DigiFed

Expertise

Advanced Technology

Digital Challenge Info Pack

Competencies

Funding

Innovative Solutions

Online conductivity sensors for predictive operation of water treatment plants

ACCIONA Agua

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Contents

About the Digital Challenge Owner - Acciona Agua

- The Water business of ACCIONA is a worldwide leader in the water treatment sector. It has strong capabilities in the design, construction, commissioning and operation of a large variety of water treatment plants, including seawater desalination facilities, using reverse osmosis (RO) technology.
- The total population that benefits from ACCIONA Agua's services is about 90 million people in 30 countries of 5 continents. ACCIONA is one of the market leaders in the RO desalination arena with a treatment capacity of almost 5 million m^3/d.

Digital Challenge Context

- Lack of knowledge by water operator about what is happening inside a pressure vessel containing several reverse osmosis (RO) membranes.
- Need to stop part of water production once problems in a rack (a series of pressure vessels joint in one unit) are identified by conventional conductivity/flow measurements in the permeate water. Preventive programmed maintenance activities are carried out to minimize problems.
- The solution will provide early-warning signals of malfunctioning, identifying the reverse osmosis (RO) element(s) that cause(s), allowing predictive maintenance and improving operation.

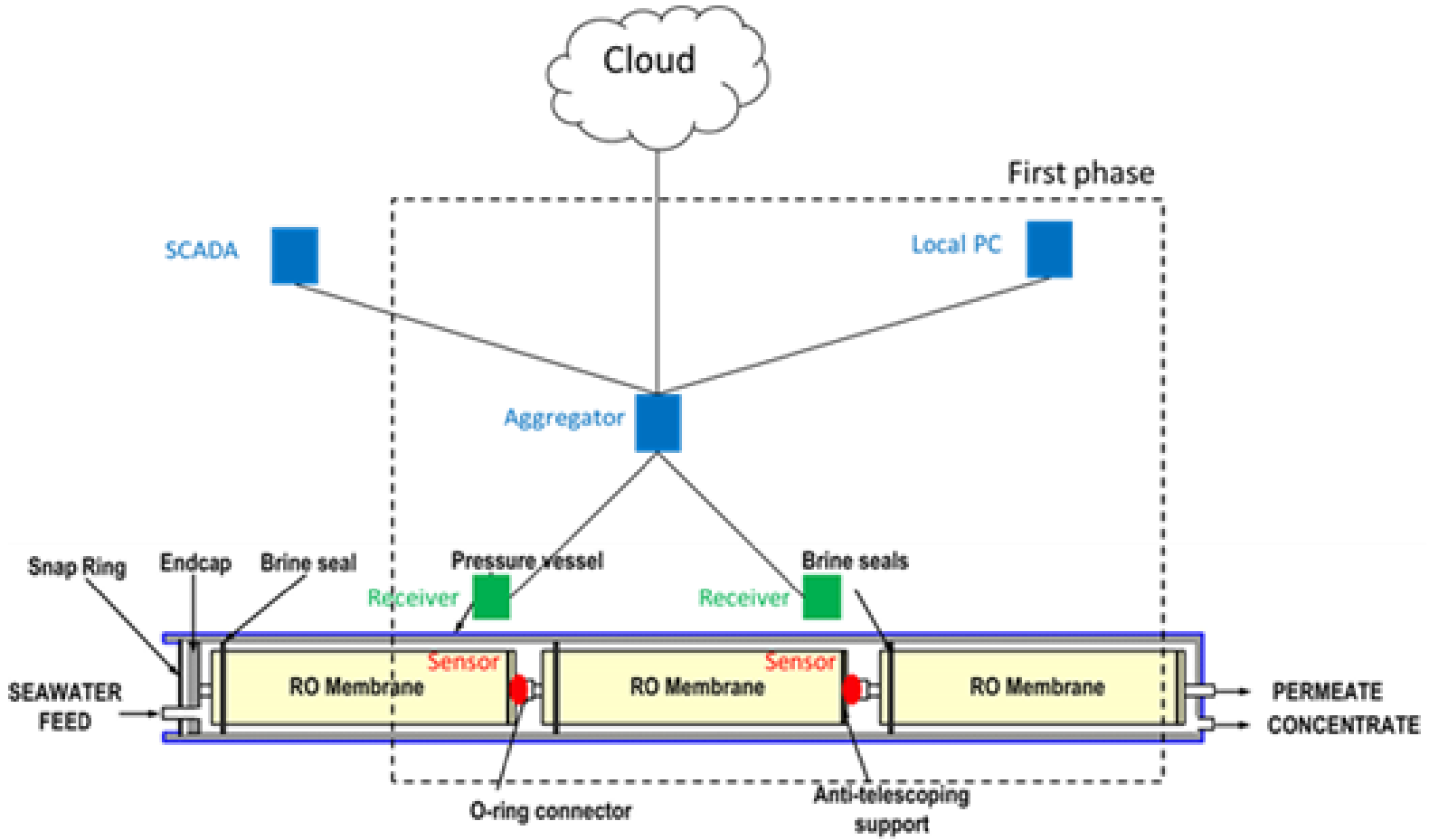
Digital Challenge Description

- **Mechanical features**: The size of the sensor must allow it to fit inside the permeate tubes (28.6 mm of diameter, polymer based), unless another alternative to measure conductivity can be found.
- **Environment requirements:** Permeate water is highly corrosive because almost all ions are removed by the reverse osmosis (RO) process. Any equipment to be in contact with permeate water should be designed and manufactured to deal with such conditions and to have a lifespan of at least 2 years. (Such environmental requirements suggests that metal components should not be in contact with the permeate water).

Other Technical Information

- **Pressure vessel material:** reinforced fiberglass.
- **Permeate tube material:** commercial plastic (ABS, PPE, PVC, PPO, PSU,…).
- **Inteconnector material:** Noryl or ABS.
- **Measurement frequency**: 1 measurement per hour (at least 1 measurement per day).
- **Conductivity measurement range:** 50 - 4000µS/cm
- **Sensor-receiver communication:** The sensor needs to wirelessly communicate with the receiver. The receivers may be placed outside the pressure vessel, in front of each sensor.

Indicative Technical Architecture Diagram



Digital Challenge Success Criteria

- Wireless sensor solution
- Signal quality (high signal-to-noise ratio, reproducibility, repeatability)
- Cost of the solution
- Wireless rechargeable long durability batteries (minimum of 2 years)
- Ease of wider implementation of the solution across locations
- Scalability of the solution
- Time-to-market

Digital Challenge Owner Support

- Technical support for the sensor development: definition of requirements, project management.
- Access to validation facilities (ACCIONA R&D Center in Spain) where the results can be compared to those obtained following traditional procedures.
- Mentoring and follow-up
- If the pilot is successful, opportunity to implement the technology in other plants operated by the company.
- ACCIONA Agua will take care of any safety training that should be carried out prior to testing the devices.

Other Relevant Info

- https://www.youtube.com/watch?v=VGYgbPKSZs4

FAQ

Where exactly must the measurements be done?

Measurements must allow identifying which membrane inside the pressure vessel is suffering from problems. Thus, measurements should be done within the permeate tube of each membrane, inside the interconnector of two membranes.

Measuring the permeate water quality at the end of the pressure tube is **not** what it is expected for this solution as it does not allow measurements for each of the 7 membranes.

The position of the membrane inside the tube affects the performance and the life of the membranes.

Should the measurements be carried out in each vessel?

Yes.

Note that each vessel contains 7 filters and the monitoring needs to be done per filter (membrane element). Different levels of fouling and degradation of membranes are due to the membrane’s position inside the pressure vessel. The permeate water monitoring (conductivity, flow rate) at the end of the tube is the current way of measuring.

FAQ

Where in the permeate tube should the sensor be placed (in the beginning, in the middle, at the end)?

At the end of each membrane element, inside each interconnector, so it could be possible to ascertain which membrane is not working properly. If the sensor is place at the beginning, the first position and last position membranes of each vessel will not be properly monitored.

Note: A wireless solution is preferred as it minimises delays/risks w.r.t the maintenance of the membranes; moreover, using cables will run into a scaling issue, for example, a desalination plant producing 400.000m3/day contains approx. 5000 pressure vessels.

Where can the sensor be attached to the tube? Are there any restrictions?

Restrictions are derived from space limitations. Interconnectors have an internal diameter of 2.86 cm.

FAQ

Measuring per membrane:

From a theoretical point of view it is correct that only the performance per pressure vessel is known with a sensor in the fresh water outlet. From a practical point of view; does one need to know no more?

Each element in a pressure vessel can have different performance problems due to fouling, chemical damages, mechanical damages, scaling, etc. Therefore, the performance of a pressure vessel does not inform us about a possible problem in one or several elements. It is crucial to monitor each element in order to know faster which elements present a problem. This rapid detection of the problematic elements will provide very valuable information, as we will be able to directly replace the damaged elements without losing time in finding the elements that must be replaced. In desalination plants, to stop a rack for a long time costs huge amounts of money. Therefore, knowing the status of each reverse osmosis element within a pressure vessel would allow us to reduce the downtime of the reverse osmosis rack and, therefore, reduce the costs associated with that downtime.

FAQ

Replacing a single filter unit on the spot is not possible and very laborious; so in practise one replaces the complete unit and do the failure analysis afterwards?

It is possible to replace a single membrane element (or some of them). Indeed, it is what is done in desalination plants. In a pressure vessel, we only replace the elements that are damaged, as the cost of a membrane element is quite high.

Sensors:

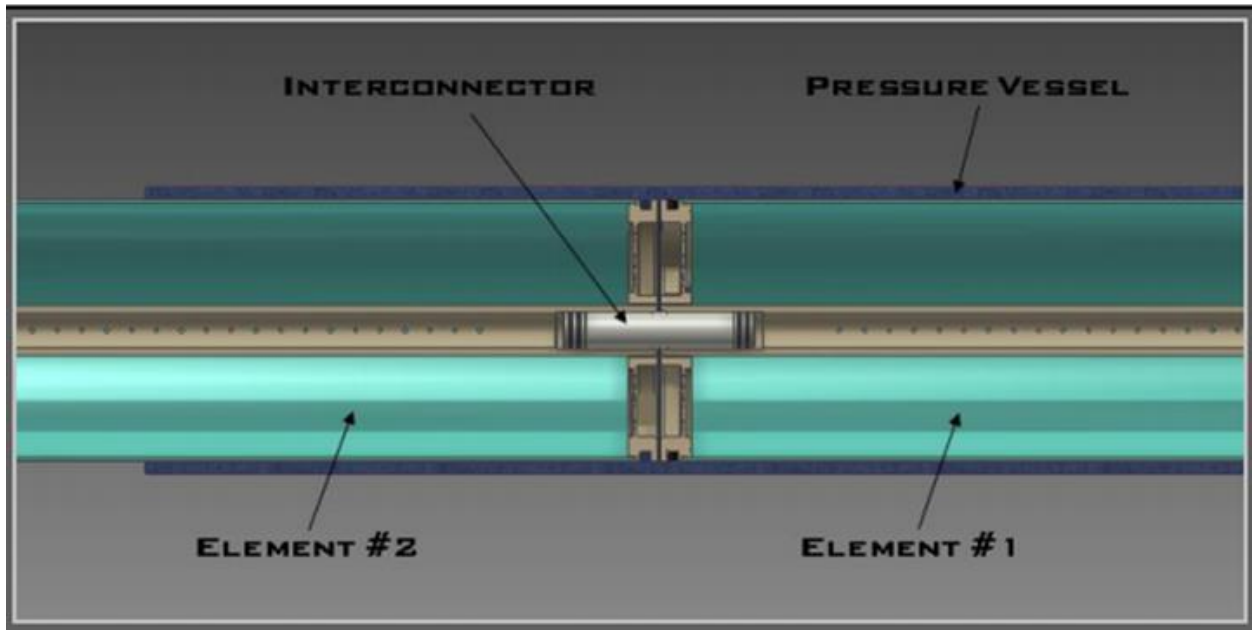
The sensor should be inside the permeate tube, measuring the permeate water

The permeate water contains no salts and is highly corrosive.

FAQ

Would placing the measurement unit between two filter sections that has its transmitter neat the inner wall of the pressure vessel and the receiver at the outside of the pressure vessel be a solution?

There is no space available between the reverse osmosis elements to place a transmitter. The reverse osmosis elements are completely in contact with each other. In addition, the water circulating out of the permeate tube is of high conductivity (>60mS) and high pressure (50-70bar).



FAQ

Wireless charging vs. magnetic charging?

Magnetic charging would be perfect. Without knowing the limitations in terms of sensor power supply, because we are not experts in this subject, we considered three possible options: wireless, magnetic and long-life batteries (at least 2 years of life).

Could battery powered devices replaced at maintenance intervals be part of the solution?

We would prefer a continuous measurement, but if it is not possible, maybe it would be enough a measurement every 1 or 2 hours, if this can make the battery smaller and last longer. As we mentioned above there is no space available between the reverse osmosis elements to place a transmitter.