MICROBIAL FUEL CELLS (MFCs) FOR WASTEWATER TREATMENT AND ENERGY PRODUCTION. A FIRST ECONOMIC ASSESSMENT

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Agenda

1. Introduction
2. Case study
3. Results
4. Conclusions

Why is important?

- The impact of wastewater discharges to inland and marine water bodies is attracting greater interest.

Lagunas de Ruidera, 2013

Water is life!

Why is important?

- Water is polluted: home use and manufacturing processes.
- Wastewaters should be adequately managed prior disposal.
- The main wastewater treatment is activated sludge.
- Disadvantages:
  - high sludge generation
  - high energy consumption (aeration process: 30-55% total energy demand)

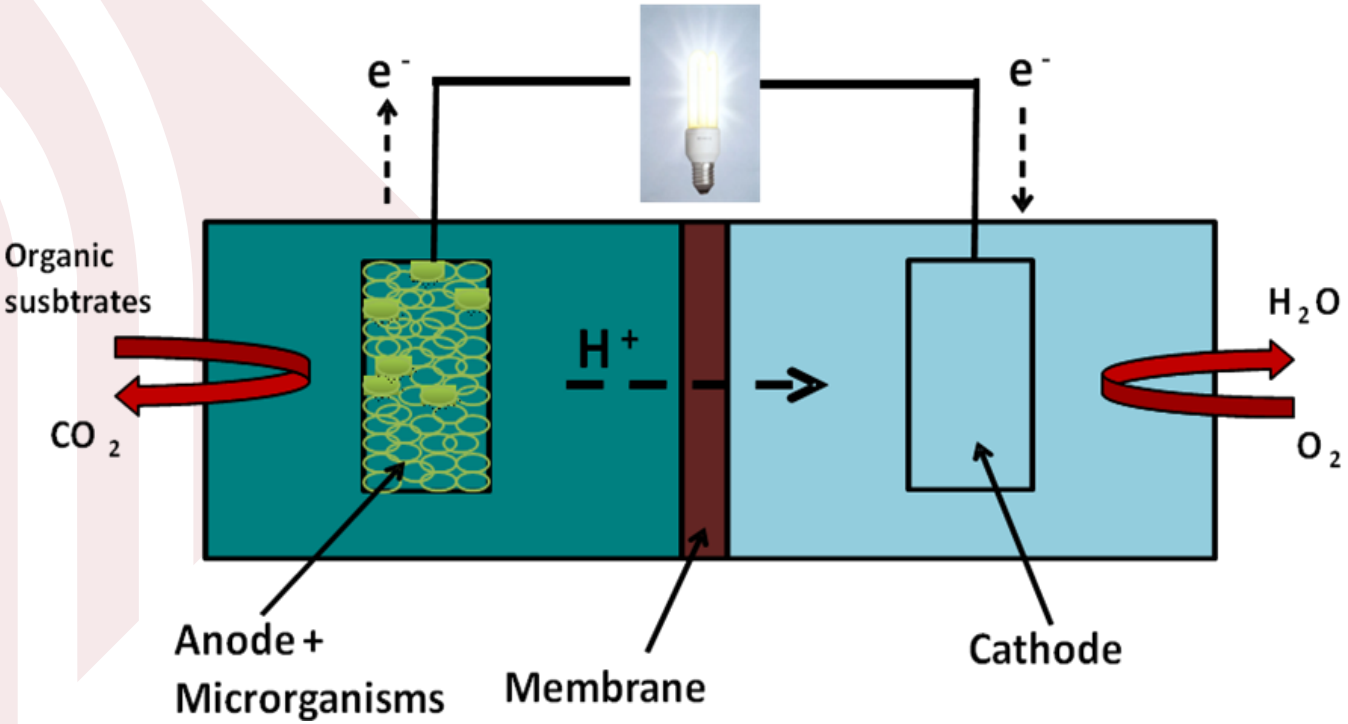
Why is important?

- Wastewaters contain energy (biodegradable organic matter)

We spend energy to remove it, why do not **recover** it?

Why is important?

- MFC (Microbial Fuel Cells)



- organic matter is released from wastewater
- electrical current is also produced

Goal

- The aim of this work is to carry out a preliminary economic assessment of a MFC system for the treatment of wastewater coming from a juice industry company.

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Design

- The wastewater treatment plant with the MFC system consists of :
  - 10 cells of 2.25 m^3 each one
  - Treatment of 54 m^3/day approx. of wastewater
  - (Chemical Oxygen Demand = 15,000 mg/L)
  - Removed COD 90%

Design

- Alternatives:
  - Case A: Cathode electrodes are coated with Pt.
  - Case B: non-Pt
  - Case C: Traditional activated sludge

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Results

- Which alternative is more profitable?
- Time-adjusted economic feasibility criteria

NPV (Net Present Value)

$$VAN_k = -A + \sum_{i=0}^{n} \frac{Q_i}{(1+k)^i (1+\lambda)^i}$$

IRR (Internal Rate of Return)

$$-A + \sum_{i=0}^{n} \frac{Q_i}{(1+TIR)^i (1+\lambda)^i} = 0$$

Results

- The cash-flows are based on the savings obtained by the MFC (case A/B) with respect to the standard plant (case C).
- Initial investment case A/B are higher than case C

Other variables:

λ (inflation)= 2%
k (discount rate)= 3%
n=15 years

Results

	CASE A (€)	CASE B (€)	CASE C (€)
Deposit	34.300	34.300	-
Electrodes (Anode)	1.500	1.500	-
Electrodes (Cathode)	3.300	1.500	-
Membrane	4.200	4.200	-
Converter DC-AC	500	500	-
Pumps	500	500	500
air-blowing device	500	500	500
Conventional reactor	-	-	35.000
Initial investment (A)	**44.800**	**43.000**	**36.000**

Results

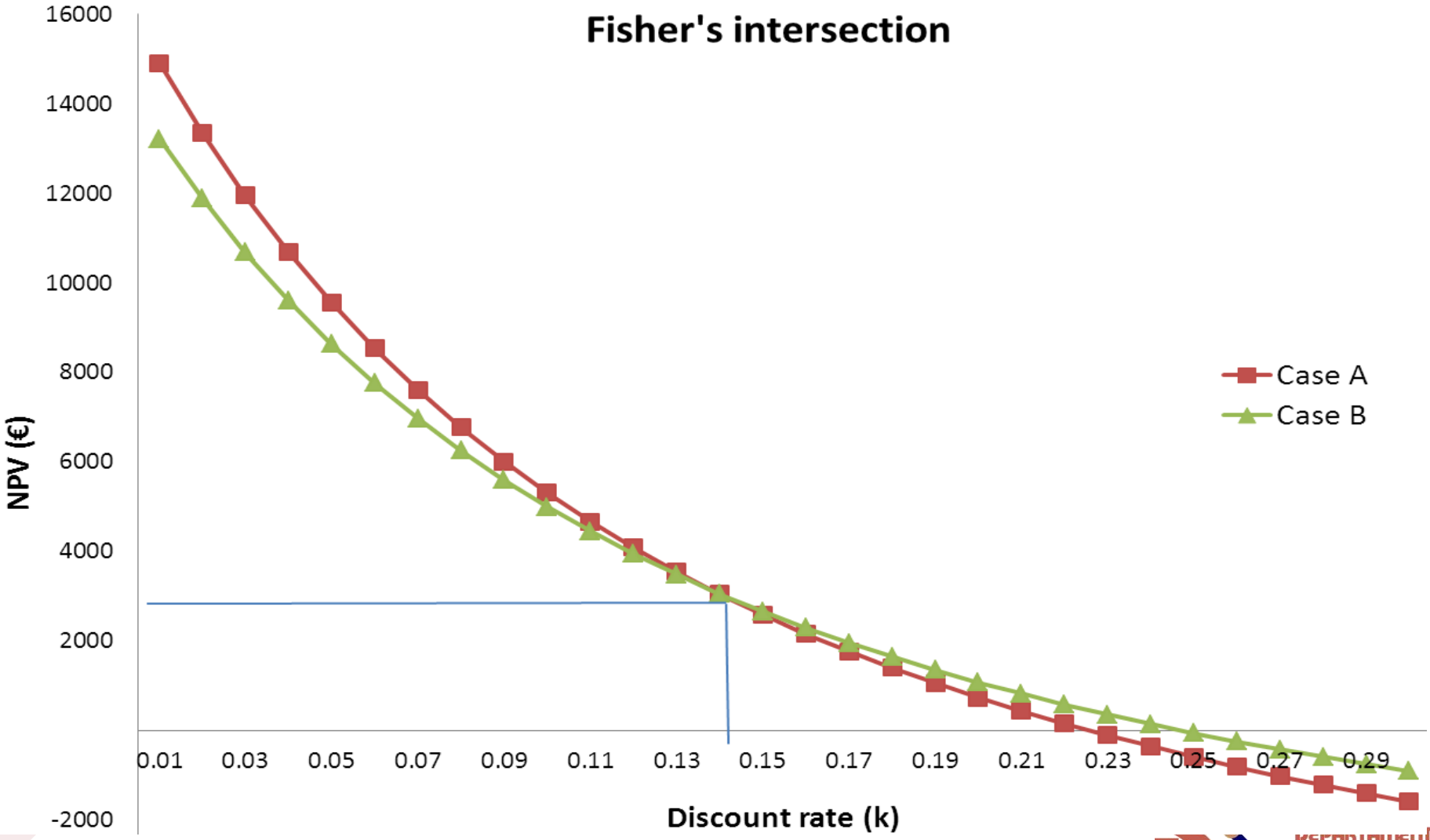
Cash-flows:

- **Optimistic scenario**: Coulombic efficiency = 20 %.
- **Probable scenario**: Coulombic efficiency = 10 %.
- **Pesimistic scenario**: Coulombic efficiency = 5 %.

Results

	Q_i (CASE A/CASE C)			Q_i (CASE B/CASE C)		
A (€)	-8.800			-7.000		
Years	**O**	**M**	**P**	**O**	**M**	**P**
1	2.914,7	2.419,1	2.171,3	2.419,1	2.171,3	2.049,1
3	2.801,5	2.325,2	2.087,0	2.325,2	2.087,0	1.969,6
5	2.692,7	2.234,9	2.005,9	2.234,9	2.005,9	1.893,1
7	2.588,2	2.148,1	1.928,0	2.148,1	1.928,0	1.819,6
9	2.487,7	2.064,7	1.853,2	2.064,7	1.853,2	1.748,9
11	-3.640,9	-4.047,5	-4.250,7	-2.760,6	-2.963,9	-3.064,1
13	2.298,2	1.907,4	1.712,1	1.907,4	1.712,1	1.615,7
15	2.209,0	1.833,4	1.645,6	1.833,4	1.645,6	1.553,0
$NPV_{3\%}$	**11.949**	**6.724**	**4.111**	**10.683**	**8.070**	**6.782**
IRR (%)	**23**	**15**	**11**	**25**	**20**	**18**

Results


Fisher's intersection
16000
14000
12000
10000
8000
6000
4000
2000
-2000
NPV (€)
0.01
0.03
0.05
0.07
0.09
0.11
0.13
0.15
0.17
0.19
0.21
0.23
0.25
0.27
0.29
Discount rate (k)
Case A
Case B

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4. Conclusions

- MFC systems are obtaining promising results in academic research.
- To convince practitioners of their advantages, it is required to analyse their economic feasibility.

This work has shown solid evidences of the benefits that MFCs may bring.

Thank you for your attention!

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