ONE-STEP PAIRED ELECTROCHEMICAL SYNTHESIS OF L-CYSTEIC ACID AND L-CYSTEINE

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ABSTRACT

The group of Applied Electrochemistry and Electrocatalysis of the University of Alicante has developed a paired electrochemical method for the synthesis of L-cysteic and L-cysteine from L-cystine. The synthesis of both compounds at the same time improves notably the economic parameters of the synthesis. Cysteic acid is an intermediate for different synthesis and normally used in cosmetic.

This technology could be of interest for pharmaceutical and fine chemical industries because of the high material yield and the low cost of the coupled synthesis of L-cysteic acid and L-cysteine. Companies producing intermediates and final chemical products interested in development of new processes or in improving the traditional ones are sought. The Group also has a pilot plant fully equipped with the necessary infrastructure in order to develope the pre-industrial phase and scaling-up of the processes.

TECHNICAL DESCRIPTION

Applied Electrochemistry is the employment of electrochemical processes in any type of industrial application as synthesis of pharmaceutical products, nanotecnologies, waste treatment, heavy metals recovering, metallic depositions, etc. The electrochemical technology is capable of simplifying in a great way the synthesis processes as well as carrying out synthesis which are very difficult to produce by classic methods. Due to these advantages the group of Applied Electrochemistry and Electrocatalysis of the University of Alicante is focused since several years on the investigation of new electrochemical processes and transfer of the knowledge and the technology to the industry.

During the electrochemical processes, the classical oxidising and reducing reagents (e.g. dichromate or permanganate salts, powdered zinc, hydrides) are substituted by charge transfer processes with electrons. The characteristics of the electron as a chemical reagent are extraordinary and very different from other chemical agents. It can be used as oxidizer and reducer and its redox potential can be controlled without changing its identity.

When comparing a conventional chemical process and an electrochemical one, it can be noted advantages on the residuals management. It is easier on the electrochemical methodology even disappearing the necessity to manage the transformed reagent, like it happens in the conventional chemical processes.

The synthesis developed is based in one-step electrochemical procedure. From L-cystine, L-cysteic acid and L-cysteine are obtained as anodic and cathodic products with very high current efficiencies and material yields. The electric cost is between 0.5 –1 kWh/kg and the total production of both products can be in the order of 50 kg (cysteic acid) + 150 kg (L-cysteine) per m¬2·day of electrodic area. The method could be extended to the synthesis of D-L-cysteic acid and D-cysteic acid. Because of the electrochemical nature of the synthesis the process could be considered as a green and environmentally friendly process.

DESIGN AND PILOT PLANT CAPABILITY

The group of Applied Electrochemistry and Electrocatalysis also has a pilot plant fully equipped with the necessary infrastructure in order to develope the pre-industrial phase and scaling-up of the processes. The pilot plant has developed several electrochemical reactors to produce chemicals at pre-industrial and industrial level.

The research group has carried out electrochemical synthesis of several products at industrial pilot scale. Among this products, 13.000 kg of S-carboxymethyl-L-cysteine has been electrochemically synthesised at this pilot plant with very good results.

ADVANTAGES AND INNOVATIVE ASPECTS

MAIN ADVANTAGES OF THE TECHNOLOGY

- The reagent used, electricity, is not stored and it is provided in the degree that it is demanded.
- It has a low cost (electric cost is around 0.5 –1 kWh/kg)
- It avoids the pollution taken place by the other reagents involved in traditional chemical synthesis. It may be considered as a green method.
- High yield for the process. Two products synthesized, at the same time that may be complementary for the same industry.

INNOVATIVE ASPECTS

- Two interesting compounds, L-cysteic acid and L-cysteine are obtained at the same time using a divided filter press electrochemical cell and starting from L-cystine.
- The cost of the synthesis (energy, manpower, reactors etc.) is substantially decreased in comparison with the cost of the synthesis of only one product.

CURRENT STATE OF DEVELOPMENT

The synthesis at a laboratory scale has been finished with successful results. Scaling up can be carried out at the electrochemical pilot plant of the University of Alicante.

The research group has carried out electrochemical synthesis of several products at industrial pilot scale. Between them, 13.000 kg of S-carboxy methyl L-cysteine has been electrochemically synthesised at the University with very good results.

MARKET APPLICATIONS

The technology could be of interest for companies belonging to the sectors of Fine chemicals, Pharmaceutics and Cosmetics.

COLLABORATION SOUGHT

The group of Applied Electrochemistry and Electrocatalysis is seeking for:

- Partners willing to scale up the synthesis in order to introduce this product in their portfolio of compounds.
- R&D departments of any company interested in carrying out feasibility studies on the industrial application of this technology.

INTELLECTUAL PROPERTY RIGHTS

Secret Know-how of the synthesis

RESEARCH GROUP PROFILE

In the following link you will find a description of the nature and activities of the Research Group:
https://cvnet.cpd.ua.es/curriculum-breve/grp/en/electroquimica-aplicada-y-electrocatalisis/356

MARKET APPLICATION (2)

Pharmacology, Cosmetics and Ophthalmology
Chemical Technology