reducing offsite loading as well.

Once sources have been determined and qualified for reuse, the challenge turns to the application method and supporting infrastructure. While a variety of techniques and hardware are available, mechanized irrigation systems possess many desirable characteristics for such reuse applications. With appropriate planning, equipment selection and management,

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[1] Food and Agriculture Organization of the United Nations. http://www.fao.org.

[2] World Health Organization. http://www.who.int

[3] Global Harvest Initiative. http://www.globalharvestinitiative.org.

[4] NumbersUSA.com, "U.S. Population Growth is a Key Factor in Paving the World's Breadbasket" (2009).

[5] Michael F. Dowgert, PhD, "In Defense of Irrigated Agriculture" (presentation, Irrigation Show Technical Conference, San Antonio, Texas, Dec. 2-4, 2009).

mechanized irrigation can become an effective effluent treatment strategy while providing necessary, supplemental irrigation.

Operation & Maintenance

Mechanized irrigation systems utilize a moving array of structural components and sprinklers to convey and apply water over larger areas. This frequently means fewer components are necessary per field as compared to the various types of fixed or permanent arrays of irrigation components. Fewer components mean fewer service points and less time required for monitoring and oversight.

In reuse systems, source water often contains some suspended material. Mechanized systems can be designed with higher tolerances to such material by increasing nozzle opening size and sprinkler styles to suit the desired characteristics. Such material can also be centrally filtered to facilitate passage and application through the system. Filtration systems can even be designed to facilitate automatic cleaning/flushing.

The majority of the key components of a mechanized irrigation system are highly visible and accessible. This simplifies the tasks of verifying proper operation, diagnosing any problems and allowing access for any repairs or maintenance. For example, many sources of reuse water contain suspended solids which can potentially create the need for cleaning sprinkler/nozzle assemblies, which can be easily diagnosed and serviced because of such visibility and access.

With mechanized systems, underground obstacles are minimized and/or consolidated as mechanized systems only require source water and/or an energy source such as electric power. This minimizes interference with land use, harvesting, tillage, planting and other various operations that may be encountered with various other types of fixed arrays of irrigation components.

The adaptability of pivots to various crops, conditions and source water is also advantageous. Sprinkler packages and application height can be adjusted or changed with relative ease to comply with water quality, crop need, climatic conditions and soil type.

Application and Uniformity

A wide variety of sprinkler packages and application methods are available for pivots. Liquid can be applied at grade level using drag hoses, above vegetation with a variety of spray and rotary type sprinklers or with high-volume arrays of large scale impact type sprinklers. In any case, mechanized systems can be designed to apply water in a highly uniform fashion and periodically analyzed to verify ongoing performance and uniformity.[6] Additionally, some development toward varying application rates is gaining in popularity and recognition as systems can be engineered to vary application rates based upon field/crop specific data by varying machine speed and cycling sprinklers or groups of sprinklers on and off systematically.[7] This sort of precision application can become a critical factor in reuse applications which are

[6] Harrison and Perry. 2010. "Evaluating and Interpreting Application Uniformity of Center Pivot Irrigation Systems"

[7] Perry and Milton. 2007. "Variable-Rate Irrigation: Concept to Commercialization"

part of a nutrient management system[8], designed to utilize vegetation to process nitrogen or other nutrients and minimize migration of such nutrients into undesirable locations.

Durability and Chemical Resistance

Mechanized systems irrigation systems are constructed of a variety of materials suitable for the conveyance of a broad variety of reuse water. Key structural elements and distribution components can be constructed of a broad array of metals, alloys, plastics and other composites. Water from various sources may contain a broad array of constituents[9] that influence material selection as many such constituents can cause accelerated corrosion. Corrosion can be mitigated with proper regard for this interaction. Manufacturers (listed elsewhere) now produce mechanized systems irrigation systems and sprinklers from a wide variety of plastics and metals. Structural elements are readily available in galvanized steel, aluminum, chromium nickel, stainless steel or polyethylene lined galvanized steel. Manufacturers often provide recommendations for the best system longevity once there is an understanding of the constituents contained in the source water.

While it is desirable to choose system materials offering the best resistance to any corrosion potential caused by source water, system life can be substantially increased by flushing components with fresh water after each use or at regular intervals to remove residues and deposits that may be caused by reuse water. In areas with limited rainfall or where deposits/residues accumulate on external system surfaces, longevity of structure can be increased by periodic cleaning or rinsing.

Conclusion

This paper is developed for the sole purpose of supporting the adoption of mechanized irrigation technology for reuse applications and in no way is intended to endorse any specific product or supplier, yet it is important to note where to look for additional options and information. At one time, several dozen manufacturers were involved in the production of mechanized irrigation systems. Over time, the U.S. market has distilled down to five major manufacturers:

-Lindsay Manufacturing (Zimmatic), www.lindsaymanufacturing.com

-Pierce Corporation, www.piercecorporation.com.

-Reinke Manufacturing, www.reinke.com

-T-L Irrigation, www.tlirr.com

-Valmont Industries (Valley), www.valmont.com

Similarly, sprinkler manufacturers have undergone a market evolution where two companies fulfill the majority of current marketplace demand:

-Nelson Irrigation Corporation, www.nelsonirrigation.com

[8] Howes, Gaudi, Ton. 2007. “Effluent Nitrogen Management for Agricultural Re-Use Applications”

[9] Hoffman, et al. 1982. “Design and Operation of Farm Irrigation Systems”, Chap. 20, Table 20.1

-Senninger Irrigation, www.senninger.com

Agricultural producers are already utilizing many alternative sources of water for irrigation. Many times, the producer's primary goal is to dispose of water that has embedded elements from associated farming operations such as manure management or food processing. Agricultural stakeholders must continue to develop practices and awareness as to how waste management operations and various primary water uses can be converted into safe, beneficial reuses. Trends in population and projected demand for agricultural products will likely lead to higher water costs and increased competition for necessary water. Cultivating alternative irrigation water sources from both on and off the farm is a desirable practice and mechanized systems possess many suitable characteristics which not only accommodate the need, but allow significant flexibility that will assist the producer with achieving his/her environmental, social and economic goals for the future.

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