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The habilitation thesis, entitled "Contributions on the valorization of renewable and residual resources in the context of the circular economy: conversion processes and assessment of ecotoxicological impact" synthesizes the scientific and academic activity carried out after obtaining the doctoral degree in 2006, with the central focus on reducing environmental impact through clean technologies, conversion of renewable resources, and ecotoxicological monitoring.

The thesis is structured into three main chapters, preceded by a general introduction.

Chapter 1 presents scientific achievements, with emphasis on the author's original contributions.

The first research direction is dedicated to the valorization of residual glycerol, a by-product of the biodiesel industry, whose efficient management is crucial for the economic viability of biofuels.

The investigations focused on the conversion of glycerol into oxygenated cetane-type additives. The superacid catalysts $\text{SO}_4^{2-}/\text{SnO}_2$ developed in this research enabled the production of high-purity compounds which, when integrated into diesel blends, led to significant reductions in emissions.

Engine tests showed a reduction in exhaust gas opacity by 12.5-19.2%, a decrease in unburned hydrocarbon emissions, and a reduction in carbon monoxide, confirming the role of oxygenated additives in complete combustion and in reducing the formation of fine particles. This research direction represents a direct contribution to reducing atmospheric pollution generated by diesel engines, with an immediate impact on air quality. Another area of research is the advanced recycling of low-density polyethylene waste through thermal and catalytic processes aimed at obtaining liquid fuels. Polyethylene conversion reduces emissions associated with incineration, limits the accumulation of persistent plastic waste, and reintegrates carbon into the economic cycle. By controlling the temperature and reaction time, liquid fractions with distributions similar to gasoline and diesel were obtained, contributing to the reduction of the carbon footprint of the energy sector by partially substituting fossil fuels.

An important pillar of the scientific activity is represented by research dedicated to obtaining advanced biofuels and sustainable aviation fuels (SAF) which also lead to emission reductions. Hydroprocessing of non-edible oils (camelina, safflower) using bifunctional catalysts led to obtaining bio-kerosene fractions meeting the Jet A1 standard, characterized by freezing points

below -40°C and high oxidative stability. By their renewable nature and "drop-in" character, these fuels reduce the net CO₂ emissions of the aviation sector, contributing to European decarbonization goals. An original contribution is the conversion of farnesene-type sesquiterpenes, derivatives of sugars, into high energy density polycyclic hydrocarbons and alkylbenzenes, suitable for use in aviation fuels. This research direction demonstrates the potential of bio-based raw materials to reduce greenhouse gas emissions and diversify sustainable fuel sources.

An important research topic is ecotoxicological monitoring and the study of biocorrosion. Studies have demonstrated the capacity of microalgae *Spirulina platensis* and *Chlorella pyrenoidosa* to biodegrade naphthenic acids, reducing their concentration through metabolic mechanisms, results confirmed by GC-MS analyses. This bioremediation capacity contributes to reducing the toxic load of industrial waters and diminishing ecological risks associated with persistent organic pollutants. The thesis details the study of microbiologically induced corrosion (MIC) of metals (aluminum, zinc, iron). Using electrochemical techniques and scanning electron microscopy (SEM), the research highlighted how microbial biofilms can accelerate or inhibit the degradation of reactive metals, offering ecological solutions for the protection of industrial infrastructures and the reduction of indirect emissions associated with accelerated corrosion.

Chapter 2 is dedicated to didactic and academic activities that complement the research directions, through the modernization of the educational process, integration of sustainability topics in student training, coordination of a significant number of graduation works, and active participation in doctoral guidance committees, thus facilitating the transfer of competencies to young researchers. The scientific portfolio includes 1 patent, over 50 publications (of which 36 in ISI journals, with 21 as first author or corresponding author) and 189 citations. A significant part of these works were published in high visibility journals (Q1-Q2), reflecting the impact and visibility of the results obtained.

Chapter 3 describes the development strategy for the next period, aiming at consolidating research in the field of environmental engineering, focusing on pollution reduction technologies, the use of machine learning algorithms for processing experimental data and molecular modeling techniques, designing advanced Metal Organic Frameworks (MOF)-type materials for CO₂ capture and immobilization of persistent organic pollutants. These directions support the general objective of the thesis: emission reduction, environmental protection, and the transition to a circular economy. A priority objective is acquiring the status of doctoral supervisor, with the aim of forming an interdisciplinary research group focused on "technologies for emission reduction" solutions. The strategy for valorizing scientific activity aims at strengthening the team's visibility through specialty works and international conferences, as well as expanding research infrastructure through accessing collaborative grants with socio-economic and academic partners.

The final section of the thesis collects the bibliographical references cited throughout the text, along with the candidate's own list of scientific publications.

In conclusion, the habilitation thesis offers a unitary and coherent framework for addressing sustainability in environmental engineering. By combining chemical reaction engineering with biotechnology and ecotoxicology, the work brings fundamental and applied contributions that support the transition to a climate-neutral society, while ensuring the foundation of a successful academic career in mentoring new generations of specialists.