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Supervisory Controller with Three-State Energy Saving Mode for Induction Motor in Fluid Transportation

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Abstract : Induction Motor (IM) driving pump is the main consumer of electricity in a typical fluid transportation system (FTS). It was illustrated that changing the connection of the stator windings from delta to star at no load could achieve noticeable active and reactive energy savings. This paper proposes a supervisory hysteresis liquid-level control with three-state energy saving mode (ESM) for IM in FTS including storage tank. The IM pump drive comprises modified star/delta switch and hydromantic coupler. Three-state ESM is defined, along with the normal running, and named analog to computer ESMs as follows: Sleeping mode in which the motor runs at no load with delta stator connection, hibernate mode in which the motor runs at no load with a star connection, and motor shutdown is the third energy saver mode. A logic flow-chart is synthesized to select the motor state at no-load for best energetic cost reduction, considering the motor thermal capacity used. An artificial neural network (ANN) state estimator, based on the recurrent architecture, is constructed and learned in order to provide fault-tolerant capability for the supervisory controller. Sequential test of Wald is used for sensor fault detection. Theoretical analysis, preliminary experimental testing and, computer simulations are performed to show the effectiveness of the proposed control in terms of reliability, power quality and energy/coenergy cost reduction with the suggestion of power factor correction.

Keywords : ANN, ESM, IM, star/delta switch, supervisory control, FT, reliability, power quality
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