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Water: The Next Oil?

A Thirst-Quenching Role

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The Expeditionary Unit Water Purifier, or EUWP, is a lightweight, transportable system capable of purifying, storing and dispensing potable water in any austere environment from virtually any water source.

Its applications range from military troop support operations and homeland defense to disaster relief, humanitarian aid and municipal water supply.

The EUWP (Figure 1) consists of an ultra-filtration (UF) membrane process to remove suspended solids, followed by a reverse osmosis (RO) desalination process to remove dissolved solids. Raw water is drawn from a surface or underground source, passed through the UF and RO modules, and stored in bladders until it is needed.

A first-generation demonstration unit can produce about 100,000-gpd of potable water from a seawater source, or more than 200,000-gpd from a fresh water source.

Light Weight is Critical

The Generation I EUWP Demonstrator includes supplies for 100 hours of operation, 40,000-gal of product water storage, and a 60-kW generator.

A team of four water treatment specialists using a 10k forklift can set up the equipment and be producing potable water within six hours. It can operate unattended, with only periodic preventive maintenance performed by the operator, and can be converted to an electric-powered system for extended-duration missions.

The equipment consists of two separate 8 x 8 x 20-ft ISO-configured platforms with a total system weight of less than 35,000-lb.

Intended mainly as a transportable system to provide potable water to military troops, the EUWP is designed to be moved into the battlefield with a single sortie of the C-130 military transport aircraft. The requirement for airborne transport helped define the allowable size and weight – if the EUWP weighed too much, the range of the C-130 would be reduced because it would have to take less fuel to account for the weight.

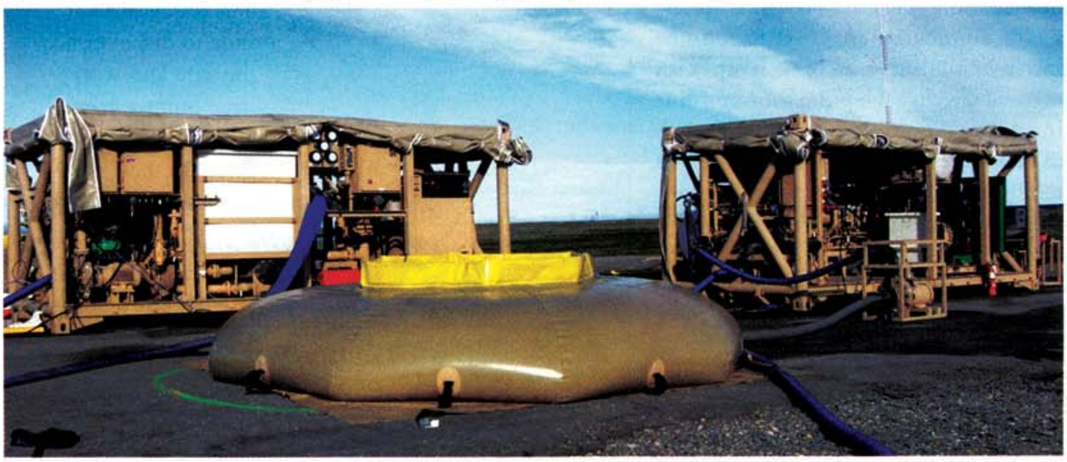
Likewise, for disaster relief, moving water – which is very heavy – by truck is a resource-intensive activity. It is easier to move a lightweight EUWP by truck or aircraft to a central location and distribute water from within the disaster zone, freeing up resources for other relief activities.

Because of the need to minimize weight, the EUWP's pumps are made of fiberglass-reinforced plastic (FRP). An FRP pump weighs approximately 25 percent of the equivalent carbon steel pump. "Using FRP pumps allowed the EUWP to come in under the target weight," explains Mike McCain, business manager at Village Marine Tec. (Gardena, CA) which developed the Generation I EUWP.

FRP Pumps: The Heart of the System

The EUWP system employs six FRP pumps – five ANSI close-coupled pumps and one self-priming close-coupled pump.

With the exception of its two-piece casing, the self-priming pump is interchangeable with its same-sized ANSI



An ultra-filtration (UF) backflush and reverse osmosis (RO) feed tank is positioned in front of an ultra-filtration module (on left) and a reverse osmosis module (on right, with a pump beside it).

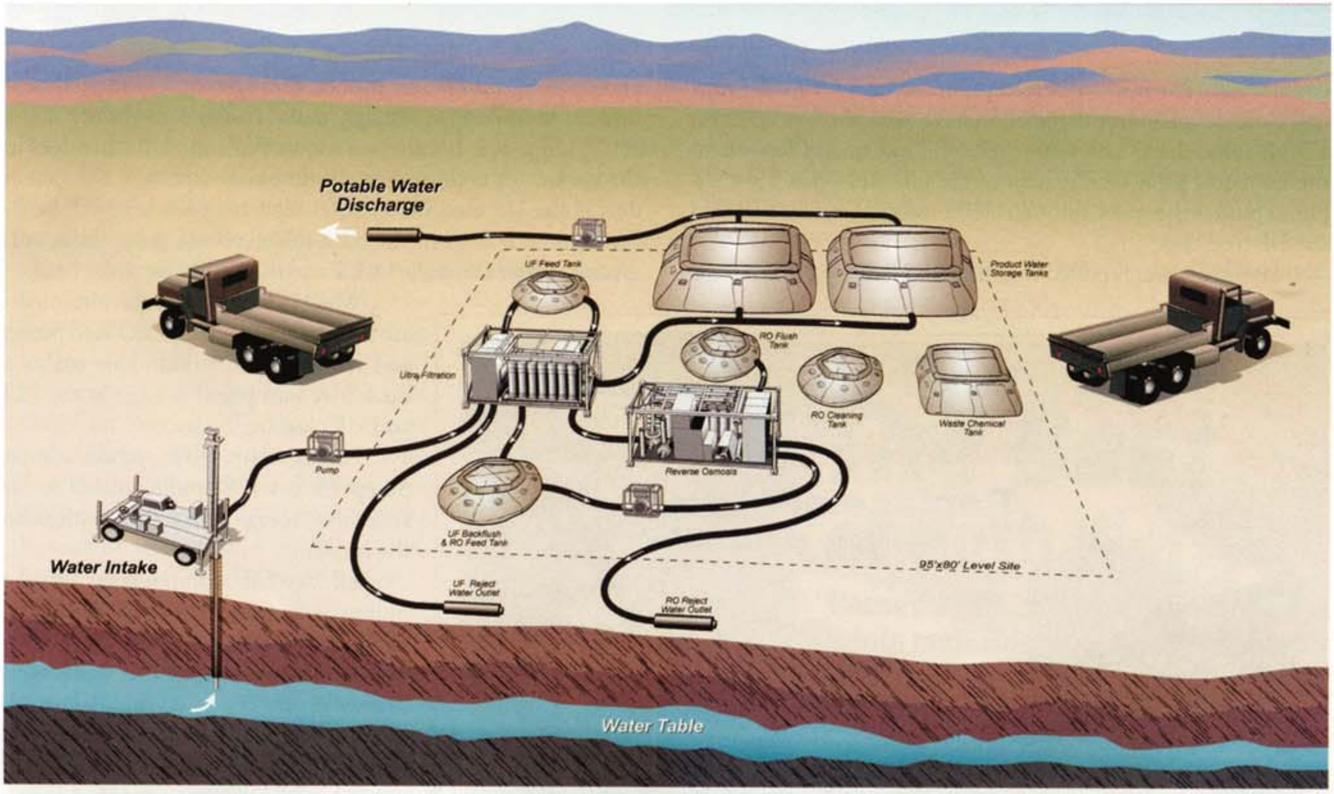


Figure 1. Artist's rendition of a 100,000-gpd Generation I Expeditionary Unit Water Purification (EUWP) site.
Source: Office of Naval Research

counterpart. The raw-water feed pump, a 3 x 4 x 10 self-priming, close-coupled unit designed to have vertical lift of 25-ft on a 50-ft inlet, draws raw water from the source and feeds it to the UF boost pump at the inlet of the UF skid. This 3 x 4 x 8 pump pushes the water through a 200-micron strainer and into the UF feed tank.

Strained water is pulled from the feed tank by the UF feed-and-cleaning pump and pushed through the UF filter system into an intermediate holding tank. This is a dual-duty 4 x 4 x 10 pump, as it is called on to fast-flush the UF cartridges in the back-flush cycle and to circulate water through the system during the UF cleaning cycle. A separate 4 x 6 x 10 UF back-flush pump is used in the back-flush cycle to pump large volumes of water through the UF cartridges on a periodic basis.

Water is pulled from the intermediate tank by the 3 x 4 x 10 RO feed pump and fed to the RO skid. This is also a dual-duty pump and is used in the RO and UF cleaning cycles.

Finally, the RO product-water pump (3 x 4 x 8) pulls potable water from the storage tanks and sends it to the user(s).

All wetted components of the pumps are constructed of fiberglass-reinforced vinyl ester resin. Only non-wetted parts are metallic: shafts and hardware are Type 303 stainless steel, and the bearing frame is polyester thermosetting powder coated cast iron. O-rings are made of Viton, and the bearing frame is epoxy-coated cast iron.

In addition to light weight, other benefits of FRP pumps include corrosion resistance, lower cost, longer service life and reduced maintenance compared to metal pumps. "We did a search of the available pumps that met our requirements. I've had good experience with these", McCain points out. "Many have been running in installations around the clock and have proven very reliable."

FRP and RO – Perfect Together

Osmosis is the naturally-occurring movement of a fluid (e.g., water) through a semi-permeable membrane into a solution of higher-solute (e.g., salt) concentration, which tends to equalize the concentrations of solute on the two sides of the membrane.

In reverse osmosis, pressure is applied to the solution of higher concentration (e.g., seawater) using a pump, which forces the fluid through the membrane in the opposite direction of osmosis. The membrane prevents the salts and contaminants from passing into the low-concentration solution.

The product is a solution with a very low solute concentration on one side of the membrane (i.e., the drinking water). The reject (or brine) is a solution of very high solute concentration on the pressurized side of the membrane.

Reverse osmosis was selected as the core technology for the EUWP because of its ability to desalinate water with a wide range of salinity – from seawater to brackish water – and its effectiveness against most water contaminants.

Decreasing the Costs of Desalination

The Expeditionary Unit Water Purification (EUWP) science and technology program is a Congressionally-mandated effort to reduce the cost of desalination in the United States.

The program is managed by the Office of Naval Research (ONR). Many other organizations have an interest in it as well: the Army's Tank Automotive Research Development and Engineering Center (TARDEC), Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), and the Department of Interior's Bureau of Reclamation (BOR), among others.

The primary goals for expeditionary water purification systems are ease of deployment, mobility, and logistics support. The current research focus of the EUWP program is technology that reduces system energy consumption, size and weight, and improves distribution capabilities.

There are two major aspects to this program.

The first is the development of two demonstrators – a 100,000-gpd water purification system that can be transported in a C-130 aircraft, known as the Generation I EUWP Demonstrator, which was designed and manufactured by Village Marine Tec. This system is based on available state-of-the-art technology and can provide support for a variety of strategic and operational missions, including military, humanitarian and homeland security operations. The Generation II Demonstrator will be a 300,000-gpd water purification engineering prototype based on the results of emerging science and technology.

The second major aspect of the program focuses on stimulating discovery and invention in science and technology to push well beyond the present state-of-the-art in water purification technologies. This aspect of the program seeks to identify, develop, and transition alternative technologies that will significantly improve midterm (5-10 years) and longer term (10-20 years) capabilities.

The short-term goal is to develop technologies that will transition directly into the next generation of portable water desalination systems and provide significant results in performance, weight savings, and size reduction. The long-term goal is to discover disruptive technologies that will dramatically reduce the costs and energy for desalination.

RO is considered one of the best available treatment techniques for most classes of chemicals. In addition, it requires less energy to desalt seawater than such technologies as distillation and electrodialysis.

Because the raw water is saline and corrosive, and the other processes in an RO plant (such as cleaning) involve corrosive chemicals, the use of high-grade alloys or nonmetallic components is always recommended. Common stainless steels (such as Types 304, 316 and 904) have limited corrosion resistance in high-salinity applications, particularly very highly brackish water and seawater. Exotic alloys that would offer sufficient corrosion resistance ae very expensive. This means fiberglass-reinforced plastic is an economical and reliable alternative for reverse osmosis desalination.

FRP has been the material of choice for horizontal and vertical pumps performing various functions throughout RO plants, specifically: seawater intake pumps; filter feed pumps; intermediate booster or raw water transfer pumps; filter backwash pumps; cleaning recirculation pumps; flushing pumps; permeate water pumps; and neutralization pumps.

According to Mohammed Saud, projects manager for Desalination System Design and Engineering at Bushnak Group's Water and Environmental Services Company (WESCO; Jeddah, Saudi Arabia), in the last several years alone FRP pumps have been installed in numerous RO-based desalination plants, with capacities ranging from 3,000-m^3/day to 25,000-m^3/day, in Saudi Arabia, Oman and India.

The EUWP operates in blowing sand, dust and rain, at air temperatures from 32-deg F to 120-deg F with water at 28-deg F to 105-deg F – all conditions that are well within the capabilities of FRP pumps.

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