Introducing a design procedure for Archimedes Screw Turbine based on optimization algorithm

Shahverdi, Kazem[a]; Najafi, Gholamhassan[b]; Mamat, Rizalman[c, d]; Ghazali, Mohd Fairusham[e]; EI-Shafy A.S.[f, g]; Mousa, Mohamed[h]

[a] Department of Water Science and Engineering, Bu-Ali Sina University, Hamedan, Iran

[b] Department of Biosystems Engineering, Tarbiat Modares University (T.M.U.), Tehran, Iran

[c] Centre for Automotive Engineering, Universiti Malaysia Pahang

[d] School of Mechanical Engineering, Ningxia University, Yinchuan, China

[e] Center for Research in Advanced Fluid and Process, University Malaysia Pahang, Lebuhraya Tun Razak, Gambang, Pahang, Kuantan, 26300, Malaysia

[f] Department of Mechanical Engineering, College of Engineering in Al-Kharj, Prince Sattam bin Abdulaziz University, Alkharj, 11942, Saudi Arabia

[g] Mechanical Power Engineering Department, Faculty of Engineering, Mansoura University, Mansoura, 35516, Egypt

[h] Electrical Engineering, Faculty of Engineering and Technology, Future University in Egypt, New Cairo, 11835, Egypt

ABSTRACT

Archimedes screw turbines have gained popularity in generating power from flowing water. One aspect that hasn't been considered yet is optimizing those parameters that are considered assumptions in the prediction models. In this research, a simple procedure was introduced to design an appropriate Archimedes screw turbine for a given site using a prediction model and an optimization model. First, the mathematical efficiency prediction model of Archimedes screw turbines was developed and validated with experimental and real-world Archimedes screw turbine data. Then, the grey wolves optimization algorithm was developed to be used as an actual engineering application, sensitively analyzed, and coupled with the prediction model. The prediction models were evaluated. The model convergence was investigated, and then, the optimization parameters were found to get maximum efficiency. The results revealed that the optimum number of iterations and grey wolves are 200 and five, respectively. Also, the best values for the inner diameter to the outer diameter ratio, the pitch to the outer diameter ratio, tilt angle, and blade number were found in ranges: 0.43–0.56, 1–1.2, 20–22.5, and 2–4, respectively.

KEYWORDS

AST; Design Procedure, Grey Wolves Optimization; Renewable Energy, Water Management

ACKNOWLEDGMENTS

This research was funded by Ningxia University, China under Helan Mountain Scholars scheme. The authors are also grateful to Universiti Malaysia Pahang (UMP) for the financial support given under the in-ternal research fund RDU 190336, RD172204, and FRGS grant RDU1901112. Dr. Najafi and Dr. Loni are grateful to the Tarbiat Modares University for the financial support given under the IG/39705 grant for the Renewable Energies of Modares research group.