Project

MEGASTACK: Stack Design for a Megawatt Scale PEM Electrolyser

JU FCH project in the Seventh Framework Programme
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D 3.3 Final MEA with most commercially viable cost reduction concepts demonstrated in single cell and supplied for stack test at partners

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Lead beneficiary	: 3 / ITM Power Trading
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Content

Abbrerivations

CCM	Catalyst Coated Membrane
FCH JU	Fuel Cells and Hydrogen Joint Undertaking
MEA	Membrane Electrode Assembly

1. Introduction

The main objective of work package WP3 is the development of a large geometric surface area MEA suitable for use in for the large stack hardware that has been developed within the MEGASTACK project. Of particularly concern are the material cost reduction concepts; minimisation of wastage and demonstration of high utilisation of catalyst.

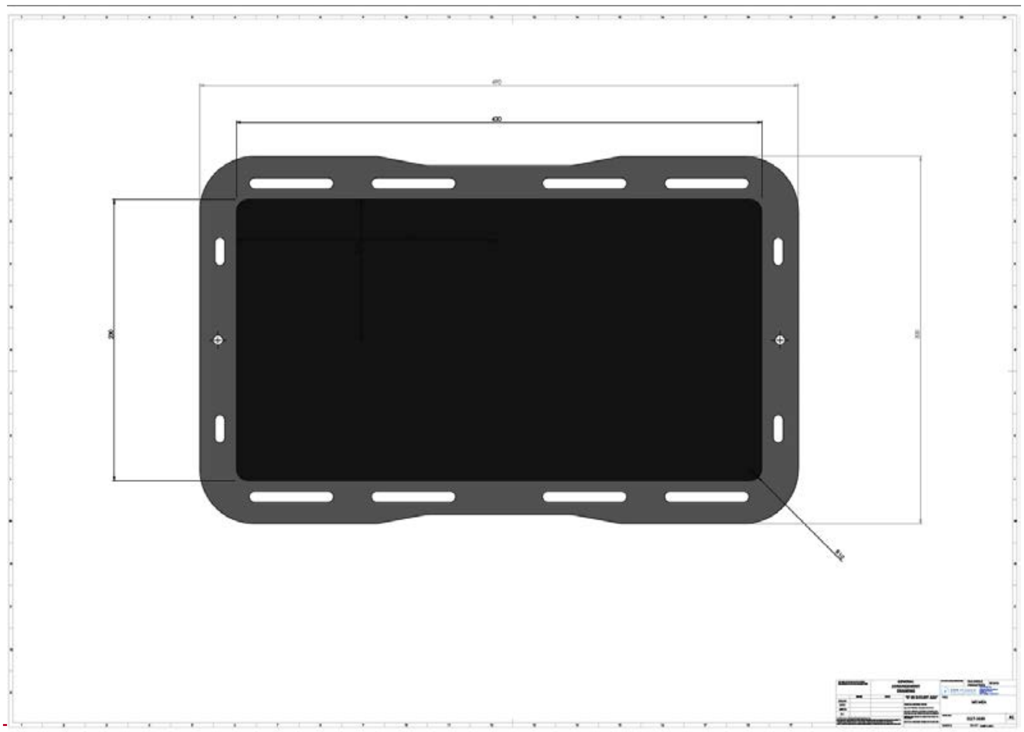
2. Final MEA design for large MEGASTACK

Low cost manufacturing of the MEA is based on two methods:

- Increasing the coated area versus uncoated surface area of the membrane. The improvement seen in the MEGASTACK project is quantified versus ITM current technology.
- Reduction of catalyst coated area in line with expected membrane expansion (distortion printing)
- Less catalyst wastage (during manufacturing) by moving from circular design to a rectangular design

2.1 CCM design

CCM design and post cutting manufacture by ITM has led to a significant reduction of uncoated area versus coated area.



~~Figure 1:~~ CCM cutting and active area –removed from public report as it contains sensitive information

2.2 CCM cost cutting summary

Cost cutting method	Cost saving achieved
Reduced dry catalyst coated area to 397x213mm	~15% catalyst ink saved
Ratio of active area over gasket area	From 1.57 (old technology) to 2.57 (MEGASTACK) 63.7% increase use of membrane effective area
Cycle time reduction (ITM internal R&D)	Demonstrated catalyst hot pressing significant cycle time reduction
Catalyst wastage from circular to rectanglar	~20% less catalyst wasted

Table 1: Summary of CCM manufacturing cost savings

3. Roll to roll progress

ITM is pursuing beyond state of the art roll to roll processing of CCMs. Significant cost savings and volume manufacture can only be envisaged this way. Hot pressing on a fixed press is used to adhere the catalyst to the membrane. This is a sequential, time consuming and manual process. This process has to be replaced by a hot rolling process (a continuous, ultimately unmanned process) in the roll-to-roll scheme.

Traditionally the cycle times of the two processes are very different and are not matched. There is also the issue with the integration to upstream coating processes – not discussed here. To resolve the disparity of cycle times, ITM has achieved advances in this area on a traditional fixed hot-press. Under certain conditions (and with a very challenging target), the transfer and adhesion of catalyst to a membrane was verified, and, significantly, effective in a fraction of the time normally associated with conventional hot pressing - approximately 10 times faster. It was necessary to optimize parameters and prove this could be done much faster with a fixed hot-press, as roll to roll manufacture requires the said rollers to impart their work to the catalyst in a fraction of the time allowed in a conventional fixed hot-press process.

The new process – under these new conditions, is considered fast enough to be a viable candidate for roll to roll manufacture which opens up an internal opportunity in terms of mass manufacture.

4. Polarisation curve of Final MEA.

4.1 Voltage as a function of current density

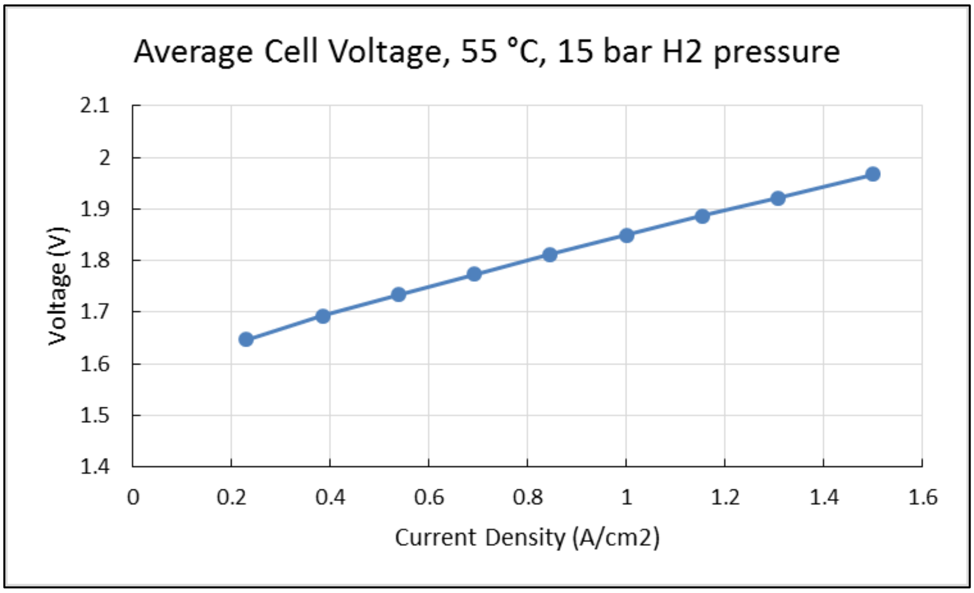


Figure 2: Polarisation curve of a 3-cell stack containing the final MEA, operating under commercial conditions.

Figure 2 shows the electrochemical performance of a 3-cell stack containing the final MEA, with the most commercially viable cost reduction concepts. The stack was operated under commercial conditions, at differential pressure (hydrogen at 15 bar, oxygen at ambient pressure). As the stack was operating under differential pressure, operation at low current density was restricted to minimize the risks of gas cross-over.

Whilst the electrochemical performance (efficiency) of this particular MEA is not best in class, it has been shown to be commercially ~~manufactur~~manufacture-able, is capable of operating under commercially relevant conditions for long periods of time and that there are no issues of mass transport even at high current densities. This will allow the design, manufacturing and cost saving ability of the scale up strategy within MEGASTACK to be demonstrated, allowing successful completion of the project.

5. Summary and Conclusions

The aim of this deliverable is not to demonstrate ultimate performance of a CCM publically, but is rather about the successful design and manufacturing scale up of a CCM technology within MEGASTACK.

This aspect of MEGASTACK demonstrates cost saving ability of scale up strategy using tangible comparisons with existing components and known methods.