SYNTHESIS OF CHEMICALS BY ELECTROCHEMICAL TECHNOLOGY

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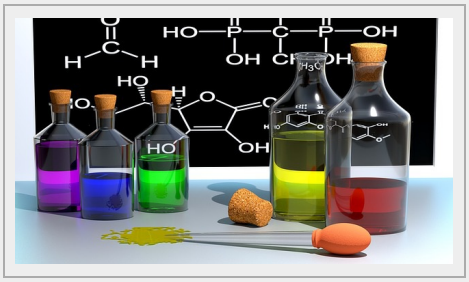
ABSTRACT

The Applied Electrochemical and Electrocatalysis Group (LEQA) at the University of Alicante has a high experience, expertise and know-how to develop and carry out the synthesis of organic products by direct or indirect electrochemical processes. The electrochemical technology has the great advantages of simplifying some classic methods of chemical synthesis as well as being environmentally friendly. This technology could be of interest for all the chemical and pharmaceutical industries that produce intermediates and final chemical products and need to develop new processes or to improve the traditional ones. The Department 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 Applied Electrochemical and Electrocatalysis Group (LEQA) at 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.

According with the research lines and the experience, the Group is able to develop a certain amount of processes of industrial interest as:

A- Direct electrochemical synthesis:

• reduction of: disulfide bound, nitro to amine group, carbon-halide bound, carbonyl to carboxyl group, double and triple C-C bound (Purpouse: It avoids the use of chemical reductors as Zn, Sn Cr...)

• Oxidation of: alcohols

B- Indirect synthesis

• Indirect synthesis by electrochemical regeneration of oxidants and reductors: iodine/iodide, Sn(IV)/Sn(II), Cr(VI)/Cr(III), bromine/bromide, chlorine/chloride, Ti(IV)/Ti(II) couples (It allows chemical reductions with a little amount of reductor avoiding the problem of saline residues)

1. Synthesis of organic products by direct or indirect electrochemical oxidations.

• Electrooxidations of olefines.

• Electrooxidations of aromatic compounds.

• Electrooxidations of aromatic and aliphatic halides.

• Electrooxidations of alcohols, glycols, polyalcohols, thiols and carbohydrates.

• Electrooxidations of carbonyl groups.

• Electrooxidations of aliphatics ethers.

• Electrooxidations of nitroalcanes.

2. Synthesis of organic products by direct or indirect electrochemical reductions.

• Electroreduction of carbonyl groups.

• Electroreduction of carboxyl groups.

• Electroreduction of amides.

• Electroreduction of imides.

• Electroreduction of nitrocompounds.

• Electroreduction of compounds with a S-S bond.

3. Electrochemical synthesis of inorganic oxidants as dicromate, Ce(IV), manganate and permanganate, hipochlorite, hipobromite, periodate, etc from theirs reduced forms.

4. Electrochemical synthesis of reductants as Ti(III), Sn(II), Cr(II), Li and Na metal from theirs oxidized forms.

This methodology can be applied in aqueous and non-aqueous systems

The electrochemical technology

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 withoutchanging its identity. It should be kept in mind that this reagent has the following advantages:

• It is not stored

• It is provided in the degree that it is demanded

• It has a low cost (more or less 0.01 $ by mol of synthesised product, depending on the process)

• It can produce species of great synthetic interest as cations and radical anions, radicals, etc.

• It avoids the pollution taken place by the other reagents

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.

Design and pilot plant capability

The Applied Electrochemical and Electrocatalysis Group (LEQA) also has a pilot plant fully equipped with the necessary infrastructure in order to development the pre-industrial phase and scaling-up of the processes. The capacity is until 20 Tn/year

The pilot plant has developed several electrochemical reactors to produce chemicals at pre-industrial and industrial level.

ADVANTAGES AND INNOVATIVE ASPECTS

- The electrochemical technology is a new way to produce chemical synthesis products
- It simplifies the classic methods of chemical synthesis
- It is less aggressive for the environment, avoiding sub-products or wastes derived for the manufacturing processes
- The products obtained need smaller purification.
- Is cheaper than the traditional ones

CURRENT STATE OF DEVELOPMENT

The electrochemical technology has been already tested at laboratory and pre-industrial level and the research team has several years of experience in this field. The installations of the pilot plant are already being working and some projects for Spanish and European clients has been carried out successfully. All the technicians and management staff have the experience necessary to guarantee the success of the projects.

MARKET APPLICATIONS

The electrochemical technology and its processes are of interest for all the chemical and pharmaceutical industries that produce intermediates and final chemical products and need to develop new processes or to improve the traditional ones by mean of electrochemical technology. Some chemicals obtained by electrochemical processes with industrial interests could be: the production of N-Acetilcysteine from cystine, p-hydroxibenzaldehyde from p-hidroxymandelic acid, glyoxilic acid from oxalic acid, etc.

COLLABORATION SOUGHT

The Applied Electrochemical and Electrocatalysis Group (LEQA) at the University of Alicante has a high experience and know-how as well as the installations required to work within the electrochemical field. It can work together with R&D departments of any company in order to develop new products and processes for industrial use demanding certain technical specifications. The Group could:

- develop electrochemical processes at laboratory, pre-industrial and industrial level until 20 Tn/year
- design and build of pilot industrial electrochemical plant included its automation according with the specifications of the client
- carry out feasibility studies on developing current or new industrial products by mean of electrochemical technology.

In this sense, this research centre seeks to transfer the technology and know-how on electrochemical field to companies by mean of patent licence or know-how agreements.

INTELLECTUAL PROPERTY RIGHTS

- Several patents covering some electrochemical processes for the synthesis of chemical products are granted (Derivatives of cysteine products).
- Concerning the use of the equipment, development and scaling of processes, process feasibility, etc, all information is protected by know-how.

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 (4)

Pollution and Environmental Impact
Pharmacology, Cosmetics and Ophthalmology
Materials and Nanotechnology
Chemical Technology