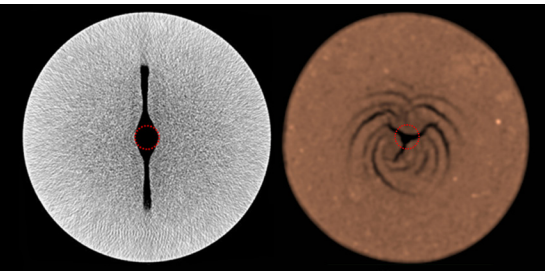
Sand management for the oil and gas industry

Unexpected and uncontrolled sand production results in costly well intervention work and, in some cases, can result in environmental hazards due to the release of hydrocarbons associated with catastrophic wellhead and production equipment failure. CSIRO has developed capability and predictive tools for sand management to address this issue and to minimise or mitigate these hazards in the oil and gas industry.

The sand management team is uniquely positioned to access CSIRO's multiple-disciplinary expertise and facilities to address most issues related to sand management. We have developed unique models to predict the initiation of sand production and estimate its severity from a given oil or gas reservoir. The models capture the essential physics of sand failure and mobilisation from formation at the grain scale, and have been experimentally validated.

As sand is liberated from the reservoir in the flow stream, it is transported through the producing system and over time is detrimental to the production tubing and downstream equipment. Our team uses state-of-the-art computational fluid dynamics (CFD) platforms, validated by physical experiments, to predict the location and severity of sand erosion for at-risk equipment. We can tailor research programs to suit specific needs, and are experienced in the interpretation of field sand production data. Based on the data analyses, we can also assist in formulating solutions to alleviate or mitigate risks associated with sand production.



CT scan images of cross sections of tested sandstone samples, showing cavity shapes and failure patterns, weak sandstone (left) and compacted unconsolidated sands (right).

Expertise

The sand management program is comprised of expertise drawn from a diverse pool of cross-disciplinary areas including geomechanics, fluid mechanics, mathematics, numerical modelling, laser diagnostics, material science, measurement science, mechanical design and instrumentation design. Due to the unique functional structure of CSIRO, wider-ranging expertise can also be accessed if required.

Facilities

In order to address multi-disciplinary issues in sand management, a suite of facilities and instrumentation is available at CSIRO and forms part of our sand management capability. These include the following:

- autonomous triaxial cells (70 MPa)
- high pressure triaxial cell (300 MPa)
- high pressure high temperature (HPHT) triaxial cell (150 MPa and 200°C)
- Hoek cell (70 MPa)
- polyaxial cells (cubic samples with either 300 mm or 400 mm side dimensions)
- sand production cells (sample diameter 86 mm or 200 mm)
- ultrasonic transmission and acoustic emission measurement systems
- gas–solid erosion wind tunnel
- liquid–solid erosion flow loop
- gas–liquid–solid erosion flow loop
- various pressure vessels for elevated pressure testing
- flexible pipe erosion testing facility (up to 6" internal diameter)
- inclinable flow-loops (various pipe sizes, 2" to 6")
- surface metrology devices: coordinate measurement machine, linear variable differential transformer
- particle sizing instrumentation (Malvern particle sizer)
- microscopy services (multiple variants on both scanning and transmission electron microscopy)
- micro X-ray computed tomography (CT) scanner
- X-ray diffraction
- material and chemical analysis equipment: mass spectrometry (MS), inductively coupled plasma-atomic emission spectroscopy (ICP-AES) etc
- laser diagnostic instrumentation: particle image velocimetry, 3D laser Doppler anemometer, focussed beam reflectance measurement
- high speed cameras
- parallel computing facilities for CFD simulations.

Sand production cell.

Applying the capability

The sand management team can conduct field data analyses, experimental and numerical simulations to predict sand production onset conditions, and estimate sand production severity prior to completing a well. This information is critical in formulating an optimal strategy to manage field sand production. When sand inevitably encounters the completion and production equipment, and is subsequently transported to the platform, we can deploy tailored empirical erosion models to predict the most affected areas and provide probabilistic estimates of equipment longevity due to material degradation through continuous sand particle impacts. This quantitative approach enables operators to plan maintenance schedules of at-risk equipment more accurately.

Our partners

We are actively engaged with major oil and gas producers and service providers including the Western Australian Energy Research Alliance (WA:ERA), Chevron Australia, Shell Australia, Technip Oceania Pty Ltd, Petroliam Nasional Berhad (PETRONAS), Woodside Energy Ltd, Santos Ltd and the Japan Vietnam Petroleum Company.

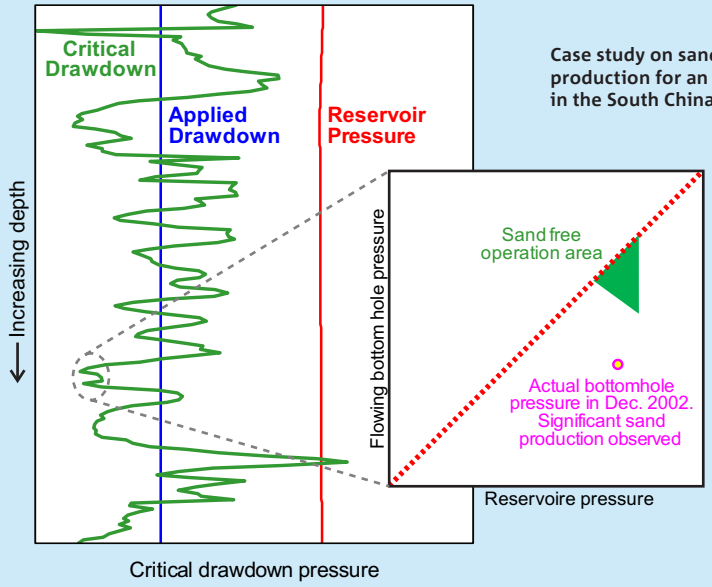
Getting involved

Interested parties can contact us to address specific issues related to their particular sand management scenarios. Parties can access our specialised capabilities (facilities, tools and equipment) and expertise developed over more than 15 years. Industry engagement can occur through partnerships, licensing arrangements and technical services agreements.

Case study

Sanding risk in an offshore field was a significant concern for an operator in the North West Shelf, Australia. Predictions made using the operator's in-house software were inconsistent with field observations. The sand management team conducted a joint sanding study with the operator, including laboratory experiments on downhole cores and sanding prediction using alternative models. The study improved the fundamental understanding of the operator on the sanding potential of their reservoirs in the field.

Sand erosion of annular cavities poses an inherent risk to oil and gas tubing and equipment. The team has built empirical erosion sub-models and employed a CFD technique, which was validated by physical laboratory experiments, to design configurations that minimised or eliminated erosion in the cavity surfaces of a typical annular cavity found in most oil and gas facilities.



Case study on sand production for an oilfield in the South China Sea.

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