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Short Communication

BIOETHANOL FROM GREYWATER DATES TO FUEL DESALINATION PLANTS

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This communication describes an approach to enhance water supplies in arid Middle Eastern countries by using alternative fuels to power desalination plants. The demand for clean drinking water is becoming critical (Al-Rimmawi, 2010) in many parts of the world, and the focus is on the use of sustainable resources to augment aquatic sources, such as groundwater and reservoirs. Desalination plants are currently run on fossil fuel derivatives, which could be replaced in the interest of mitigating climate change (El-Nashar, 1989) and reducing our dependence on them.

To alleviate the growing shortage of water, particularly in arid regions, a practical approach is to deploy bioethanol from surplus and greywater dates to fuel desalination plants. In times of natural disasters and turmoil, water shortage could become chronic, and sustainability is a primary concern. Bioethanol is an acclaimed fuel additive used widely in Brazil and North America (Oliveira *et al*., 2005) as a source of clean energy. It is known that production of bioethanol has faced disagreeable competition with food production (Murillo, 2013), and has been at the centre of land sequestration issues related to agricultural products. However, deserts are expansive and date palms could be grown under hardy and robust conditions without competing for land and disabling the date industry.

Surplus dates - originating from excessive food production and low-gradefruit - that are not consumed could be salvaged for extracting bioethanol. Another prospective source of dates is from the use of greywater systems (Nolde, 2005) to irrigate vast expanses of desert. The second case is more exciting and greywater systems could be designed for the specific production of dates under desert conditions. Specially constructed plants could be used to divert greywater from urban, suburban and ablution centres to arid areas dedicated to cultivating dates for bioethanol production. Of considerable significance is that date palms have a level of tolerance for salt water. From previous studies (Alhammadi, 2006) it is known that date palms can flourish in saline water with a salt content of 3000 ppm (0.30%). Sea water has a salinity of about 3.5% and could be blended with grey water to irrigate date palms. This would reduce the amount of greywater needed for irrigation. Figure 1 represents a typical blended sea-water/greywater system engineered to irrigate land demarcated for agricultural date production.

An alternative is to add the waste salt from desalination to greywater. This would appreciably reduce the waste products from desalination plants and lead to a cycle where the superfluous waste material is re-used to produce clean drinking water (Fig. 2).

It costs roughly US $1000 to produce about 1200 m^3 potable water from sea water using current desalination technology (Paulson, 2015). Evidently, this figure does not include harnessing oil and capturing and sequestering the carbon dioxide emissions. This cost could be diminished to make bioethanol technology a viable proposition. Overall, the whole process governing bioethanol production, from growing the dates to the final product, should be economical and not exceed current fossil fuel costs incurred from running desalination plants. If economic considerations are taken into account, it is clear that the greywater itself and land (desert) come with basic costs. Some of these costs are not necessarily cumulative, but there is a definite progressive labour cost for cultivating and harvesting the dates; and a financial outlay for erecting and maintaining a high-powered greywater system. Processing costs for the biomass (dates) is also minimal and the feedstock can be routinely deployed for bioethanol production. Re-modelling parts of desalination plants for bioethanol deployment will form a segment of the overall expenditure, but is not accumulative. Generation of bioethanol on a small scale from locally produced dates is ongoing in our research laboratory. The process itself is standard and entails fermentation followed by distillation and purification.

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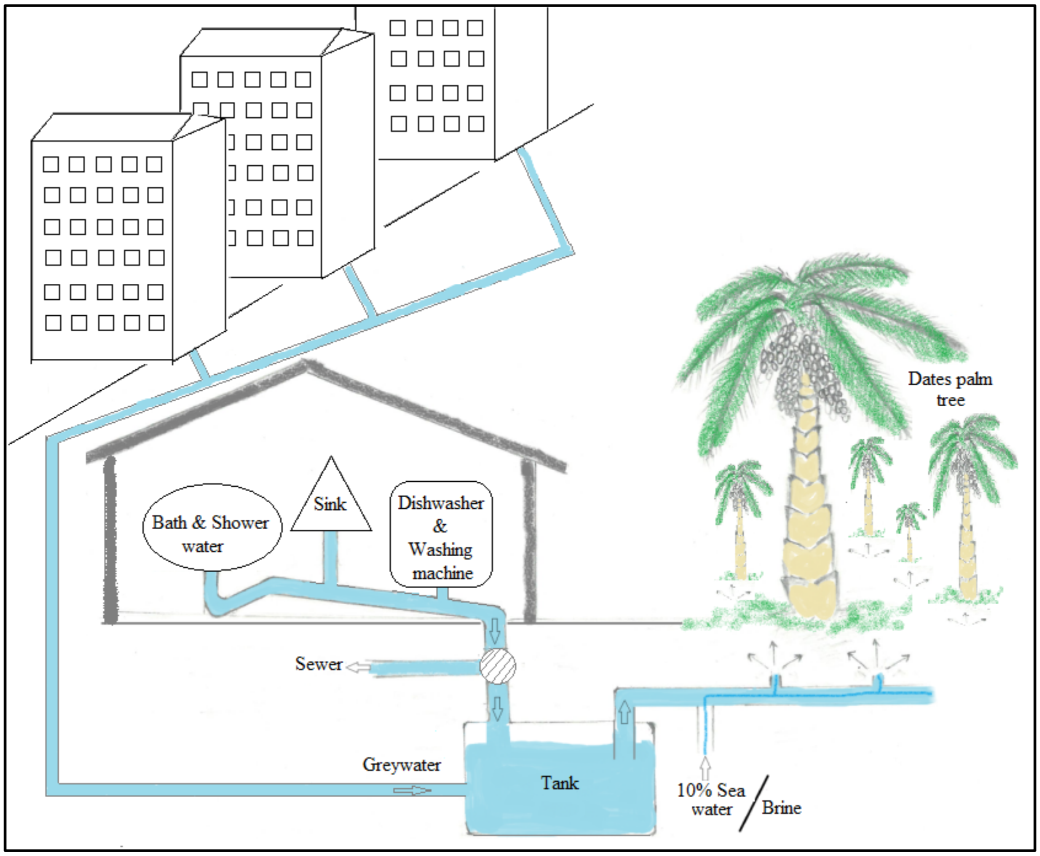

Fig. 1. Production of greywater dates.

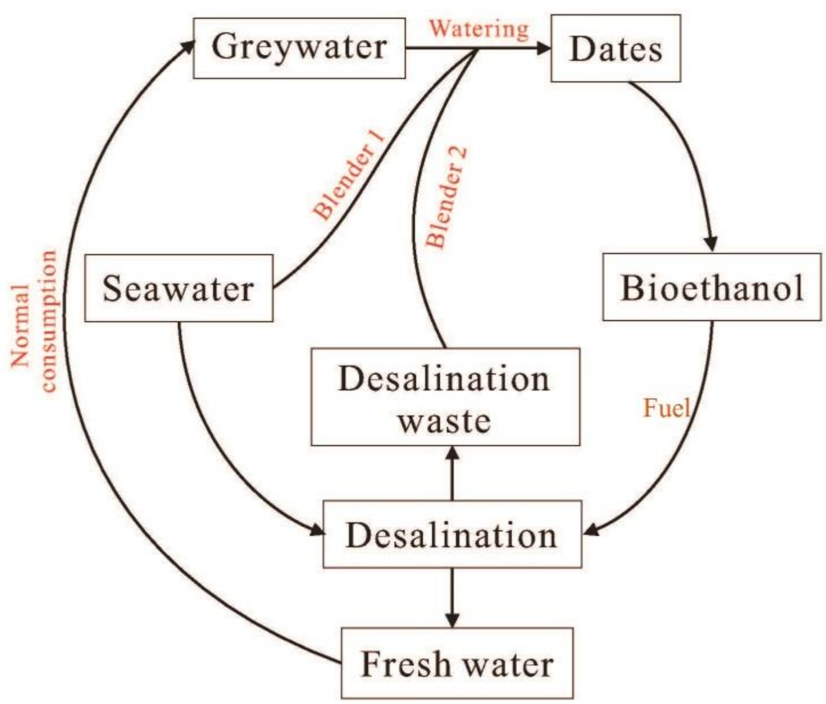

Fig. 2. Greywater cycle.

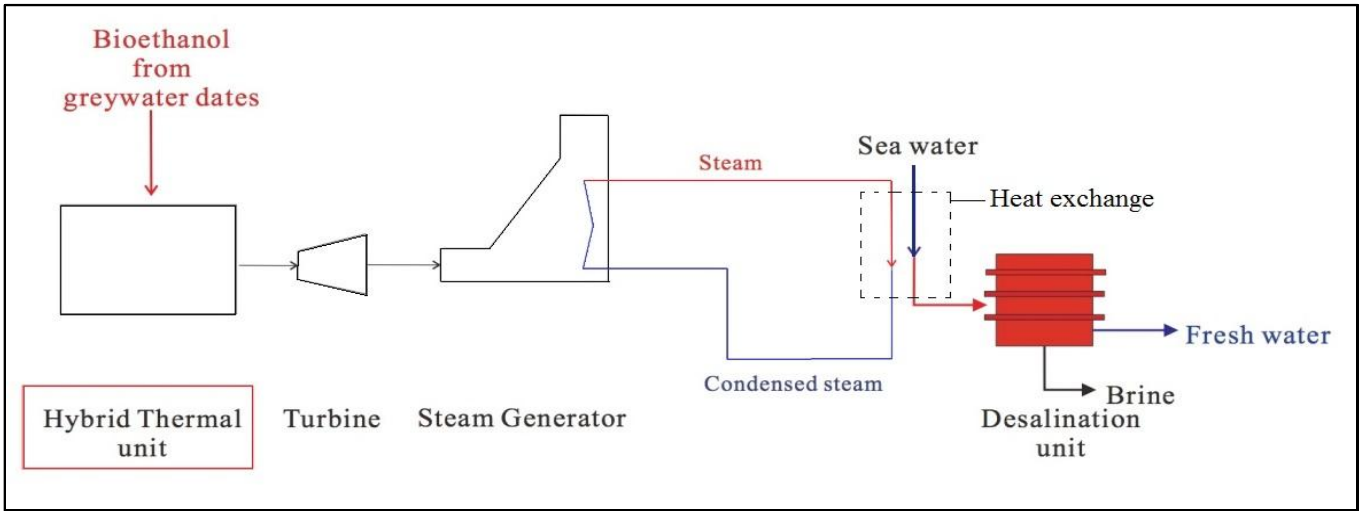

Fig. 3. Future modern desalination plant with hybrid thermal unit.

The cost of distillation could be scaled down by ultimately using the produced bioethanol for thermal energy. On a lab-scale up to about 40% bioethanol can be derived from the feedstock. Of course, there are several factors that could affect this yield, including the quality of the dates and the season in which they are harvested. However, this output is favourable and could be extrapolated to a large scale industrial plant. With prudent planning, millions of tons of dates could be harvested each year using greywater technology without competing with the traditional date industry. Separate tracts of land and independent water supplies can be earmarked for wholesale production without deforestation, and without affecting land demand and regular water supplies.

One of the primary motives for proposing the use of bioethanol to fuel desalination plants is to alleviate climate change. Carbon dioxide emissions from desalination plants are enormous and the race is on to utilise renewable energy sources (El-Nashar, 1989; Paulson, 2015) to power desalination plants and thus mitigate climate change. Many desalination plants are driven by thermal energy for distillation. Some utilise the phenomenon of reverse osmosis, which requires less energy. Naturally, the machinery and thermal unit of the system will have to be either modified or hybridised for generation of thermal energy by the processed bioethanol. Figure 3 represents a future modern desalination plant with a hybrid thermal unit using bioethanol for production of thermal energy for steam generation. The development of a hybrid unit is a relatively inexpensive installation and constitutes a minor change in the whole system.

In closing, it would be worthwhile to state that regions such as California, where severe droughts are encountered, could also seek recourse to supplementing water supplies by implementing this approach. In this age of sustainable living we are driven to use all our available resources to sustain lives and the environment. Water scarcity is becoming perilous and fuelling desalination plants with bioethanol extracted from surplus dates cultivated on vast tracts of desert land is a workable and realistic option – especially if greywater could be channelled from urban and rural areas for purposes of irrigation.

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