Multi-Response Optimisation of Physical Quantities for Carreau Nanofluid flow by Operating Taguchi based Grey Relational Analysis over a Non-Linear Curved Surface

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Abstract: For optimization of performance attributes, when the decision making relies on more than one attribute, the grey relational analysis reveals its stature. Grey relational analysis focuses on optimizing the attributes obtained under the modelling of Carreau nanofluid flow past a stretched-curved surface, with the primary role of the Cattaneo-Christov thermal transmission design. All the engineering quantities of the flow are individually optimized using Taguchi methodology with a $L27$ orthogonal array recording the signal-to-noise ratio response, which is further consolidated by the manoeuvre of Grey relational analysis. Outcomes of the present analysis disclose that the parametric combination of the third experimental run with power law index at 0.7, curvature parameter at 3.5, Weissenberg number at 1, first order slip parameter at 0.1, and Prandtl number at 7.3 is an optimized level to obtain least skin-friction and the highest rate of heat and mass transmission. Analysis of variance suggests that the curvature parameter has the largest contribution to grey relational grade of about 49.31%, and the least contribution is prompted by the first order slip parameter of 1.36%. The response graph for grey relational grade against control parameters for different key levels signifies that $A1$,$B1$,$C3$,$D1$ and $E1$ shows the highest level for grey relational grade, which showcases the optimum levels of the control factors under consideration.

Keywords: Grey Relational Analysis; multiple response optimisation; Taguchi method; Carreau nanofluid; Cattaneo-Christov model; curved stretching sheet.