QUALITY STUDY ON ORDERED THREE-PHASE RECTIFIERS

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ABSTRACT: *The paper presents a qualitative comparative study between 3 of the main types of three-phase rectifiers ordered used in the supply of electromechanical and thermal consumers such as DC motors and DC electric arc. As the quality parameters, the critical control angle of the α_{cr} rectifier and the switching angle γ were considered.*

KEY WORDS: ordered rectifier, critical angle, switching angle.

1. INTRODUCTION

The critical control angle of the α_{cr} rectifier, defined as the electric control angle that makes the boundary between the uninterrupted current and the open current of the rectifier, is not the same for any circuit that uses a certain type of rectifier [1-5].
As it is known, the uninterrupted current regime is not desirable in a circuit because, for example, considering two of the frequently encountered consumers; it causes a non-uniform rotation of an electric motor and an interruption of the electric arc. This depends on the structure of the electrical circuit and the values of the equivalent components in the circuit[6-10].
The higher the critical angle value, the better it is considered that the circuit in question is more efficient.
The switching angle γ, defined as the electric angle which is a measure of the temporary short-circuit in a power rectifier (and not only), is desirable in an electric circuit to have a lower value as it causes the overloading of the component elements of the circuit as well as decreasing the electrical efficiency of the circuit[11-15].
Just as the rectifier's critical control angle and switching angle depends on the circuit structure and the equivalent circuit values [16-18].
The performance of a rectifier is negatively impacted by the increase in the switching angle γ.

2. TECHNICAL REQUIREMENTS

The comparative qualitative study of the present looks at 3 of the main types of three-phase rectifiers ordered in practice: the mono-alternating three-phase rectifier, the M3, the three-phase triple-phase rectifier, the M6, and the twin-phase three-phase rectifier, M12.
The critical control angle of the rectifier α_{cr} for a rectifier is given by:

$$\alpha_{cr} = \frac{\pi}{2} - \frac{\pi}{m} \quad \textbf{(1)}$$

where:
m- the number of pulses
The α_{cr} values for the three types of rectifiers analyzed, namely the three-phase controlled rectifier, M3, the three-phase bridge rectifier, M6, and the twin-phase three-phase rectifier ordered M12 are shown in Table 1.

Table 1. The α_{cr} values for the three types of rectifiers analyzed

	M3	M6	M12
$\alpha_{cr}[^0]$	30	60	75

The mean rectified voltage $U_{d\alpha\gamma}$ to the output of a rectifier ordered is given by:

$$U_{d\alpha\gamma} = U_{d0}\frac{\cos\alpha + \cos(\alpha+\gamma)}{2} \quad \textbf{(2)}$$

Taking into account the values of the critical angle α_{cr} for each of the rectifiers analyzed, shown in Table 1:

$$\alpha_{crM3} = 30^o \quad \textbf{(3)}$$

$$\alpha_{crM6} = 60^o \quad \textbf{(4)}$$

$$\alpha_{crM12} = 75^o \quad \textbf{(5)}$$

and the relation (2), in which the average voltage of the non-ordered U_{d0} rectifier is taken as a value in the figure 1, figure 2, figure 3, the results obtained for the output voltages of each of the three rectifiers analyzed, M3, M6, M12, are given by three values of the angle equivalent switching γ_{echiv}:

$$\gamma_{1echiv} = 0^o \quad \textbf{(6)}$$

$$\gamma_{2echiv} = 5^o \quad \textbf{(7)}$$

$$\gamma_{3echiv} = 10^o \quad \textbf{(8)}$$

where by γ_{echiv} the number of simple switches during the period of each type of rectifier was taken into account.

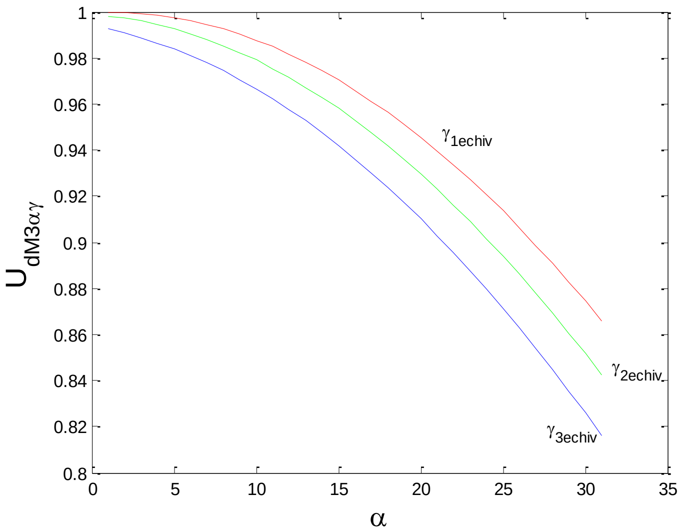

Figure 1. Output voltages of the mono-alternating three-phase rectifier, M3

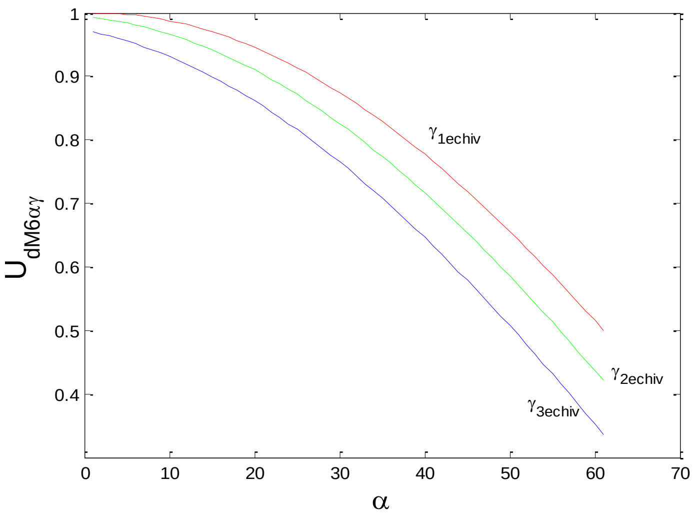

Figure 2. Output voltages of the three-phase triple-phase rectifier, M6

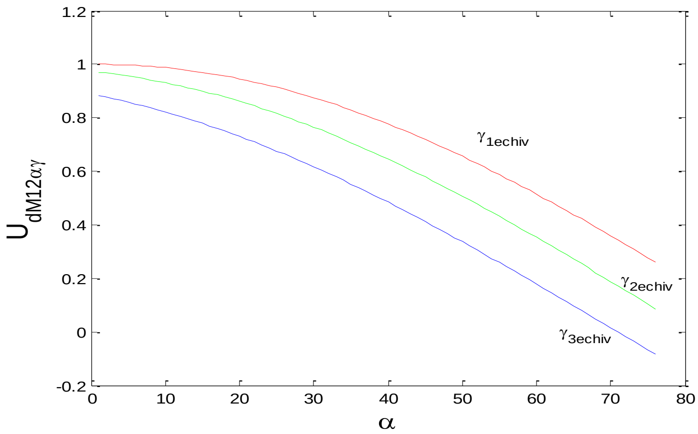

Figure 3. Output voltages of the twin-phase three-phase rectifier, M12

3. CONCLUSION

Depending on the value of the rectifier's critical control angle, the order in which the three types of rectifiers ordered are performing is:

1. Dual-phase three-phase controlled rectifier, M12;
2. Three phase rectifier, M6;
3. Three phase rectifier mono-alternating, denoted M3.

This hierarchy is theoretically justified by the higher number of pulses per period since the rectifier output, which delays the occurrence of the intermittent conduction phenomenon

Depending on the value of the switching angle γ, the rectifier is even better as it is lower. The γ_{echiv} equivalent switching angle for a given γ commutation angle is even greater as the number of period commutations in the rectifier is higher and for this reason the quality hierarchy in this case is:

1. the mono-alternating three-phase controlled rectifier, M3;
2. three-phase bridge rectifier, M6;
3. the three-phase rectifier, denoted M12.

Globally, given the two contradictory situations regarding the rectifiers analyzed in terms of the quality criteria presented, it can be appreciated that choosing the type of optimal rectifier is dependent on the concrete application in which it should work.

In practice, of the three types of rectifiers analyzed, it has been found that the most used type of rectifier is the 3-phase bridge rectifier, referred to as M6.

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