Adaptive Control of Gearless Wind Energy Transfers

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ABSTRACT

Gearless hydraulic wind power transfer systems are considered noble candidates to transfer wind energy to generators since they can collect the energy of multiple wind turbines in one generation unit. However, non-ideal dynamics of hydraulic systems imposed by pressure drops, leakage coefficient variations, and motor/generator coupling damping coefficient, degrade the performance of power generation. This poster represents a model reference adaptive controller (MRAC) to maintain and track a reference speed profile at the generator of a hydraulic wind power transfer. The mathematical modeling of a gearless hydraulic wind power is used to generate a close model of the plant. The control performance is verified with simulation results, which demonstrate close speed tracking profile.

SYSTEM DESCRIPTION

• A Hydraulic Transmission System (HTS) consists of a displacement pump driven by the prime-mover (Wind) and one or more either fixed or variable-displacement hydraulic motors.

• The hydraulic transmission uses the pump to convert the input mechanical energy into pressurized fluid. Hydraulic hoses are used to deliver and distribute the potential energy to the energy consumers such as hydraulic motors to convert the potential energy back to mechanical energy.

A check valve is used to ensure the unidirectional flow of the hydraulic fluid. A pressure relief valve protects the system components from destructive impact of high-pressure fluid.

A specific volume of hydraulic fluid is distributed between the motors based on characteristics of the hydraulic circuit.

MATHEMATICAL MODEL

• The dynamic model of the hydraulic system is obtained by using governing equations of the hydraulic components in an integrated configuration.

• A distinctive ideal model and plant model are created for the system.

• The ideal system model neglects the effect of pressure drop in the hydraulic system which is mainly due to inner hose friction, hose geometry, temperature variation, fluid viscosity, couplings and adapters, and flow rate.

• Moreover, the practical leakage coefficient of the rotary machinery is a function of operating pressure. The non-ideal model of the system incorporates these imperfections.

• The ideal model incorporates the governing mathematical equations of every individual hydraulic circuit component in block diagrams.

ADAPTIVE CONTROLLER

• A model reference adaptive control approach is introduced to regulate the flow of hydraulic liquid to the main hydraulic motor.

• The flow regulation should maintain a specified frequency of generated voltage in standalone applications, and control the amount of generated power in grid connected applications.

• The closed-loop controlled system is comprised of an ideal hydraulic system (model) and an imperfect system with unknown parameters (plant). The controller synchronizes the angular velocity of the plant with that of the model and compensates for the non-idealities.

RESULTS AND DISCUSSIONS

• The figure below shows the angular velocity profile supplied to the pump.

• The dynamic response of the model and the plant with no cont: * *

• The controller synchronizes the velocity of the plant and the model