

CONCLUSIONS AFTER THE PROJECT

The partnership has gained much experience and has assessed the results of the project very valuable and positive. The project had a very ambitious objective, joining two different technologies and using a fuel, biogas, never tried before in the SOFC technology.

As for the biotrickling filter, the efficiency of the biological treatment achieved varied from 90% up to 100% in the removal of H_2S , operating steadily, in the 4 sites tested. The reliability of this technology working with different gases has been proved, although the time reaction of bacteria when fed with very variable H_2S concentrations must be taken into consideration.

Siloxane removal with biotechnological methods could not be tested due to the lack of these compounds at the site where the filter was operating steadily.

The testing of the SOFC in the landfill in Vacarisses resulted in an electrical and thermal efficiency of 29% and 24,5% respectively, showing that, despite the fact of operating a SOFC designed for natural gas, the operation with biogas in the landfill did not have an appreciable impact on the fuel cell performance.

At this site other sulphur compounds than H_2S - traces of dimethylsulphide (DMS) and carbondisulphide (CS_2) - produced a degradation in the stack in few hours of operation, which was shown by the reduction of the voltage produced in every of the cell in the stack in a 4%.

Although the biogas run before the SOFC through an AC filter devoted for the removal of H_2S and siloxane, it was proved that other sulphur compounds are not retained and so the last security upgrading must be filled with AC addressed for the specific contents of harmful compounds. It was also proved that the pre upgrading carried out internally in the SOFC could not either to reduce those little levels up to a safe one.

This fact showed with any doubt that the biogas has to be analyzed carefully before deciding on the installation of a SOFC since some harmful impurities might be too difficult or to costly to be removed.

Other result of the project is that the content of methane in the biogas as well as the flow must be relatively constant and over a certain level; in Galicia a content of methane lower 50% did not reach the power input needed to be able to operate the SOFC.

Regarding the stationary FC tested with natural gas, it run on line but with low efficiency. The fuel cell stack functioned as expected. However, malfunctions in the control system prevented the unit from reaching full operating temperature and, hence, optimum efficiency.

As final conclusion it can be stated that the SOFC is very sensitive equipment lacking robustness and so the removal of poisonous compounds in the biogas it is a priority. Biotrickling filters are a cost-effective way to remove them, although it must be accompanied by safety methods (i.e. AC) which guarantee a steady quality of the biogas stream with very low concentration of the harmful compounds (< 1 ppm).

Thanks to the project implementation there are important and positive ***lessons learned***:

- Public administrations have not developed equal proceedings for the **permit obtaining** in every region due to the lack of knowledge of this emerging technology. Therefore obstacles might be found when dealing with installation and grid connection of this equipment. It is strongly recommended to get information in advance in order to establish a sensible timing.
- A firm commitment in the technical support must be requested to the manufacturer when purchasing the equipment. The supplier should also provide a reasonable operation period guaranteed.
- SOFC efficiency operating with biogas is comparable to that when using natural gas.
- SOFC technology is suitable for steady biogas streams: CH₄ content must be over a certain level and no major changes should be in the content of harmful compounds. Therefore it is not a proper technology for landfills with high variations. An intensive analysis of the biogas composition is required before being used with SOFC.
- Biotrickling filters are a cost-effective technology for biogas purification which has to be tightened with other security filters to ensure the requirements of the SOFC.