

High Pressure Plasma Electrolysis Experiments

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Plasma Electrolysis

- First experiments by Ohmuri and Mizuno⁽¹⁾.
- Reproduced by several laboratories including Fauvarque and Clauzon⁽²⁾.
- On the internet, many demonstrations without accurate measurements.

(1) T. Mizuno, T. Ohmuri, T. Akimoto, and A. Takahashi, "Production of heat during plasma electrolysis in liquid", *Jpn. J. Appl. Phys.* 39(10), 6055-6061 (2000).

(2) J.F. Fauvarque, P. Clauzon, G. Le Buzit, and J.-M. Lallevé "Abnormal excess heat observed during Mizuno- type experiments" *ICCF12 Proceedings*, Yokohama, Japan, 2005, p. 80-85.

Objective

- Pressure and temperature effect,
 - Reactivity increases with temperature,
 - Plasma density increases with pressure,
- ➔ Design a cell in order to study reactions at high temperature and high pressure.

Calorimetry Principles

- The electrical input is measured with a Wattmeter, sampling frequency: 70kHz
- The heat energy is measured by the loss of water measured by the weight loss.

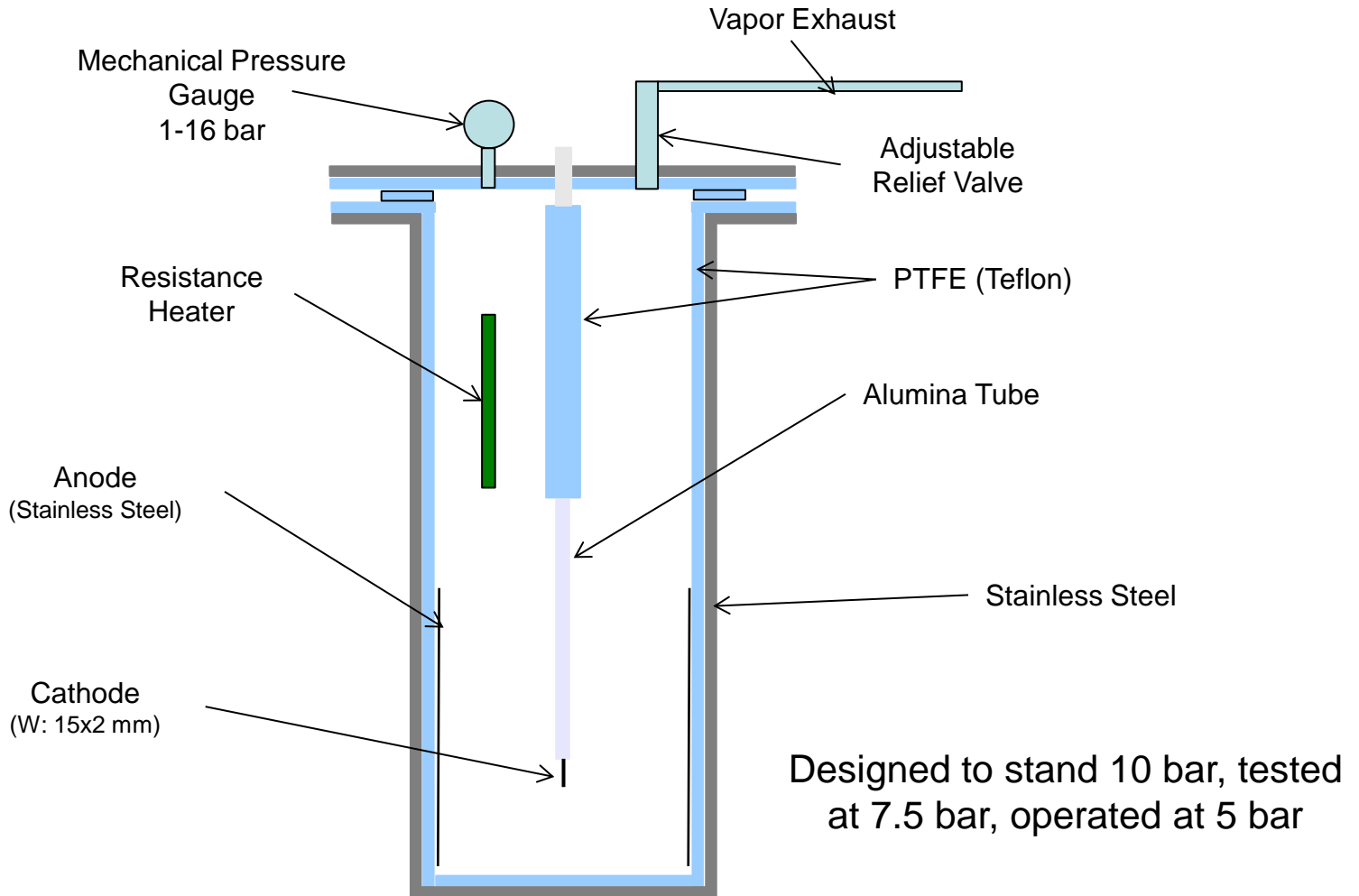
Pressure vs. Temperature

Pressure (bar)	Heat of vaporization (J/g)	Boiling Temperature (° C)
1	2258	100
2	2202	120
3	2163	134
4	2133	144
5	2107	152

Cell specifications

- All Teflon chamber
- Capable of standing up to 10 bar and 177° C
- Total weight is less than 6kg, due to existing equipment limitations
- Relief valve
- Pressure gauge
- Resistor (300 W) for calibration.

Cell Schematic



Cell : Inside



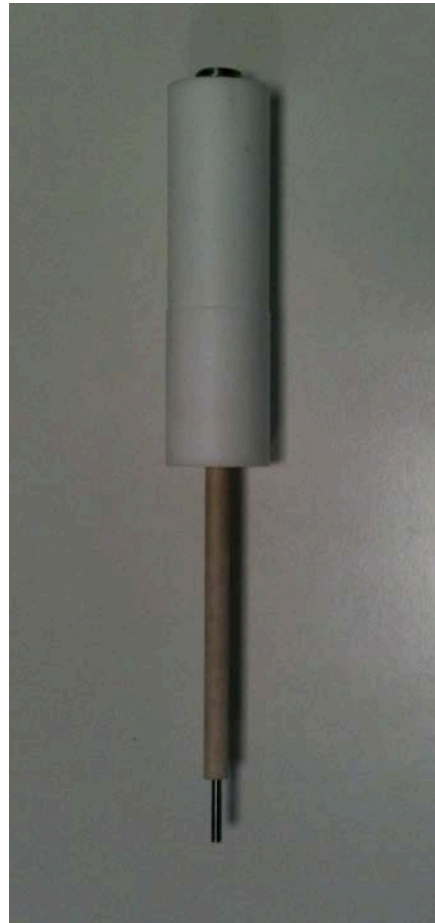
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Complete Cell on the Scale



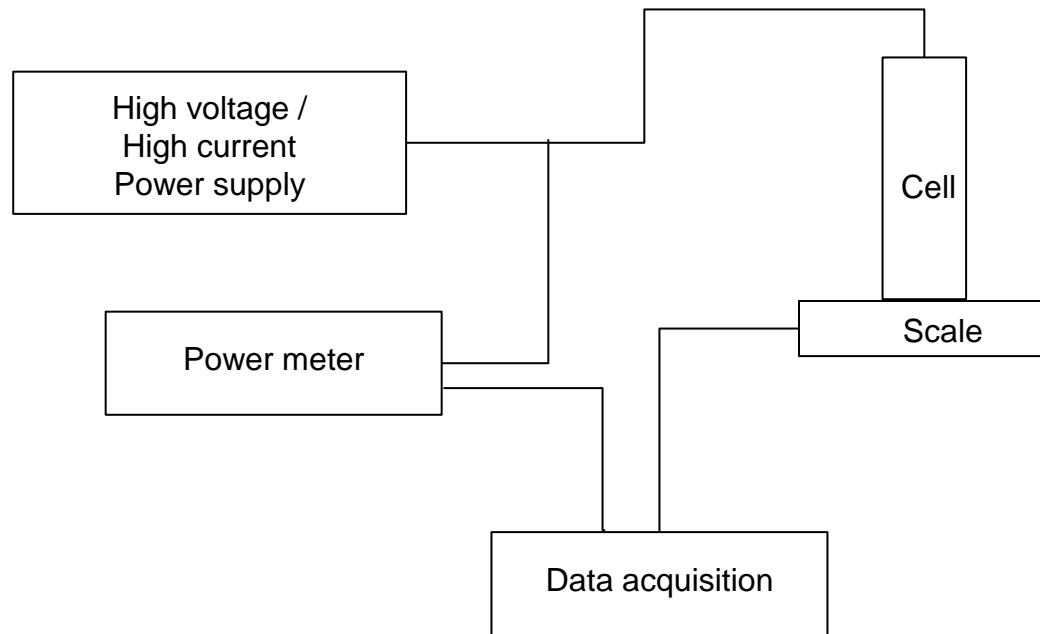
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Cathode details



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Set-up Schematic



Calibration

- With resistance heater losses varies with pressure:

Pressure (bar)	Loss (Watt)	Power (Watt)
1	75 +/- 5	250/300
2	95 +/- 5	300
3	102 +/- 5	300
4	111 +/- 5	300
5	117 +/- 5	250/300

Experimental Conditions

- Electrolyte: H₂O and K₂CO₃ 0.03/0.06 mol/liter
- Quantity: 1.3 liter
- Electrode: W + 2% Th rod 15mm x 2mm

Parameters

- Cathode material
- Cathode dimensions
- Electrolyte composition: nature / concentration
- Pressure / Temperature
- Voltage / Current
- Pulsing voltage

Preliminary Results

Conditions:

- Constant Voltage: max = 360 Volt
- Current max: 2 Amp
- Pressure 5 bar / 152° C

Results:

- Average Power In: 404 Watt
- Average XSH: 21 Watt
- COP: 1.05
- Duration 56 minute

Precision of the measurements

- Power in : measured with a Wattmeter sampling frequency 70 kHz, at constant voltage.
- Power out : measured with a 6 kg / 0.2 mg scale.
- Dry water vapor coming out.

Dry vapor



Conclusion

Advantages:

- This type of calorimetry operates at constant temperature.
- Very short time constant.
- Variable temperature and pressure.
- Potentially high COP.
- Excellent for demonstration purposes.
- Possible measurement of deuterium formation if any.

Disadvantages:

- Destruction of the cathode during operation.
- Total duration is time limited with this design.