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DEMCOPEM 2MW

Demonstration of a combined heat and power 2MWe PEM fuel cell generator and integration into an existing chlorine production plant

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Publishable summary

Not applicable

Contents

1 Executive summary

The stack performance of the DEMCOPEM-2MW power plant is evaluated for the first years of operation in Yingkou, China. The cell voltage in Yingkou is shown to decrease much faster than in a similar plant in Delfzijl, the Netherlands. The reversible decay is almost 100 fold higher in China, while the irreversible decay is roughly 3 to 10 times higher than Nedstack's XXL stacks operating in Delfzijl. The reason for this heavily accelerated degradation is due to feed stream contaminations, of both hydrogen and air.

2 Introduction

The Demcopem 2 MW unit was installed at the Ynnovate site in the summer of 2016. During August and Sept commissioning and SAT was carried out by Ynnovate, Nedstack and MTSA and the plant has run since then.

During numerous plant visits it was noticed that Ynnovate's site utilities were not always according to the required specifications, see also D5.7. Relevant non-conformities include:

- The hydrogen pipeline was found to be full with particles during the commissioning stage and was thoroughly rinsed after the first visit in August 2016
- The hydrogen feed frequently contained caustic condensate, increasing the conductivity in the hydrogen humidifier, occasionally even tripping the plant. This improved after the installation of a scrubber in Oct. 2017, but only upon correct operation of the additional scrubber.
- Air contaminants were notably observed such as ammonia smell, originating from an adjacent plant also leading to system trips due to sudden cathode humidifier conductivity rise. Also Cl_2 or HCl was smelled occasionally as well as the presence of brown smoggy ambient air.
- Demin water feed quality was frequently out of spec, even leading to the saturation of the anode deionizer resin in October when feeding "fresh" OSBL demin water with >1000µS/cm
- Occasionally the N_2 pressure was too low and the quality out of spec (e.g. O_2 concentration up to 5%)

Furthermore, the 2 MW unit has not always been in operation due to site construction activities (e.g. limiting the hydrogen supply or grid absorption capacity) or stack investigations.
Nedstack developed a comprehensive cell voltage monitoring (CVM) software package to monitor the performance of all stacks over time. A similar software package is installed in the Delfzijl unit. These data have been used to study the performance development as well as in house measurements on Nedstack's test stations.

3 Demcopem stack performance assessment and comparison to Delfzijl performance

The Demcopem 2 MW installation consists of 6 separate fuel cell/inverter groups (G1..G6) that can individually be operated, with each their own set point of approx. 350 kW. Due to small variations in set-point, flow, and operating time, the currents between the modules may vary slightly and for comparison are all normalized to 120 A based on the avg Demcopem stack IV as measured at Nedstack. This proved to be in good accordance with the performance as measured in the Demcopem installation BoL.

A similar pilot plant has been in operation at the Nouryon (formerly AkzoNobel) site in Delfzijl, the Netherlands for over 10 years. Nedstack's XXL stacks have been tested there for durability, as well as the same stacks with the Demcopem MEA, which has specifically been developed by Johnson Matthey in the Demcopem project.

In Fig. 1 the performance (avg. cell voltage) is shown as a function of operating time. The Demcopem MEA in stacks S0307 and S2336 shows a slightly higher decay rate in comparison to the latest generation XXL stacks (S0114, S0224, S0240). However, when compared to the average cell voltage of three representative fuel cell groups in Yingkou (G3, 4, 5) a significantly higher decay is observed. Also, the broad scattering of approx. 100 mV shows the excessive reversible decay at the Chinese site, see also D7.1 and the MS 7.1 report where the performance comparison is further detailed and where degraded stacks from China were demonstrated to perform normally again in Delfzijl.

The installation of the additional hydrogen scrubber can be recognized from the interruption in voltage decline around 5000 hrs.

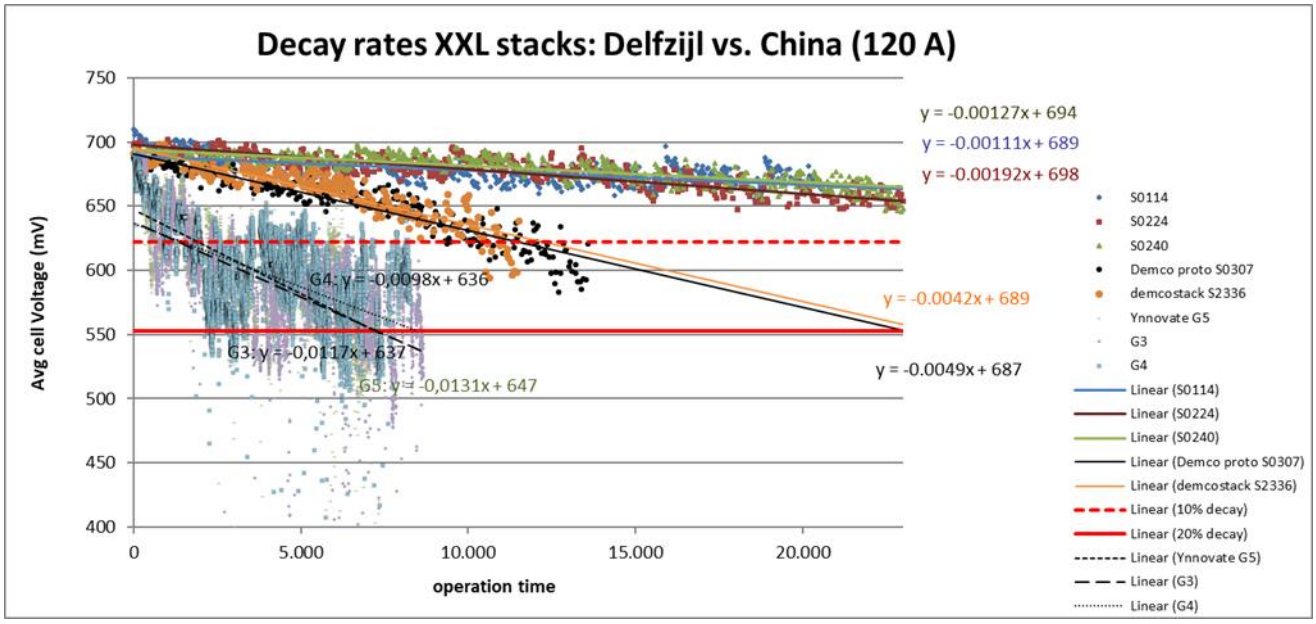

Fig.1 – cell performance in China vs Delfzijl as a function of operating time

Unfortunately, it did not appear to be possible to analyze the feed stream quality by the plant operator.

4 Stack repairs

In the complete operational period, 3 batches of in total 19 repair stacks returned to Nedstack for analyses and repair, see D6.8 - Report on stack failure causes. Detailed analyses of MEA failure causes will be reported in D6.4 by Johnson Matthey.

5 Conclusion

The stack performance of the DEMCOPEM-2MW power plant is found to decrease much faster than in a similar plant in Delfzijl, the Netherlands. The reversible decay is almost 100 fold higher in China, while the irreversible decay is roughly 3 to 10 times higher than Nedstack's XXL stacks in Delfzijl. The reason for this heavily accelerated degradation is due to feed stream contaminations, of both hydrogen and air.

6 Recommendations

A comprehensive multi-staged action plan was proposed to the plant operator, adding equipment for feed stream treatment to prevent excessive contamination to enter the plant, and as a result prevent deterioration of the stack performance. A limited number of new stacks should be also be included to demonstrate the effectiveness of the proposed improvement plan.

7 Acknowledgment

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