Braiding uniform magnetic field inside a cylindrical reactor for photocatalytic reforming of petrochemical wastewater

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ABSTRACT

Being routinely investigated, the coaxial coil pairs are known to exhibit a nearly flat magnetic field intensity in the central region. The Helmholtz coils is an example of such coil capable of producing uniform magnetic field, however its use in conjunction with inductive wireless power transfer in wastewater photoreforming has not been well explored. In this study, an optimum coil spacing for a Helmholtz pair is suggested and sought by analytical approach. Subsequently, a numerical solution is obtained for the magnetic flux density inside a cylindrical chamber of known radius and height by employing the finite element method. The axisymmetric nature of the model is exploited to reduce computation cost. The mean values are combined based on the method detailed in the Cochrane handbook to obtain an average magnetic flux density inside the cylinder and repeated to obtain an average value for 77 combinations of coil diameter and height. Linear and nonlinear regression techniques are applied to determine the relationship between the dependent variable and the independent variables. In contrast to the more common coil spacing of R, where R refers to the coil radius, a spacing of 1.5R is feasible which increase the maximum usable volume by a factor of 1.5 under acceptable deviation in flux density. Nonlinear transformation using the logarithmic model yield the best combination of 0.97/0.18 for the coefficient of determination and residual sum of squares, respectively. The technique demonstrated herein can be used to set up multiple Helmholtz coil geometry for farming a uniform magnetic field density in photoreforming of petrochemical wastewater by inductive wireless power transfer to multiple arbitrary LED based receivers.

KEYWORDS

Photocatalytic oxidation; Circular coil; Homogenous flux density; Photoreforming; Helmholtz coil spacing

ACKNOWLEDGEMENT

This authors wish to acknowledge the financial support from the following two grant schemes: PGRS200337, and TRGS/1/2018/UMP/02/2/1 RDU191802-1.