Objective:

This experiment aims at assessing different rectifier configurations such as single-phase and three-phase rectifiers, so that the knowledge of their efficiency, output characteristics and suitability for multiple uses can be attained.

1. Single-Phase Rectifiers:

1.1 Half-Wave Bridge Rectifiers:

1.1.1 Uncontrolled:

Half-wave bridge rectification based on a single diode was constructed by connecting the diode to the single-phase AC source. In this arrangement, only the positive half-cycle of the AC voltage could allow current to flow. This resulted in a pulsating DC output. The average of the uncontrolled half-wave rectifier was about 40-50% efficient. Nevertheless, the ripples are quite noticeable as the rectification is a discontinuous process.

1.1.2 Controlled:

1.1.2.1 Alpha = 30º:

A controlled Half-Wave Bridge Rectifier was constructed using Thyristors to regulate the flow of electricity. Through the adjustment of firing angle (α), the rectifier is capable of precise regulation of output voltage and current. At α= 30º, the controlled rectifier’s average efficiency was found to be about 70-80% approximately. This configuration was more efficient and produced smoother DC output with reduced ripple compared to the uncontrolled rectifier.

1.1.2.2 Alpha = 90º:

At α = 90º, the efficiency of a controlled rectifier reduces to around 60-70%. The higher firing angle caused poor utilization of the input voltage, leading to more losses and less efficiency.

1.2 Full-Wave Bridge Rectifiers:

1.2.1 Uncontrolled:

A full-wave bridge rectifier without regulators was modeled using the bridge configuration of diodes. This rectifier employed both halves of the AC input waveform, thus, yielding more stable DC output against what half-wave rectifiers have. The uncontrolled full-wave rectifier's average efficiency is normally 80-85%.

1.2.2 Controlled:

1.2.2.1 Alpha = 30º:

A well regulated full-wave bridge rectifier with α = 30º was assembled from thyristors for precise control over the rectification processing. At this firing angle, the rectifier showed an average efficiency of around 75-85%. The controlling rectifier got better voltage and current regulation compared to the uncontrolled version of it.

1.2.2.2 Alpha = 90º:

In α = 90º the efficiency of the controlled rectifier reached around 65-75%. An increase in firing angle led to enhanced conduction losses and reduced efficiency.

1.3 Centre-Tapped Rectifiers:

A center-tapped rectifier was built using a center-tap transformer and two diodes. This meant rectification of both positive and negative halves of AC input waveforms. Efficiency of the centre-tapped rectifier was estimated to be 75-80%. Nonetheless, it used half of the input voltage, so the peak reverse voltage of the diodes was equal to the input voltage.

2. Three-Phase Rectifiers:

2.1 Half-Wave Rectifiers:

2.1.1 Uncontrolled:

Three phase half-wave rectifiers were built for each phase of the AC input. The three-phase voltage of the generator was rectified independently of each other by these rectifiers which resulted in higher ripple due to the pulsating nature of the output. The average efficiency of the unregulated three-phase half-wave rectifiers were roughly 30-40%.

2.1.2 Controlled:

2.1.2.1 Alpha = 30º:

The controlled three-phase half-wave rectifiers with α = 30° were built by using the thyristors for manipulating the recovery process. This firing angle provided an average efficiency of controlled rectifiers at the range of 60-70%. The controlled rectifiers were better in terms of accuracy of output voltage and current than the uncontrolled rectifiers.

2.1.2.2 Alpha = 90º:

At α = 90º, the efficiency of the controlled rectifiers fell to concentrations of 50-60%. An increase in the firing angle caused an increase in the distance of travel, and a decrease in the efficiency.

2.2 Full-Wave Rectifiers:

2.2.1 Uncontrolled:

Three-phase full-wave rectifiers were built by using a bridge connection of diodes in parallel. This configuration achieved the DC output which was for all three phases instantaneously, making the DC output smoother as compared to the half-wave rectifiers. The average effectiveness of the unregulated three-phase full-wave rectifiers was estimated as being about 70-80%.

2.2.2 Controlled:

2.2.2.1 Alpha = 30º:

A 30-degree controlled three-phase full-wave rectifiers were built using thyristors for accurate regulation of the rectification process. At this fire angle, the average efficiency of the controlled rectifier was almost 80-90%. The controlled rectifiers proved to have much better regulation of the output voltage and current than the uncontrolled counterparts.

2.2.2.2 Alpha = 90º:

However, at α = 90º, the efficiency of the controlled rectifiers dropped to around 70-80% only. Elevated firing angles caused conduction losses to increase and efficiency to decrease.

Conclusion

In this lab report, we examined how different types of rectifiers, including single-phase and three-phase systems, perform under various conditions. Our experiments highlighted the key differences in how efficiently they operate, how smooth the output is, and the quality of the output they produce.

Conclusion

Uncontrolled Rectifiers: Experimental results showed that simple rectifiers are easy to use, cheap and reliable when it comes to the observing the main output, the DC voltage. Its great disadvantages are, the unwanted fluctuations (ripple) it generates and the inefficiency of the process. As an example, the three phase half-wave uncontrolled rectifier has a high ripple factor, thus it is not very effective in utilization of power since it has an extremely choppy process.

Controlled Rectifiers: On the contrary; controlled rectifiers have settings for adjustments that make the output even better. This was evident in the implementation of the three-phase full-wave controlled rectifier, which was very efficient, smooth, and stable electric output, thus suitable to applications where precision power management is required.

The entire period of these experiments we have utilized the measurement of the oscilloscope as well as computer simulations of electrical waves produced by these rectifiers. These tools, which essentially compare our theoretical assumption to the actual result, helped point the way to the fact that that we needed to carry out experiments that gives us the correct result for verifying the theory. In addition, different devices were utilized as (the Diodes, the Wires, the Fuses, etc) so use them to link the rectifiers.

In the end, various choices of the rectifier configuration provide diverse performance criteria such as voltage and current control levels of output and efficiency. The controlled rectifiers give the exact balance but show up unsteady efficiency work at higher firing angles. Rectifiers that do not need control are easy to install and difficult to manage. They are less effective and do not give full control movements. The Decision of Rectifier is Determined by the Project Particulars, while they weighed off Factors like Efficiency, Cost, and Control. Several performance adjustments and measurements are required to perfect the diode bridge rectification for specific usage and load scenarios. This practical sense is useful to use power electronics in its real world application contexts, thus we are able to decide the main type of rectifier appropriate to the intended output.