High Performance Improvement of PWM Rectifier using Fuzzy Logic Control

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ABSTRACT

In recent years, the rapid technological evolution experienced by power electronics has made its use very abundant in industrial applications, particularly in the conversion of electrical energy. This conversion is often done using electronic interfaces which are, in the majority of cases, diode rectifiers. This type of interface behaves with respect to the network supply as a non-linear load and the conversion cannot therefore be done without a notable deterioration in the quality of the energy, particularly evident at the level of the forms of energy. The presence of harmonics in the network power supply could, on the one hand, damage the electrical devices connected to it and, on the other hand, cause poor energy quality. It is for this reason that harmonic standards are recommended, such as the IEEE 519 standard, which imposes a maximum limit on THD. Several methods of reducing harmonics exist. These methods are based on passive filters, active filters and PWM rectifiers. The work in this paper presents the modeling, control and simulation of PWM rectifier based on fuzzy logic controller. This strategy is used to eliminate the harmonics distortion, insure unity power factor and to obtain the DC side capacitor voltage constant, while the input currents from the power supply should be sinusoidal and in phase with respective phase voltages. Simulation results are presented and interpreted.

Keywords: Fuzzy logic controller, PWM rectifier; Harmonic.

1 Introduction

Electrical energy distributors strive to provide a quality product characterized by a balanced three-phase system. However, given the proliferation of power electronic equipments with non-linear current/voltage characteristics, distortion harmonic of the voltage and currents wave becomes more and more important. This is particularly the case equipment which has the property of injecting non-sinusoidal currents into the power supply network [1], [2]. Thanks to their abilities to reduce the harmonic content of the current drawn from the network and to ensure a bidirectional transfer of power, their speed of response, their limitation size, weight and cost, PWM rectifiers have become more and more a interesting way of interfacing with the electrical network for different applications industrial, especially high-performance electric drives [3]. The PWM rectifier has six power transistors with anti-parallel diodes; these diodes are mainly used to carry out the PWM generation as well as the power bidirectional conversion. The converter is supplied by three-phase source in series with coupling inductance (Lc), the PWM rectifier is supplying R load connected in parallel with DC capacitor voltage [4]. Unpolluted equipment, sinusoidal input currents with unity power factor are some of many advantages of PWM Rectifier. Several control strategies were proposed in recent works for the PWM rectifier, DPC strategy based on fuzzy logic controller provides sinusoidal line current and lower harmonic distortion in to the AC line power. This paper is dedicated to this specific type of rectifiers, shown in Figure 1.

2 Methodology

In this paper, the mathematical model of PWM rectifier is analyzed firstly, which leads to the mathematical model in the two-phase stationary coordinates. After that the Direct Power Control (DPC) based on

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hysteresis band current has been proposed. The aim is to control directly the active and reactive powers in a PWM rectifier. Fuzzy logic control is developed in this work to obtain desired DC output voltage and minimize the total harmonic distortion. The linguistic input variables are defined as (N, Z, P,) which, negative, zero, and positive respectively. In the output the linguistic variables are defined as (PB, PM, PS) which, positive big, positive mean and, positive small zero respectively.

3 Results and Discussion

Figure 2 and 3 show the line current and the input voltage. In the presence of PWM rectifier, it is well shown that the line current is sinusoidal and nearly in-shape with the respective phase voltages. The THD decreases to at 0, 43 %, see figure 4. The figure 5 shows the DC capacitor voltage variation for both cases; with and without fuzzy logic controller. It is clear that its value follows up its initial reference value. Figure. 6 shows the improvement of the instantaneous active and reactive powers, it can be clearly shown that the reactive power flow is zero consumption.

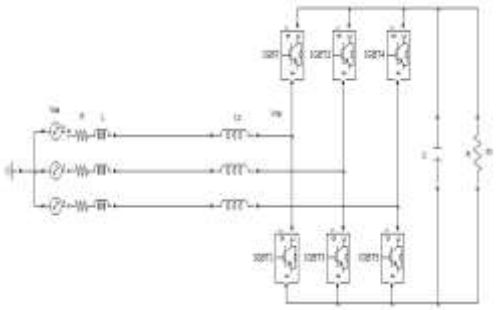

Figure 1: *PWM rectifier converter*

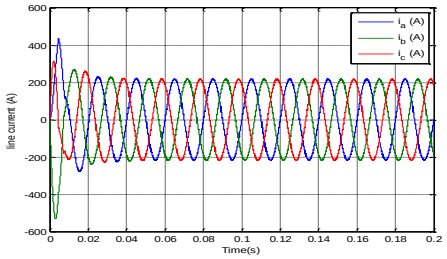

Figure 2: Line current

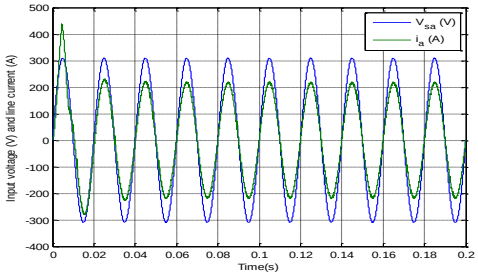

Figure 3: Line current and input voltage

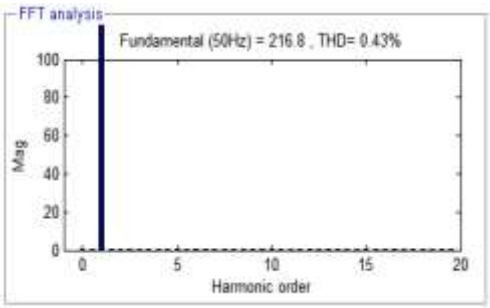

Figure 4: Line current spectrum

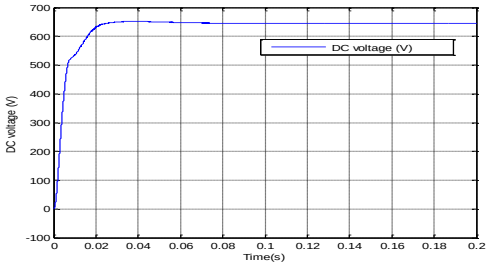

Figure 5: *DC capacitor voltage*

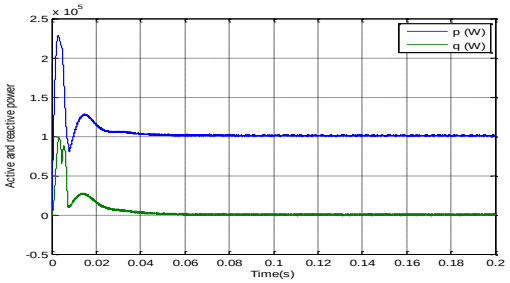

Figure 6: *Active and reactive powers*

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4 Conclusion

In this paper a new improved control structure of the line current and the DC capacitor voltage of a PWM rectifier have been presented. The simulation results obtained clearly showed that the fuzzy controller improves the system performances in term of the DC side capacitor voltage, power-factor correction and the THD of the line current.

How to Cite

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