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News

IFPEN

Renewable energies

Responsible oil and gas

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CORROSION, ONE OF THE MAJOR CHALLENGES OF THE ENERGY TRANSITION, HAS BEEN THE FOCUS OF SIGNIFICANT RESEARCH AT IFPEN

Corrosion attacks the equipment used by the energy industry, affecting installations used for CO_2 capture and transport, hydrogen storage and transport, geothermal energy and biomass conversion processes, as well as oil and natural gas installations. In all these sectors, corrosion also adversely affects safety, the environment and process profitability. IFPEN's research targets all these areas with a view to preventing and remedying the effects of corrosion. Studies are conducted in harsh environments, with high pressures and high temperatures and in the presence of aggressive gases such as CO_2, H_2S and hydrogen. IFPEN also uses modeling in order to gain a better understanding of the physicochemical mechanisms at work in the process and predict the long-term corrosion kinetics. The multi-scale tools employed range from laboratory test benches through to industrial demonstrator, via medium-sized pilot facilities.

PREVENTING DEGRADATION IN BIOREFINERIES

Biorefinery installations, which convert biomass into biofuels, biogas and other bio-based molecules, can be attacked by corrosive impurities such as water, alkali salts and chlorides. It is necessary to check that installations are suitable for this biomass where existing refineries are repurposed or to choose the appropriate materials when building new installations. For example, on a pilot unit that reproduces the complete chain involved in the production of biodiesel via the hydrotreatment of vegetable oils used by researchers to test different types of catalyst with a view to optimizing the industrial process, metal test coupons are inserted to study their behavior in the presence of vegetable oils and hydrogen at temperatures of up to 500 degrees. Corrosion monitoring systems have also been installed on actual industrial units, such as the Dunkirk BioTfueL® unit commissioned at the start of 2020. This demonstrator, which converts lignocellulosic biomass into biodiesel and biokerosene, contains coupon insertion systems that are used to validate the choice of materials.

The use of metal test coupons to study corrosion

To judge the resistance of a metal material in a harsh environment (high pressure, high temperature in highly

aggressive aqueous or gaseous media) coupons of the material in question are inserted into the installation, be it a piece of laboratory equipment, a pilot unit or an industrial site. Monitoring tools such as thermobalances are used to continuously measure the mass of these coupons. The mass of deposits formed on the coupons as well as corrosion speeds can be deduced. Optical or electronic microscopy can be used to refine this approach by analyzing deposits or enabling the detection of highly localized corrosion or potential fractures.

NATURAL GAS TREATMENT AND CO_2 CAPTURE

In the fields of natural gas treatment and CO_2 capture, IFPEN has an amine absorption/regeneration pilot unit that is used to simulate different scenarios and test innovative solvents. Once again, corrosion coupons covering different grades of steel are inserted into these installations to test the resistance of the materials in these environments.

GEOTHERMAL ENERGY, CO_2 STORAGE, HYDROGEN: CORROSION IN AQUEOUS ENVIRONMENTS AND IN THE PRESENCE OF SOUR GASES

In installations used for geothermal energy, CO_2 storage and hydrogen, IFPEN is studying corrosion in an aqueous environment and in the presence of sour gases such as CO_2 and H_2S. Tests are conducted in test cells and measurements are obtained using impedance spectroscopy. This technique provides information about corrosion mechanisms and speed, as well as deposits formed on the metal surface. Hydrogen can also penetrate steel and weaken its mechanical properties. This phenomenon is studied by conducting electrochemical tests to determine hydrogen permeation through a steel membrane. To study the risks of the embrittlement of hydrogen storage and transport facilities, another method, adapted to liquid and gaseous media, uses a hollow metal sample exposed to a corrosive environment. Hydrogen diffuses in the cavity where the increase in pressure is measured.
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To achieve higher pressures and higher temperatures - for example 100 bars and 200 degrees - IFPEN uses autoclaves or other equipment available via the French Corrosion Institute. It also has access to the shared CorRTEx (Corrosion Research, Technology and Expertise) test loop to conduct experiments with pressure of up to 200 bars and temperatures of up to 350 degrees in the presence of CO_2 and H_2S. It is worth pointing out that the CorRTEx loop provides better control of the corrosive environment, something that is difficult to achieve in a simple closed reactor.

THE OIL AND GAS INDUSTRY: PROTECTING AGAINST CORROSIVE FLUIDS AT HIGH TEMPERATURES AND HIGH PRESSURES

To test the resistance of materials used in offshore production and in refining and petrochemical plants , IFPEN has technical resources such as thermobalances to continuously measure the mass of metal samples exposed to controlled gas and fluid mixtures at high temperatures and pressures. This process makes it possible, for example, to monitor the increase in mass associated with the formation of a coke deposit.

To find out more:

In November 2020, IFPEN organized a workshop dedicated to corrosion in the low-carbon energy sector : IFPEN Scienc'Innov Corrosion in Low Carbon Energies.

Watch the video presenting IFPEN’s research aimed at tackling corrosion.

Corrosion, one of the major challenges of the energy transition, has been the focus of significant research at IFPEN
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