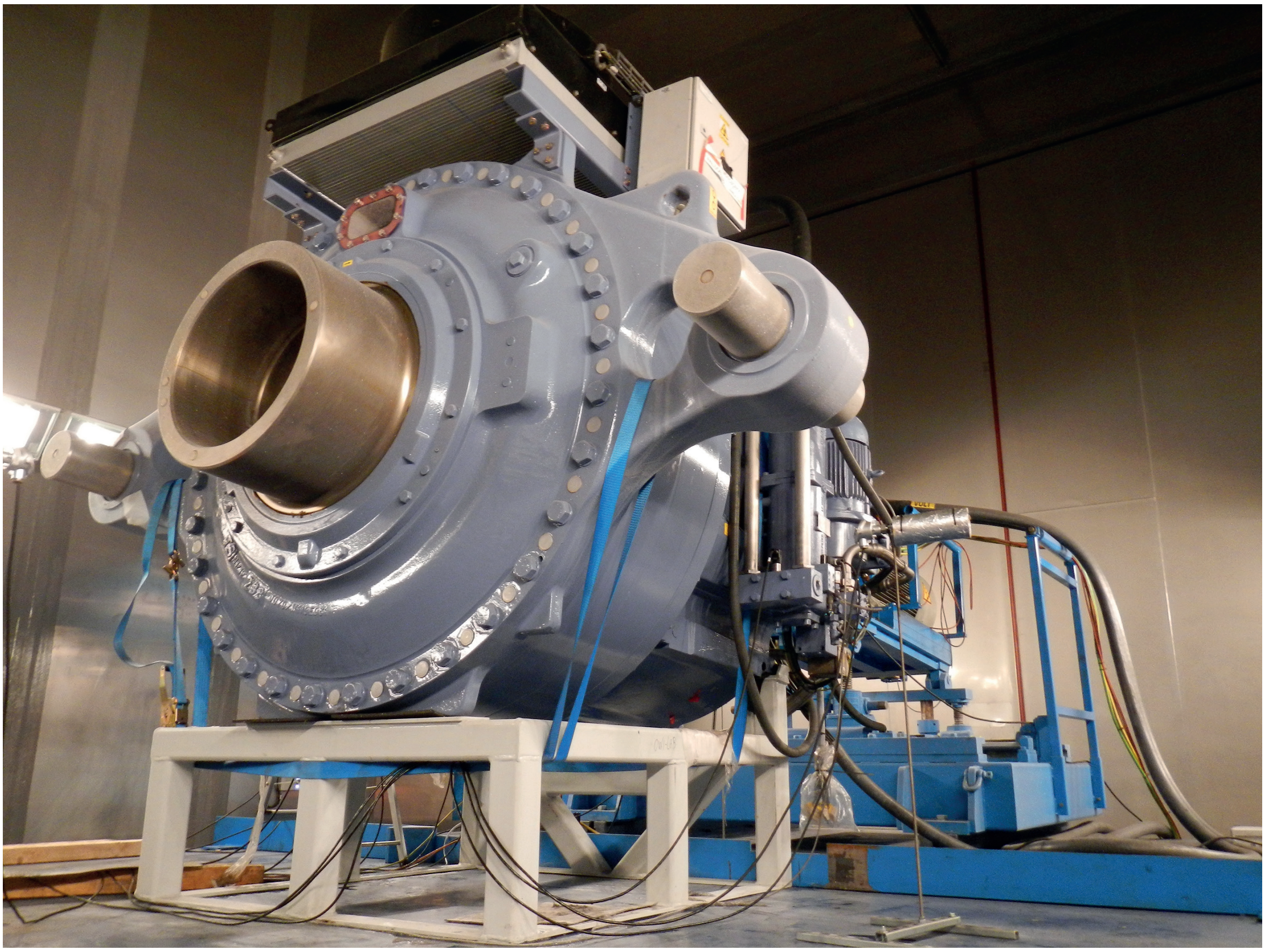


Cold climate testing

PES went to Belgium to investigate the latest development in extreme climate testing. The OWI-lab is using field experience to provide a purpose built testing facility in the heart Europe.

Alternative energy sources are a key part in achieving the goals set at the Paris climate conference in December 2015. Non-polluting energy sources are seen as a vital part in reaching the targets. Alternative energy sources have been implemented worldwide, sometimes in less than convenient places.

Field experience through completed projects has grown exponentially. This means more challenging projects have become viable options. It is now possible to embark on the projects, knowing the greater installation costs and OM challenges no longer outweigh the benefits, which come from this work.

One of the challenges, in this expanding business, is to cope with developments in remote locations, with extreme environmental conditions. OEMs and components suppliers are looking to adapt their products to these demanding environments, by optimising design or adding specialised features.

The adapted systems are prone to failures, which are related to these extreme conditions, such as sealing problems caused by differential thermal expansion, cracks due to change in brittleness, or problems with lubrication, or hydraulics due to changed viscosity. Therefore it is vital to validate the new (sub-) system in these harsh environmental conditions. Doing so will reduce the risk of problems later on in the project which could result in higher costs.

OWI-lab opened one of Europe's largest climatic test facilities in the Port of Antwerp, for such research and validation tests. The Large Climate Chamber has been operational since 2012 and has been steadily building up knowledge on extreme climate testing.

The test cell has a useable length, width and height of respectively 10,5, 7 and 8 meters which allows for test objects over 550m³. This together with the floor capacity

of up to 150 tonnes and the needed lifting capacity for such weights, on site, makes the chamber ideal for testing larger (sub-) systems, as an alternative to the usual component tests in small climate cabinets. The possible simulated temperatures range from +60 °C to -60 °C, with the possibility of controlling the humidity or simulating solar heat.

Cold climate wind turbines

Latest market studies indicate that by the end of 2015, approximately 127GW of wind power capacity had been installed in so called ‘cold climate’ regions. Over the next few years, up to 2020, it is estimated that nearly 60GW of new installations will be added.

Based on market forecasts from the Global Wind Energy Council, this would mean that by 2020, approximately one in four of the installed wind turbines worldwide will be operating in a location where there is either icing or low temperatures.These locations in cold climates are particularly interesting because of the excellent wind conditions. Most of these regions are less populated which also makes projects easier in terms of planning permission.

However developments have other location specific problems. In ambient temperatures ranging ±0°C to -10°C icing may occur. This can significantly impact the annual energy production (AEP) of the wind turbine, for example ice accretion on rotor blades reduces the energy yield.

On the one hand, it can also shorten the mechanical lifetime of certain wind turbine components. Both can have a significant impact on the reliability, efficiency and profitability of the wind farm project. Also, icing can pose health & safety issues such as ice throw and ice-fall risk, which is dangerous for the O&M crews maintaining the wind turbines. Special maintenance strategies and tools are required and in some locations, vehicles to reach the wind turbines, in harsh winter conditions, need to be planned for.

Also risk mitigation measures for passers-by and in some cases, even for protected animals, living or walking near a wind farm, need to be anticipated in the project. Icing on the rotor blade can also increase the sound levels, which can cause problems with local environmental permits. All these potentially negative effects need to be evaluated early in the planning phase and mitigated by special measures or tools in the operations and maintenance (O&M) phase of the wind farm.

Low temperatures can also harm the wind turbine’s lifetime if not taken properly into consideration. Different materials, lubrication fluids, grease and lubrication strategies are used for cold climate wind turbines.

During operation enough heat is generated to overcome low temperatures, but mainly during cold start-up, components like gearboxes, generators, pitch & yaw systems, transformers, in fact all components which have lubrication, grease, or di-electric fluids, can be at risk due to the high viscosity. Also long survival periods and stand-still in cold conditions might harm mechanical parts and machinery.

Due to the past experiences with normal, standard designed wind turbines in cold climate sites, the industry has been made aware that this special environment needs special measures. Most wind turbine OEM’s and their component and technology suppliers are developing cold climate adaptions, or so called cold climate packages tailored for the demands in cold climate installations.

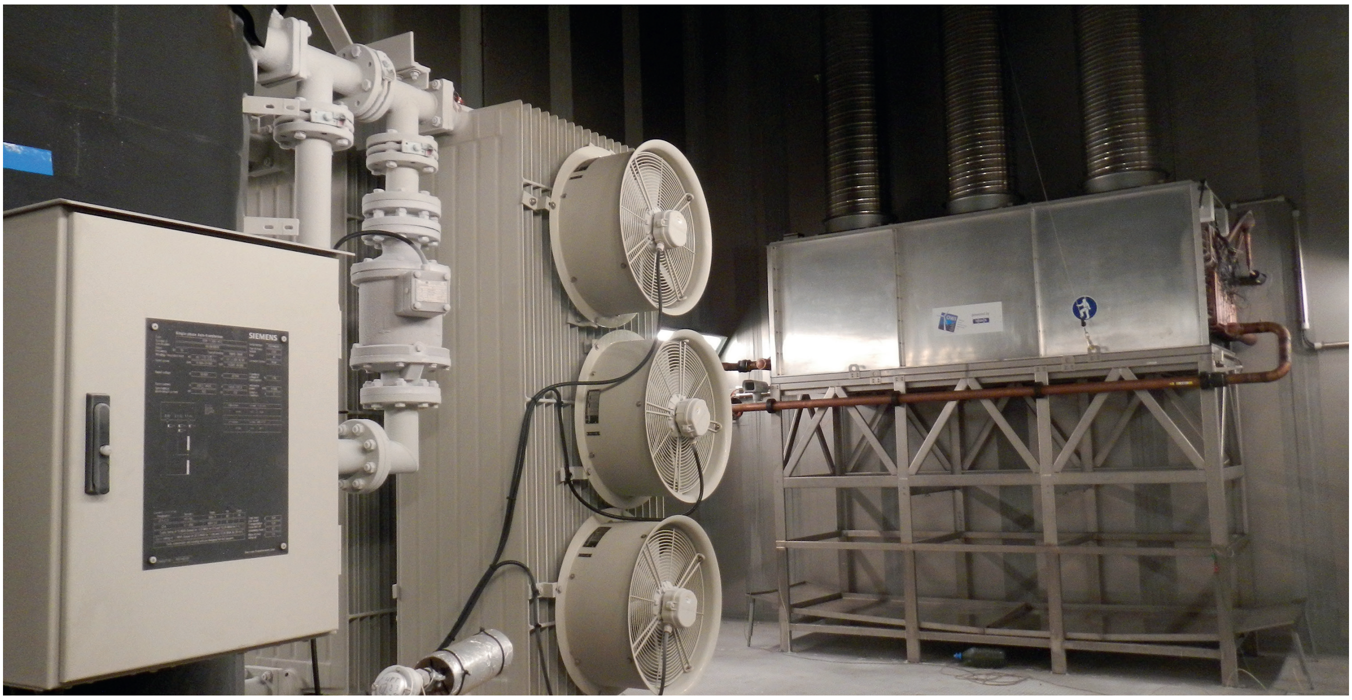
Validating a new specialised cold climate gearbox oil

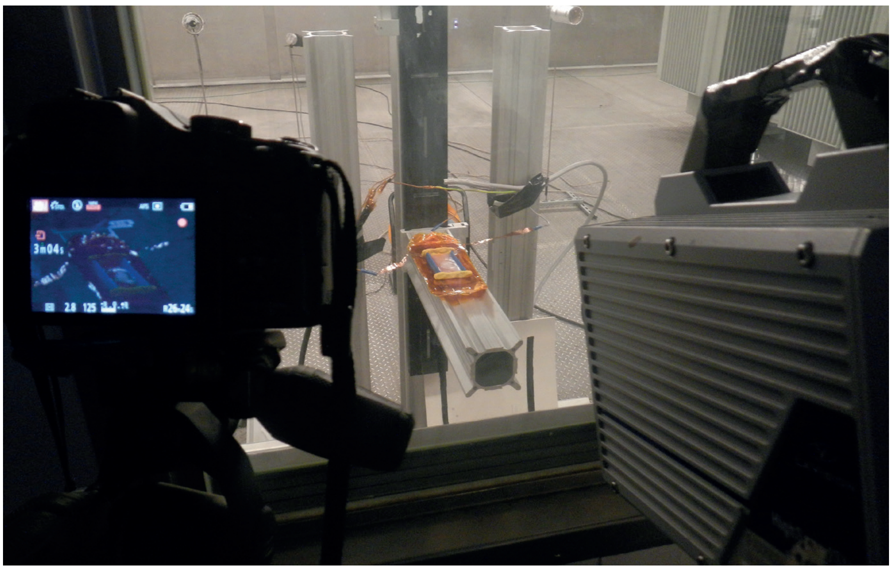
In the summer of 2016 the OWI-Lab validated a new oil developed by Shell. This wind turbine gearbox oil was specially designed to give excellent performance in cold conditions. The oil will have an impact on the time to grid from a cold start up but this had to be tested. The OWI-Lab, with its own R&D 2MW gearbox and experience in validating cold start procedures for gearboxes, made the ideal partner for such a test.

We tested both the original oil and the newly developed oil at different low temperatures. The in house designed, no load test bench allowed us to simulate the start-up procedure completely until nominal RPM in no load. This while measuring torque needed for start-up and total power fed to the gearbox. These real life validation tests inside a gearbox were the essential last steps in the development of the oil.

Electrical component testing

Earlier last year a 15MVA transformer was tested by Siemens. The 15 tonnes sample was equipped with more than 85 sensors and tested continuously in cold conditions for over 4 weeks. The transformer was filled with an environmentally friendly, but highly viscous synthetic ester fluid. Its high viscosity at low temperatures impedes





natural fluid flow and thus leads to a change of thermal performance.

This is especially relevant for cooling by external radiators and pumps, which is standard for power transformers. Fluid flow in the small radiator ducts is completely different from flow at the tank wall, even more so in case of high viscosity. The viscous fluid is extremely demanding for the pump so extra care needs to be taken with the cold climate version. The test results were vital for updating the design models to further improve these high power cold climate transformers.

Research and development

In 2015 the Lab participated in research by the Technical University of Delft. The research focused on a new de-icing method for wind turbine blades. Using a nanosecond pulse they were able to create plasma on the outside of the blade. This plasma is several 100K and would melt ice immediately without much residual heat loss on the blade material.

DBD plasma actuators have been previously investigated in aerodynamic research for their unique features and flow control properties. In wind turbines changing the aerodynamics of the blades can be useful to help stop the system in emergency situations.

This, together with the de-icing possibilities, would allow for an exceptional system with a double function. However the technology is still in the research stage and tests done in lab were conducted on smaller blade coupons with only little amounts of ice on them.

www.owi-lab.be/content/climate-chamber-testing