An EconoPure™ White Paper

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Drinking Water - India

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July 17, 2012

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EconoPure™ Water Systems

EconoPure™ Water Systems (formerly DVX Water Technologies, LLC) designs and manufactures highly economical, scalable, low-fouling membrane systems. The Company leverages the unique low-fouling nanofiltration ("LFNano™") system consisting of a unique membrane element that is designed to avoid particulate fouling, biofouling, and scaling. As the name suggests, the LFNano™ utilizes proven nanofiltration (NF) membrane technology and applies proprietary processes to enhance performance and decrease cost (both capital and operating). Typically the LFNano™ does not require pre-treatment or process chemicals, and with cleaning intervals measured in months and years rather than minutes and weeks it is an ideal treatment solution for virtually any application including:

• Drinking water treatment
• Industrial effluents or influents
• Desalination (brackish or seawater)
• Wastewater treatment/reuse

Introduction

India's large and growing population is putting severe strain on the country's natural resources. Most water sources are contaminated by sewage and agricultural runoff. The World Bank estimates that 21% of communicable diseases in India are related to unsafe water. In India, diarrhea alone causes more than 1,600 deaths daily. Proven water treatment systems today are often too complex and do not represent sustainable, safe treatment solutions.

Problem Statement

India faces serious problems providing clean drinking water. The problem spans both the quality of the water as well as the quantity. The quality is affected by silt, sediment, bacteria, viruses, and leaching arsenic. Industrialization and updated farming practices have added other organic and inorganic contaminants to water sources. The growing scarcity of clean, fresh (not saline) water has increased the competition for these resources and the overuse of groundwater is making the problem worse. This wide variety of contaminants requires innovative, flexible solutions.

Existing Options

When treating fresh water for drinking, the method of choice has typically involved a media (usually sand) filtration followed by disinfection (perhaps with chlorine). This type of treatment works well for removing large solids, bacteria, and larger microbes that occur naturally in water sources. However, these types of systems do not provide an actual barrier against the targeted contaminants, so breakthroughs can occur.

The water industry has addressed this concern through the use of other non-media or membrane filters such as microfiltration (MF) or ultrafiltration (UF). These systems do better at providing a reliable barrier for removal of particulates, bacteria, microbes and, to some extent, viruses. However, these systems can be costly, complex, and maintenance intensive. In this specific case, they also to do not address the dissolved contaminants such as arsenic, salt, pesticides, industrial waste, etc.

To effectively remove these dissolved contaminants, many systems now employ reverse osmosis (RO) membranes. RO membranes can be used effectively to produce ultrapure drinking water over the entire range of sources including seawater. Like the MF and UF, RO systems are complex and costly as well as energy intensive. However, the single greatest limitation to RO treatment is the effects of membrane fouling. The pore size (opening) of the RO membrane is so small that even the slightest amount of particulate matter can prevent or slow down the water, requiring cleaning of the membrane. The result is that the pretreatment for RO systems can be more costly and maintenance intensive than the actual RO system.

> *"The next great water technology company will be the one that finds a solution to membrane fouling."*
>
> *Christopher Gasson*
> *Editor, Global Water Intelligence*
> *October, 2010*

EconoPure™ Solution

Effective, Easy and Economical Treatment of Water

The innovative nanofiltration treatment system developed by EconoPure™ - the LFNano™ - provides the highest quality treatment in a simple to operate, cost effective package. The combination of proprietary technologically-advanced nanofiltration membranes and the patent-pending system configuration of EconoPure™ results in a system that is far simpler than UF filters, yet with vastly better performance (water quality). When compared to RO systems, for low NaCl feed water, the LFNano™ provides similar results at a fraction of the cost. The fouling resistance of the LFNano™ permits the use of membrane treatment for such challenging feed waters as are encountered in India. While ultimate operations will depend upon the exact source water quality, the LFNano™ provides the exceptional level of treatment associated with nanofiltration membranes without the complex pretreatment and operations of current membrane systems.

The LFNano™ membrane system combines three innovative features:

1) Specialized low fouling NF membrane element
2) Particulate coating/injection
3) Feed water velocity control

These three features work together to reduce fouling by: reducing the hydraulic resistance of standard elements; introducing specialized particulates onto the surface of the membrane as a protective barrier; and maintaining consistent cross-flow velocity.

The nanofiltration membrane chemistry primarily targets rejection of divalent or polyvalent salts such as calcium and magnesium, not the single charged monovalent salts like sodium and chloride. For most water treatment applications the contaminants of concern either fall into this target category or are much larger. Such contaminants such as viruses, pesticides, petroleum, color, heavy metals, etc. will be virtually completely eliminated by the nanofiltration membrane, resulting in exceptionally clean product water.

Typical LFNano™ Treatment

Contaminant	Rejection %
Divalent ions (Ca, Mg, etc.)	40% to 60%
Monovalent ions (NaCl)	15%
Viruses	99.99% or more
Large Contaminants (pesticides, heavy metals, etc.)	90 to 95% or more

For more complex chemistries, the LFNano™ can be outfitted with other nanofiltration variants or coupled with other treatment systems. In the particular case of high salinity, the LFNano™ would act as the pretreatment for an RO system. As a pretreatment system, the LFNano™ provides the best quality feed water to the RO, reducing energy consumption, increasing output, and nearly eliminating chemical membrane cleaning.

***Benefit 1 -* Effective** – The nanofiltration membrane produces exceptional quality product water, removing nearly all contaminants to very high levels. Alone, the NF membrane addresses all treatment needs that do not require desalting. For the applications that do, the NF is the best pretreatment for a RO system that is available.

***Benefit 2 -* Easy** – The low fouling nature of the LFNano™ system requires little or no pretreatment, no process chemicals and minimal cleaning. The system is inherently flexible in adjusting to operational needs, flow demands and varying feed water quality. The system contains minimal valves and industry standard pumps. The result: water treatment that is easy to operate and easy to maintain.

***Benefit 3 -* Economical** – The LFNano™ is the economical alternative to the extensive pretreatment, operational complexity, and frequent cleaning of current systems. In a standalone application, the LFNano™ offsets two or three complex processes with one simple process. As a pretreatment for RO, the LFNano™ offsets the standard complex pretreatment systems. In addition, it lowers energy consumption while increasing the recovery rate and minimizing the required cleaning of the RO membrane.

Implementation

The flexibility of the LFNano™ system makes the installation and implementation easy. We have a simple questionnaire to determine the basic setup of your system. The 3 basic questions are:

1. Water Quality and Quantity – What is the expected quality of the feed water and desired quality and quantity of the product water?
2. Operational Considerations – Will you move it? How many hours per day will you operate it? Will an operator be available?
3. Logistics – Are there specific power requirements? Do you need spares?

The inherent modular nature of the LFNano™ allows for custom-configurable systems to meet any requirement. The below figure is typical of an installation – in this case about 3,350 liters/hour.

9'–3" (2.82 m)
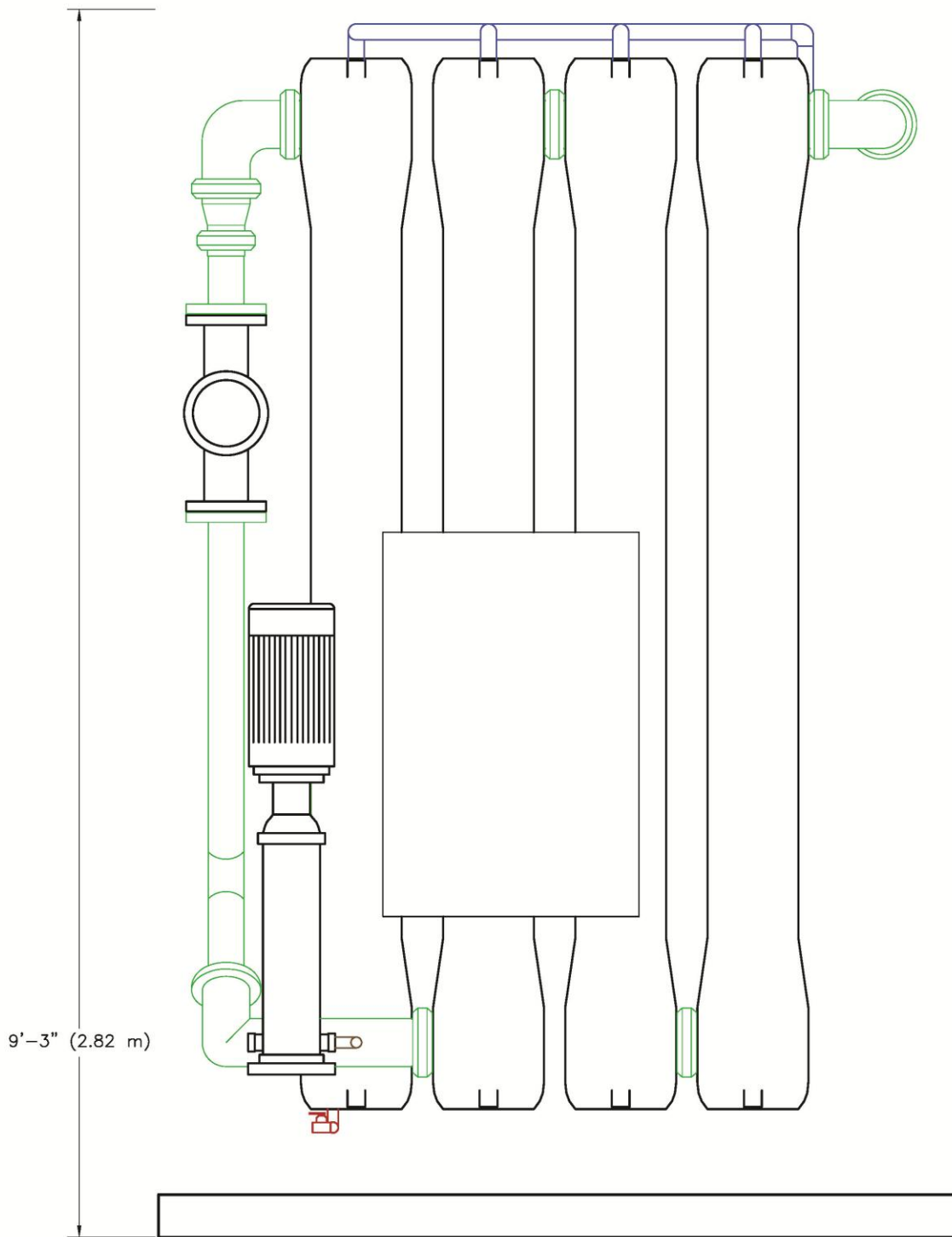
Profile of Seven Vessel LFNano™ System

Summary

The LFNano™ by EconoPure™ Water Systems is an ideal solution for India's critical drinking water shortage. The situation in India is a complex ecological, logistical, and economic issue; all of which are addressed by the use of LFNano™.

- The LFNano™ engineered for superior performance with highly contaminated surface water sources.

- The low energy consumption of the system not only provides for lower operating costs, but is also environmentally friendly.

- The compact size and the low-fouling feature allow the system to accommodate highly variable source waters with little to no adjustment, making for a flexible system. The system can be easily transported to benefit many villages, or, for larger communities, can be stationary-operated on a near-continuous basis.

- Finally, the LFNano™ is designed to be affordable and compact. The design also abets a lower operating cost, and the low-fouling membrane feature significantly reduces maintenance costs.