ZAC+

Zinc-Air FuelCell plus Recycler

Projekt ZAC+
Overview 09/2018

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OPEN SOURCE ECOLOGY GERMANY

Introduction

This is an overview about the ZAC+ Project by OpenSourceEcology Germany , September 2018.

Definition: What it is and what not.

Primary cell: Battery
* not rechargable

Sekundary cell: Accumulator
* rechargable
* limited amount of Full-Charge-Cycles

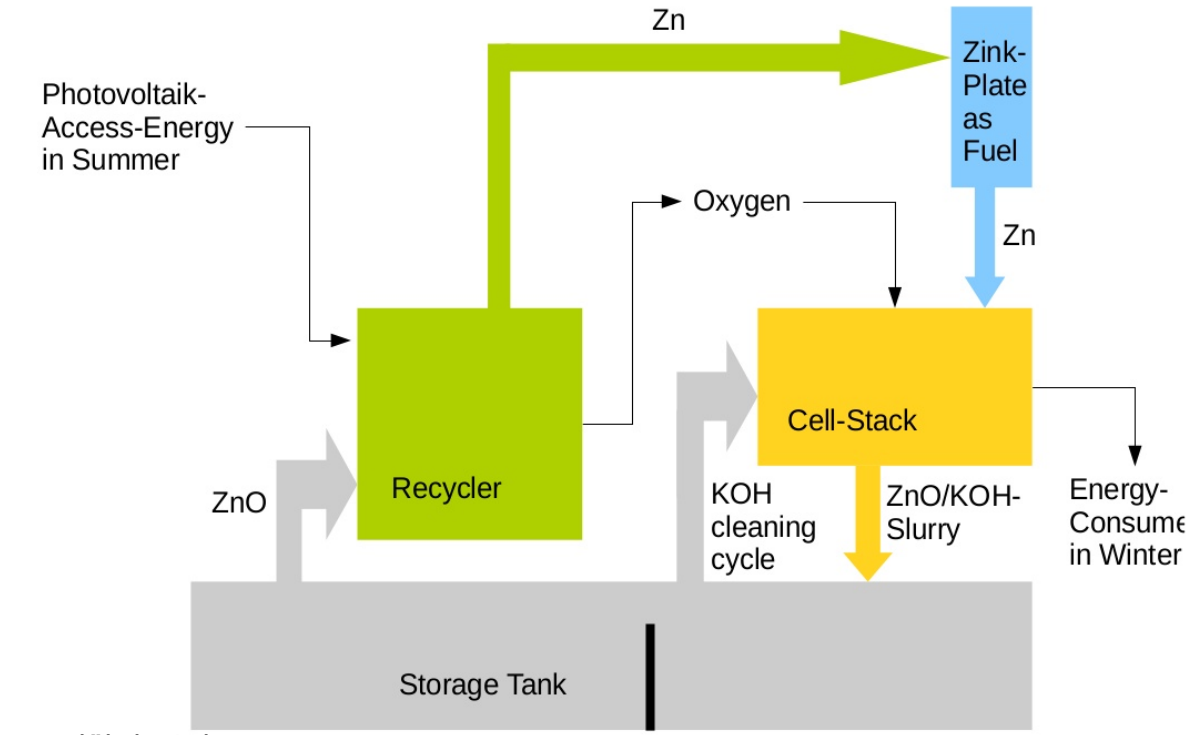
Tertiary cell: Fuelcell
* as long as fuel is feeded into it, electrical energy will be produced by the cell

Zink (Zn) will be oxidized into ZincOxid (ZnO) by the gas-cathode (GDL, Gas Diffusion Layer) with oxygen from the free air, which produces electrical energy.

The ZincOxide is separated mechanically and then becomes regenerated into Zinc in an external Recycler-process by delivery of electrical energy (e.g. from photovoltaics). Now the circle is closed. The Zink can be stored as fuel as long as you want and in arbitrary amounts.
==> Saisonal LongTermStorage

We use PotassiumHydroxide as Electrolyte within the fuelcell but also in the recycler.

ZAC+ Zinc-Air FuelCell plus Recycler, for Longterm-Storage



zugeführt wird.

Approach

Project-Segmentation: 3 Modules

1. The Fuelcell:

consists of

- Zinc-Anode
- Gas-Cathode (GDL)
- Reaction-chamber with electrolyte

The Zinc will be feeded into continuosly as a flat plate, which sildes down by its own wheight if the lower edge is burned.

The electrolyte becomes also continuosly added freshly and is afterwards cleaned up within a short circulation-loop (while the zincoxide will be removed mechanically)

Also the air-supply can be controlled (air-pressure, Scrubber)

The gas-cathode can be easily exchanged by movin and removing it into appropriate slots.

2. The Recycler:

A separate electrogalvanic process. A cointainment with KOH-electrolyte and zincoxide and to little steel-grids working as anode and cathode. WHen supplying these with power, the pure zinc is agglomerating at the anode with a sponge-like structure.

3. Gas-Cathode Production:

Limiting factor (from economical point of view), therefore ist desirable to produce our own GDLs (OSP). Until then we use a commercial GDL.

Methodical strategy

Disclaimer: ZAC+ is not a Reengineering- but a R&D-Projekt ==> outcome open

* Other projects in science and economy try to develop a compact accu (secondary cell)

==> difficult; so far no commercial project

* we bet instead on mechanical separation of zincoxide

==> not well suited for EVs
==> but perfect for PV-LongTermStorage
==> Safe Side, it working is guaranteed

* we try to use the gravity for things like zinc-feed, gradient in chamber and zincoxide-separation, for saving energy within the process (eg. for Hopper-motor)

==> better overall-efficency

* Power of OSHW: We try to replace expensive nano-tech-equipment (which we don't own) by practical experiments, community-menpower and -skills

Status-update

Modul1: Brennstoffzelle

- Pre-Prototype "Kathodentester" as closed chamber, still without electrolyte-circulation (Proof of concept)

==> Well defined test- and measuring-environment for demonstrating the "burning"-process

==> Proof: Generation of electrical energy works !

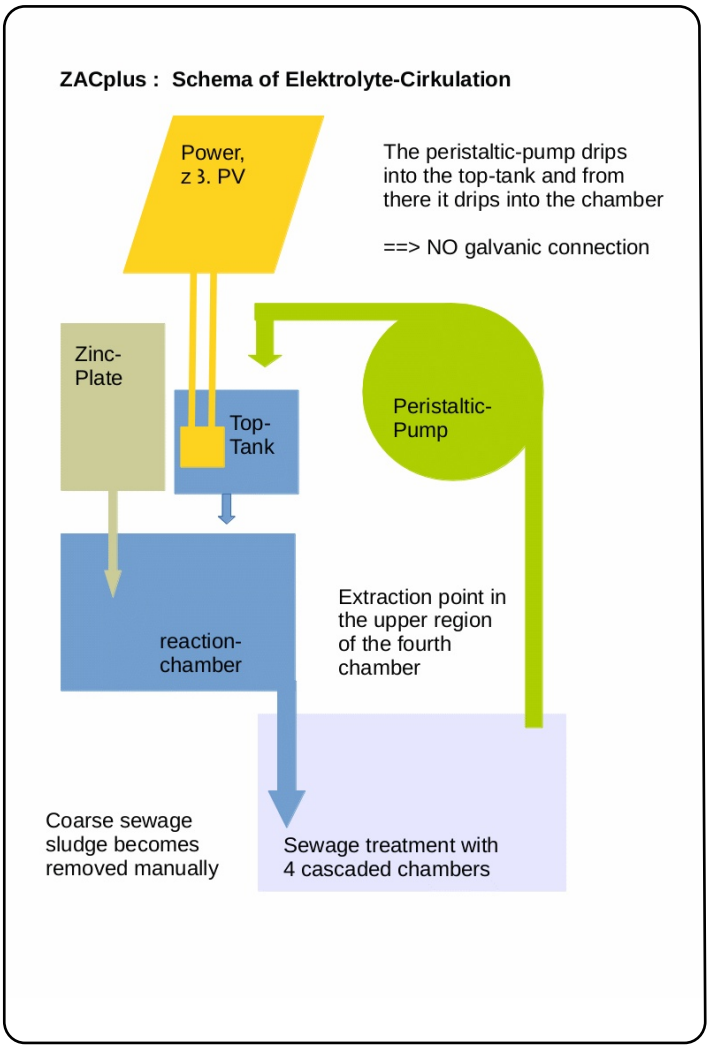
==> Characterisation of different GDL-types

==> Energy-tightness of min. 600 Wh/Kg

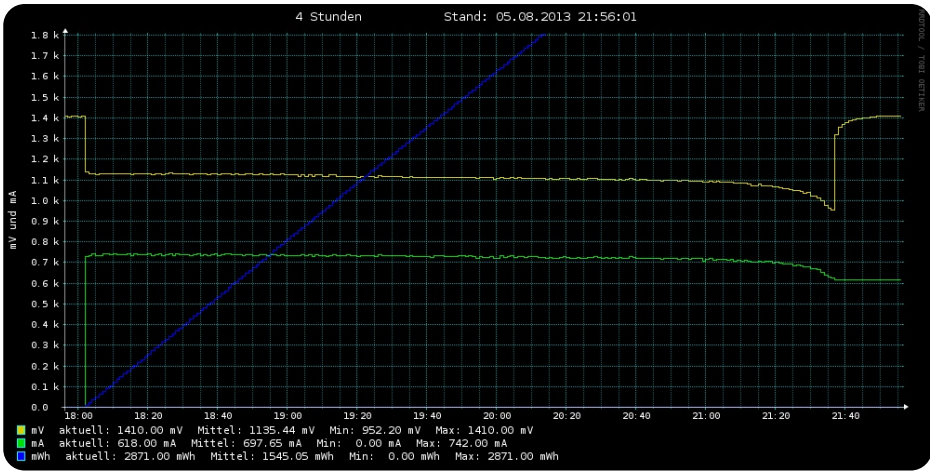
==> Status: finished !

- New Prototyp 1 under construction

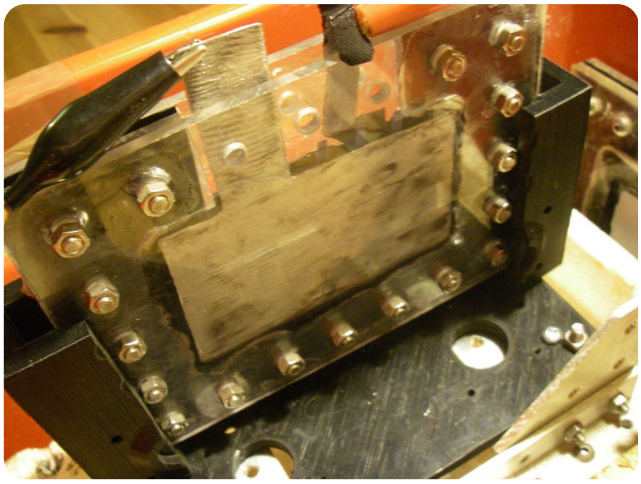
* Elektrolytecirculation
* Airflow-Control
* 3D-printable: Multiplicator f. Community



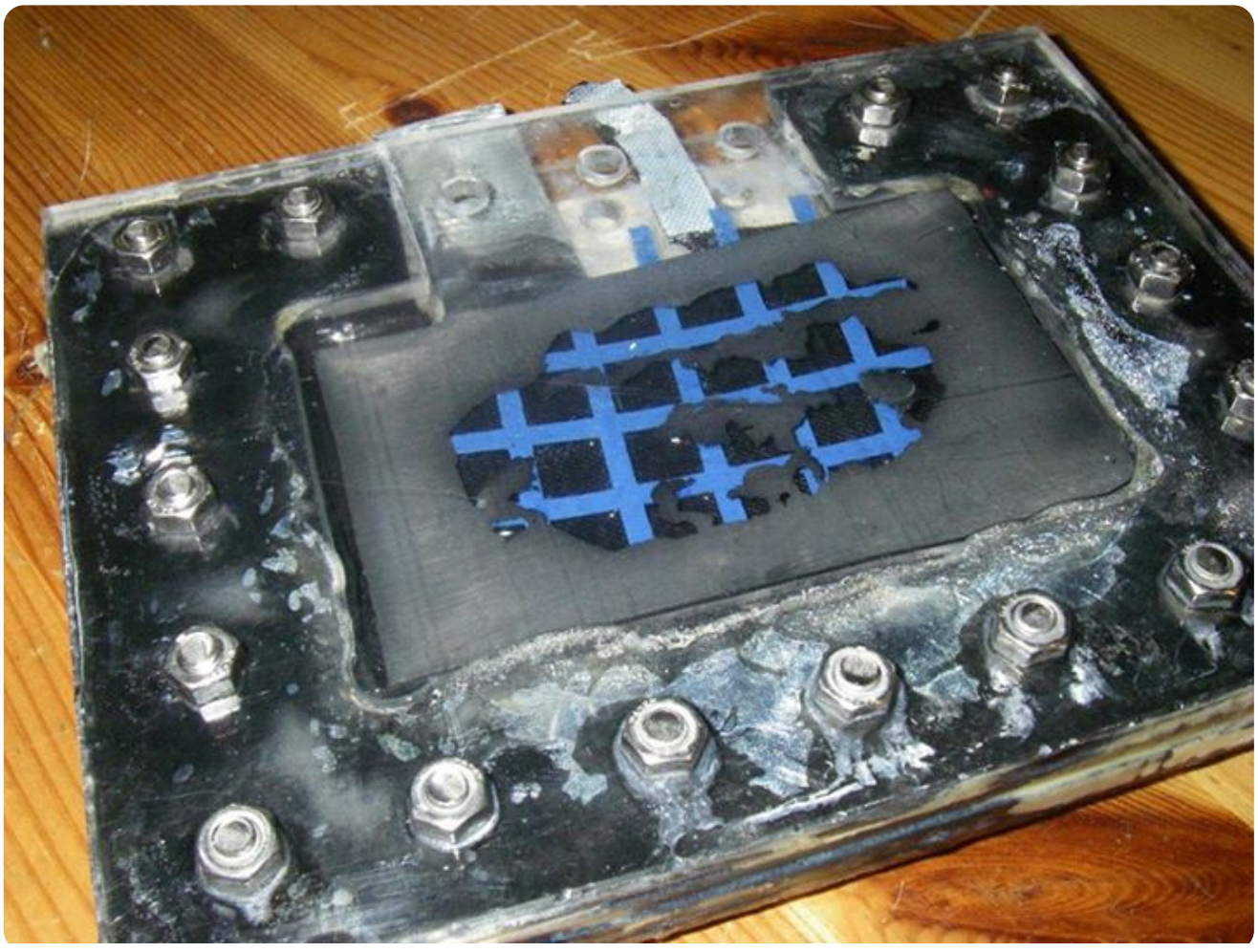
- ZACmeter: Metering-Setup and - circuit, allows standardized capacity-measurement and DB-supported visualization



Status update



Modul 1: Fuelcell: ZACmeter



Status-update

Modul2: Recycler

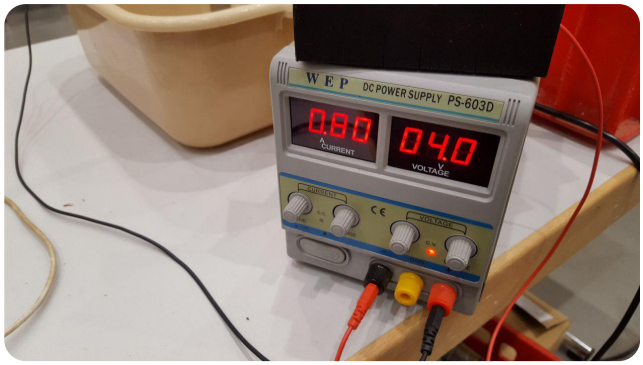
- relativ simple electrogalvanic process

- qualitative demonstration of the Zinc regeneration from zincoxide

==> Zinc-particel can be obtained in a simple manner and the becom opressed into zinc-plates

==> Circle is closed

==> works well with KOH as electrolyte



- First quatitative measurements

==> relation current / voltage grows linear

==> probably overall-efficiency of about 32% ! (Impressive value,compareed to H+- and Methan-Synthesis / Power2X)

Status-update

Modul3: GDL-Production

- until now we didnt produce a working GDL on our own (mostly because we concentrated ourselves on Modul 1)

- But: First trys have been looking promising

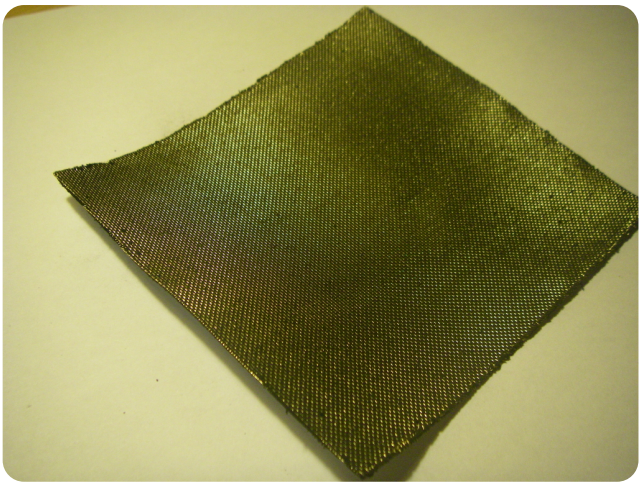
<== All components (steel-grid, PTFE-powder, carbon-powder, PTFE-membrane) are easily available from regular sources

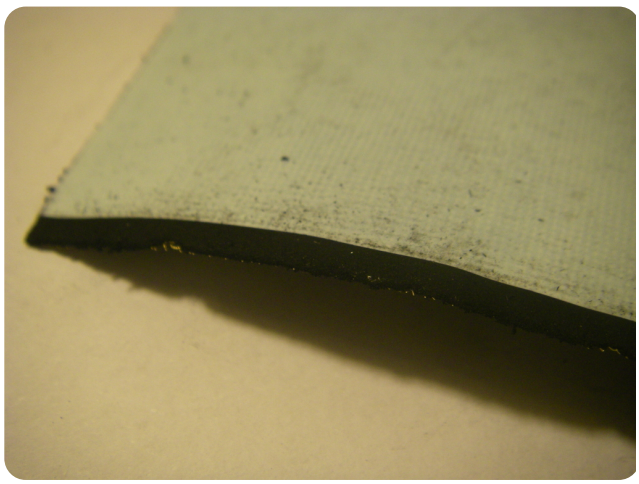
<== A temperature of 320°C is needed and a Kalander-like device or process (see Quantumsphere, https://www.youtube.com/watch?v=ZyKOzVrc7lo min 4:40 - 5:30)

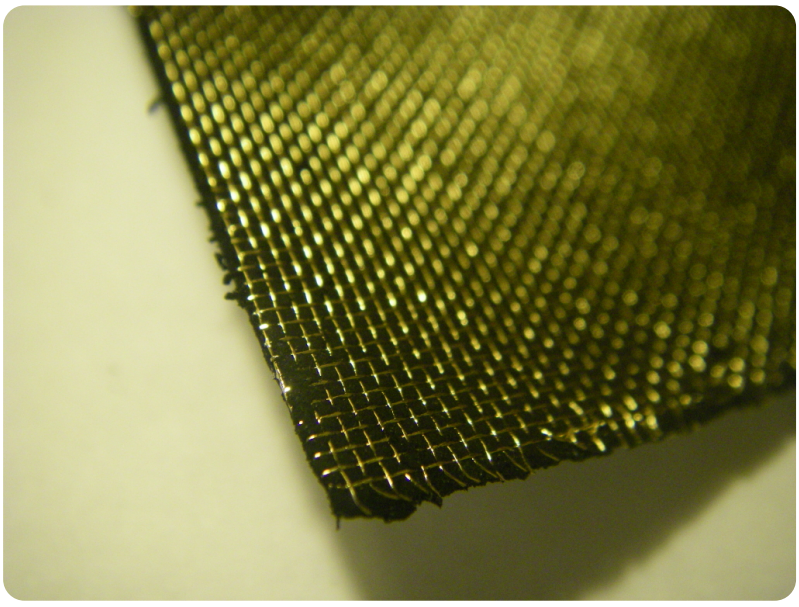
- Recently we use a commercial GDL

==> Allows comparison between a commercial one and our (later) selfproduced GDL

Pictures: commercial GDLs from the german producer Gaskatel







Scientific Research & Development

Research: Corequestions

1. GDL-Lifetime and No. of Working-hours ?

* How many working hours can we reach with a GDL ? (Gaskatel, OSEG-GDL) ?

* Which factors influence the lifetime and how ? (==> Optimization)

Possible factors:

- Zincoxide-Saturation in the Elektrolyte

- Clogging of GDL-Pores by
  a. Zincoxide
  b. Potassium-Carbonate (==> Scrubber !)

- Drowning of GDL (==> AirPressur !)

2. Optimum Burning ?

* Gradient, Streaming, Whirls

3. Optimum Circulation-velocity of KOH ?

4. Overall-Effiency ?

5. Nominal Power of cell ?

* Stack, Economy

Development: Optimizations

1. General: Increase surface-area of 3-Phasen-Border

2. Mechanical Separation of zincoxide

3. Scrubber

4. Frame, Case (Integration with FreeCAD, UniProKit)

5. Recycler and Plate-pressing

For Research and answering the corequestions we use the Prototype 1 which is currently under construction

This is a small single cell with electrolyte circulation.

As soon as we reach an acceptable lifetime of the GDL, we can based on these experiences start with Prototype 2.

Here the single cell has already the end-size.

Furthermore it will be designed "slim-lined" as precondition for a whole stack

==> productive version

Some detailed aspects

- Technical model

* allows different scenarios for dimensioning and scaling

* makes suggestions for appropriate starting-values

* helps to identify optmization-points and dependencies (==> Efficiency)

* Tech Specs

- economical model

* Use-Case, zB. OpenEcoLab2:
7000KWh, 3KW, 32KWh/d
==> how many stacks and how many cells per stack ?

* costs of building one cell or stack

* operational costs

* Benefit, Surplus (z.B. RWE w/o EEG: x2.5)

- 3D-Printing

* Not trivial with larger parts in ABS (Warping, Cracks) maybe ThermoInsulation can help

* either with big printer (30cm printing volume)

* or with normal (20cm) printer ==> glewing

* Important multiplicator, we can build several cells for parallel testing !