A BEE COLONY OPTIMIZATION BASED-FUZZY LOGIC-PID CONTROL DESIGN OF ELECTROLYZER FOR MICROGRID STABILIZATION

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ABSTRACT. This paper proposes the optimal fuzzy logic based-proportional-integral-derivative (FLPID) controller design of the electrolyzer (EZ) by a bee colony optimization (BCO) for microgrid (MG) stabilization. The study MG system consists of wind power (WP), photovoltaic (PV), fuel cell (FC) equipped with EZ, diesel generator, and load. The intermittent power generations from WP and PV cause the severe power fluctuation in the MG. To alleviate power fluctuation, the EZ which is normally used to produce the hydrogen input for FC, can be applied. By control of active and reactive powers absorbed by EZ, the power fluctuation can be stabilized. The structure of active and reactive power controllers of EZ is the FLPID which consists of scale factors (SCs), membership functions (MFs), and control rules (CRs). Without trial and error, SCs, MFs, and CRs of the FLPID controller are automatically optimized by a BCO. Simulation study confirms that the proposed EZ with an optimal FLPID controller is much superior to the EZ with a conventional FLPID controller or an optimal PID controller in terms of stabilizing effect and robustness against various loading conditions and severe disturbances.

Keywords: Electrolyzer, Microgrid, Fuzzy PID control, Bee colony optimization

1. Introduction. Nowadays, the microgrid (MG) is expected as the smart electrical power management for rural and isolated areas that cannot access to the main power grid due to the restriction of installation costs of transmission lines, right of way difficulties, social, and environmental impacts [1]. The MG is the cluster of the distributed generation with renewable energy sources and/or conventional generating units and loads [2]. At present, there are many MG projects around the world such as Kythnos Island MG in Greece [2], Aichi, Kyotango and Hachinohe MG projects in Japan [3], and the Consortium for Electric Reliability Technology Solutions (CERTS) project in the United States [4], etc.

Generally, renewable energy sources such as wind power (WP), photovoltaic (PV), fuel cell (FC) with electrolyzer (EZ), are usually installed in the MG, since these sources are inexhaustible, environmental friendly, clean, and no CO₂ emission [5]. These renewable energy sources are often operated with the conventional electricity generations such as diesel generator (DG), and gas turbine. Nevertheless, the solar and wind energy are intermittent in nature. The power generation from WP and PV is variable [6]. This causes the power unbalance in generation and load [7], and results in the severe power fluctuation in the MG [8-10]. To suppress the power fluctuation, several methods have been proposed in previous works [11-14]. Recent advancement in the EZ equipped with an FC has opened up options for using hydrogen as an energy storage. In addition to a