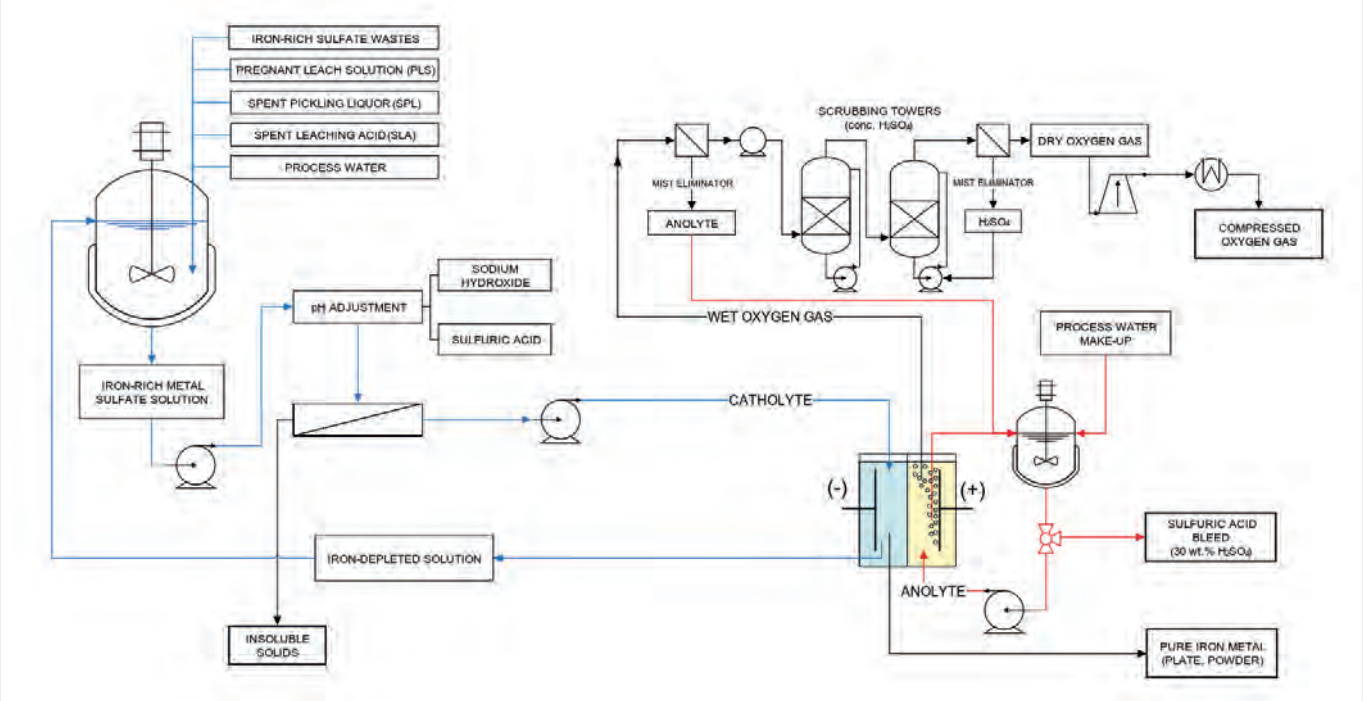


Electrowinning Iron and Recycling Sulfuric Acid from Iron Sulfates: a Zero-Carbon Iron-Making Process

In November 2023, a monograph that outlines the patented FerWIN® technology, a green and zero-carbon iron-making process, was published under the title Electrowinning Iron and Recycling Sulfuric Acid from Iron Sulfates: a Zero-Carbon Iron-Making Process. It details the electrowinning of iron metal and the recycling of sulfuric acid from iron sulfates, contributing to decarbonization and sustainability in the steel industry. Supported by extensive experimental data and calculations, it targets industrial electrochemists, engineers, metallurgists, and steel industry professionals seeking to understand and implement this innovative electrochemical approach for producing green steel and mitigating carbon emissions. Topics covered include electrochemistry, reactor design, testing, cost analysis, and implementation strategies, making it valuable for both technical practitioners and managerial personnel in the steelmaking industry.

By Lucija Kozina

We have gladly grabbed the opportunity to talk to the author, Dr. Francois Cardarelli, who kindly gave us additional insight into this book's background and shared some thoughts on the state of the steel industry from an expert point of view.

GSW: Please share some more information on your background and your company's mission.

FC: I am the President and Owner of Electrochem Technologies & Materials Inc. By training, I am an industrial electrochemist with a strong background in physical chemistry, nuclear and materials science, and a Ph.D. in chemical engineering from the Paul Sabatier University in Toulouse. I invented and co-invented 16 patents, some still owned by Rio Tinto and Hydro Quebec,

and I am the sole author of three reference handbooks published worldwide by Springer. I have 34 years of industrial experience in North America and Europe inventing, developing, and commercializing electrochemical, chemical, and metallurgical processes for extracting, recycling, refining, and producing a variety of metals and chemicals including iron, lithium, titanium, vanadium, niobium, tantalum, tungsten, rare earths from ores and wastes.

Electrochem Technologies & Materials Inc. is a private Canadian Corporation founded in 2010 and headquartered in Montreal, Canada. The company currently owns seven patent families granted and enforced in many jurisdictions worldwide on proprietary chemical, metallurgical and electrochemical technologies that are innovative, and sustainable. Commercially, the company manufactures industrial electrodes and electrolyzers for its customers and to support its own electrochemical operations. The company also produces vanadium, niobium, tantalum, and tungsten chemicals at its production facilities in Boucherville, QC, Canada. Recently, the company became a registered imprint by publishing professional books.

Fifteen percent of the company income is reinvested in R&D to invent disruptive technologies and new materials.

GSW: How did this research start and what prompted you to write the book in the first place?

FC: The patented FerWIN® process started as a means of addressing the recycling of metallurgical effluents, and industrial wastes containing iron sulfates that are by-produced by the mining, chemical, metallurgical, and steelmaking industries. These wastes represent at least 5 million tonnes of metallic iron equivalents that are currently disposed of or landfilled without any further treatment worldwide. It was of paramount importance to recover and monetize the iron and sulfuric acid values using a true zero-carbon iron-making technology operating near room temperature and relying solely on electricity while avoiding the release of greenhouse gases. Later, in 2017, the integration of the FerWIN® with the processing of magnetite, hematite and DSO by sulfation along with iron-rich bauxite residues was tested successfully. The latter represents an additional source of iron with 175 million tonnes of tailings containing up to 40% iron that are disposed of annually.

Dr. Francois Cardarelli, President and Owner of Electrochem Technologies & Materials Inc.

After more than a decade of intense prototyping and piloting both in-house and onsite with several industrial partners, I finally decided to gather and summarize part of the work performed, the experimental data, and to provide costs and benefits, financial and sensitivity analysis. The purpose was to offer a reference handbook for implementing and helping the dissemination of this disruptive technology.

This monograph was written to address the men and women engaged in the traditional iron and steelmaking industries who want to understand this novel electrochemical technology outside their conventional blast furnace, direct reduced iron, and electric arc smelting processes. Finally, the monograph may be of interest to persons in the steelmaking industries occupying managerial positions such as chief executives, chief operating officers, and V.P. of operations.

GSW: What makes the FerWIN technology stand out in your opinion?

FC: The FerWIN® process is a true zero-carbon iron-making process producing either pure iron metal (99.995%) or iron-rich alloys with Mn, Ni, Cr, or V by recycling wastes and effluents largely available on each continent while releasing oxygen gas to the atmosphere. Of course, there are several competing routes currently under development such as the electrolysis in alkaline medium, and the electrolysis of molten oxides. By contrast, the FerWIN® process uses existing equipment available commercially and operates near room temperature (50-60°C) with a lower energy consumption of only 10 GJ/tonne. Moreover, the production cost can be as low as $250/tonne in targeted jurisdictions having access to affordable electricity (e.g., Canada, Scandinavia, Brazil, India and China). Finally, the integration with the sulfuric acid digestion of hematite, and magnetite will allow implementing a two-step iron-making process.

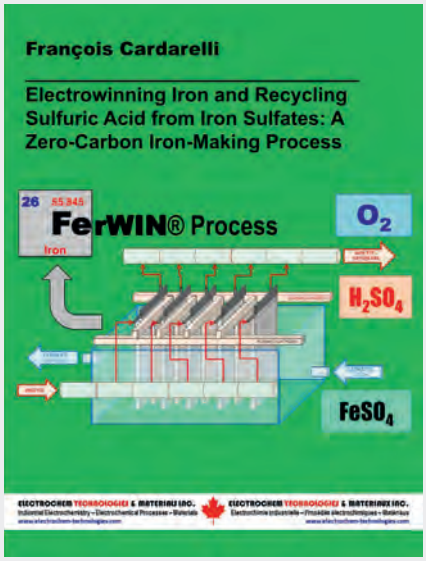
GSW: Do you believe this technology will help the green steel industry? In what way?

FC: If the technology is implemented commercially, it will reduce the quantity of non-renewable resources or materials consumed while preventing the release of greenhouse gas emissions. Thus, it also offers a huge potential as a cost-effective zero-carbon iron-making technology that is less energy-demanding, and labor-intensive than the current iron-making process taking into account both the coking and pelletizing processes together with the blast furnace operation.

Finally, in the long term, this electrochemical technology could potentially lead to significant industrial changes in the steelmaking industry not yet envisioned as a novel environmentally friendly alternative route for iron making in replacement of the CO_2-emitting blast furnace.

However, we must remain realistic, and we cannot expect steelmakers to tear down their existing facilities but rather promote the new technology for either expanding their current production capacity or when building new facilities by accessing the large pool of copperas, ferrous sulfates, and bauxite residues currently available worldwide.

GSW: You are an expert with extensive experience in different areas and industries – how would you comment on the current state of the steel industry and its journey towards more sustainable methods?



The 499-page monograph that outlines the patented FerWIN® technology, a green and zero-carbon iron-making process, was published in November 2023 (ISBN 978-1777576936).

FC: Like most chemical and metallurgical industries, the iron- and steelmaking industries are highly conservative, especially towards novel technologies (often with good reasons). This is especially true when these technologies involve electrochemistry that is not known in iron and steelmaking while being widely used for more than a century in the zinc, copper and nickel industries. Lastly, except for the molten iron produced by electrolysis from molten oxides, all the electrolytic iron produced along with iron reduced by hydrogen has to be re-melted using an EAF to produce green steel in suitable forms thus the electric smelting is here to remain as a mandatory production method.