Kuwaiti Applications

Application of VS for Industrial and Urban Wastewater Treatment and other Applications under Kuwaiti Environment.

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INTRODUCTION

Fresh and potable water scarcity is predicted to become the greatest single threat to international stability, human health, global food supply, poverty and even the specter of war in some regions. According to the World Resources Institute, within 25 years, more than half of the world population will be suffering severe fresh water shortages. This looming crisis is reflected by a host of international conferences in the last few years. Therefore wastewater, after being properly treated, should be considered as a resource rather than a problem under the arid environment like Kuwait.

Desalinization of seawater and chemically treated polluted and contaminated water are energy-hungry and very costly that most developing countries cannot afford. But most importantly, the by-products of these treatment processes, such as salt and concentrated toxic materials are often themselves, a bigger problem.

Application of the Vetiver System to improve wastewater quality is a new and innovative phytoremedial technology, which has the potential to meet all the right criteria. It is a natural, green, simple, practicable and cost effective solution and most importantly, its by-product offers a range of uses from handicrafts, animal feeds, thatches, mulch and fuel just to name a few.

This paper presents the state of knowledge of the proven applications of VS in wastewater treatment and disposal and explores the potential of using these applications in Kuwait. Therefore it will concentrate on the following applications:

1. **Treating effluent in storage ponds and wetland**
2. **Stabilisation of infrastructure with primary treated effluent**
3. **Desert rehabilitation and cropping with underground water**
4. **Water harvesting**
5. **Using semi saline water from oil wells for desert rehabilitation**

SOME ENVIRONMENTAL ATTRIBUTES OF KUWAIT

- **Climate**

Kuwait has a typical Mediterranean climate, dry and hot summer, and wet and cold winter. Temperature often exceed 45oC in July, and maximum 20oC in winter with frequent frosts

Rainfall ranges from 23 to 206mm/year, averaging 111mm/year,

- **Soil**

Soils are mostly sand to sandy loam, bordered by extensive mudflats created by the floodwaters of the Tigris and Euphrates Rivers which enter the north end of the Gulf through the Shatt Al-Arab waterway. The soils are normally, compacted due to military activity.

ATTRIBUTES OF VETIVER FOR SEMI-ARID AND ARID ENVIRONMENT

As presented by various speakers, vetiver grs as many extraordinary attributes, but the following are especially suited for various application in Kuwait:

- High level of tolerance to drought and flood
- High level of tolerance to cold (-14^{o}C) and heat (55 ^{o}C)
- High level of tolerance to extremely adverse growing conditions such as high soil acidity and heavy metal toxicities.
- High level of tolerance to soil salinity, sodicity and alkalinity.
- High level of tolerance to fire, animal grazing and heavy traffic.
- Very quick recovery after the adverse conditions improved.

POTENTIAL APPLICATIONS IN KUWAIT

1. **Treating effluent in storage ponds and wetlands**

As presented previously by this author, VS is the most effective, low costs and environmentally friendly means of treating domestic, urban and industrial effluent, onsite, in storage ponds and/or wetlands such as the Al-Jahra wetlands in western Kuwait, which has been used as sewage disposal lagoons.

The only natural wetlands in Kuwait are marine and coastal. There are no natural lakes of any kind and no permanent water courses. The only significant freshwater wetland is a complex of shallow pools and marshes fed by sewage and other wastewater in an area of sabkha near the town of Al-Jahra at the west end of Kuwait Bay.

The sewage and other wastewater by:

- Wetlands
- Soil based reed bed
- Flow through system

All these systems can be applied not only at the Al-jahra wetland, but also applicable in any population centres.

Wetlands

Natural or man made wetlands are recognised as a very effective and low cost system of treating effluent and wastewater, and VS is the most effective method due to its fast growth, high biomass and high pollutant absorption rate.

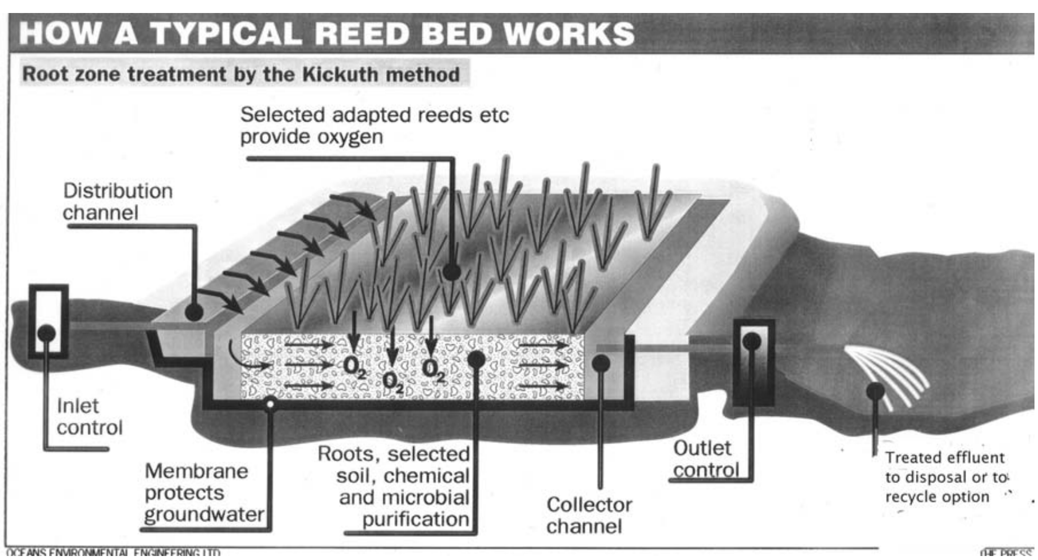
Ponded wetlands

Semi wetland

Soil Based Reed Beds (SBRB)

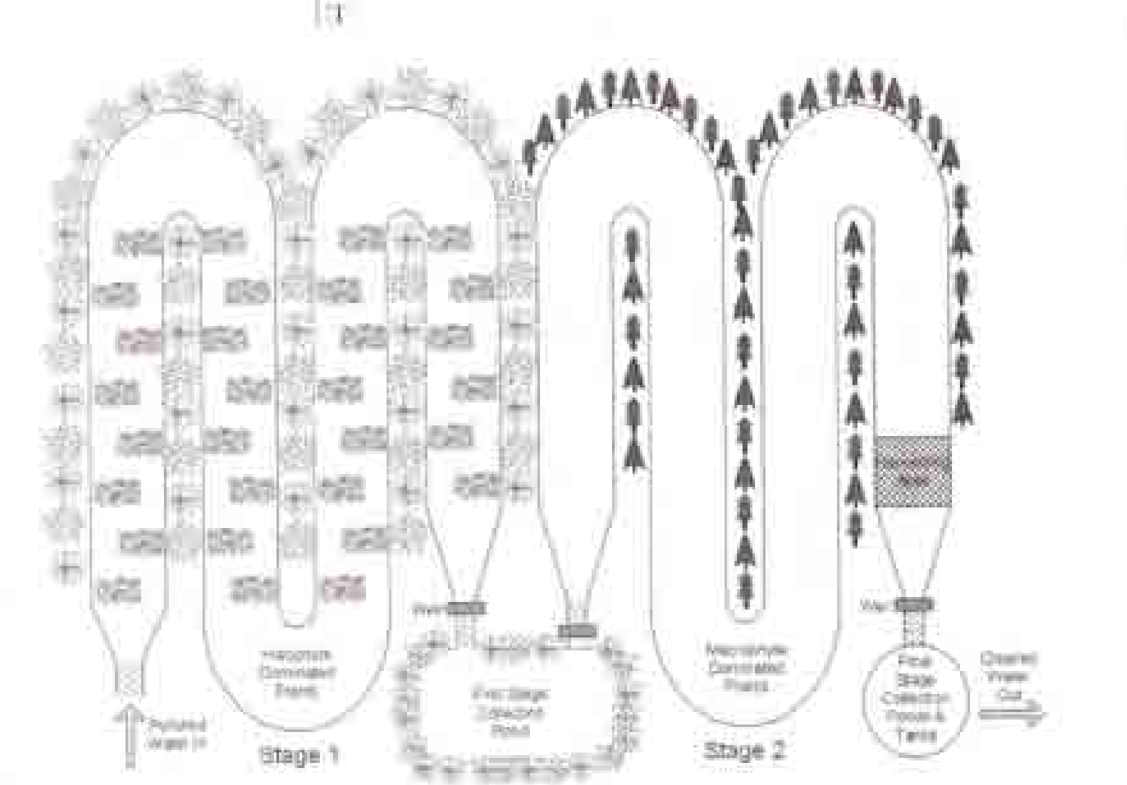
SBRBs have been used widely throughout the world to effectively treat domestic wastewater, as well as a diverse range of highly contaminated industrial, chemical and agricultural effluents. The reed bed system described here is a soil based plant and micro-biological system in which the effluent moves through the soil fully below the reed bed surface. Prof. Kickuth in Germany originally developed this wastewater treatment approach over 30 years ago. SBRB systems have since been developed and refined through hundreds of successful applications around the world. This includes substantial reduction of nutrients (i.e. total nitrogen and phosphorus) as well as Biological Oxygen Demand (BOD), Suspended Solids (SS) and Faecal Coliforms (FC).

Using the sub-surface flow system the wastewater comes into contact with the wide range of microorganisms that occur in high densities on the surface of the growing media and around the plant roots. Where fine particle size media are used (soils and fine sands), the number of micro-organisms is very significant. Additionally in the soil based system the inherent reactivity of the clay particles and humic particles within the matrix can be exploited as a measurable contributor to the treatment process

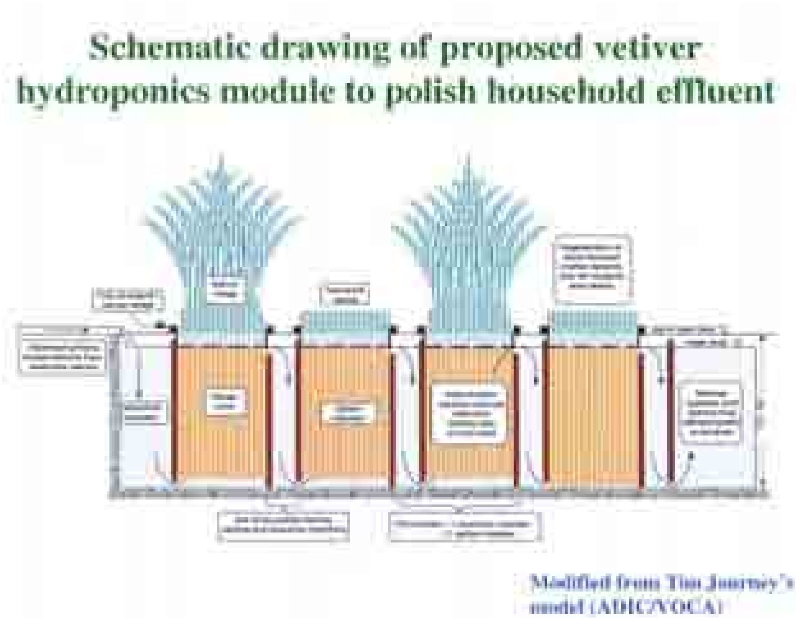


Flow through system

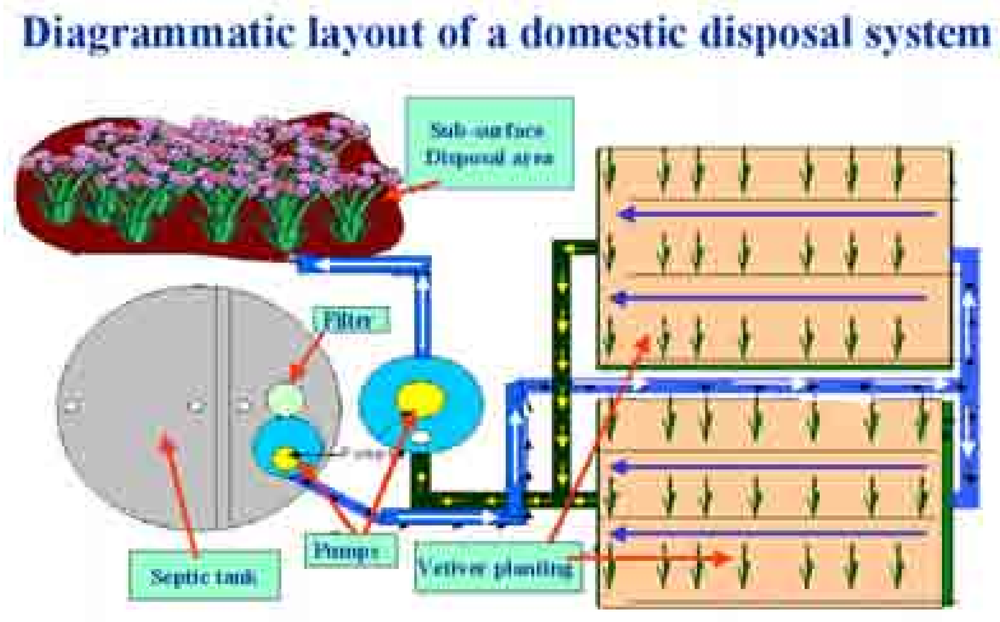
Industrial Scale



Small Business Scale



Domestic Scale for Single Household



For an average house in Australia, with 4-6 people, an area of $23m^2$ and 120 vetiver plants are needed to dispose all the sewage effluent, both black and grey water, generated by this household.

Young vetiver plants incorporated to garden bed

Three months later

2. Stabilisation of infrastructure with primary treated effluent

Sewage effluent, landfill leachate, industrial wastewaters are commonly rich in nutrients, particularly N and P. They are therefore a valuable resource under arid environment like Kuwait. Depending on their sources, these wastewaters may need to be first treated to eliminate bacterial contaminations such as *E, coli* and *Coliform* bacteria. Applications will include earthworks and land shaping for real estate development, dredged material and landfill earth works for urban and industrial developments and other construction around the population centers,

3. Desert rehabilitation and cropping with underground water

Most of the soils in the Middle East are desert soils with low organic carbon content, high pH (due either to high $CaCO_3$ or of high Na_2CO_3) concentrations, low available N and relatively high levels of P and of K. In most cases the soils have a coarse structure starting from sandy soils and ending with gravely soils, and the most preferred the local are sandy and gravely soils.

In the Negev desert in Israel, semi saline underground water is use for ornamental plants as well as horticultural crop such as tomato, citrus etc.

Case Study (D. Pasternak pers.com.)

- ***Ramat Negev, or the occupies about 30% of the Israeli Negev desert***
- ***From 1943-1956 three Kibbutzim-(Collective settlements) were established in Negev Highlands. Lack of fresh water prevented further development of the region***
- ***In the mid sixties, as a result of oil exploration, saline water was discovered at a depth of 1,000m***
- ***In 1970 an experimental desalination plant was built. A well costing US$1.00 million was drilled to supply water for desalination.***
- ***The EC of this well water was 4.5dS/m. SAR was 8.5. Chloride was the main anion and Na the main cation***
- ***In 1971 a small experimental plot was built by the saline water well to explore direct use of saline water for irrigation***
- ***Tomatoes were classified as a moderately salt tolerant species.***
- ***Sprinkler irrigation was used on seven processing tomatoes varieties***
- ***Yield reduction was >30% on saline water irrigation***
- ***But drip irrigated tomatoes (and other crops) can 'tolerate" saline water better than tomatoes irrigated by surface or sprinkler methods***
- ***Research effort over a 10 years period has turned tomatoes from a relatively "salt sensitive" crop into a "salt tolerant" crop.***
- ***Using the information gained in this study it is possible now to grow processing tomatoes with 6.2 dS/m (4,000ppm TDS) water with no reduction in revenue***
- ***A separate study demonstrated that salinity significantly improves the taste of table tomato . The "desert sweet" brand created to market saline water tomatoes significantly increased income from these tomatoes as compared with fresh water irrigated tomatoes***

In addition to the potential of applying this technology to growing other crops such as dates, and citrus fruits. With its relatively high tolerance to salinity vetiver grass would thrive under these conditions and therefore providing a green cover on the landscape as well as fodder for livestock.

4. Water harvesting

4.1 Rehabilitation of arid land and desert areas

When planted in row vetiver plants will form a hedge, a living porous barrier which slows and spreads run-off water and traps sediment. As water flow is slowed down, its erosive power is reduced and at the same time the hedges allows more time for water to infiltrate to the soil, and any eroded material is trapped. Therefore an effective hedge will reduce soil erosion, conserve soil moisture and trap sediment on site.

There are five main ways that vetiver can improve the rehabilitation of degraded arid lands, and the reclamation or stopping the spread of desertification:

Spreading and improving infiltration of run-off water

One of the main reasons that revegetation of degraded arid land and desert fringes do not occur naturally is the loss of surface water due to slow rate of water infiltration. This is due to the exposure of subsoil or surface crusting resulting from overgrazing or wind erosion. The slow infiltration will lead to excessive run-off which often concentrates in depressions or gullies and very quickly drains off from the land and is lost from the area where it is needed most for the rehabilitation process. Appropriately laid out vetiver hedges will slow and spread the water which is concentrated in these depressions and gullies to other areas of the land. It will then have more time to infiltrate and move deeper to the sub surface profile where it is less likely to be lost from surface evaporation.

Over time this trapped soil moisture will further improve the soil structure which will provide more favourable environment for the revegetation either by introduced plants or naturally from seeds from the surrounding areas.

Diverting and concentrating water

When planted on a low grade slope (0.2-0.5%) vetiver hedges can be used as very effective diversion structures to collect and divert water to protect a critical areas such as gully heads, to concentrate run-off water to areas where rehabilitation is a top priority or to a recharge catchments to improve under ground water supply. The latter practice has been used very successfully in the semi arid zone of India to improve water supply in village wells down slope.

Trapping sediment

Silt fans formed from the trapped sediment, resulted from both water and wind erosion, are important sites for revegetation in the following ways:

- The soil is lighter in texture, often more sandy, giving a higher rate of water infiltration so it is more efficient in conserving soil moisture particularly following light rain.
- It is often more fertile than the surrounding soil.
- It is a rich source of seeds from plants which are endemic to the region; this is a very important point in the revegetation of arid zone.

o Experience in Australia and around the world show that these silt fans are the first areas to be colonised by local plants or sown species. As these silt fans extended up slope with time the revegetation process continue to spread naturally.

Providing shade

Shade is often overlooked as an important factor for the success of revegetation in the hot and dry climate of arid and desert fringe environment. In South Africa, Kimberlite the waste rock from diamond mining, is black in colour and in the full sun of summer temperatures higher than 55^0C have been recorded on the surface. Under these conditions very few plants can be established particularly from seeds, vetiver has been successfully established on the Kimberlite under irrigation, but most interestingly it was found that the areas next to certain hedges, grasses and other plants have also been established voluntarily. On closer examination it was found that these plants were located mostly next to vetiver hedges which provided good shade to the seedlings, indicating that vetiver hedges were able to protect the young seedlings from the hot sun.

In Australia vetiver hedges have been shown to provide good shade for sheep on the treeless grassland in the tropics, where heat stress can reduce lambing up to 30%. Therefore wherever possible vetiver hedges should be planted in the general North-South direction to maximise the shading benefit.

Protection soil from wind erosion and plants from sand blasting and sand drift

Strong winds in arid and desert zones are often detrimental to plant growth, eroding surface soil, drying up soil moisture and physically damaging plants particularly seedlings. Vetiver hedges have been used very effectively as wind barriers to reduce wind erosion in semi arid zone in tropical Australia and also to protect crops from sand drift and blasting in coastal dunes in China and vietnam

4.2 Shallow ponding, artificial Wadis

A **Wadi** is a ‘dry riverbed’ that only contains water during times of heavy rain. It is an area of ‘clay accumulation’ where over the period of hundreds of years, the silt and clay fractions have been washed and ‘ground’ (by the action of animals’ hooves) out of the surrounding soil and transported to the ‘out-wash plain’ leaving the sand behind to form the desert.

In Australia the same principles were applied in a practice called ‘shallow ponding’ where low retaining earthen structures were built to collect and temporarily pond run-off water. This practice has been used very successfully to revegetate barren lands in arid and fringe desert zones in central Australia.

Shallow pond is being built on barren salt pan in Central Australia.

Catching rain water to 20-30cm depth

Vetiver established and grew well in 4 months. Note the barren ground outside the ponds

In Kuwait with suitable soil types and topography, the shallow ponding method will create man-made wadis. With its massive and extremely deep root system vetiver will thrive in these artificial wadis, providing fodder to livestock.

5. Using semi saline water from oil wells for desert rehabilitation

As mentioned above, semi saline water usually comes up to surface as results of oil drilling in Saudi and Israeli deserts, If similar process is occurring in Kuwait then this water can be used to revegetate areas around oil well, to control wind erosion, reduce sand storms and also provide feed for animal.

Similar technology as mentioned before could be developed and adopted for the rehabilitation of war-affected desert dunes near the oil wells.

Conclusion

Global results show that the VS effectively reduced soil erosion, improved the quality of wastewater, due to its unique characteristics, such as higher biomass, fast growth, and strong root systems. VS is unique for its use for sustainable development and environmental integrity.

But to achieve these goals, VS has to be applied correctly with appropriate design and maintenance