mean error in rotor speed. So Slightly higher power production can be achieved by SMC for below rated operation, at the cost of higher pulsations in the generated torque. A trade-off should be made between mean error with acceptable limit and STD of generated torque. Even though mean error in FSMC is comparatively more than SMC but according to the reduced oscillation in drive train FSMC is better than SMC.

Table 10 Controller disturbance with parameter uncertainty of different control strategy

Control strategy	NSSFE	NDSFE	SMC	FSMC
STD(T_g) kNm	6.144	3.091	2.546	2.477
Mean (error)	0.1355	0.1001	0.0688	0.0976

5. Conclusions

This paper deals with the objective of extracting maximum power generation with minimum mechanical stress on the drive train in VSWTs. Here a fuzzy sliding mode control is proposed to ensure the above objective and to impose an ideal feedback control solution despite of model disturbance and uncertainty in the model parameters. The proposed control was found to be more robust to parametric uncertainty in turbine parameters with a constant disturbance of 1kNm. The existing classical control techniques such as ATF, ISC, NSSFE and NDSFE are adapted in this paper. Existing controllers are having the drawbacks of steady state tracking error, significance power loss and complex control law. In this paper estimation of effective wind speed is done by the modified Newton Raphson and the proposed FSMC is used to extract the maximum power capture at below rated wind speed. Different wind speed profiles are tested for proposed as well as existing controllers, from these results it is concluded that, the proposed FSMC controller gives better efficiency and reduced oscillation in the drive train compared with existing controllers. Indeed, the fuzzy sliding-mode approach is used so as to produce less chattering in the generated torque control action.

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