Validation Electromagnetic Model for Determining the Speed of Absorptive Photonic in a Solar Collector in V (V-Collector)

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Highlights

- The accomplishment of mathematical analysis of the electromagnetic field of a contaminated fluid.
- Obtaining a model of the local volumetric speed of absorption of photons
- The attenuation and phase factors obtained from basis of the electromagnetic characteristics of contaminated fluid.

1. Introduction

In the presented research the mathematical analysis of electromagnetic fields was carried out to determine the local volumetric speed of photon absorption (LVRPA). Based on the electrical and magnetic characteristics of the suspension, the quantum yield of the heterogeneous photocatalytic process (TiO_2) in the collector was determined. The analysis of electromagnetic characteristics of the medium allowed us to make an estimation of the local energy absorption inherent to the medium, to be able to obtain a model of the local volumetric speed. For this purpose, experiments were designed to determine electromagnetic parameters involved in the mathematical solution of the model. The model was validated with the data from the literature [1] under the same experimental conditions as reported in [1], presenting a clear adjustment between the reported measurements and the developed electromagnetic model.

2. Methods

The mathematical physical model for the determination of the LVRPA was developed according to the electromagnetic properties of the suspension. Properties such as the electrical permittivity, magnetic permeability, and electrical conductivity had to be determined experimentally. These were determined as follows: 1) Electrical Permeability: By the concept of electric capacitance, the suspension was established as a dielectric for a capacitor of parallel plates and the permeability of the medium was determined, since this characteristic clearly depends on the concentration and pH of the sample. The electric capacitance depends on the geometry of the capacitor (the area of plates and distance of separation between them), variables determined by the experimenter.

2) Magnetic permeability: It was determined by establishing the relation of the earth's magnetic field and the variation of this one by affecting the solution. The change of direction of the field was related to the magnetic permeability.

3) Electrical conductivity: To determine the electrical conductivity by Ohm's law, an electric voltage was applied to a cylindrical vessel of known radius and length (experimental variables) immersed in the suspension. The reading of the resistance is inversely proportional to the conductivity.

3. Results and discussion

Titanium dioxide TiO2, according to the above assumptions, must absorb the energy in its whole volume, which is why, when it is distributed homogeneously in the fluid, it is enough to establish the distance of penetration of light and to establish the energy absorbed.

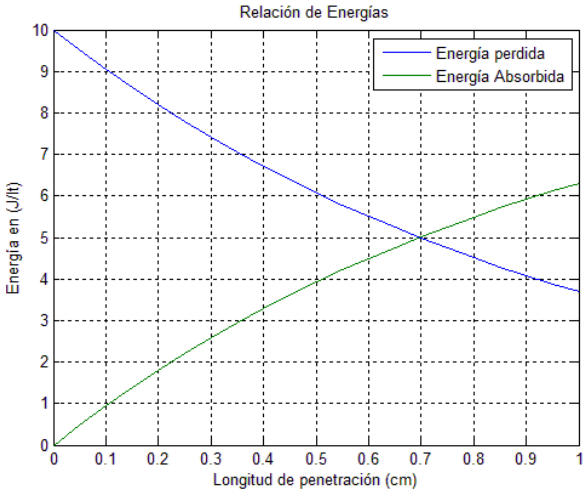

Figure 1. Relationship of energies (lost - absorbed)

The tendency of the curve will depend on the contaminated aqueous medium, so that for a medium with large opacity levels there will be large losses of energy in the electromagnetic wave. Exactly when small distances have been penetrated in the aqueous medium, in which case the catalyst is at the boundary of the reactor, ie the walls of the tube.
If the medium presents a slight opacity, the electromagnetic wave will easily penetrate the medium without greater loss of energy in which case the distribution of the catalyst must be homogeneous in the medium.
Electromagnetic waves in the ultraviolet spectrum do not disperse considerably, and the frequency does not change upon penetration into the aqueous medium.
The electromagnetic model proposed for the LVRPA is independent of the type of concentrator, that is, electromagnetic waves will impact the walls of the tube, and the description of the process depends solely on the electrical and magnetic characteristics of the suspension.

4. Conclusions

The electromagnetic characteristics are clearly related to chemical characteristics of the suspension. For the case reported by Bandala [1] the electromagnetic characteristics are related to the concentration of oxalic acid. In other words, the characteristics of permeability, conductivity, and permittivity, reflect the chemical characteristics of the solution concentration, ie, the concentration of oxalic acid can be measured or the electromagnetic characteristics can be measured to obtain the attenuation factor of the studied medium.

References

[1] E. Bandala, C. Arancibia, S. Orozco, C. Estrada, Solar Photoreactors Comparison Based On Oxalic Acid Photocatalytic Degradation. Solar Energy 77. 2004. 503–512p

Keywords
Electromagnetic model, Phase factor, Attenuation factor