November 4/7, 2013, Timişoara, Romania

HYSULFCEL

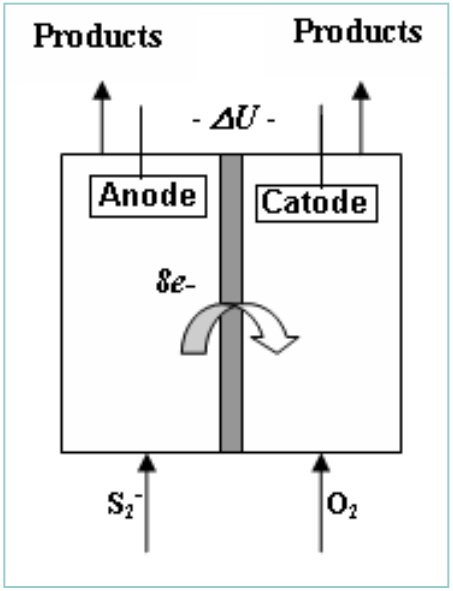
Sulfide-driven fuel cell. Choice of construction and electrodes.

E. Razkazova-Velkova, M. Martinov

V. Beshkov

HYSULFCEL

Process description



Anode: $S^{2-} + 4OH^{-} - 8e^{-} = SO_4^{2-} + 4H^{+}$

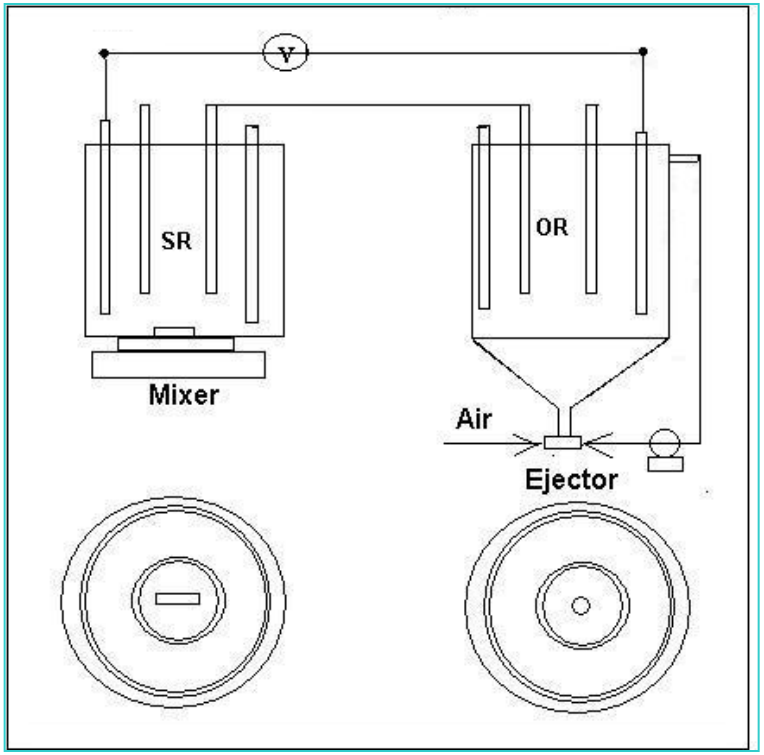
Cathode: $2O_2 + 8H^{+} + 8e^{-} = 4H_2O$

The net reaction is:

$S^{2-} + 2O_2 = SO_4^{2-}$

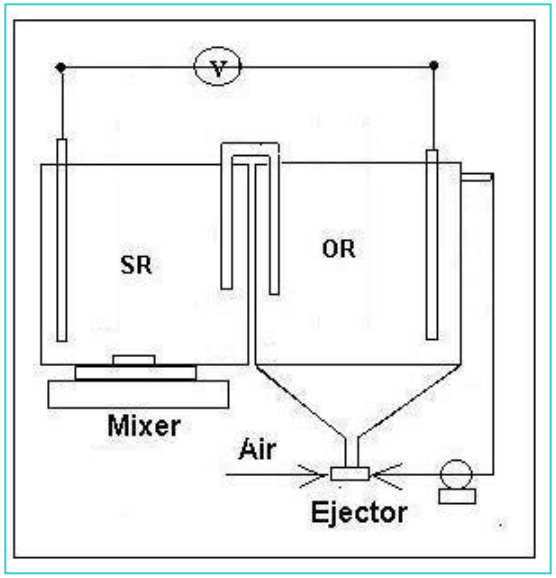
HYSULFCEL

Construction of the cell



Construction 1- connection wire

Construction of the cell



Construction 2- connection salt bridge

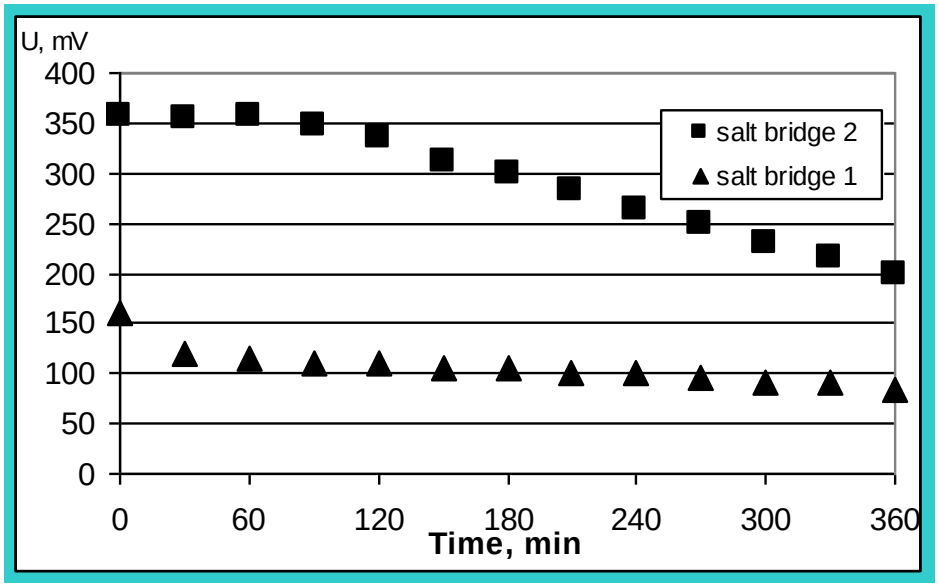
Table 1.

	Diameter, mm	Content	Electrical resistance, Ω
Salt bridge 1	5	Agar +KCl	30000
Salt bridge 2	10	Sea water*	1000

* Sea salt into tap water

HYSULFCEL

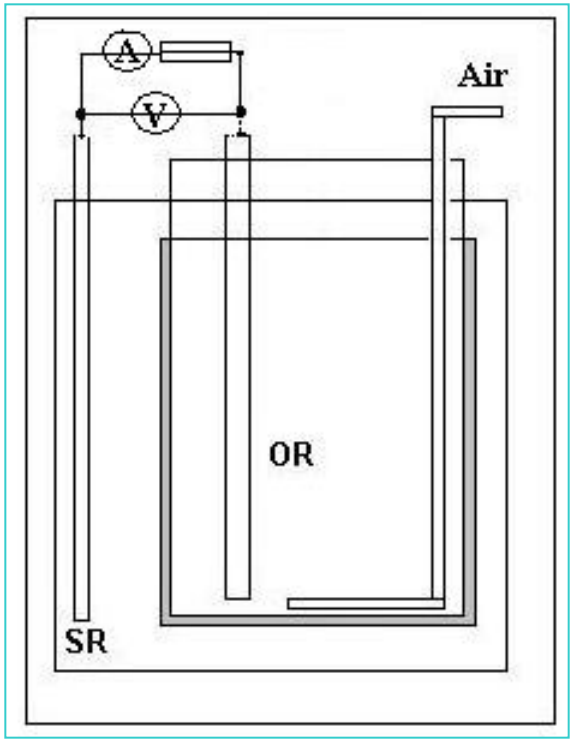
Construction of the cell



Influence of the type of the salt bridge on the resulting electrical voltage

HYSULFCEL

Construction of the cell



Construction 3 – connection membrane Sel Gard 3501

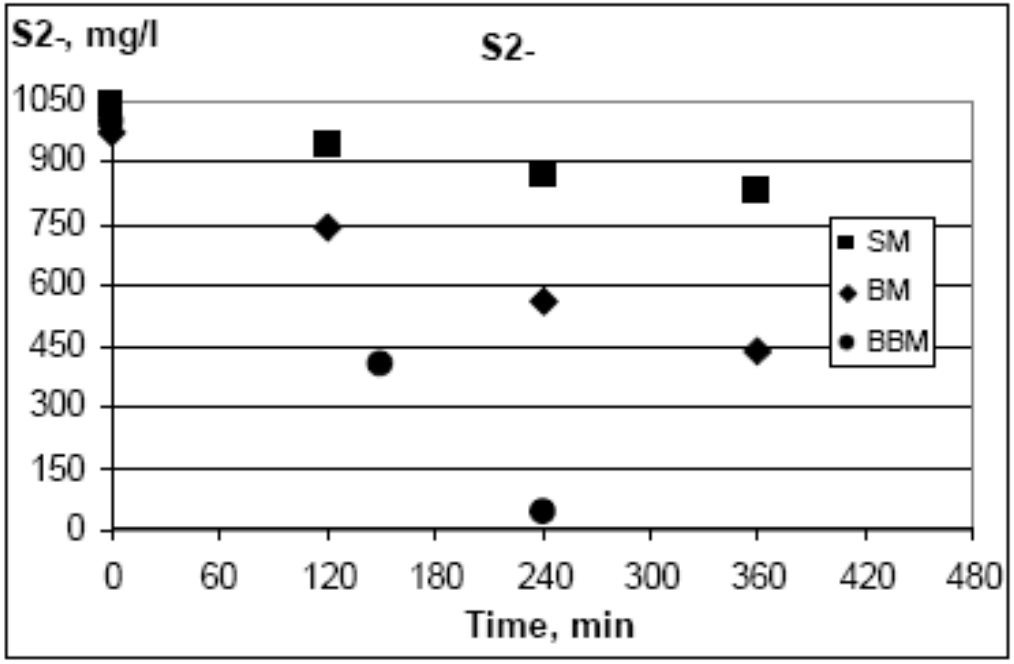
Construction of the cell

Table 2.

	Diameter, mm	Place of the perforations	Working surface of the membrane, mm^2	Electrical resistance, Ω

HYSULFCEL

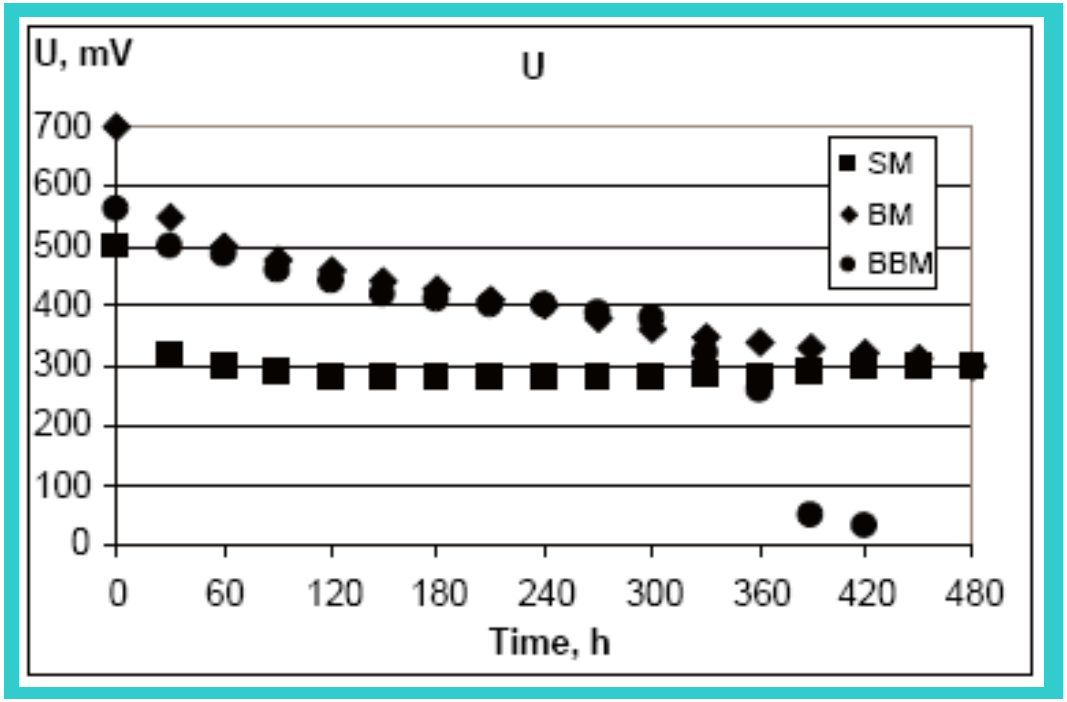
Construction of the cell



Influence of the size of the membrane on the oxidation rate of the sulfide ions

HYSULFCEL

Construction of the cell



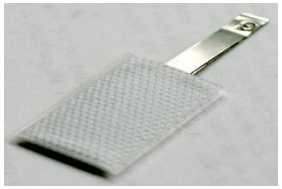
Influence of the size of the membrane on the resulting electrical voltage.

HYSULFCEL

Choice of electrodes

1. Graphite rods with dimensions- 6 mm, length-200 mm , working surface 2000 mm^2

2. Electrode over Ni foam-Norit NK, PTFE, graphite and catalyst of (Co spinel (Co_3O_4)) 10 %, with mounted Sel Gard 3501. Sizes: 30 x 15 x 1 mm Surface 900 mm^2



Ni foam before use

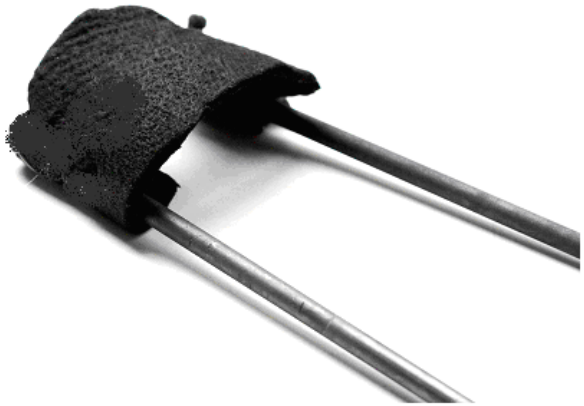
Ni foam after use

Choice of electrodes

3. PTFE and catalyst of (Co spinel (Co_3O_4)) 10 %, hot pressed over stainless steel metal net. Diameter 45 mm and surface 3000 mm^2

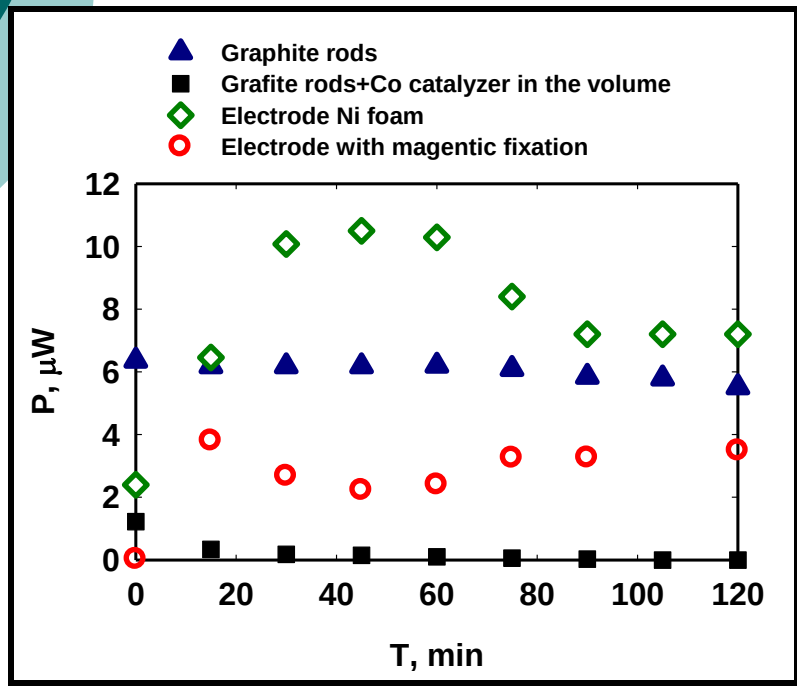
4. Graphite rods with activated carbon over the surface- 6 mm, length-200 mm , working surface 2000 mm^2

5. Pyrolized and activated carbon padding. Dimensions: 110 x 45 x 5 mm, surface 10000 mm^2

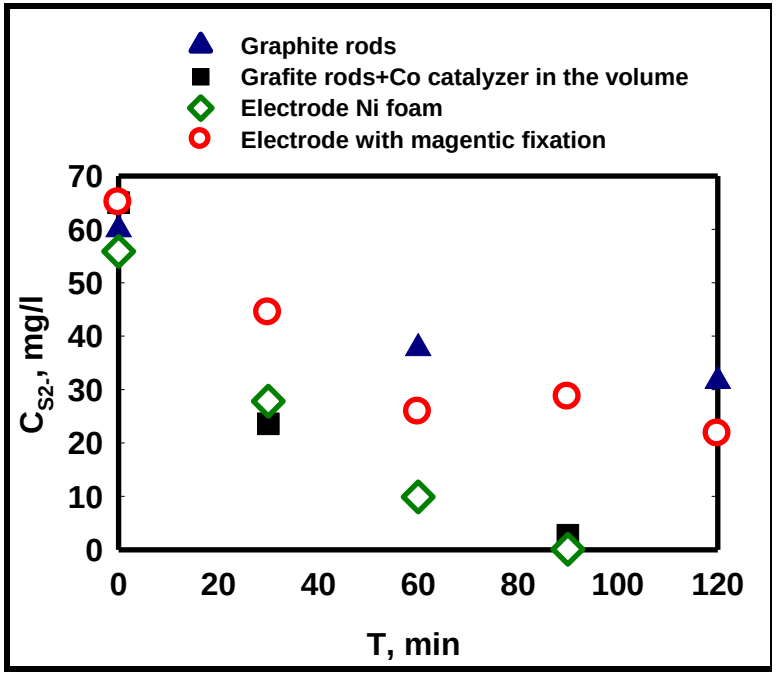


HYSULFCEL

Choice of electrodes



Comparison of the obtained electrical power from the fuel cell with agar salt bridge and different electrodes



Oxidation rate with different electrodes

Choice of electrodes

Table 3.

Type of Electrode	*U, mV*	*I, mA*	*P, µW*	*U, mV (open circuit)*
Graphite +AC	42	0.19	8	320
Graphite	22	0.1	2.2	200

3.6 times increase of the received electrical power

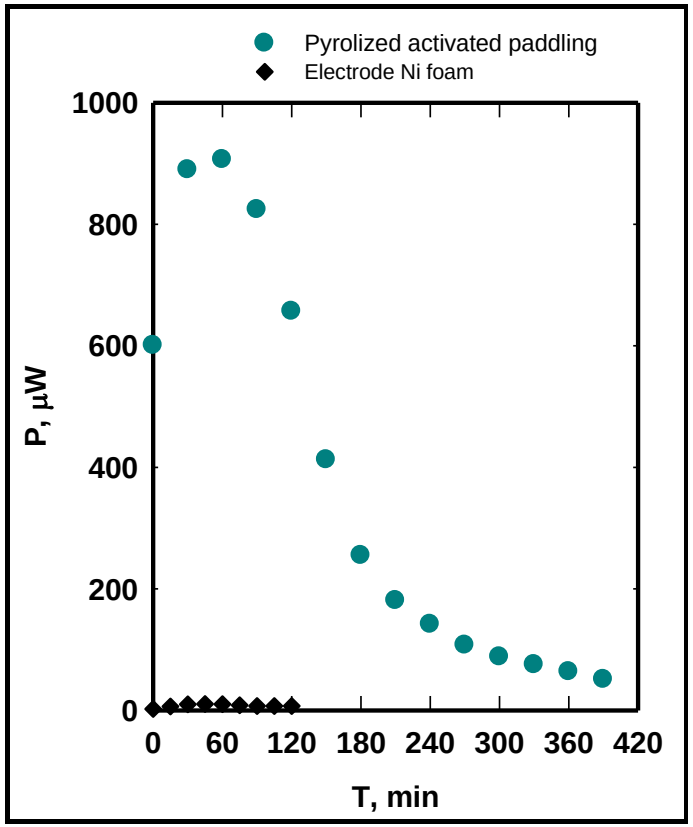
Table 4.

Type of Electrode	*U, mV*	*I, mA*	*P, µW*	*U, mV (open curcuit)*
AC in the SR	31.8	0.15	4.8	180
AC in both reactors	74.5	0.34	25. 3	440

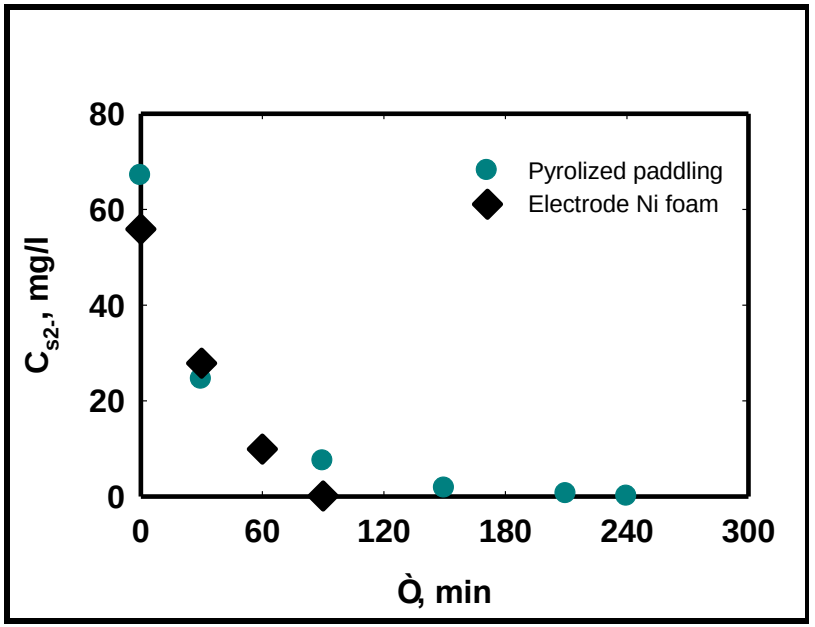
Over 5 times increase of the received electrical power

HYSULFCEL

Choice of electrodes



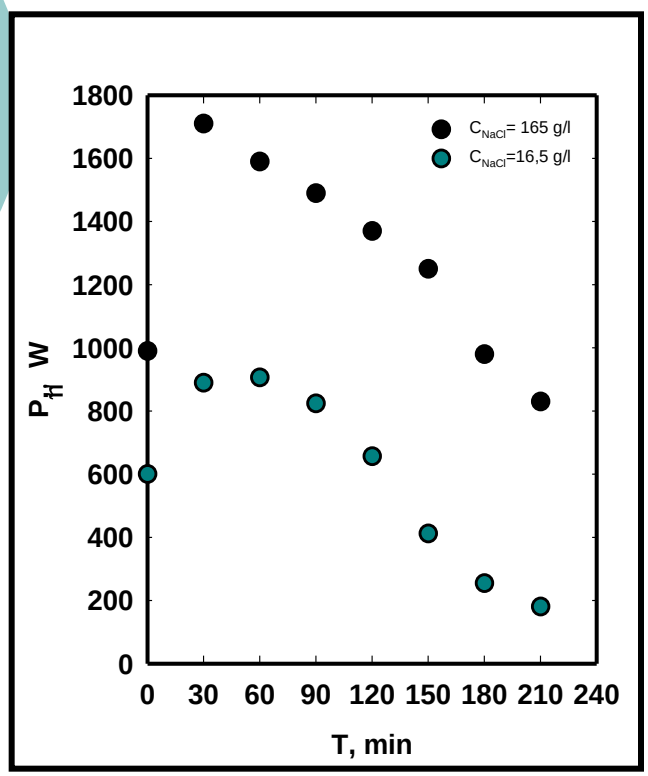
Electrical power for electrode Ni foam and activated paddling



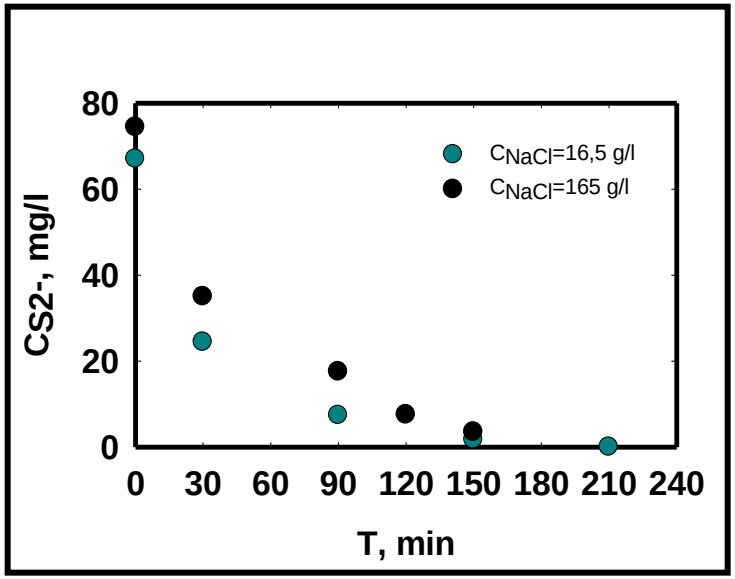
Oxidation rate for electrode Ni foam and activated paddling

HYSULFCEL

Choice of electrodes

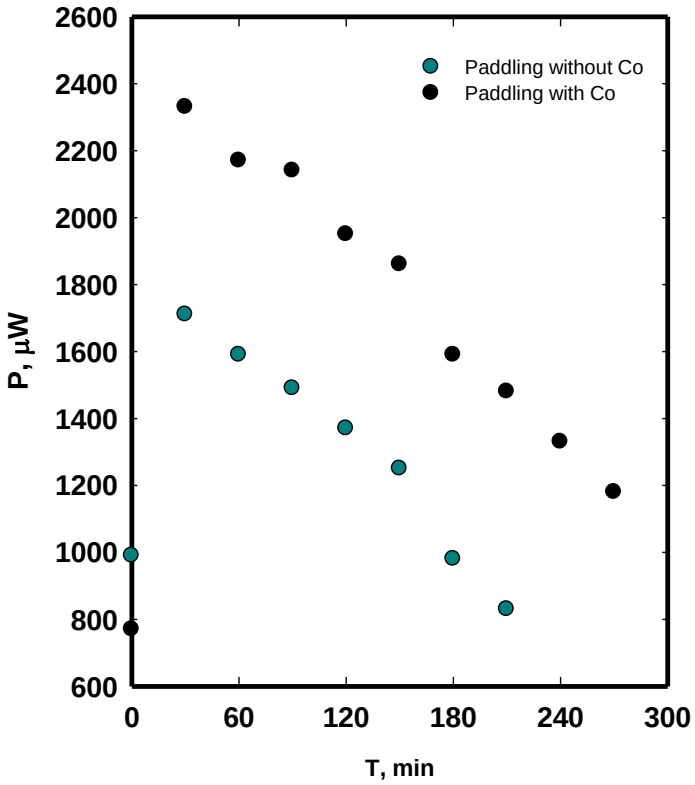


Electrical power for electrode activated paddling with different concentration of NaCl.



Oxidation rate for electrode activated paddling with different concentration of NaCl

HYSULFCEL



There are no sulfides in the solution after the first hour.

Electrical power for electrode activated paddling with and without Co_3O_4

Conclusions:

The decrease of the internal resistance of the system leads to higher electrical power obtained from the cell and higher oxidation rate. The best results are with the membrane with the largest surface.

- **The presence of catalyst intensifies the process. Moreover its absence leads also to a high quantity of stable reducing agents instead of sulphates.**
- **The catalyst has to be firmly integrated into the electrode for best performance of the fuel cell**
- **Increasing the internal surface of the electrodes generates higher electricity power indicators.**
- **The increase of the sulphide content trough reverse osmosis will increase the salinity of the used electrolyte that guides to higher electricity power obtained from the cell.**

Future challenges:

- Searching for other more appropriate membranes.
- Improving the mechanical strength of the electrodes.
- Testing different catalysts.

THANK YOU FOR THE

ATTENTION!