Report on Faculty Travel Grant for International Connections
Country Visited: Israel

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Background:
During the last three years we have developed a brackish water desalination technique that produces significantly much less concentrate to be disposed of. The process is particularly attractive for inland brackish water desalination. Israel is a water stressed country and I personally knew some faculty members in two different universities working in similar areas.

Travel Dates and Institutions Visited:
February 21- March 7 in 2014; Technion University in Haifa and Ben Gurion University in Ber Seva

Major Researchers of Contact:
Prof. Rafi Semiat at Technion and Prof Jack Gurion in Ben Gurion University

Lectures/Seminars:
In both Technion and Ben Gurion I gave a talk that was well attended. The abstract of the talk is attached.

Contacts and Follow-Up Research:
I had discussions with other faculty members in both places and that led to several mutually beneficial areas of interest.

I found out for the first time a special funding outlet named Bi-national Science Foundation between Israel and the USA:
http://www.bsf.org.il/BSFPublic/DefaultPage1.aspx?PageId=21&innerTextID=21

I plan to pursue funding opportunities in the near future.

From Desalination to Decontamination: Water Technology Innovations through Hybrid Processes and Hybrid Materials

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Ion Exchange (IX) and Reverse Osmosis (RO) are universally recognized as two fundamentally different processes for treating water. While RO uses semi-permeable membranes to separate dissolved electrolytes from water, IX uses functionalized polymeric materials, mostly in the form of beads or granules, to remove dissolved ions from water. Although seemingly unrelated, we present here the results of an investigation that acts as a bridge between the RO and IX processes to mitigate the problems associated with brackish water desalination. Most brackish water desalination plants are located inland and must resort to expensive concentrate disposal methods like deep well injection or evaporation ponds. Increasing the recovery of RO process would obviously reduce the volume of concentrate to be disposed of but cannot be implemented due to scaling of sulfate salts ($CaSO_4$, $BaSO_4$, etc.) and consequent fouling of RO membranes. Similar fouling is likely to occur in the presence of phosphate and aggravated by concentration polarization at the membrane-water interface. We have developed a hybrid Ione Exchange-Reverse Osmosis (HIX-RO) process where tunable anion exchange resins can eliminate sulfate precipitation without addition of external regenerants or anti-scaling chemicals. At the same time permeate recovery is enhanced and the volume of the concentrate can be cut in half or even lower.

Although unknown nearly twenty five years ago, natural arsenic contamination of groundwater has emerged as a major global crisis affecting over fifty countries. The adverse health effects resulting from drinking arsenic contaminated groundwater are most prevalent among countries in South and Southeast Asia, namely, Cambodia, Bangladesh, Laos, Nepal, Vietnam and the eastern region of India. Fluoride is also a frequently observed groundwater contaminant in the continents of Asia and Africa. According to the World Health Organization (WHO) estimate, over 300 million people are threatened globally with arsenic- and fluoride-inflicted health impairment including cancer of the skin, lungs, kidney, urinary bladder and skeletal fluorosis. To this end, we have developed and commercialized an arsenic-selective hybrid nanosorbent, referred to as hybrid anion exchanger or HAIX. This new adsorbent uses the fundamental tenet of the Donnan Membrane Principle. The HAIX material is now in use in five different countries and currently, over one million people in both the developed and the developing world drink arsenic safe water through its use. Its synthesis and properties will be presented.