Electrochemical treatment of whey wastewater

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Introduction:

- In the agri-food sector, dairy industry produces a huge amount of wastewater, which is characterized by a high organic matter.
- The use of electrocoagulation (EC) and electrooxidation (EO) are considered as attractive approaches to reduce the concentration of chemical oxygen demand (COD), which is present in whey wastewater [1].
- In addition to the increase of whey wastewater in the water systems, the dairy industry and process is responsible for the increased Volatile Organic Compound (VOCs) emissions, which based on their origin have a direct impact on the environment.

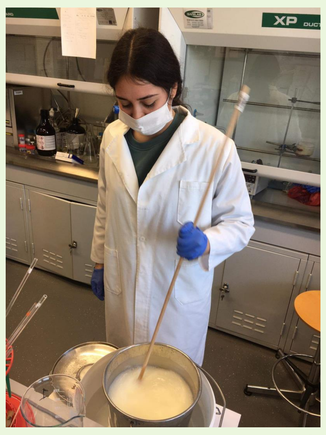

Figure 1. Homogenization of a sample before its storage.

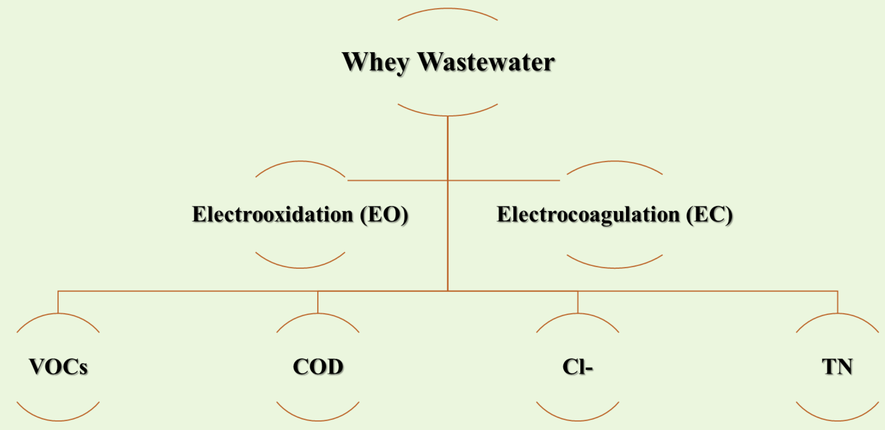

Figure 2. The experimental processes.

Experimental part:

- The whey wastewater was collected from a traditional small cheese factory in Cyprus. The samples were stored for 30 days at -80 °C [2].
- Then, electrocoagulation (EC) using Aluminium electrodes (Figure 3) and electrooxidation (EO) using Boron Doped Diamond (BDD) electrodes (Figure 6), were applied. For both processes, the electrodes were immersed in a 300 ml baker of whey wastewater, which was connected to a CPX200D Dual 180 watt DC power supply of 0-60 V and 0-10 A.
- The treated samples were measured with VIS photometer before and after 2 hours of EC and EO to determine the concentrations of COD, TN and Cl-.
- Also, thermal desorption-gas chromatography-mass spectrometry (TD-GC-MS) analyses were performed for the identification of VOCs.
- The parameters of COD, Cl-, TN, VOCs, pH, conductivity and temperature (T), presented different behavior after the EC and EO treatments of whey wastewater.

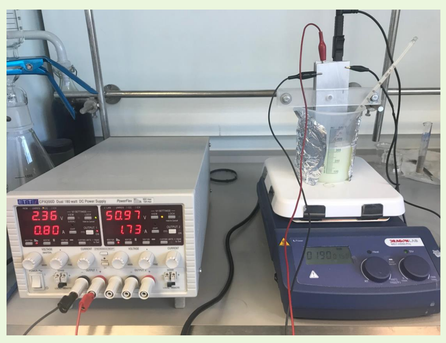

Figure 3. EC of a whey sample.

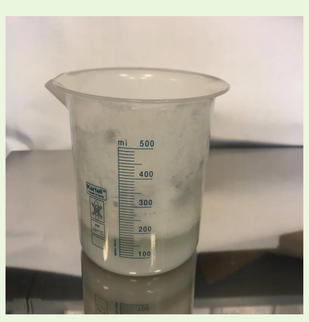

Figure 4. The sample (grey) after two hours of EC.

Figure 5. The electrodes before (1) and after (2) the EC process.

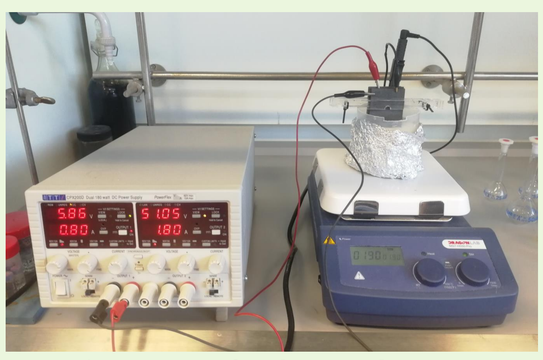

Figure 6. EO of a whey sample.

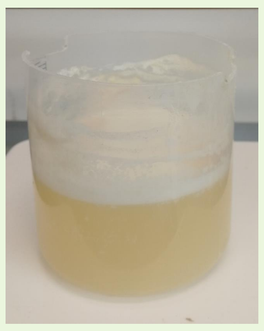

Figure 7. The sample (yellow) after two hours of EO.

Results:

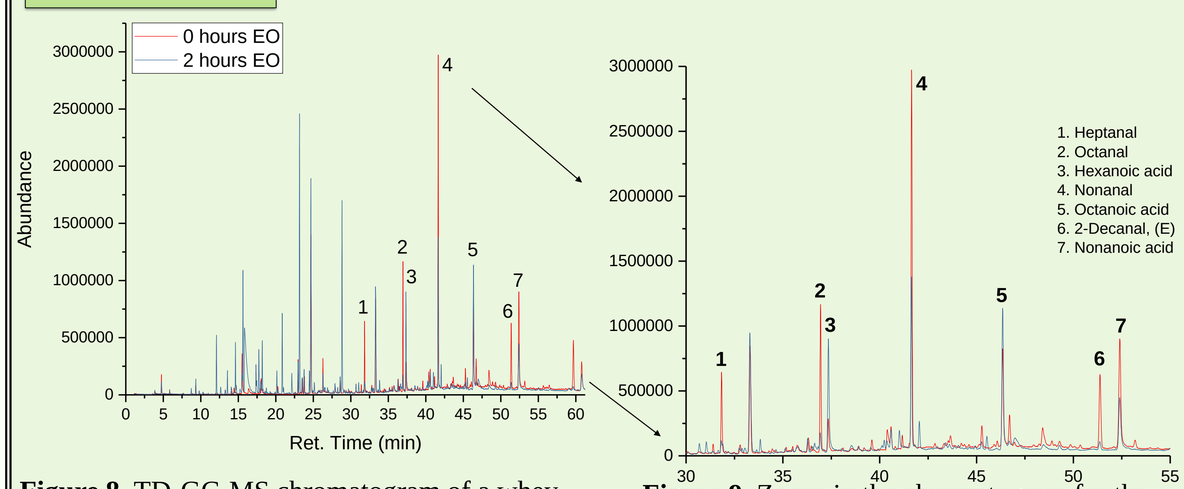

Figure 8. TD-GC-MS chromatogram of a whey wastewater sample, before and after two hours of EO.

Figure 9. Zoom-in the chromatogram for the numbered aldehydes and acids (Rt. 30-55 min).

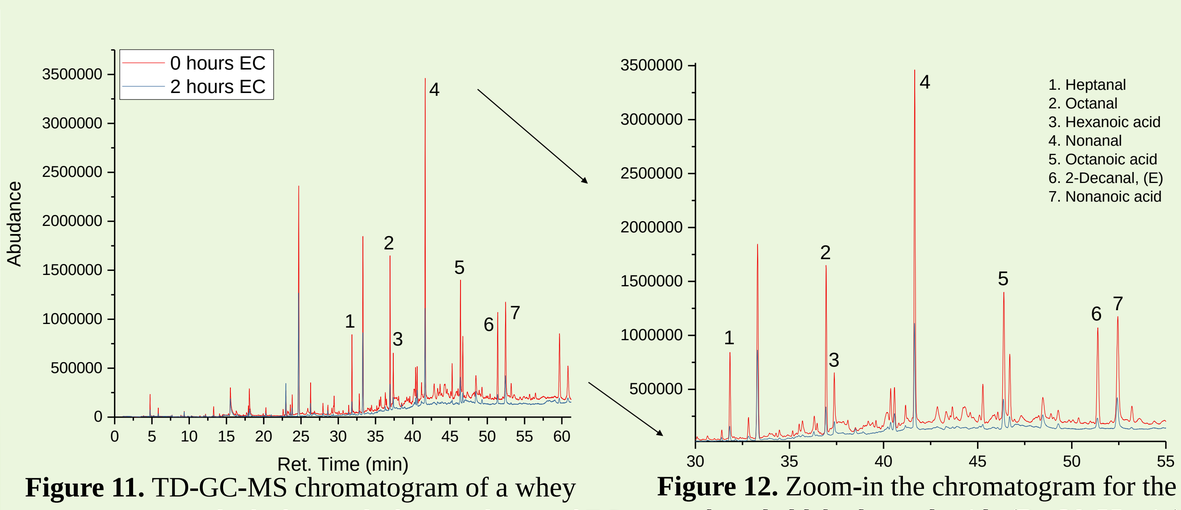

Figure 11. TD-GC-MS chromatogram of a whey wastewater sample, before and after two hours of EC.

Figure 12. Zoom-in the chromatogram for the numbered aldehydes and acids (Rt. 30-55 min).

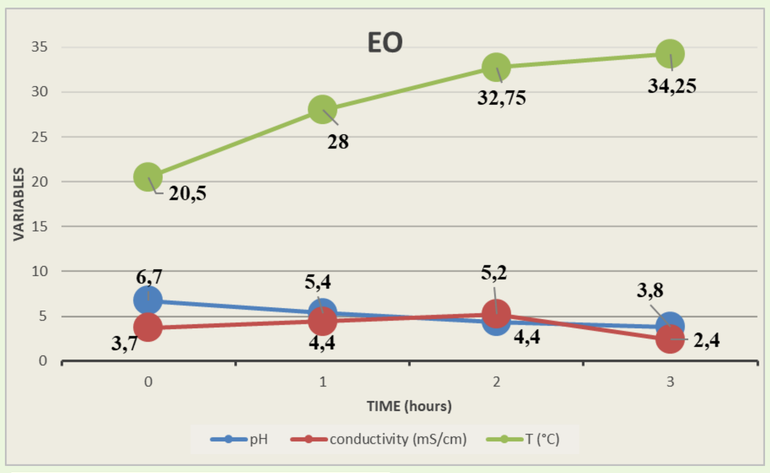

Figure 10. Variables of pH, conductivity and temperature during the EO process.

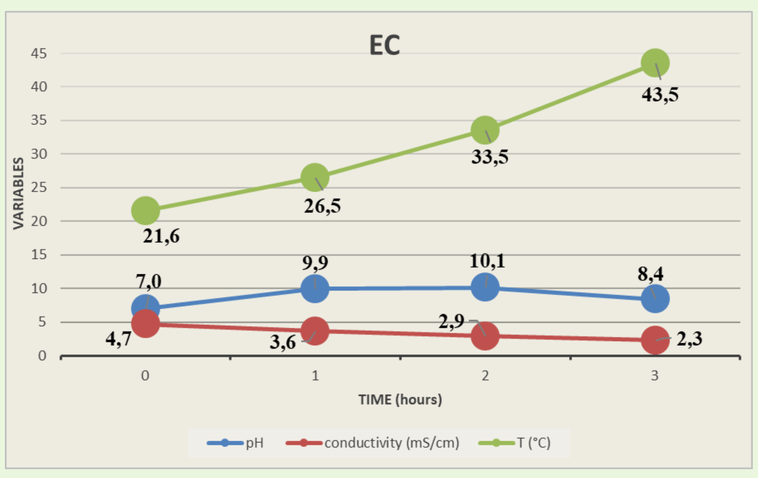

Figure 13. Variables of pH, conductivity and temperature during the EC process.

Conclusions:

According to the results of Table 1:

- Both electrochemical processes achieved the removal of COD approximately 15 to 16 %.
- The concentration of Cl- during the EC process decreased, while in the EO process increased.
- The total VOCs in EO process were increased. On the contrary, in the EC process the VOCs were decreased.
- EO treatment has negatively impact in the air environment as it results in VOCs production.
- In both treatments, the TN content was increased.

Table 1. Values of the under-study parameters prior and after the EC and EO processes.

	% Removal (-) or % increase (+) of the measuring parameters			
Treatment	**COD**	**Cl-**	**TN**	**Total VOCs**
EC	15,43 (-)	12,97 (-)	43,64 (+)	62,14 (-)
EO	16,30 (-)	7,43 (+)	28,57 (+)	51,17 (+)

References:

[1] Tirado L., Ömür G., Enric B., and Ignasi S. Treatment of Cheese Whey Wastewater by Combined Electrochemical Processes. *Journal of Applied Electrochemistry* 48, no. 12, 1307–19.
[2] Tunick, Michael H., Susan K., Iandola, and Diane L. Van Hekken. Comparison of SPME Methods for Determining Volatile Compounds in Milk, Cheese, and Whey Powder. *Foods* 2, no. 4, 534–43.