

Flow testing validation of a new method for formation water and MEG measurement in wet gas using a water analysis sensor and a Venturi

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Primary Challenge:

Measurement of water flow rate and MEG dosage are often key issues for subsea wet gas wells and distinguishing between formation water and condensed water is an important factor both for managing reservoirs and for cost-effective control of chemical injection.

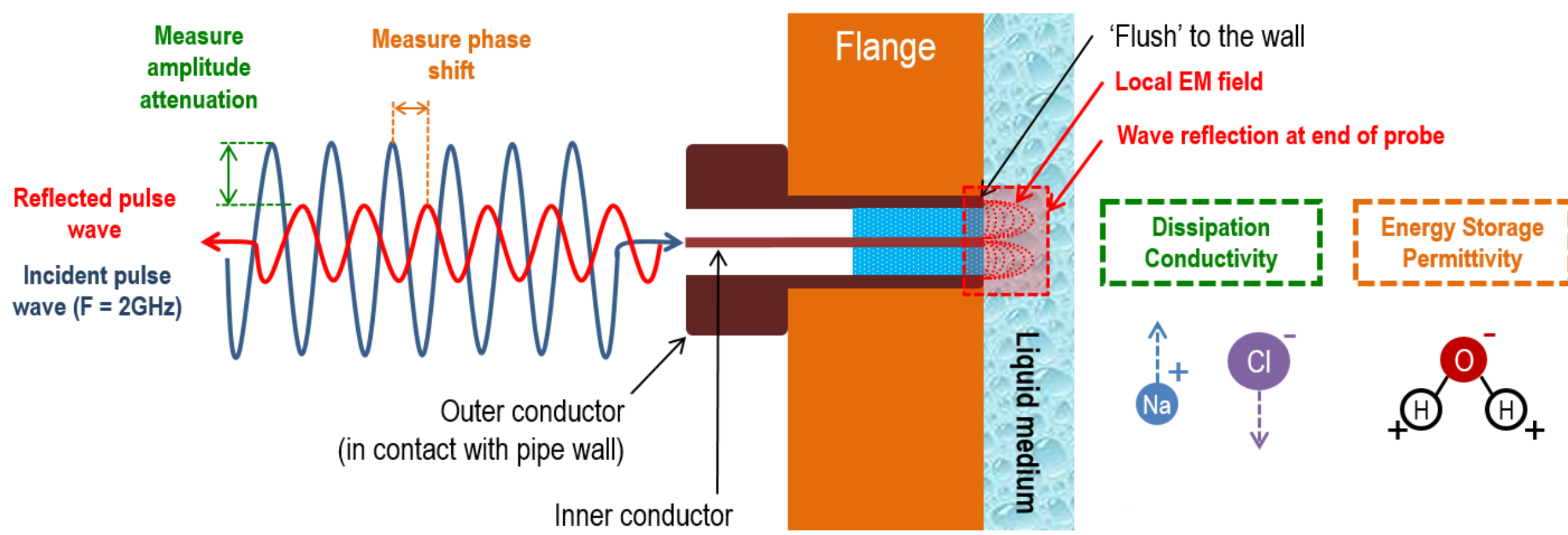
Secondary Challenge:

Validating measurements of condensed water and formation water flow rates under subsea field conditions is challenging and until recently flow loop facilities were not available that could simulate such field conditions for chemical injection.

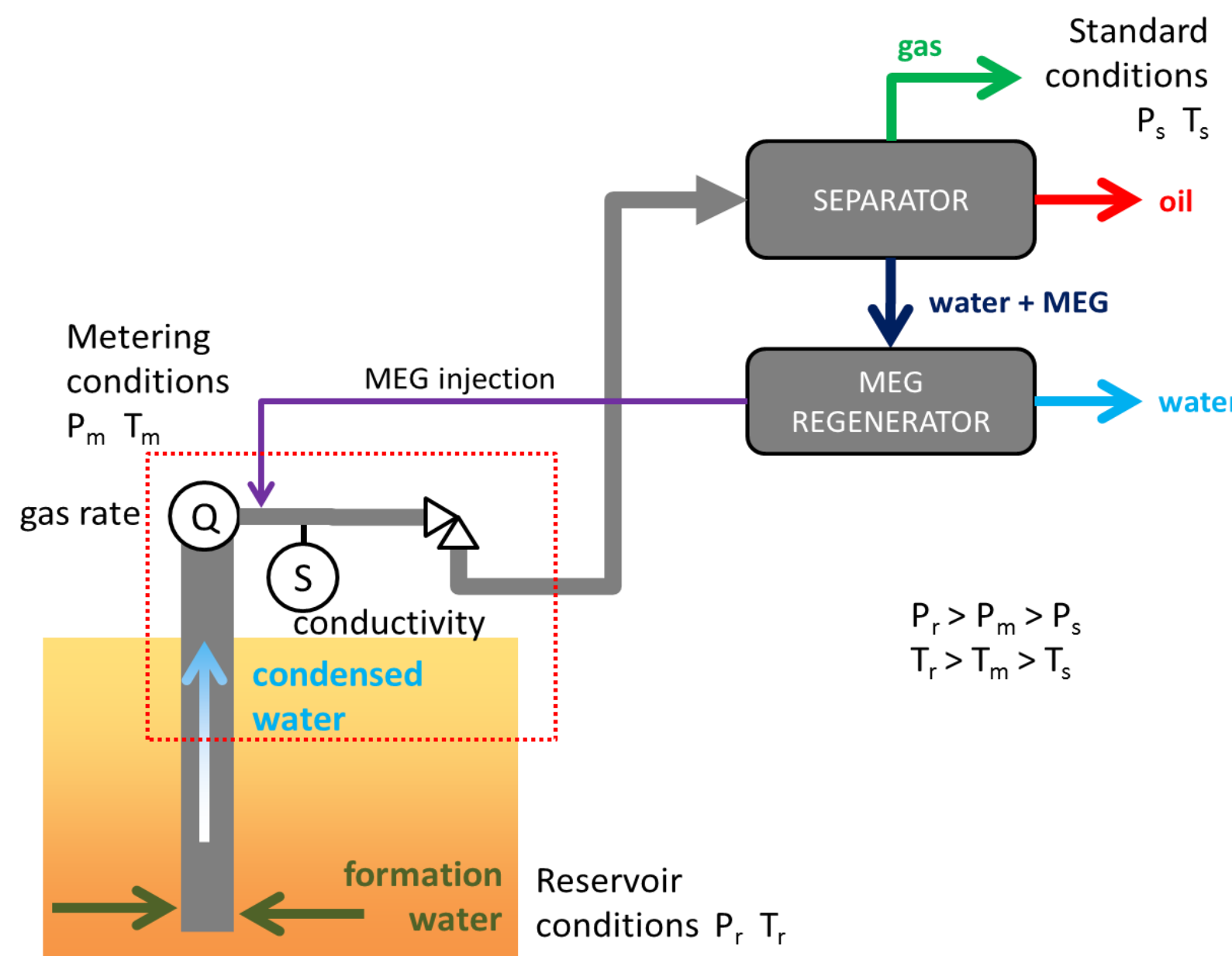
Among the challenges for creating realistic laboratory flow conditions to validate measurement technologies is the temperature change from reservoir to the measurement position at the well head which causes condensation of freshwater. In addition, the injection of chemicals that are highly miscible with the water phase of a closed flow loop causes a continuous change in the water phase properties. It is thus necessary to use a flow loop where the water phase (including chemicals) is only used in a single pass and not recirculated.

AquaWatcher water analysis sensor:

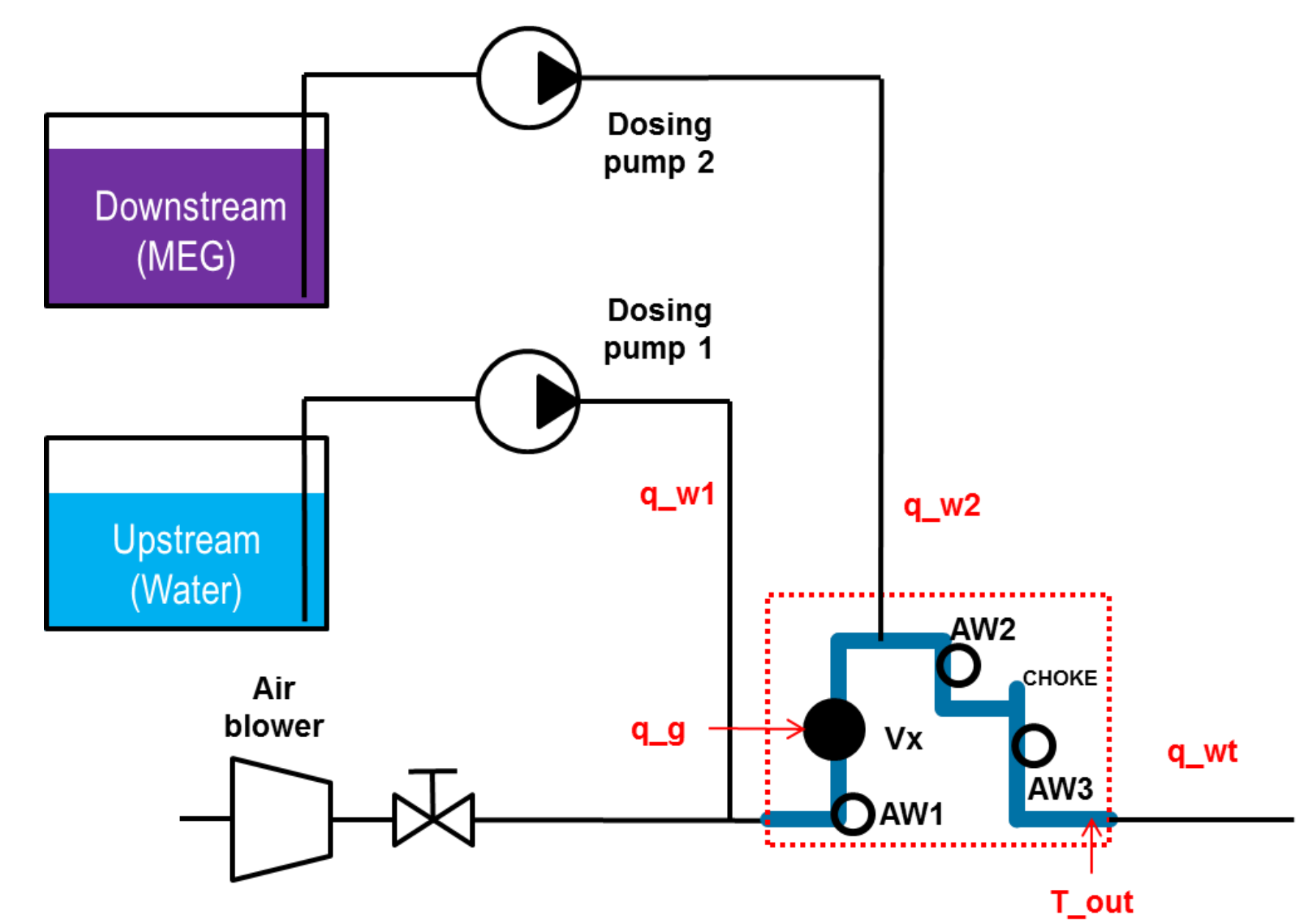
AquaWatcher is an open-ended microwave frequency probe that measures the complex reflection coefficient in the vicinity of the probe tip. It can detect and characterize water in multiphase and wet gas flows. AquaWatcher sensors can indicate water salinity or MEG concentration in water as well as providing water detection functionality.



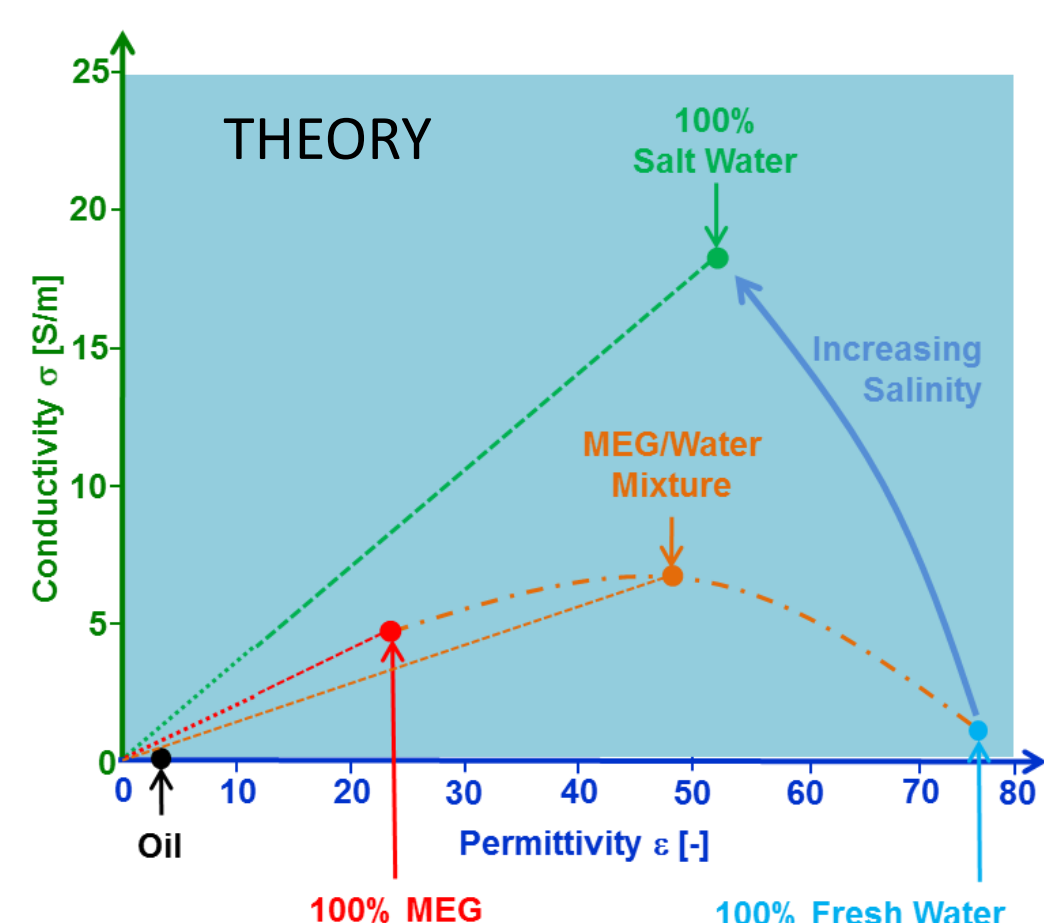
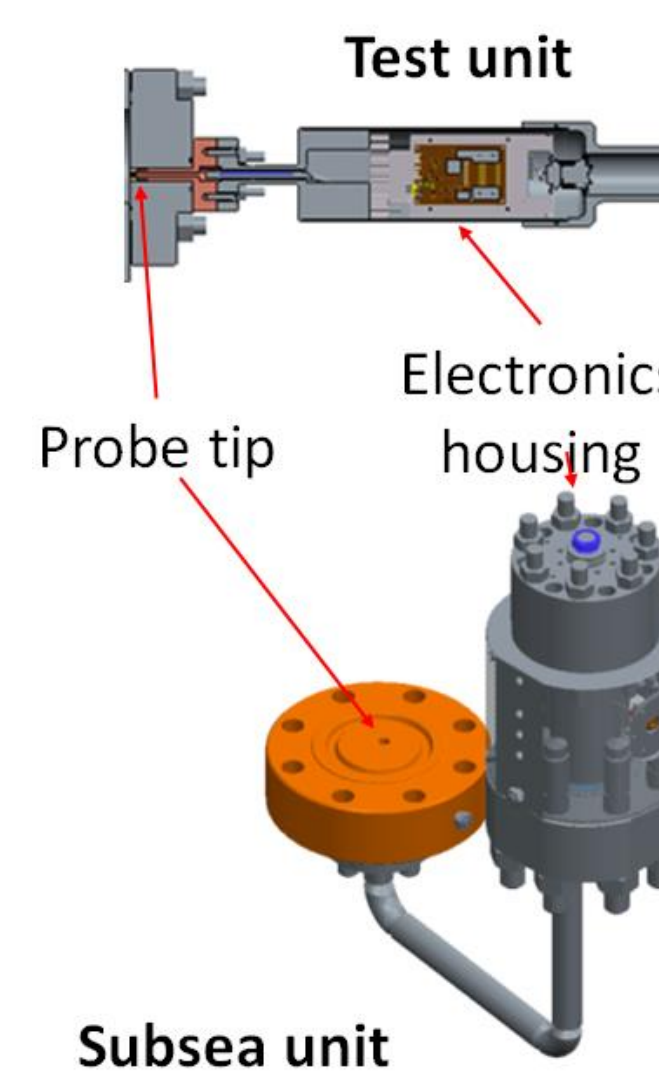
Simplified schematic of a gas well



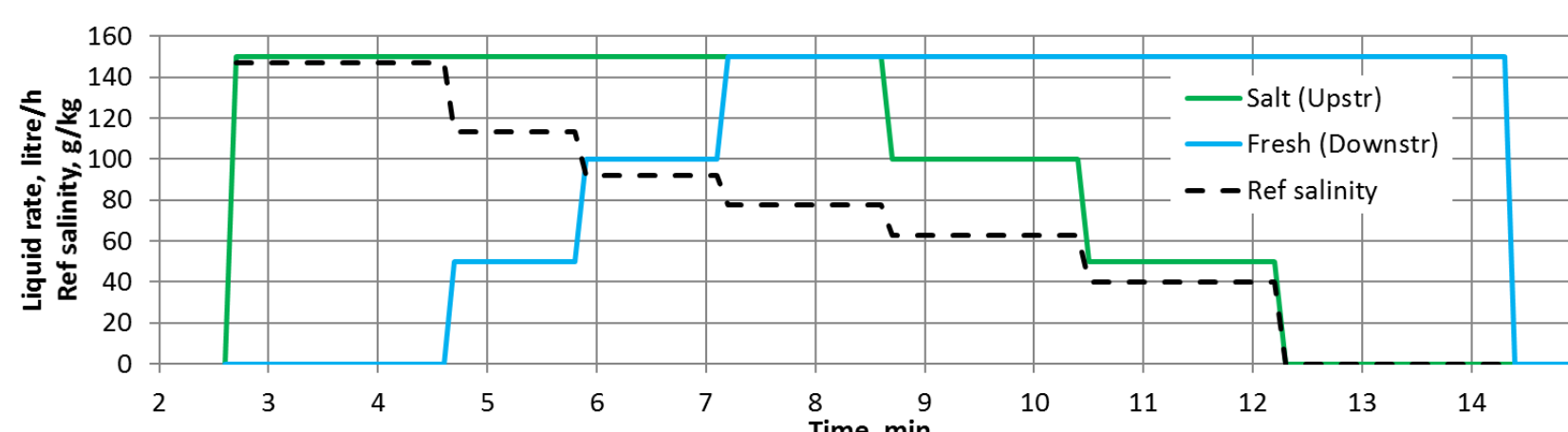
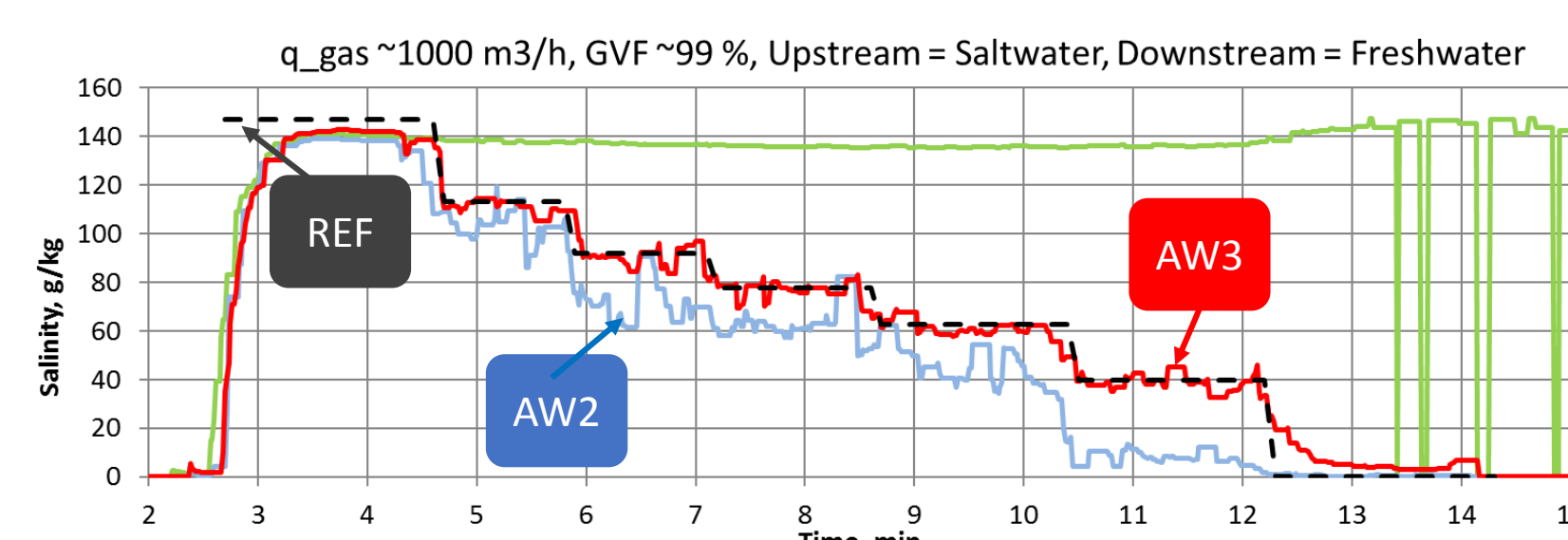
One-pass flow rig for testing MEG-water measurements



One-pass flow rig for testing MEG-water measurements

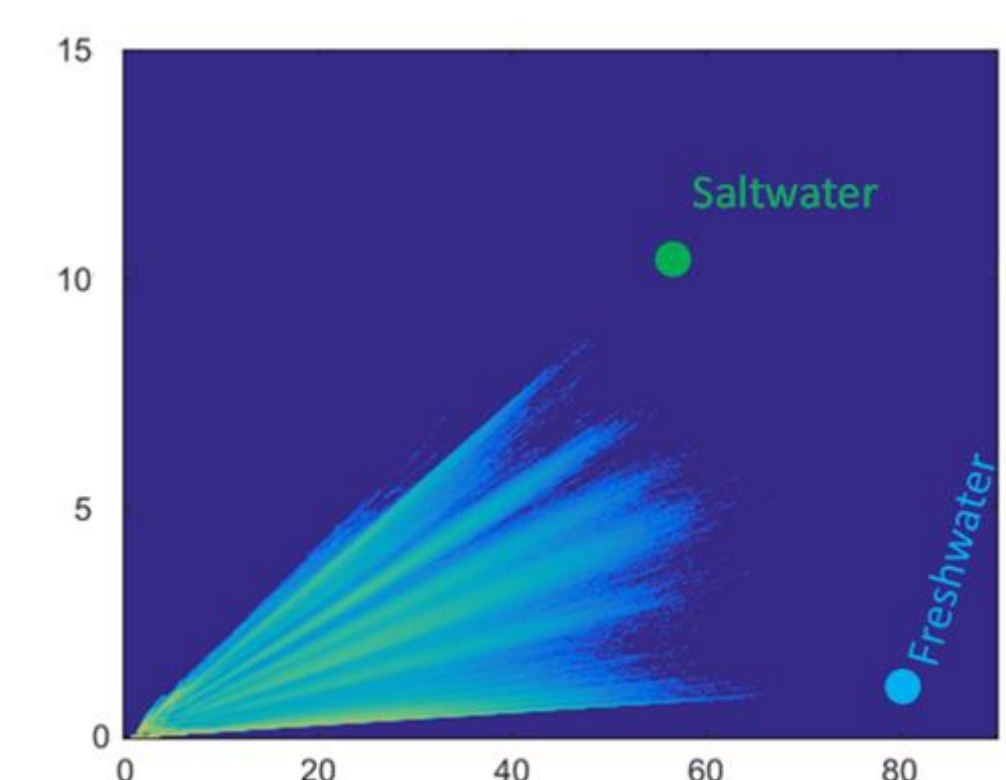


SALINITY MEASUREMENT FOR FORMATION WATER



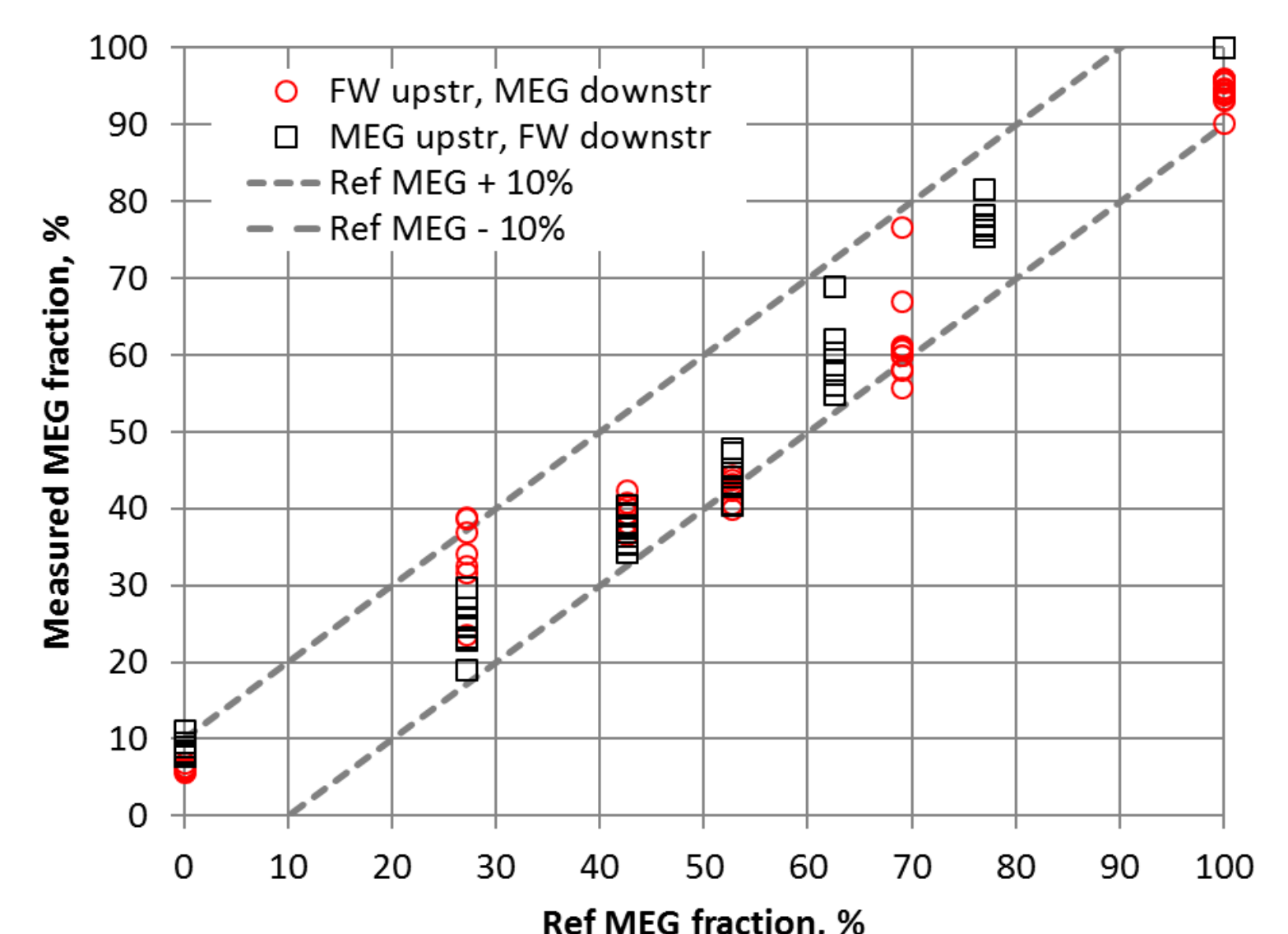
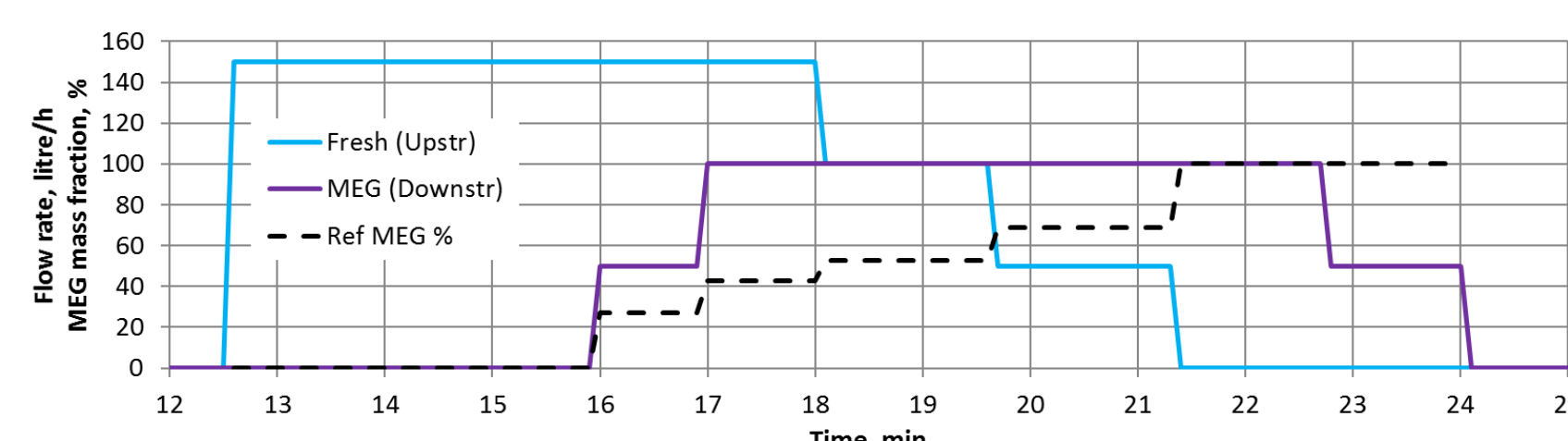
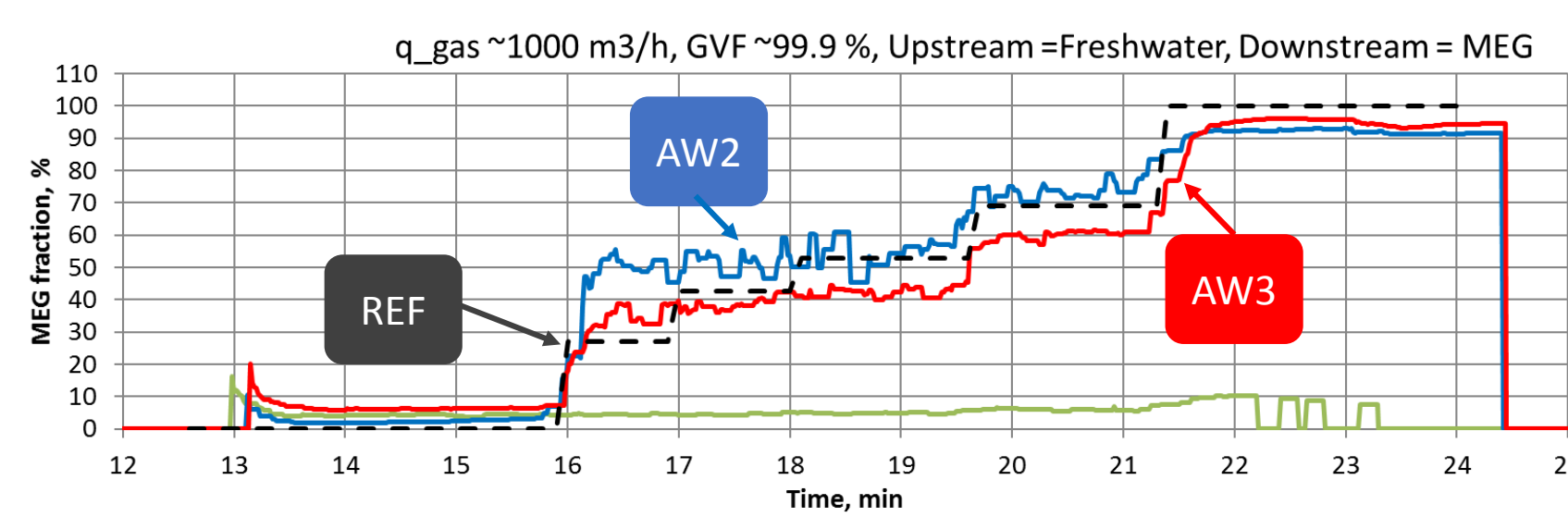
Typical measurement conditions for test setup:

- GVF > 99.7 %
- Water rate up to 22 bbl/d (150 l/h)
- MEG rate up to 22 bbl/d (150 l/h)
- Fresh + salt water, fresh water + MEG, salt water + MEG



FORMATION WATER

MEG-WATER RATIO MEASUREMENT



MEG-WATER RATIO

Conclusions

A prototype wet gas measurement system comprising a gas rate measurement and a water analysis sensor has been flow tested.

Results show salinity measurements can be used to indicate breakthrough of formation water.

MEG-water measurements can be made to sufficient accuracy to enable improved control of MEG injection rates.

Further work is required to evaluate the method under field conditions.