

PROJECT LEADER

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SYSTEMS USED

Magnus and Zeus



HOURS / STORAGE

4,500,000 core hours in Magnus



AREA OF SCIENCE

Petroleum and Reservoir



APPLICATIONS USED

Python, OpenMPI, cran/
getopt, cran/optparse, cran/
numbers, llaniewski/rtemplate,
llaniewski/gvector, llaniewski/
polyAlgebra, RInside

UNDERSTANDING FLUID BEHAVIOUR TO IMPROVE GAS WELL PRODUCTIVITY

9

Team members

4,500,000

Core hours Allocated

4

Industry partners

\$5,000,000

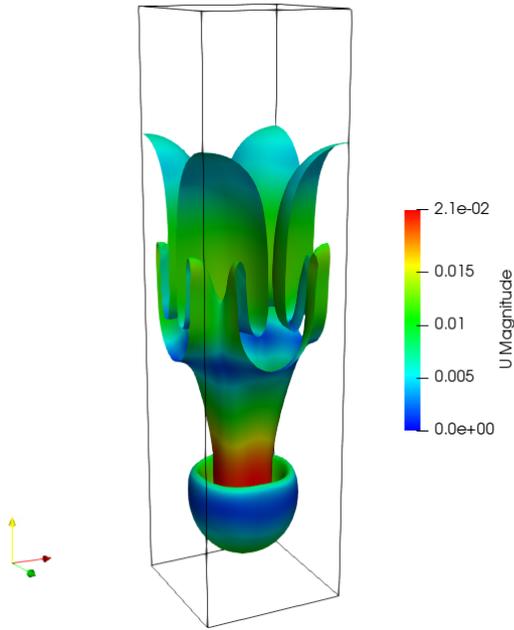
in funding received the
last five years

Coal seam gas (CSG) is a valuable export commodity. It is also used domestically in a range of applications, from generating low-emission electricity and fuelling natural gas-powered buses, through to producing fertiliser and plastics. It's a vital part of the Australian economy. Pawsey Supercomputing Centre is helping researchers to develop more efficient ways to extract this natural resource.

Partner Institution:

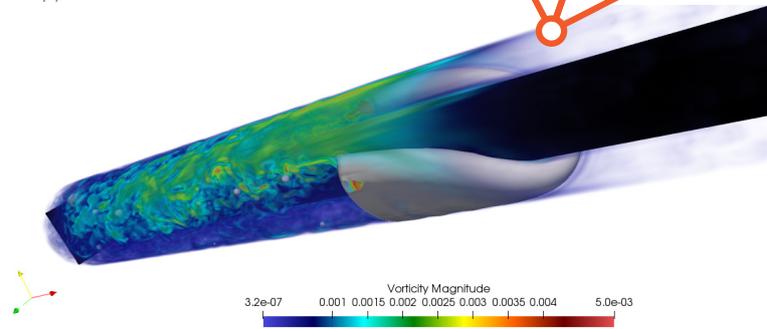


THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA



Left image: Interface location and velocity in the classical instability problem of Rayleigh and Taylor

Image below: Disruption of wake behaviour during the rise of a Taylor bubble in an annular pipe



THE CHALLENGE

Dr Christopher Leonardi and Dr Mahshid Firouzi from The University of Queensland, along with graduate student Travis Mitchell, are formulating advanced computational models to understand how gas and water flow in CSG wells. With these models, engineers can more accurately simulate the transport of hydrocarbons through pipeline networks, allowing them to design and build more efficient extraction systems.

"The fluid physics in a CSG well is an important boundary condition for the modelling of gas and water flow in the coal seam. It's also an important input to the downstream gathering network of gas pipelines. Understanding the physics is essential for predicting the flow regime and pressure distribution in the well," said Dr Leonardi.

Coal seam gas is initially trapped by water pressure within the seam. As such, this water must first be pumped to the surface to liberate the gas. The characteristic ways that water and gas travel together in a pipeline are referred to as flow regimes. CSG wells exhibit a variety of regimes, from bubbles in a continuous fluid through to annular flow, meaning the gas travels through the centre of the pipe while the liquid water coats the pipe walls in a thin film. The dynamics and ultimately the impact of these flow regimes is what the team from UQ have modelled.

"If you don't understand the flow regime and pressure profile in the wellbore, then you'll not only have poor control over the

individual well, but also over the upstream and downstream systems. You'll have a poorer understanding of how your production infrastructure is working as system."

Modelling complex fluid dynamics is a challenging task that requires significant computing power. To further complicate matters, the team needed to simulate the flow under a wide variety of operating conditions. The pipe's angle of inclination, the ratio of water to gas, and the well pressure were all important factors. For this, they turned to the Pawsey Supercomputing Centre.

THE SOLUTION

To tackle these large-scale calculations, Travis has used Pawsey's Magnus and Zeus supercomputers. With these machines, the team were able to deploy multiple simulations at once, drastically cutting down on work time.

The team also took advantage of Zeus's post-processing software. This allowed them to visualise the results of their simulations at Pawsey without sending hundreds of gigabytes of data across the country.

"One of the benefits of access to Zeus is the cloud-based visualisation tools. We were able to post-process our results via the web using a simple laptop, without the need to transport gigabytes of data to local, high-powered machines," said Travis.

THE OUTCOME

"Operating on large data sets is computationally demanding. If you tried to run it on a single processor, you could be talking about months for a simulation. With the help of Pawsey we could bring that down to just a few hours, depending on the size and length of the simulation," said Dr Leonardi.

Not everyone who needs to simulate the extraction of CSG has access to a supercomputer. That's where the team's work

comes in. Engineers can use Travis's research to fine-tune simplified models developed for real-time computation on desktop hardware, improving their reliability and accuracy.

The team's models have the ability to help other engineering fields that deal with liquid-gas flows. From oil and gas, to chemical reactors, to studying environmental flows.

"Because we're incorporating so much of the relevant physics in the model, it has a broad range of potential applications. Although our current focus is on bubble propagation, the same model can be quite easily manipulated for use in a range of other engineering disciplines," said Dr Leonardi.

However, the team's primary focus remains on trying to improve the efficiency, safety and fundamental

understanding of the flow physics associated with CSG production. An industry that facilitates low-emissions energy and generates billions of dollars in export revenue.

With Pawsey Supercomputing Centre, Travis, Chris and Mahshid are improving the productivity of a vital industry and shedding light on the fundamental behaviour of fluids.