

Accepted Manuscript

Computational modeling of unsteady third-grade fluid flow over a vertical cylinder: A study of heat transfer visualization

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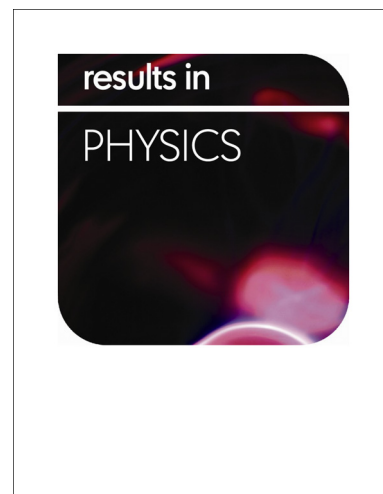
PII: S2211-3797(17)32009-0
DOI: <https://doi.org/10.1016/j.rinp.2017.12.054>
Reference: RINP 1131

To appear in: *Results in Physics*

Received Date: 19 October 2017
Revised Date: 1 December 2017
Accepted Date: 18 December 2017

Please cite this article as: Reddy, G.J., Hiremath, A., Kumar, M., Computational modeling of unsteady third-grade fluid flow over a vertical cylinder: A study of heat transfer visualization, *Results in Physics* (2017), doi: <https://doi.org/10.1016/j.rinp.2017.12.054>

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1 **Computational modeling of unsteady third-grade fluid flow over a** 2 **vertical cylinder: A study of heat transfer visualization**

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8 **Abstract:** The present paper aims to investigate the effect of Prandtl number for unsteady third-
9 grade fluid flow over a uniformly heated vertical cylinder using Bejan's heat function concept.
10 The mathematical model of this problem is given by highly time-dependent non-linear coupled
11 equations and are resolved by an efficient unconditionally stable implicit scheme. The time
12 histories of average values of momentum and heat transport coefficients as well as the steady-
13 state flow variables are displayed graphically for distinct values of non-dimensional control
14 parameters arising in the system. As the non-dimensional parameter value gets amplified, the
15 time taken for the fluid flow variables to attain the time-independent state is decreasing. The
16 dimensionless heat function values are closely associated with an overall rate of heat transfer.
17 Thermal energy transfer visualization implies that the heat function contours are compact in the
18 neighborhood of the leading edge of the hot cylindrical wall. It is noticed that the deviations of
19 flow-field variables from the hot wall for a non-Newtonian third-grade fluid flow are significant
20 compared to the usual Newtonian fluid flow.

21 **Keywords:** Third-grade fluid; Heat function; Boussinesq's approximation; Vertical cylinder;
22 Implicit method; Prandtl number.

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