Abstract - This paper describes a complete analysis of a three-phase bridge rectifier with resistive load, using Matlab/Simulink environments. The work presents the analysis of the wave forms of the three-phase controlled rectifier in normal functioning regime.

Key words: rectifier, bridge, SCR, diode, LIGB1.

1. INTRODUCTION

The rectifier depicted in fig. 1 is formed by 6 thyristors and 2 diodes with a three phase power source, in which we have 4 branches, 3 of them only with diodes and one branch with thyristors. The branch on which the diodes are connected is connected to the power source null.

2. FUNCTION

The regulation of the load tension is made by modifying the driving angle of the thyristors.

Depending on the driving angle of the thyristors we have 3 functioning domains:

Domain I of functioning, in which the driving angle $\alpha < \alpha < 30$. In this domain we have a conduction state only for thyristors. The rectifier is a three phase in bridge, full driven, RTP6, in which we have 6 pulses on a period.

The medium value of the rectified tension is given by:

$$U_{oa} = U_o \cos \alpha \quad (1)$$

$$U_o = \sqrt{2} U_2 \sin \frac{\pi m}{\pi} \frac{m}{m} \quad (2)$$

with $U_2$ is the tension of phase.

The rectified tension pulses are given by fragments of the line tension. That’s because only the devices that have the greater line tension are commuting.

If we note with 1 logic the conduction state and with 0 logic the blocking state, the conducting and commuting sequence is given by the step matrix:
The rectified tension contains only $n=km$ order components (multiple of $m$ phases).

\[ u_d = U_{do} \left[ 1 + \sum_{k=1}^{\infty} \cos k\pi \left( \frac{\cos[km\omega t - (km+1)\alpha]}{km+1} \right) \right] \]

\[ + \frac{1}{\sin(6n\omega t + \nu_{6n})} \left( \frac{1}{(6n+1)^2} + \frac{1}{(6n-1)^2} - \frac{2\cos 2\alpha}{(6n+1)(6n-1)} \right)^{1/2} \]

\[ \nu_{6n} = -\frac{n\pi}{6} + \arctan \left( \frac{\cos(6n+1)\alpha}{\sin(6n+1)\alpha} \right) - \arctan \left( \frac{\cos(6n-1)\alpha}{\sin(6n-1)\alpha} \right) \]

**Domain II.** If we angle the driving, $30^\circ < \alpha < 90^\circ$ we have time intervals in which alternatively conducts 2 thyristors and one thyristor and a diode.

The waveform of the load tension is given by fragments of the line tension (when thyristors are conducting) alternating with fragments of the phase tension (when a thyristor and a diode are conducting).

In the same way as in the domain I, we can write the step matrix, which is:

**Domain III.** If we angle the driving, $90^\circ < \alpha < 150^\circ$.

![Fig.2. The rectifier full controller.](image)
If we can say that the circuit in fig 2 is full rectifier, then the circuit in fig 1 is a half rectifier.

As for the AC converters, presented in fig 3, related to the devices type we can have AC converters full driven or half driven. Depending on the type of the devices we have 3 functioning domains.

![Fig.3. AC converter.](image)

At a rectifier, for driving a DC electric motor, we have to follow:
- the regulation of the medium value of the rectified tension, in order to ensure the couple of the running machine;
- the harmonics content, in order to analyze the way in which the electrical network is loaded with harmonics from the rectifier functioning and how the electrical DC engine is loaded with harmonics which drive to the overheating and functioning limitation.

If we compare the two step matrix given by the relations 1 and 2, we can deduce:
- for the domain I each device drives a time interval equal with $\frac{2\pi}{m} = 120^\circ$ ($m$= number of phases) and for the domain II we have a driving angle equal with $\frac{\pi}{m} = 60^\circ$. The conduction interval is equal with a step of the step matrix.

The steps have equal length. From the Fourier series developing results that the first non-zero harmonic, for domain I is $f_1 = pf = 300$Hz and for the domain II, the frequency of the first harmonics depends of the fragments of the line or phase tension which approximates the load tension
  - $f_1 = 300$Hz – when the thyristors are conducting (we have RTP6)
  - $f_1 = 300$Hz or $f_1 = 150$Hz when a thyristor and a diode are conducting

The optimal filter to make smooth the output tension should be projected in the domain 150Hz-300Hz, so it cannot fulfill.

CONCLUSION: In the case of using the rectifier with several pulses, in which a branch of the bridge uses the null of the electrical network, in order to have an optimal filter we have to use, in functioning each domain separately.

We can say that we have 3 functioning domains for C input converters because the output differs: Dc for rectifier and AC for AC converters.

REFERENCES
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