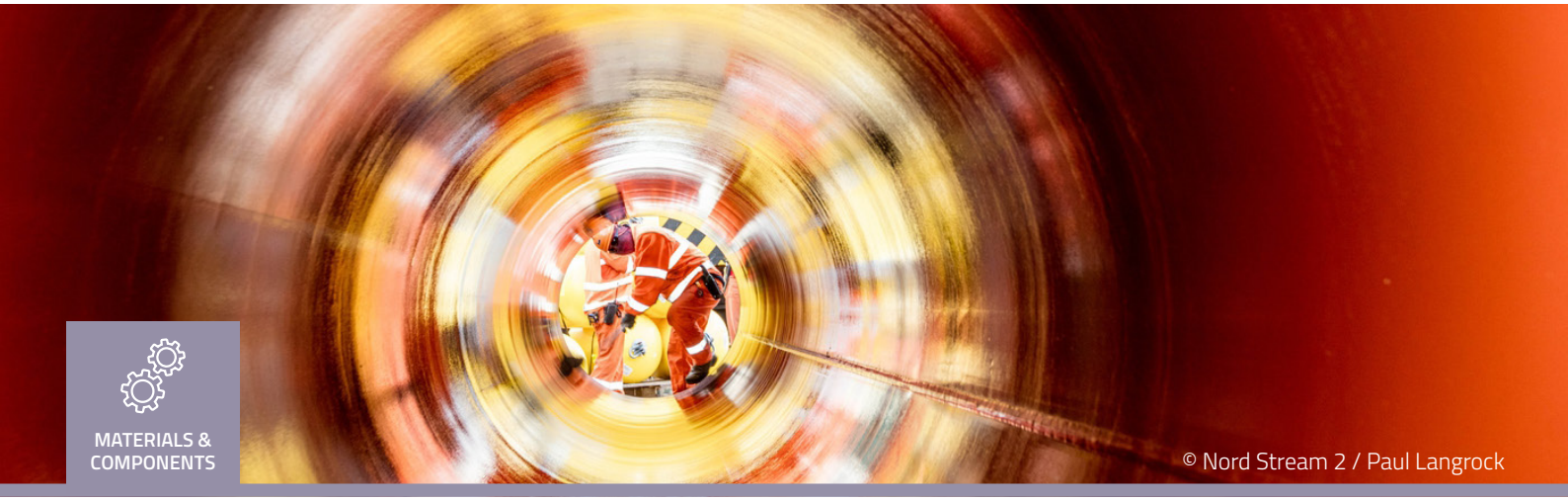

MATERIALS & COMPONENTS

NEUTRONS DETECT CLOGS IN PIPELINES

Industry and private consumers alike depend on oil and gas pipes that stretch thousands of kilometers underwater. However, it is not uncommon for pipelines to become clogged. With collaborators at the Research Neutron Source FRM II and the consulting company, Science S.A.V.E.D, scientists from TechnipFMC (a company specialising in subsea pipelines) demonstrated that neutrons are an ideal probe to locate blockages in underwater pipes.

THE CHALLENGE

For a clog to be remediated in-situ, the affected section of the pipeline must be found. However, locating clogs from the outside is challenging, particularly when underwater pipelines are laid at depths of up to 2000 metres. While thermal imaging cameras and gamma rays can be used to detect clogs, neither work underwater. Ultrasound, on the other hand, has no problem penetrating water but blockages can only be detected near the pipeline wall.

THE EXPERIMENT

Using the Prompt Gamma Activation Analysis instrument at FRM II in Germany, the researchers established that neutrons can be used to differentiate between oil and gas and the blockage.

Additionally, neutron radiography and tomography, and fast neutron-induced gamma ray spectroscopy, showed that a sufficiently large number of neutrons can penetrate the metal walls of the pipelines to enable measurements underwater.

THE RESULTS

The experiments demonstrate that neutrons are ideal for locating plugs in a non-contact, non-destructive and reliable way, despite thick pipe walls. Moreover, the technique can distinguish an incipient blockage from a fully developed one, enabling preventative measures to be taken. In practice, a mobile detector with a small neutron source can move back and forth along the pipeline to look for plugs.

Fig 1. Especially when a pipeline is idle for a longer time at low temperatures, hydrate plugs can form, similar to the methane hydrate core shown in the picture.

> We are very pleased that, with the help of the measurements at the research neutron source, we have now found an efficient method that makes it much easier to detect these plugs in the future.
>
> **Xavier Sebastian**
> TechnipFMC

Bouat, S., et al. (2021) 'Detection of hydrate plugs inside submarine pipelines using neutrons'. *Nondestructive Testing and Evaluation*, pp.1-13.

INDUSTRIAL APPLICATIONS OF NEUTRON SCIENCE

LENS LEAGUE OF ADVANCED EUROPEAN NEUTRON SOURCES

For decades, European neutron facilities have established productive collaborations with a diverse range of industrial users. Such partnerships have delivered important results for industry, providing insights into materials and methods that have driven process optimisations and technological innovations.

WHY USE NEUTRONS?

STUDY STRUCTURE

Neutron wavelengths are are comparable to the spacings of atoms and molecules.

STUDY DYNAMICS

Neutron energies are comparable to the time scales of molecular diffusion, vibrations and rotations.

STUDY MAGNETISM

The neutron's magnetic moment can be used to study the microscopic magnetic properties of materials.

PENETRATION POWER

Neutrons can penetrate deep into matter (including many different metals) enabling the study of large samples - even within complex sample environments.

NON-DESTRUCTIVE

As a non-destructive, non-invasive probe, neutrons are suitable for the characterisation of delicate and precious samples.

VERSATILE SAMPLE ENVIRONMENTS

Sophisticated sample environments enable measurements under operating conditions - including extreme temperatures, pressures, etc.

SENSITIVITY TO LIGHT ELEMENTS

The neutron scattering power of nuclei varies in a quasi-random manner such that lighter atoms (e.g. H, Li) can be studied in the presence of heavier ones.

ISOTOPIC CONTRAST

Neutrons are sensitive to different isotopes of the same element, so isotopic substitution (e.g. H/D) can be used to highlight specific structural features.

COMPLEMENTARITY

Neutron scattering is highly complementary to other techniques, such as X-ray scattering, electron microscopy, magnetic resonance and computational methods.

HOW CAN INDUSTRY USERS GET ACCESS TO NEUTRON FACILITIES?

European neutron facilities provide industrial users with access to advanced instrumentation for R&D. No prior experience is needed – expert scientific and technical staff provide support for users to get the most from their experiments.

Neutron facilities offer a variety of mechanisms to access their infrastructure, including proprietary access, academic partnerships and public beamtime.

For more information, email contact@lens-initiative.org