Analisis Pengujian Emisi Arus Harmonik pada Lampu Light Emitting Diode (LED) dan Pengembangan Filter Pasif untuk Optimasi Kinerja = Analysis of Harmonic Current Emission Tests on Light Emitting Diode (LED) Lamps and Development of Passive Filters for Performance Optimization

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Abstrak

Penggunaan lampu LED di Indonesia meningkat sejak tahun 2013. Lampu LED memiliki keunggulan faktor konsumsi daya yang rendah dan efisiensi yang tinggi. Lampu LED merupakan beban non-linier yang menyebabkan distorsi harmonik pada sistem tenaga listrik. Distorsi harmonik tersebut merupakan emisi arus harmonik yang mengakibatkan panas berlebih pada inti magnet peralatan listrik yang terkoneksi dalam satu jaringan listrik yang sama. Oleh karena itu, diperlukan batasan nilai emisi arus harmonik untuk meningkatkan optimasi kinerja pada lampu LED. Pada penelitian ini dilakukan pengujian emisi arus harmonik lampu LED yang memiliki rangkaian driver internal. Sebanyak 35 sampel dari 7 merek dengan jenis peringkat daya 3 Watt, 5 Watt, 7 Watt, 11 Watt dan 15 Watt diuji. Proses untuk mendapatkan nilai arus harmonik orde ke-3 dan orde ke-5 dilakukan dengan metode Fast Fourier Transform (FFT). Nilai arus harmonik yang terukur akan dibandingkan dengan persyaratan pada Standar SNI IEC 61000-3-2 tentang batas emisi arus harmonik untuk arus input perangkat 16 Ampere per fase. Pengembangan disain model filter pasif eksternal diterapkan untuk melakukan analisis optimasi kinerja pada lampu LED. Frekuensi cut-off pada model filter pasif dirancang pada frekuensi sekitar 150 Hz. Hasil pengujian awal (tanpa filter eksternal) menunjukan nilai emisi arus harmonik yang melebihi persyaratan SNI IEC 61000-3-2. Selanjutnya, dilakukan pengujian emisi arus harmonik pada lampu LED dengan tambahan model filter eksternal. Hasil pengujian arus harmonik setelah ditambahkan model filter eksternal menunjukan pengurangan nilai arus harmonik pada orde ke-3 dan ke-5 yang tidak melebihi batas emisi arus harmonik pada persyaratan standar SNI IEC 61000-3-2. Hasil penelitian keseluruhan menunjukkan rangkaian model filter eksternal dapat menurunkan emisi arus harmonik orde ke-3 dan orde ke-5, serta meningkatkan power factor sampel lampu LED di setiap peringkat kategori daya. Sedangkan nilai faktor Q pada komponen filter eksternal mempengaruhi perubahan intensitas cahaya lampu LED. Semakin besar nilai faktor Q menyebabkan peningkatan intensitas cahaya lampu LED.

.....The use of LED lamps in Indonesia has increased since 2013. LED lamps have the advantages of low power consumption and high efficiency. However, LED lights are non-linear loads that cause harmonic distortion in the electrical power system. This harmonic distortion is the emission of harmonic currents, resulting in overheating the magnetic core of electrical equipment connected to the same electrical network. Therefore, it is necessary to limit the emission value of harmonic currents to improve the performance optimization of LED lamps. In this study, the conducted harmonic current emission tests LED lamps with an internal driver circuit. A total of 35 samples from 7 brands with power ratings of 3 Watt, 5 Watt, 7 Watt, 11 Watt, and 15 Watt tested. The initial test conduct to get the value of the 3rd and 5th order harmonic currents. The process of obtaining the value of the 3rd order and 5th order harmonic currents using the Fast Fourier Transform (FFT) method. The measuring harmonic current values compare with the requirements in SNI

IEC 61000-3-2 standard regarding the emission limits of harmonic currents for device input currents 16 Ampere per phase. Development of the external passive filter model design is applied to perform an optimization analysis of the performance of the LED lamp. In passive filter models, the cut-off frequency design at a frequency of around 150 Hz. The initial test results (without an external filter) show the emission value of harmonic currents that exceed the requirements of SNI IEC 61000-3-2. Subsequently, testing the emission of harmonic currents on LED lamps with an external filter model. The harmonic current test results after adding the external filter model show a reduction in the value of harmonic currents in the 3rd and 5th orders, which do not exceed the emission limits of harmonic currents in the requirements of the SNI IEC 61000-3-2 standard.The overall research results show that the external filter model series can reduce the emission of 3rd and 5th order harmonic currents and increase the power factor of the LED lamp samples in each power category rating. Meanwhile, the value of the Q factor on the external filter component affects changes in the light intensity of the LED lamp. The greater the value of the Q factor causes an increase in the light intensity of the LED lamp.