Enhancing CSG well production through FBHP control

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Research team

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Problem definition and aim

Estimation of counter-current two-phase flow pressure profiles is important in a wide range of industrial applications, including coal seam gas (CSG) wells (Figure 1), where prediction of the flowing bottom-hole pressure (FBHP) is key to optimise the well performance. The CSG industry is currently using simulators containing models that were originally developed for conventional wells (co-current flow in pipes) for their CSG developments (counter-current flow in annuli).

This project aims to provide insights into the complex dynamics of gas-liquid counter-current flows, both theoretically and experimentally, under varying operating conditions.

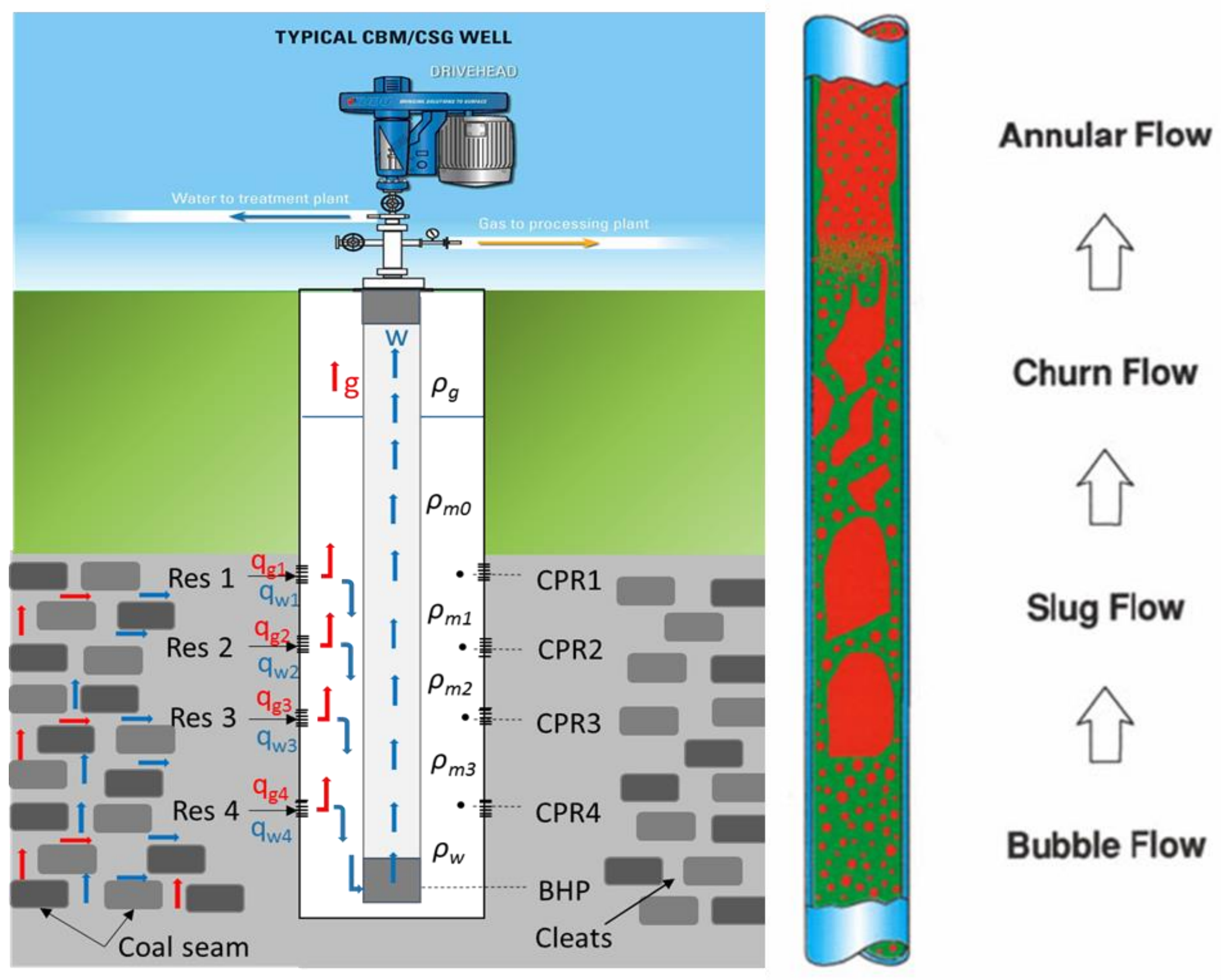

Figure 1: *Two-phase flow regimes across a well-bore*

Methodology

UQ’s Transparent Wellbore Flow Simulation Facilities (Figure 2) were designed to replicate as closely as possible the production zone of a typical pumped CSG well in Queensland, Australia

- **7-in casing** and **2¾-in tubing**
- **air and water used for safety**

Experimental results are used to:

- Provide a reliable flow map using signal analysis of the pressure signals
- Validate models developed within the research team
- Investigate flow regimes (bubble, slug, churn, and annular) and their associated holdups and pressure profiles
- Determine the onset of counter-current flow limitation (gas carryover and “slugging”)

Parameter	7” well
Rig height	30'
Annulus height	24'
Max. air flow	380 Mscf/d
Max. water flow	10,000 bbl/d

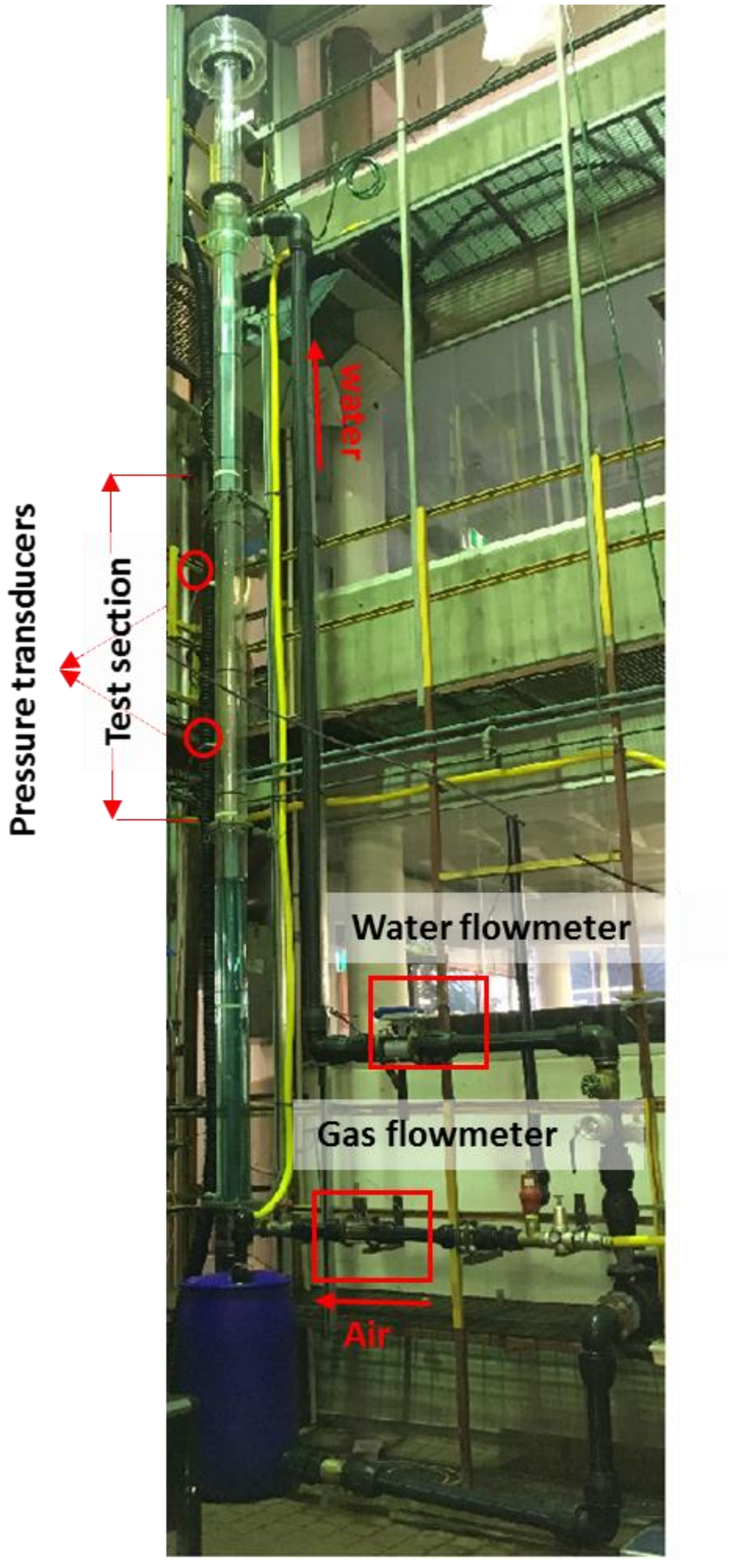

Figure 2: *UQ’s laboratory wellbore flow simulator*

Flow regime identification using signal processing

Two-phase flow properties are intrinsically linked to the flow regimes that develop.

Each flow regime was experimentally observed to produce characteristic pressure fluctuation signals (Figure 3) associated with gas-liquid interfacial structures.

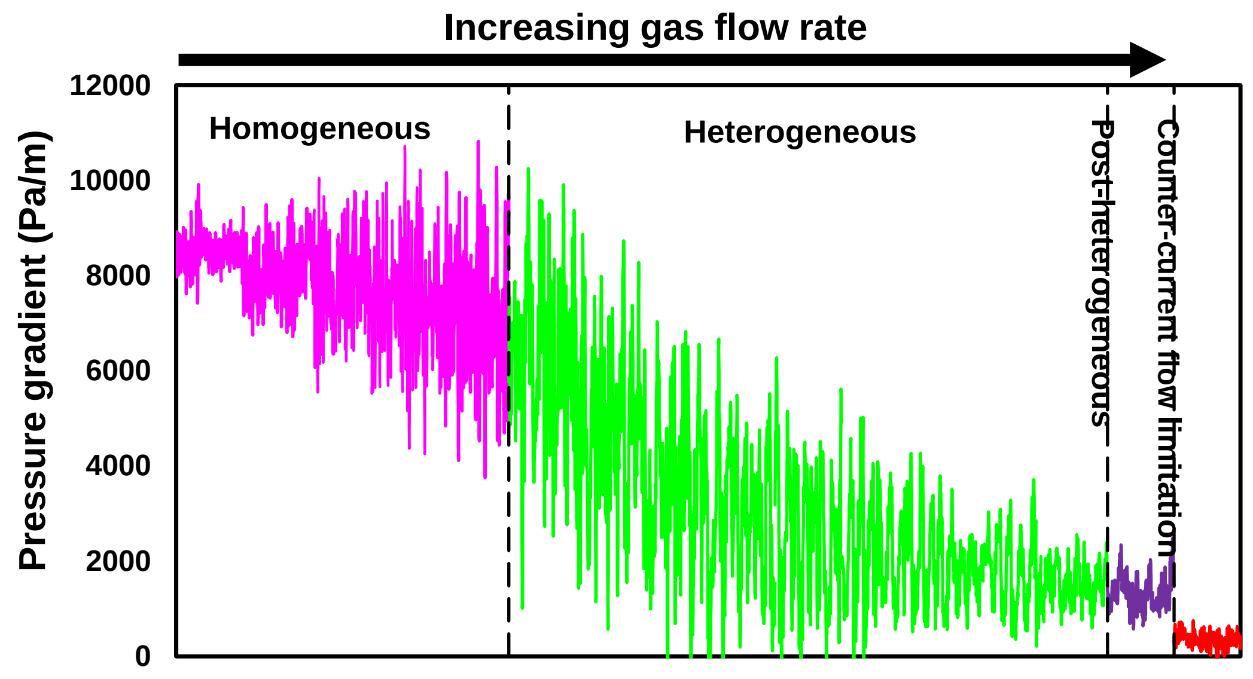

Figure 3: *Pressure signals reveal flow regime transitions*

Four signal processing techniques (autocorrelation, power spectral density, Shannon entropy and permutation entropy) were applied on pressure signals to objectively identify flow regimes and their transitions. Examples of autocorrelation plots for different flows are shown in Figure 4.

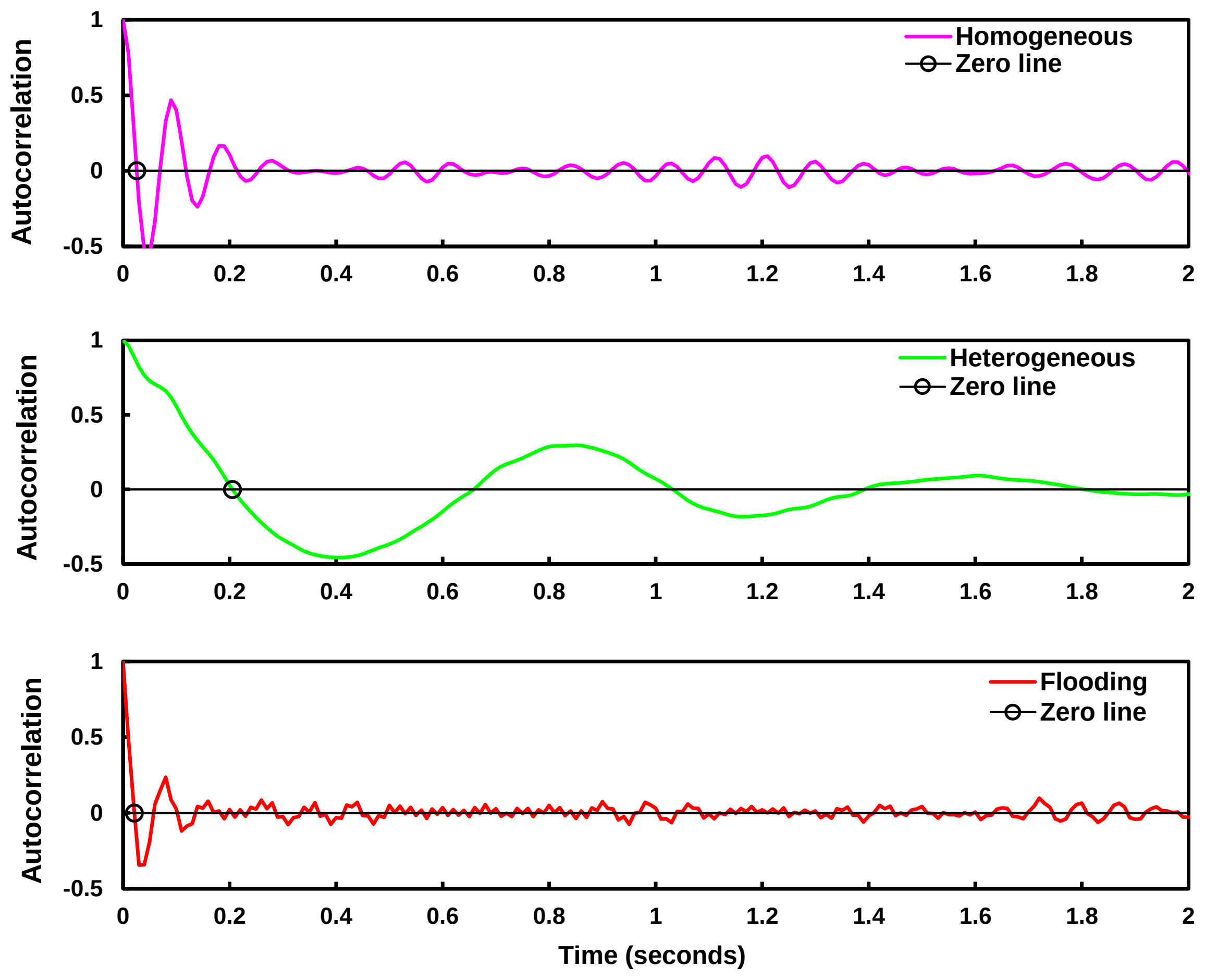

Figure 4: *Autocorrelation functions of pressure signals for different flow regimes*

Effect of salinity on flow regimes

Associated water in Queensland, predominantly consists of NaCl with salinity levels typically ranging from 200 ppm to more than 10,000 ppm.

Salinity was shown to inhibit bubble coalescence, increasing void fractions and impeding flow regime transitions (Figure 5), for homogeneous and heterogeneous flows.

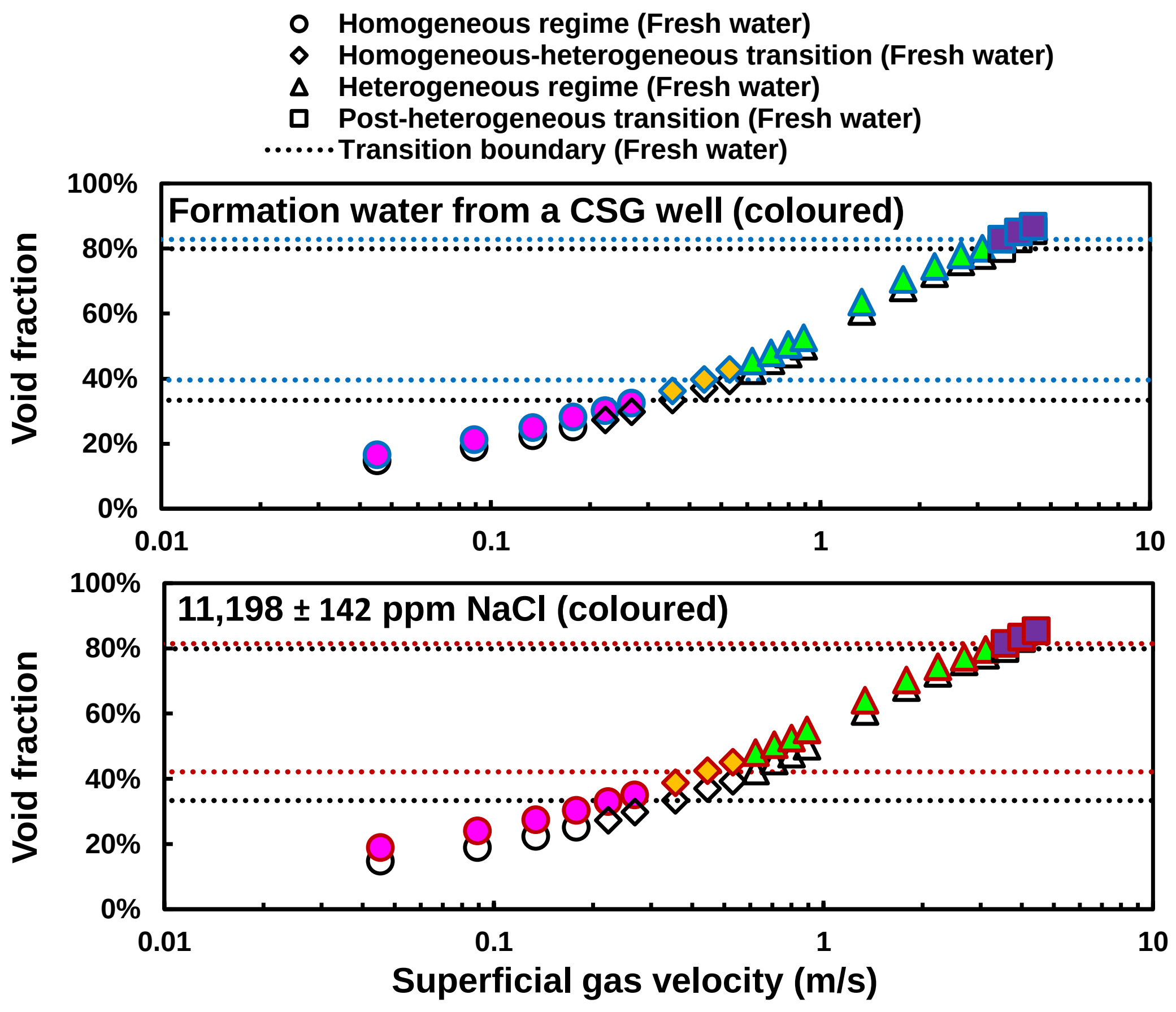

Figure 5: *Effect of salinity at constant water rate of 0.018 m/s*

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REDUCE COST
INCREASE SUPPLY
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