POWER FACTOR CORRECTION FOR RESIDENTIAL

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SUPERVISOR DECLARATION

I hereby declare that I have read through this report entitle "Power Factor Correction for Residential" and found that it has been comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power).

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Date : 8/6/2017

Power Factor Correction For Residential

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A report submitted in fulfilment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

I declare that this report entitle "Power Factor Correction for Residential" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature for any other degree.

Signature : .....

Name : NORHAZIMI BIN ISMAIL

Date : 8/6/2017

Dedicated to my beloved parent (Ismail Bin Zakaria and Zah Binti Mohamed), friends and lecturers for their never ending helps

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ABSTRACT

Nowadays, demand on electricity power among the residential consumer is increasing due to the many factors especially climate changes. Increase in temperature for example will increase the usage of air conditioners, hence will also increase the electricity bills among the households consumer. Due to this problem, people are starting to find ways to reduce electricity bills by not having to sacrifice their comfort. As a response, energy saver devices have started to emerge in our market. The capability of this device to reduce electricity bills are not proven yet because some claims this device is effective to reduce electricity bills, but others claim this device does not serve its purpose at all. Therefore, the objective of this research is to explore the truth about the capability of this device and also to study its effect when applied to the domestic electrical system. Experimental test was conducted in laboratory environment by using resistive load bank and inductive load bank to imitate the residential load of single phase system. During the experimental test, two different brand of energy saver were tested to prove the capability of this device whether or not it will reduce electricity bills. Based on the result of the experimental test, the device only manage to reduce the current and reactive power of the system while at the same time the power factor and total harmonic distortion were increased. However, the active power stays the same which means no effect at all in decreasing the electricity bills. Further studies also showed that the energy saver will cause for damage on the appliances in the long run due to the increment of total harmonic distortion generated in the system.

ABSTRAK

Pada masa kini, permintaan terhadap kuasa elektrik dalam kalangan pengguna domestik semakin meningkat disebabkan oleh beberapa faktor terutamanya faktor perubahan cuaca. Dengan meningkatnya suhu persekitaran, sebagai contoh ianya akan menyebabkan pennguna akan menggunakan penghawa dingin secara maksimum dan akan menyebabkan bil elektrik mereka meningkat. Oleh itu, masyarakat mula mencari jalan untuk mengurangkan bil elektrik mereka tanpa perlu mengorbankan keselesaan mereka. Maka dengan itu, alat jimat elektrik mula muncul dalam pasaran sekarang. Kesahihan tentang keberkesanan alat jimat elektrik mampu untuk jimatkan elektrik ini masih belum terbukti kerana sesetengah pegguna menyatkan alat jimat eletrik mamput untuk jimatkan bil elektrik, tetapi sesetengah lagi menyatakan alat ini tidak befungsi seperti mana yang dinyatakan. Oleh itu objektif kajian ini ialah untuk mengkaji tentang kebolehan sebenar alat jimat elektrik dan untuk mengkaji kesan meggunakan alat jimat eletrik kepada pegguna domestik. Ujikaji telah dijalankan di dalam persekitaran makmal dengan menggunakan “resistive load bank” dan “inductive load bank” dengan meniru gaya system satu fasa pegguna domestik. Semasa ujikaji dijalankan, dua jenis jenama alat jimat elektrik yang berbeza diuji untuk membuktikan kebolehan sebenar alat ini samada mampu menjimatkan elektrik ataupun tidak. Bedasarkan keputusan ujikaji, alat ini hanya mampu mengurangkan arus dan “reactive power” didalam system dan pada masa yang sama “power factor” dan “total harmonic distortion” didalam system meningkat. Walaubagaimanpun, “active power” didalam system tetap tidak berubah dan hal ini memberi makna tidak ada berlakunya pengurangan bil elektrik. Ujikaji ini juga menunjukan kesan peggunaan alat ini mendatangkan kesan yang buruk terhadap peralatan elektrik dirumah oleh kerana peningkatan “THD” di dalam system.

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CHAPTER 1

1.0 INTRODUCTION

The history of electricity had been found hundred years ago by Benjamin Franklin famous kite experiment in 1752 [1]. This experiment have shown just how little we know about electricity and afterwards a revolution of electricity grown tremendously to find new ways to use it in order to improve our lives. In 1831, one of first breakthrough in electricity occurred when British scientist Michael Faraday discovered the basic principles of electricity generation [1]. Based on the experiment of Franklin and others, he created induce electric current by moving magnet inside coils of copper wire. The discovery of this principle has revolution and this principle is used in our modern power plant today to produce much stronger currents on much larger scale of generation.

There are several ways to produce electricity which is, some of the stations run on the power of coal and steam, while others run on the power of the wind or falling water. Some even use the power of the sun alone to generate electricity. In order to produce electricity it needed energy resources. Energy resources can be classified as renewable energy and non renewable energy. Basically to distribute electricity to the consumer it needs to undergo a several steps as show in figure 1.1. Firstly electricity needs to generate at power station. Then the transmission process will take place due to the most power stations far away from consumer. The length of transmission process normally hundreds kilometre away before arrive at distribution. At distribution process, it will distribute the electricity to the consumer. All of this step so expansive.

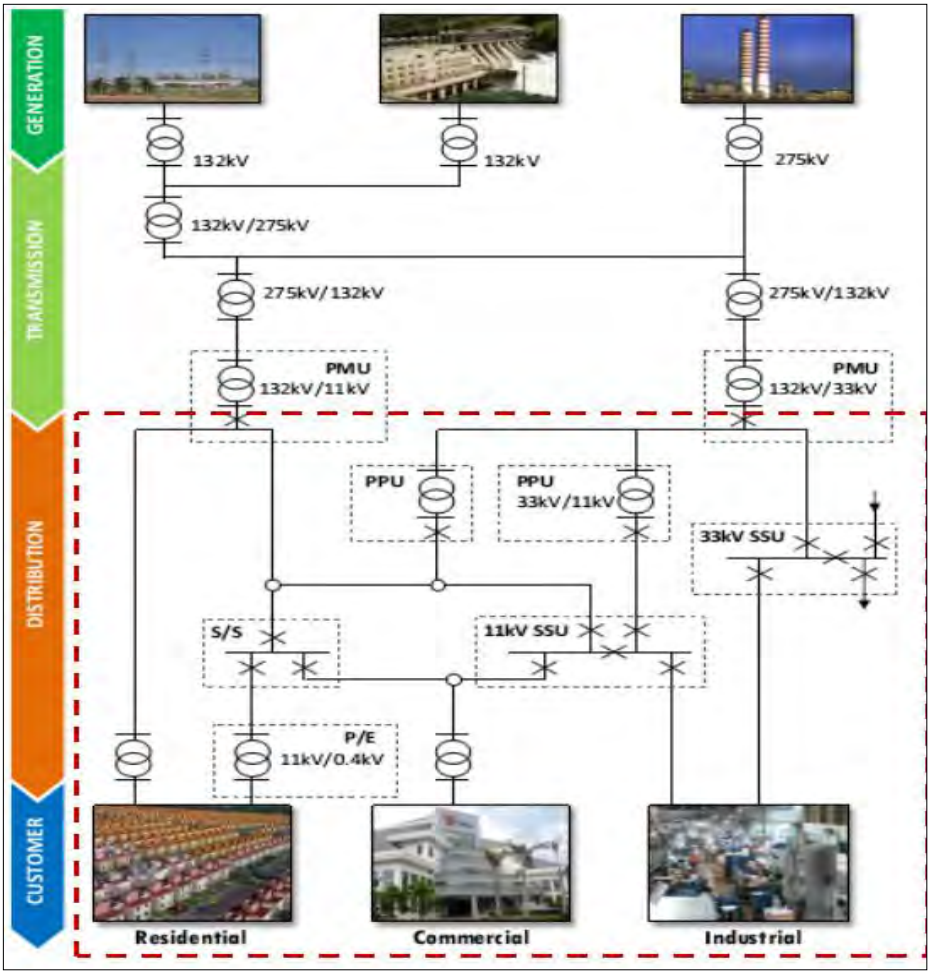

Figure 1.1: Example of electricity provider network system.

To generate electricity and to transfer it to consumer will cause high expenditure. As we know, electrical power system is the expensive in term of capital investment and operating cost contrast to other systems. In order to refund this capital, the electricity provider will charge the consumer base on electricity tariff rate based on kW/hour of their usage. In Malaysia, there are several types of Tenaga Nasional Berhad (TNB) customers which are residential, commercial and industrial. The tariff rate will be different for all of the type of the customers. The focus of this research will focus on residential only.

As conclusion, the bills of electricity base on tariff rate and the power usage by the consumer. Nowadays the power usage by consumer was increasing and the electricity tariff is unpredictable. All of this will make the increasing bills for the consumer. In order to reduce electricity bills, consumers start to find ways to reduce their electricity bills. Because of this problem, energy saving device had emerged in our market. The ability of this device still in questionable. Base on retailer website, it claim the energy saver can be reduce 330% of currently electricity bills [11][12].

1.1 MOTIVATION

Population in human race is always rising. As the population rise, the demand for electricity also increases as well. So, electricity provider needs to generate more electric to fulfil the demand by the customers. The cost to generate high scale electric power is very expansive because almost all of the sources power is limited and the cost is unpredictable. It's also costly to transfer electric power to the consumer. However, the cost will be responsibility by the electric consumer through to billing charges by the tariff rate that was set by electric power provider.

The change in climate also affected the increasing of the electricity bills. For example, during el-nino that cause increasing in ambient temperature or global warming will make many households use their air conditioners more than usual. Due to this action, their electricity bills are increase more than usual. Hence, there's demand for a start to find a way to control or reduce electricity consumption among consumers. Peoples are willing to invest to reduce the electricity bills by purchasing the energy saver that already exist in our market even they did not know the true capability of that device whether it can save electricity bill or not. Another that, the effect of energy saver to the system is also unknown whether it risks electrical appliances at home or not.

To ensure the investment that made by consumers is worthy, study on energy saver device need to be conduct to prove the real capability of the energy saver device in order to make sure the people are not be fooled by the claim of the energy saver can reduce an electricity bills.

1.2 PROBLEM STATEMENT

There are tons of product that been claimed as the 'energy saver' had been released in the market nowadays. The availability of the power/energy saver in the market had caused for mixed reaction from the consumers. Some claimed that it can be reduce up to 30% of the electricity bills which seem to be a really smart saving. The other half claimed that the device does not serve its purpose at all, which is not worth the hype at all. This research hence tries to demystify the two contrasting consumer responses with practical experimental approach

1.3 OBJECTIVE

1. To identify the working mechanism/operation of the commercial energy saver.

2. To determine the effectiveness of the energy saver on the different type and sizes of loads (R, L, R+L)

3. To recognize the impact of the energy saver on home appliances.

1.3 SCOPE OF PROJECT

The research will focus on the following scope:

a. The focus of this research will be for single phase residential only.
b. This research will be conducted on two different brands of energy saver available in the market.
c. This study will be conducted in laboratory environment with resistive and inductive load banks in term of kW and kVar.

CHAPTER 2

LITRATURE REVIEW

2.0 Introduction

This chapter covers the research theoretical part that relate on this research work. Information from the literature review is very important on this research to explain briefly about theoretical part that relate on this research.

2.1 Theory and Basic Principles

2.1.1 Power Factor Correction

Power factor is the ratio between active power (kW) to apparent power (kVA) that exists in electrical equipment or in complete electrical installation system [2]. High of power factor means how effective electrical power is being used. Power factor also can be defining the cosine of the phase angle between active power (kW) and apparent power (kVA). The following figure 2.1 will show the power triangle and the relationship of power factor between active power and apparent power.

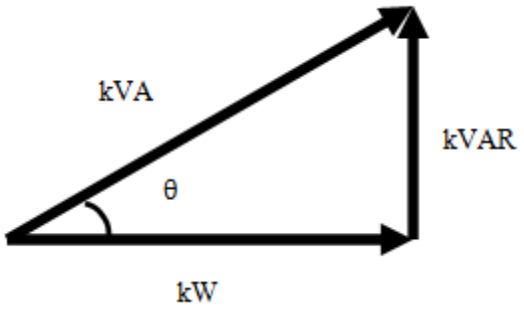

Figure 2.1: Power Triangle.

$$\text{Power Factor} = \text{Cos } \theta = \frac{adjacent}{hypotenuse} = \frac{kW}{kVa} \qquad (2.1)$$

In order to improve the efficiency and to reduce losses, power factor correction need to be apply. Power factor correction is the ways to restore the power factor to unity in order to reduce losses and meanwhile it supposed to reduce electricity bills [2]. In real world, usually power factor correction form in capacitors to neutralize magnetizing current. If capacitor connected to the circuit that nominally lagging power factor it will reduce the circuit lags proportional to make the circuit become nearly of unity power factor [2]. When apparent power (kVA) is greater than real power (kW), the utility must supply the excess reactive current plus the working current, for this case capacitors will work as reactive current generators by providing the reactive current to reduce the total amount of current in system must draw from the utility [3]. In figure 2.2 illustrate that when capacitor is connected into the nominally lagging system, it will reduce the lagging power factor to become near to unity.

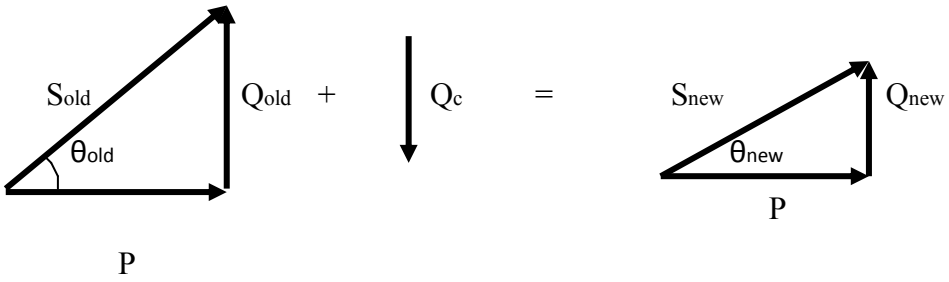

Figure 2.2: Illustration when capacitor is added to the system

There so many benefit of power factor correction which is reduced electric utility bills, increased efficiency of the system, improved voltage and reduce losses.

2.1.2 Total Harmonic Distortion

Most of our electrical system from generation to distribution, electricity is produce in alternating current (AC). A pure sinusoidal voltage sinusoidal voltage produced by an ideal AC generator built with finely distributed stator and field winding that operate in a uniform magnetic field since the first AC generator evolve hundreds years ago, electrical systems have experienced harmonics [5]. Harmonic distortion is the change of waveform of the supply voltage from the ideal sinusoidal [4]. When different waveform distortion together in power supply system, a new reference waveform called Total Harmonic Distortion (THD) is produced. An ideal of single phase of voltage supply 240V at frequency 50Hz with a sinusoidal waveform shown in figure 2.3.

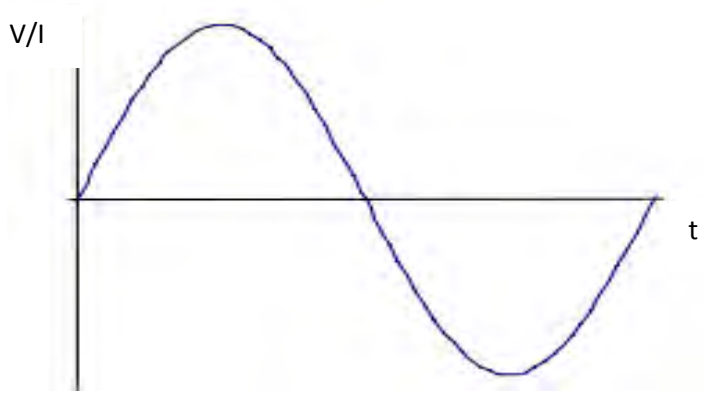

Figure 2.3: Ideal sinusoidal waveform

The actual of electricity system can be departing from the ideal sinusoidal waveform in several respects. In figure 2.4 (a) shows a distortion of one cycle occasionally due to the switching of power factor correction capacitor on the power system and this not harmonic distortion [4]. Figure 2.4 (b) and (c) shows the form of harmonic distortion, giving flat-topped and notching effects respectively [4].