Korea puts $170m into SWRO and reuse

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Harmonizing the needs of the world community with one of its emerging market strengths, the government of the Republic of Korea (South Korea) has recently funded a six-year US$ 170 million research initiative in seawater desalination. Over 500 researchers from 16 universities will contribute to the work of the 50-member core team at Gung Ju Institute of Science & Technology (GIST) in South Korea.

Water-resource planning and long-term projections indicate that desalination will play a major part in the provision of water supply for the South Korean nation. Global water security needs coupled with the continued growth of mass urbanization on the coasts reflect what is now a major growing industry.

Government leaders funded the research initiative in part due to the success of South Korean multinational firms in the desalination export sector. However, the South Korean desalination initiative has a humanitarian goal as well, since much of the world's population faces a future of uncertain access to clean water.

Thus far, South Korean exports to the Middle East have been focused on thermal desalination, but the international trend leans more toward reverse osmosis (RO). In terms of its own national needs, RO is well suited to South Korea's projected water consumption.

Given this international trend, the South Korean government has decided to direct its financing and research focus towards seawater RO (SWRO) and reuse. Already a global leader in the production of membranes, South Korean industry is a natural partner with its government for a research initiative in membrane science.

Launch of SeaHERO

SeaHERO, Seawater Engineering & Architecture of High Efficiency RO was launched by the South Korean government in August 2007. The program is coordinated by In S Kim, executive director of the Center for Seawater Desalination Plant located at GIST. It is a six-year effort with the goal of providing innovation in RO membranes, energy recovery and reducing the cost of engineering, procurement, construction (EPC) and operation and maintenance (O&M).

The program is a traditional Asian blend of government initiative, academic research and corporate partnership. The focus is on discrete outcomes that will ultimately accelerate industrial activity and increase economic strength.

The four core technology areas are:

1. Platform technology; membranes, energy recovery, automation, efficiency;
2. Material localization; identifying and facilitating the next generation of manufacturers and suppliers;
3. EPC; cost reduction and design standardization;
4. O&M; efficiency and low serviceability targets.

New membrane improvements and energy recovery are a part of the program and join the ranks of similar desalination research efforts worldwide. The South Korean initiative differentiates itself by tackling innovation in large-scale plants, reducing EPC costs and seeking to transform O&M. In this arena the partnership with corporations will play a significant role in the later part of this research initiative.

KIST will play the lead support role later in the process. They will coordinate heavily with Doosan to provide innovation for increased sale and delivery of a reliable and low energy-cost (<4kWh/m^3) for treated water.

Research Components

Three major technical themes guide the overall research project. By tackling the technical themes within each research agenda, it is believed that overall success will be achieved.

The themes follow an acronym of 3L. They are

1. Large scale,
2. Low energy,
3. Low fouling.

Taken together, these themes are the core of Korea's plan to be a leader in desalination. Large-scale systems are now the standard, with the average global tender for RO desalination plants exceeding 100,000 m^3/d. Integration of systems, EPC practices and scaling are needed if desalination is to expand beyond 500,000 m^3/d.

Low energy is a paramount global research issue within desalination, and numerous corporations and universities are tackling this challenge. The test bed will have the capacity to test pelton turbines, isobaric energy-recovery devices and other energy-recovery systems.

Low fouling is tied not only to recovery, but also to O&M. Continuous monitoring is key to good operations and lower overall maintenance costs. Long lifetime membranes directly impact the life-cycle costs of the membranes - a significant core component cost of any SWRO desalination plant. O&M is a critical cost metric, but is achieved with continuous monitoring when low energy goals are met.

The test-bed design and development of core technology will take place during the first phase, ending in the later part of this year. The four core technology areas began development this year with the design of the test-bed to be completed by 2010. The verification, application and commercialization of the new localized components will commence in 2010.

Program Structure

The initial heart of the program is Core Research Project Number 1. Involving over 10 universities, the goal is to investigate a wide range of process, manufacturing and engineering innovation that can be applied to desalination.

In this initial phase, manufacturing and industrial opportunities will be identified. The program will follow through with improvement of the core technology for eventual verification and commercialization. Ultimately, all of this work is supported by a broader industrial and engineering framework capable of executing large construction, industrial and infrastructure projects in a rational and directed manner.

Core Research Project Number 1 is focused on the future infrastructure technology for seawater plants. Led by Kookmin University's Professor Jinsik Sohn, the project includes five broad areas of evaluation:

- Harmonized pretreatment options for variable seawater quality
- Infrastructure, construction and project management
- SWRO process monitoring technologies
- Next-generation analysis and process monitoring for membranes
- Post-treatment and brine handling.

Core Research Project Number 2 is focused on commercialization of core localized components such as membranes, pressure vessels, energy-recovery systems and high-pressure pumps. This project is led out of GIST by Assistant Professor Dr Joon Ha Kim.

Doosan provides crucial support for Core Research Project Number 3. Acting from its broad industrial capacity, Doosan's research contribution is to target a working large-scale system SWRO train as the culmination of its work with SeaHERO and its research contribution. The company has scheduled a large 27,000 m^3/d SWRO unit for commercial dispatch and is committed to designing and delivering a 45,560 m^3/d test-bed system to GIST.

Core research area 4 is O&M; efficiency and low serviceability targets. The objective here is reducing overall operational cost. SWRO systems are less forgiving than thermal in terms of operations; fouling and other maintenance challenges can quickly escalate and impede the overall efficiency of the system, directly affecting the cost of water. Good design is, of course, critical for operators to be able to monitor, access and service systems. It must also be mindful of O&M issues and make sure that they are considered and integrated.

Academic partners for the initiative include Korea University and Korea Institute of Construction Technology (KICT) . The project is led by Doosan Heavy Industries & Construction's JK Park. In total, 146 researchers (7 PhDs, 28 Masters, and 111 Bachelor degrees) will join the team.

Doosan, one of the largest thermal EPCs in the world, is committing heavily to the latter section of this initiative. Doosan's portfolio is deep for thermal plants, but they are still ramping up on the SWRO side. The bulk of their co-operation focuses on cost reduction in the EPC area and also in material and sizing.

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Participating Academic Partners

A staggering 16 universities and academic institutions are participating in the project. Coordinated and administered by GIST, the initial primary recipients of grant support from the government are Kookmin University, Korea University, GIST and all four overseas university partners.

Recognizing the global nature of the seawater challenge, the projects tap four overseas universities for cooperation:

- Georgia Tech is one of the leading environmental engineering universities in the United States.
- Singapore University is well engaged in the Government of Singapore's NEWater initiative.
- Cincinnati University, one of the leading water research centers in the United States and closely affiliated with the US Environmental Protection Agency's National Risk Management Research Laboratory is also involved.
- The TU Berlin participates in the commercialization/localization efforts in Core Research Project Number 3.

In November of 2007, the first joint workshop between the center for Seawater Desalination Plant and the European Desalination Society (EDS) took place on the campus of GIST. The opening of the workshop featured welcome remarks from both Miriam Balaban of EDS and Dr Kim of GIST. The keynote was presented by Dr J Schippers from UNESCO IHE Institute for Water Education, who spoke on "MIF more than an alternative to SDI". The topics covered included a broad review of SWRO and membranes, with a particular focus on membrane fouling indices.

The second workshop will take place on 8-9 October 2008 in Gwanju.

Participating Corporate Partners

South Korean companies, already global players in desalination are actively participating with the government initiative. Though the bulk of the membrane activities are undertaken and coordinated on the academic side, industry is contributing with valuable in-kind labor and equipment. Research capacity and expertise on in-platform technology in South Korea is extensive. Woongjin Chemical (formerly Saehan Membrane) is central to the membrane research agenda. Hyosung Pump Company is focusing on pumping systems and energy-recovery systems. Internally they are engineering and designing pump configurations.

Conclusion

SeaHERO is an extensive 6-year agenda to advance intellectually and industrially into the seawater desalination sector. It is heavily focused on membranes in its initial research work.

For such an ambitious agenda, the clarity of importance and valuation of pretreatment has been identified and is being incorporated in the larger strategy. Research breakthroughs, data, innovation and industrialization will all flow from SeaHERO if they meet their targets.