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Transient Performance of a Vertical Axis Wind Turbine[1] AYKUT ONOL, SERHAT YESILYURT, Sabanci University — A coupled CFD/rotor dynamics modeling approach is presented for the analysis of realistic transient behavior of a height-normalized, three-straight-bladed VAWT subject to inertial effects of the rotor and generator load which is manipulated by a feedback control under standardized wind gusts. The model employs the k-ε turbulence model to approximate unsteady Reynolds-averaged Navier-Stokes equations and is validated with data from field measurements. As distinct from related studies, here, the angular velocity is calculated from the rotor's equation of motion; thus, the dynamic response of the rotor is taken into account. Results include the following: First, the rotor's inertia filters large amplitude oscillations in the wind torque owing to the first-order dynamics. Second, the generator and wind torques differ especially during wind transients subject to the conservation of angular momentum of the rotor. Third, oscillations of the power coefficient exceed the Betz limit temporarily due to the energy storage in the rotor, which acts as a temporary buffer that stores the kinetic energy like a flywheel in short durations. Last, average of transient power coefficients peaks at a smaller tip-speed ratio for wind gusts than steady winds.

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