Wind Energ. Sci. Discuss., referee comment RC3
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Comment on wes-2021-18

Peter Jamieson (Referee)

Referee comment on "Maximal power per device area of a ducted turbine" by Nojan Bagheri-Sadeghi et al., Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2021-18-RC3, 2021

This paper explores and aims to quantify a limit on power output from a ducted turbine and I agree with Reviewer RC1 is a useful contribution to DAWT literature. It is totally logical that there is a limit to power from any energy extraction system related to its dimensions and the work adds to evidence showing that such a limit does exceed the Betz limit based on the exit area (if presumed to be the maximum sectional area of the duct) and discrediting a common fallacy that may cause ducted turbine concepts to be undervalued. I think the paper is a nice piece of work taken in the specific context of the Eppler E423 aerofoil but the comment (line 80) " a similar result should hold for other duct cross sections as well" is too much of a stretch without direct evidence.

I believe this paper would have been strengthened, perhaps hugely, by parallel investigations in inviscid flow. This is because in real flow, there are two quite different contributions to a power limit, one fundamentally related to device size (possibly only maximum section area) and another that may or may not be fundamental relating to flow separation effects.

Although the references are quite full and relevant, in addition those mentioned by RC1, I think the PhD thesis of McLaren-Gow (reference attached) and some other of his publications can shed a lot of light on the present topics. I was stimulated by your paper to process some of his results on right angled ducts (cylinder with exit flange) and aerofoil ducts (represented only by the camber line profile) and perhaps see a limit on Cp total even when rotor Cp in inviscid flow is unbounded. Regarding your comments around line 40, I attach a reference with a figure and some explanation - basically in inviscid flow it seems that no finite duct will realise rotor Cp max at a Ct value as great as 8/9 but in real flow, due to some benefit from external flows, Cts associated with rotor Cp max around and a little above 8/9 can result.

I find the comments on duct length very interesting and a valuable investigation as far as it goes but again find it a step too much to generalise from the one aerofoil that there is

an optimum duct length ~ 15% D.

The changes I would strongly recommend are to qualify the comments in line 80 and 176.

Please also note the supplement to this comment:
https://wes.copernicus.org/preprints/wes-2021-18/wes-2021-18-RC3-supplement.pdf