Solar Polygeneration Collector for Combined Heat, Power, Hydrogen Fuel and Wastewater Treatment

SPECTRUM

# Optimised photocatalytic $H_2$ production using nanostructured low cost and sustainable photocatalysts


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# Public Executive Summary

The SPECTRUM project aims to design, develop, prototype, and test lab-scale solar collectors that effectively utilise the entire solar spectrum to cogenerate heat, electricity and hydrogen. SPECTRUM Work package 1 is dedicated to the optimization of the photocatalytic process of industrial wastewater (IWW) treatment and hydrogen generation and is divided in four tasks. This deliverable D1.3 provides an account of the activities carried out in Task 1.3, "Optimization of Photocatalytic $H_2$ Production Process at Laboratory Scale," as well as the results achieved during its duration.

The photocatalysts developed in Task 1.2, "Development of nanostructured low cost and sustainable photocatalyst", were tested for hydrogen production in a slurry type batch reactor using UV radiation as light source. In these preliminary assays, synthetic aqueous solutions containing ethanol or glycerol as sacrificial agent (SA) were used to test the performance of a first series of copper decorated $TiO_2$ nanoparticles (NP) photocatalysts. A comprehensive series of experiments enabled the selection of the most effective photocatalyst, Cu-decorated $TiO_2$ nanoparticles with 6 weight % of copper (Cu/TNP-6). This photocatalyst was then utilized with aqueous solutions of ethanol or glycerol to optimize three key operational parameters — pH, photocatalyst concentration, and sacrificial agent concentration. The same methodology was subsequently applied to evaluate the performance of two additional copper-based photocatalyst sets developed in Task 1.2: copper-decorated $TiO_2$ nanotubes and copper/biochar-decorated $TiO_2$ nanoparticles.

During the final phase of the task, a set of seven IWW, previously selected in Task 1.1, containing in its composition compounds such as alcohols, glycerol, phenols or organic acids as potential sacrificial agents, were evaluated in the photocatalytic process for pollutant degradation with hydrogen co-generation. This assessment aimed to determine the most suitable candidates for subsequent SPECTRUM activities.

The composition of gas mixtures generated during the photocatalytic assays was determined using gas chromatography, while pre- and post-treatment IWW composition (COD, TOC and $BOD_5$ values of the liquid phase and specific tests targeting potential SA) were analysed to assess the degree of remediation achieved and any resulting chemical transformations. HPLC analysis permitted to identify and quantify the reaction products resulting from the photooxidation of organic compounds present in the original IWW.



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