Comparison of textile-based packed bed filters with other innovative technologies.

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EXECUTIVE SUMMARY

For the past decades, packed bed filters (PBFs) have successfully provided consistent and reliable treatment for small to medium wastewater flows. Textile-based packed bed filters, incorporating an engineered treatment medium, have greatly expanded packed bed technology options by incorporating a manufactured media that is easily serviced and capable of producing high quality effluent. The effluent quality produced by these units is consistently superior to that discharged by the majority of our nation's municipal treatment facilities and is ideal for many water-reuse applications. Numerous installations have been made in Greece the last decade focusing on an easy to maintain wastewater treatment plants with minimum cost of operation, minimum biosolids production, high reliability and flexibility, Consistent trouble-free operation of the system, very long warrantees and lifetime as well as superb effluent quality. The quality produced can be compared with MBR plants' effluent, but with lower investment costs and 7-10 times less in O&M costs.

1 INTRODUCTION

The efforts to improve loading capacities and serviceability have led to extensive research into a wide variety of media (e.g., foam, glass, styrene, plastic products, expanded clays, zeolite, limestone, furnace slag, peat, etc.). Over the last decades, this research has led to the development of an advanced technology for packed bed filters that uses an engineered textile medium assembled in a variety of configurations.

1.1 Background

Textile provides all the benefits inherent in the packed bed filter design but overcomes the limitations listed bellow.

- **Land area** — The land area needed is significantly smaller than that for sand filters because loading rates are 5 to 30 times higher (typically, 600-1200 Lpd/m^2 with peak flow capacity/factor (PF) of 2.0 or greater, based on residential effluent quality as described in Tables 1 and 2). Thus, the footprint area for a textile filter serving a typical four-bedroom single-family home is now only about 2 square meters. If the textile filter is positioned over the processing tank, virtually no additional area is required. Comparing with activated sludge variations the surface is more or less at the same size
- **Media quality and availability** — The manufactured textile medium ensures consistent quality and availability, lasting for more than 25 years and cheap for replacement.
- **Installation quality** — Lightweight textile medium (64 kg/m^3) and small filter size make pre-manufactured treatment units practical, eliminating onsite construction and reducing installation time, labor, and construction errors. These characteristics make textile systems ideal for cost-saving self-help programs and particularly suited for difficult-to-access and remotely located sites.
- **Serviceability** — Special configurations allow for ease of maintenance and cleaning without expensive or large excavation equipment, or the need for replacing the medium. A single-family residential filter can now be cleaned and serviced in as little as an hour. The initial research on the textile medium began with small chips or “coupons” with a complex fiber structure, which offered an extremely large surface area for biomass attachment. Later research has been focused on developing textile filter blends and configurations that address early packed bed filter issues regarding ease of serviceability without sacrificing equivalent performance. Porosity, attached growth surface area, and water-holding capacity contribute to the textile media’s treatment performance.
- **Porosity**. The porosity of the textile media is several times greater than that of sand, gravel, and other particle-type mediums. The more porous the medium, the greater its hydraulic conductivity, the greater its air space (which enhances the capacity of passively ventilated systems and free air movement), and the greater its capacity for the accumulation of solids and biomass development.
- **Surface area** . Textile media can be blended with a variety of fibers to achieve relatively large total surface area per unit volume (m^2/m^3). In current media blends, the typical attached-growth surface area is 4-8 times greater than recirculating filter media. Expanding the biomass growth area provides a greater surface potential for air and effluent to interface and come in contact with the biomass.
- **Water-holding capacity** . The water-holding capacity of textile media also varies considerably depending on the media density, type of material, and blend of fibers. The water-holding capacity in textile media is also several times greater than expected in the sands and gravels used in filters. Water-holding capacity performs a key function in the treatment process. Together with the programmed dosing time and frequency, it governs the effluent retention time within the filter and ultimate effluent quality.
- **Light weight.** Since the polypropylene textile is very light, the system is very easy to transfer and install.

2 PERFORMANCE OF TEXTILE - BASED PACKED BED FILTERS

In the past three years, performance evaluations have been conducted and reported on by facilities such as the University of California, Davis Campus; NSF International; and NovaTec Consultants, Inc. of Vancouver, British Columbia. The University of California Davis study (*Leverenz, et al., 2000*) was conducted following standard method composite sampling and testing procedures. The evaluations performed by NSF International and NovaTec Consultants (*Vassos and Turk, 2002*) were conducted per ANSI/NSF Standard 40 protocol. The ANSI/NSF Standard 40 evaluation resulted in the first ever certification of a packed-bed textile filter under ANSI/NSF Standard 40 for Residential Wastewater Treatment Systems. Over the course of the NSF40 evaluation, the average effluent cBOD5 was 5 mg/L and the average effluent TSS was 4 mg/L at a hydraulic loading rate of 1185 Lpd/m^2. The units evaluated contained vertically aligned textile sheets (AX) as shown in Figure 1. The evaluations successfully established the ability of this configuration to meet advanced wastewater treatment levels and surpassed, by a considerable margin, the effluent quality performance requirements established by ANSI/NSF Standard 40 for Class I effluent.

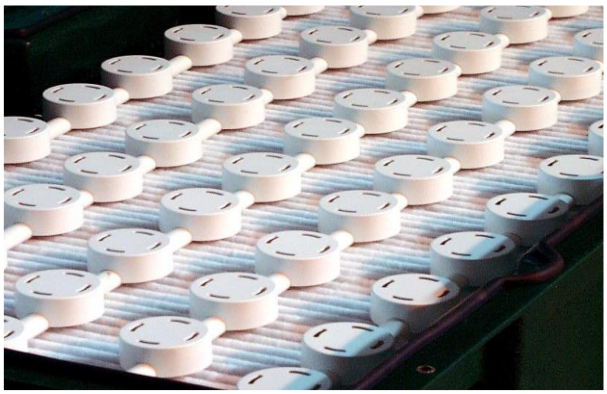

Figure 1: AX20 AdvanTex® filter with aligned textile sheets

Additional performance evaluation demonstrated the ability of the unit to function under peak design hydraulic and solids-loading conditions for extended periods of time, without service. Over a span of nearly 14 months, NovaTec Consultants (*Vassos and Turk, 2002*) continuously evaluated performance under peak hydraulic loading conditions (HLR). For 10 of those months, the HLR exceeded 2445 Lpd/m^2, and for a period of about 3.5 months the loading rate was 1.965 Lpd/m^2.

2.1 Additional Attributes of Packed Bed Filters

All small-scale wastewater systems serving individual homes or clusters of homes need to meet the following requirements:

- Quick startup
- Efficient performance with highly variable wastewater strengths and flows, including occasional hydraulic and biologic overloads
- No release of untreated sewage if a malfunction occurs
- Consistent trouble-free operation; low maintenance (e.g. annual service call recommended; on-site routine service time 1 hour ±)
- Ease of maintenance (components should be easily accessible and serviceable
- Low energy consumption
- Adequate storage during power outages (normally 24 hours or more at typical flows)
- Recoverable and expandable
- Reliability in providing the level of treated water required to final dispersal treatment processes

3 INSTALLATIONS IN GREECE

More than 60 installations have been implemented in every part of Greece. The solution was found very attractive in islands and small communities as well as tourist resorts, club hotels and country households. During the tough period that Greek economy goes through, there are innovative wastewater treatment systems that provide very good quality effluent with a total cost of 6-7 Euro per capita per year including electricity cost. Comparable with all known commercial compact systems in Europe, AdvanTex has the best Economic Analysis results with the lower total combined costs (investment, operation and maintenance) with very good tertiary effluent!

4 CONCLUSION

Test data from residential and commercial packed bed filters incorporating textile media has shown that textile filters provide consistent, high quality wastewater treatment: better than 10/10 cBOD5/TSS. Consequently, they have proven to be an ideal solution in the following, diverse applications:

- New onsite wastewater treatment systems
- Repairs and reclamation projects
- Jurisdictions requiring nutrient reduction
- Seasonal or periodically used facilities
- Facilities with extreme variations in daily flows
- Overloaded single and multiple-pass sand and gravel filters
- Wherever water reuse is essential

Moreover, effluent sewers incorporating textile filter treatment units can be used to replace failing conventional collection and treatment systems. Because textile is lightweight, it can be incorporated into small, affordable, pre-manufactured treatment units. And because the units are modular, they permit easy system expansion in the event of continued over-use or under-design.

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