Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2019-44-RC1, 2019
© Author(s) 2019. This work is distributed under
the Creative Commons Attribution 4.0 License.

eawe european academy of wind energy
Open Access WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "A Double Multiple Streamtube model for Vertical Axis Wind Turbines of arbitrary rotor loading" *by* Anis A. Ayati et al.

Hubert BRANGER (Referee)

branger@irphe.univ-mrs.fr

Received and published: 22 September 2019

Here are some comments on "A Double Multiple Streamtube model for Vertical Axis Wind Turbines of arbitrary rotor loading Âż, by Anis A. Ayati, Konstantinos Steiros, Mark A. Miller, Subrahmanyam Duvvuri and Marcus Hultmark.

The double multiple stream tube model (DMST) is a worldwide analytic model used to predict the flow around vertical axis wind turbines (VAWT). DMST approach is less accurate than CFD codes, but it is far more rapid, far easier to be implemented and far more robust. The authors propose here an improvement, which allows the model to be applicable even to high loaded VAWT, i.e. with high solidity ratios and high tip speed ratios. A new momentum theory is applied to the DMST scheme. This DMST

Printer-friendly version

Discussion paper

CC BY

improvement is tested over direct power measurements on VAWT in the HRTF Princeton Facility. The authors modified the classical Rankine-Froude momentum theory with the new Steiros-Hultmark momentum theory, introducing the base suction effect in the wake. With this trick, the flow past the first half circle may be predicted even if the induction factor “a” is larger than 50% . (normally Uwake= Uinput(1-2a), so if a is greater than $\frac{1}{2}$, Uwake is null or negative . . .).

This new model was tested and compared to experiments performed on a very small VAWT (Radius 4.8 cm , chord length 2.1 cm, blade span: 16 cm !) but with high Reynolds numbers thanks to high density working fluids, and high solidity ratios. The new proposed DMST model provides much better power predictions than the conventional Rankine-Froude model.

It was a pleasure to read this paper. I did not see any mistake. I have just one remark about Figure 7 which seems doubtful: - Figure 7 left : the solid line is supposed to be the current model (see legend) : so why it shows negative velocity values everywhere ? I thought that only the conventional model show negatives values, not the current model: I think there is a mismatch in the figure 7 legend.

- Figure 7 right : why there is absolutely no difference between the solid line (current model) and the conventional one (dot line) apart at teta=10° ?? Induction factors are the same for both models except at 10° ?

However, I have to recall that static lift and drag curves have been used here, and it is known that dynamic stall plays a relevant role in the VAWT problem. Obviously there errors introduced by this fact, whatever the DMST method used. Moreover dynamic stall may be important at low TSR (i.e. in this paper) with hysteresis behavior. In the past, a lot of effort has been invested into developing modifications to the original DMST model to include those effects (Paraschivoiu 2002, Paraschivoiu and Major 1992). Most of the dynamic stall models applied to DMST consist of a series of semi-empirical procedures applied in the calculation of the lift and drag coefficients of the VAWT blade.

CC BY

So, I wonder what could be the performance of this new DMST model, in comparison with old fashioned DMST model but with dynamic stall corrections.

I personally think that the paper can be published as it is, but a precise check of figure 7 and its legend is required, and a few sentences on DMST models with stall corrections could help the reading.

Paraschivoiu I., “Wind Turbine Design With Emphasis on Darrieus Concept”. ISBN 2-553-00931-3. Polytechnic International Press, Montreal, Canada, 2002. Ecole Polytechnique de Montreal.

Paraschivoiu I. and Major S.R., “Indicial Method calculating Dynamic Stall on a Vertical-Axis Wind Turbine.”, Journal of Propulsion and Power, 8(4):909-911, 1992.

Interactive comment on Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2019-44, 2019.

Printer-friendly version

Discussion paper

CC BY