Paper ID: ET-33

Power Factor Improvement of Compact Fluorescent Lamp

Mamun Hossen[1], Md. Zillur Rahman [2], Julkar Nain[3]

[1, 2, 3] Department of Electrical and Electronic Engineering,

[1, 2] Varendra University, Rajshahi, Bangladesh

[2] Rajshahi University of Engineering and Technology, Bangladesh

*mamun105ruet@gmail.com

Abstract

The main reason for using CFLs is the savings that can be achieved in terms of energy and running costs, which benefit the householder. Due to their higher efficiency, a 25 watt (W) CFL can provide the equivalent light output to a 100 W incandescent bulb. Up until now there has been much negativity expressed by consumers towards the CFL technology. A major problem has been a lack of knowledge about the characteristics of CFLs,. In this thesis We have tested five different brand of CFL and determine corresponding power and power factor.It is seen that power factor is low ranging about 0.5-0.7. To improve the power Factor capacitor is connected but power Factor is not increased.Then an inductive load is connected in this time power factor increases

.

Keywords: Compact fluorescent lamp,Power factor Correction, inductive Load.

1. INTRODUCTION

Compact fluorescent lamps (CFL) are lighting devices that have been available on the market for over 20 years; however, their use on a large scale has been limited by their unsatisfactory performances when compared to the classical incandescent lamps. Among the main disadvantages the consumers complained about their higher production cost and the questionable light quality. Apart from these, there is other drawbacks that should be mentioned, such as the low value power factor (0.5-0.6), the pollution of the network with harmonics of both low and high frequency, the short lifetime when it comes to repeated plugging-unplugging, unsecure performance or even non-functioning in warm or cold environment. Due to the unmatched rise in the energy demand, certain decisions regarding the streamline of consumers were taken at a worldwide level. In this respect, the marketing of the 100W incandescent lamps, consumption-wise ineffective, was prohibited at the beginning of 2010. Consequently, it is until 2016 that all the incandescent lamps should be removed from the market, with the exception of a few particular cases. These decisions bring about the CFL as one of the main alternatives in the replacement of the classical illumination lamps. Although in the past few years we noticed many improvements in the quality of the generated light, a longer lifetime and even a reduction in the production cost, the impact of this decision should be objectively analyzed. Accordingly, worldwide hundreds of millions of lamps will be replaced and the energy consumption is estimated to be up to 5 times lower. The power factor of these lamps, on the other hand, is 0.5 as opposed to the unitary power factor of the incandescent lamps, which might lead to an imbalance in the distribution network[1].

Disadvantage of Low Power Factor

One disadvantage is that the true power factor is considerably less than the output KVA.This means that for a generation station to supply a given power it may have to work above its normal KVAcapacity with the consequent excess temperature rise of the genetrator,supply cable ,sub circxuit switchgear.

Another bad feature of low power factoris that large amount of wattles KVA produced.This causes losses in the large machine as well as running cost in the whole plant.

A third disadvantage of low power factor is that a large voltage drop in alternator is caused [2].

2. DETERMINATION OF POWER AND POWER FACTOR

It is my first experiment. The objective of this experiment is to deter- mine power and power factor of five samples.

2.1 Required apparatus:

1) Ammeter
2) Voltmeter
3) Wattmeter
4) Variac

2.2 Circuit diagram:

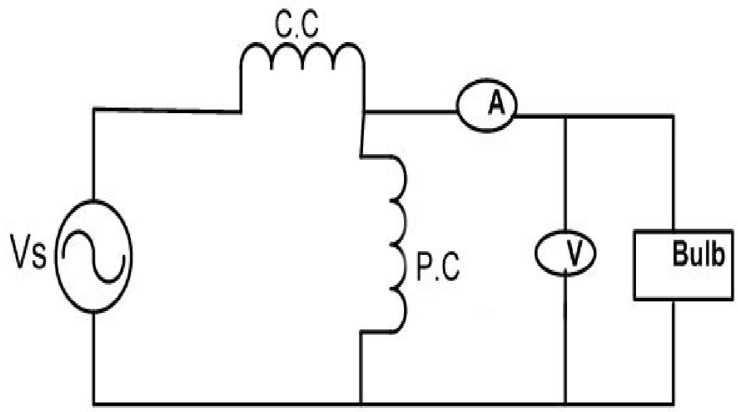

Figure. 1: Power & p.f measurement of bulb

2.3 Procedure

1) We have connected circuit according to the figure.
2) Sample bulbs are connected to the circuit one by one.
3) Then We have taken the readings

2.4 Data Table:

Table -1: Power Factor With different supply voltage

Brand name	Voltage	Current	power	Power factor
Sample-1	235	0.129	19.5	0.64
	240	.12	21	0.729
	245	.127	21.1	0.678
	253	0.15	23	0.6
Sample-2	235	0.174	19	0.46
	240	.139	19	0.5989
	245	0.14	19	0.58
	253	0.205	20	0.38
Sample-3	235	0.164	21	0.544
	240	0.174	21.5	0.511
	245	0.155	21.4	0.56
	253	0.166	21.5	0.511
Sample-4	235	0.14	20.5	0.62
	240	0.175	22	0.523
	245	.167	22.2	0.5425
	253	0.155	21.5	0.54
Sample-5	235	0.185	18.5	.4255
	240	.166	19	.475
	245	0.162	20	0.5039
	253	.158	20.5	0.5128

From the value of data table we have plotted a curve of power vs. voltage.

The figure is given below:

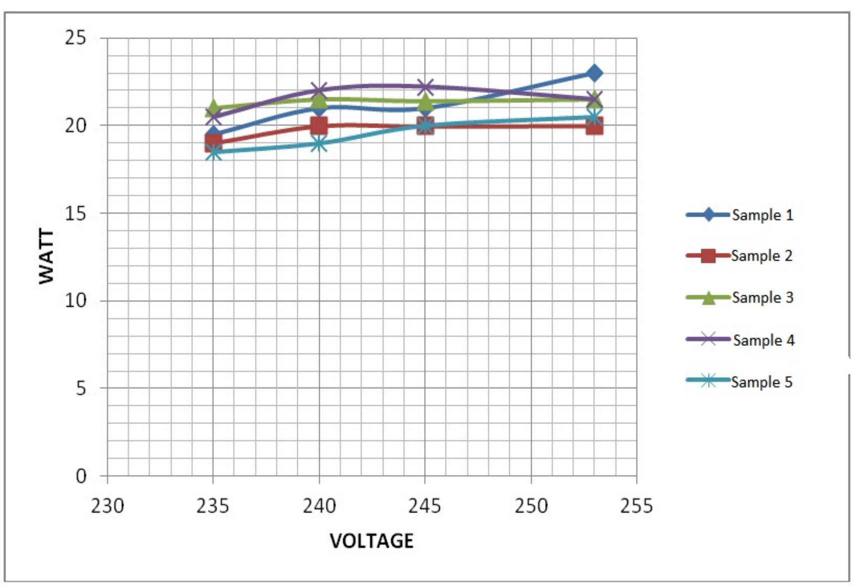

Figure.2: Power factor vs. voltage curve

From the value of data table I have plotted a curve of power factor vs voltage. The figure is given below:

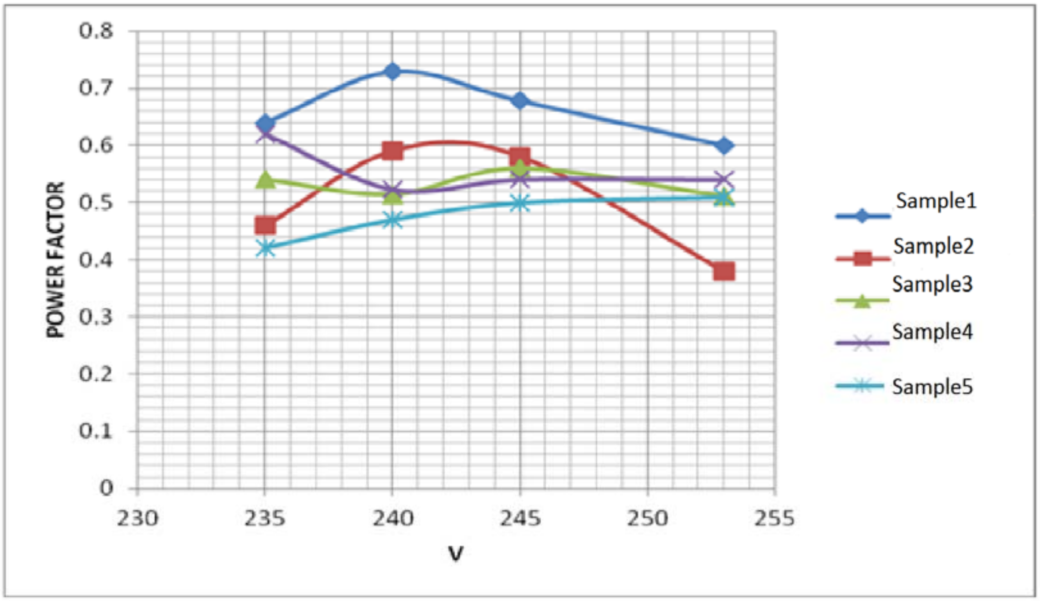

Figure.3: Power factor vs voltage curve

Discussion: The above data table shows the required power and power factor for various supply voltage. It is my first experiment. Here We have used five different supply voltages such as 230v, 235v, 240v, 245v, 253v. Then We have determined corresponding power and power factor. After knowing the values of power and power factor We have drawn two curves, first one is power vs. voltage and second one is power factor vs. voltage. The figures above shows these two curve. From the power factor curve it is evident that power factor of all the CFL is around 0.5-0.7. So it is needed to increase the power factor.

3 POWER FACTOR IMPROVEMENT WITH THE HELP OF CAPACITOR

It is our second experiment. The objective of this experiment is to improve the power factor of CFL bulb.

3.1 Required apparatus:

1) Ammeter
2) Voltmeter
3) Wattmeter
4) Variac

3.2 Circuit diagram:

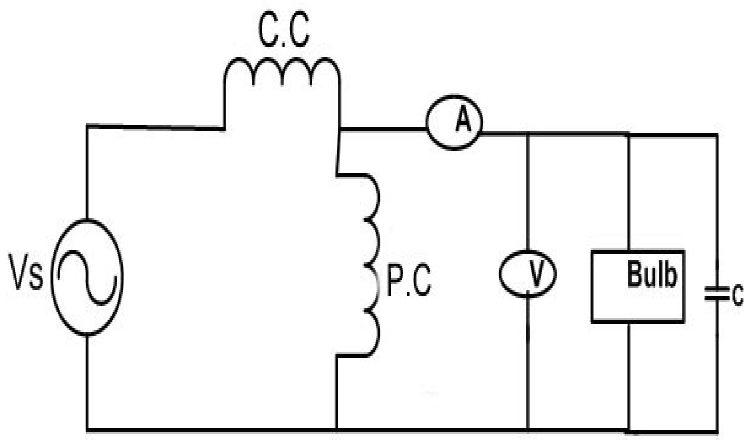

Figure.4: Power & p.f measurement of bulb with capacitor.

3.3 Procedure:

1) We have connected circuit according to the figure.
2) Sample bulbs is connected to the circuit one by one.
3) A capacitor is connected in parallel.
4) Then We have taken the readings.

Figure.5: Measurement of power factor with capacitor.

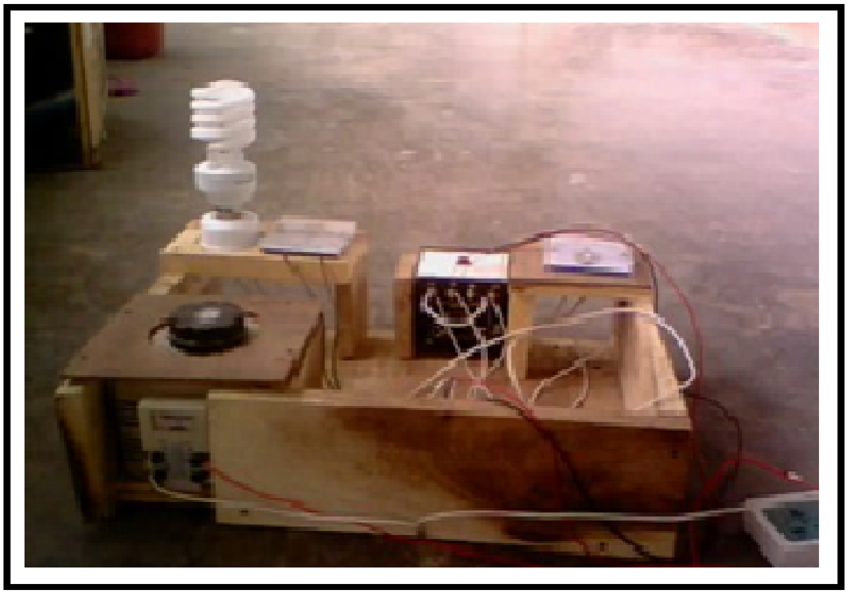

Figure6: Measurement of power factor with capacitor.

Data table with capacitor:

Table -2: Power Factor With Capacitor

Brand name	Supply voltage	POWER FACTOR
SAMPLE 1	220	.68
SAMPLE 2	220	.74
SAMPLE 3	220	.71
SAMPLE 4	220	.81
SAMPLE 5	220	.795

Data table without capacitor:

Table -3: Power Factor Without Capacitor

Brand name	Supply voltage	POWER FACTOR

SAMPLE 1	220	.75
SAMPLE 2	220	.82
SAMPLE 3	220	.82
SAMPLE 4	220	.90
SAMPLE 5	220	.81

Discussion: The data table above shows power factor with and without capacitor. From the data table it is clear that as a result of placing capacitor power factor decreases for all the CFL. For example power factor of the sample-1 bulb was .75 without capacitor and it becomes .68 with capacitor. Then the result of this experiment is not satisfactory at all.

3.5 POWER FACTOR IMPROVEMENT WITH THE HELP OF AN INDUCTIVE LOAD: It is my second experiment. The objective of this experiment is to determine improve the power factor of five samples.

3.6 Required apparatus:

1) Ammeter
2) Voltmeter
3) Wattmeter
4) Variac

3.7 Circuit diagram:

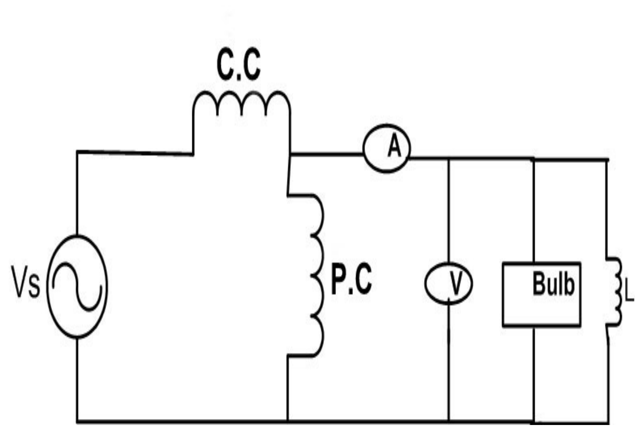

Figure.7: Power & p.f measurement of bulb with inductor

3.8 Procedure:

1) We have connected the circuit according to the figure.
2) Sample bulbs are connected to the circuit one by one.
3) An inductor is connected in parallel with the bulb.

4) Then We have taken the readings.

Figure 8: Measurement of power factor with inductive load.

Figure9: Measurement of power factor with inductive load.

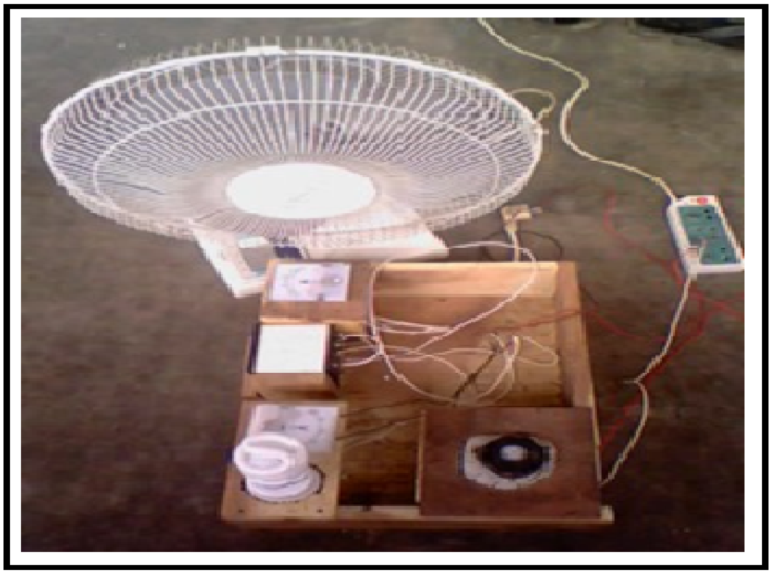

Figure 10: Measurement of power factor with inductive load

Data table with inductive load:

Table -4: Power Factor with inductive load

Brand name	Supply voltage	Power factor
Sample 1	220	.937
Sample 2	220	.96
Sample 3	220	.96
Sample 4	220	.99
Sample 5	220	.99

Discussion: The data table above shows power factor with Fan. From the data table it is clear that as a result of connecting inductive load power factor increases for all the CFL. For example power factor of the Sample-1 bulb was .75 without Fan and it becomes .937 with Fan. So the result of this experiment is very satisfactory.

CHAPTER EIGHT

4 Power factor of a typical residence having

1) Only CFL
2) CFL+others(FAN,MOTOR)

4.1 Now I will use 5 Sample bulbs having following specification:

Here I will calculate the p.f of sample-1 bulb .Data below is obtained from my first experiment**.**

1) V=220v
2) P=23w (given)

3) P=20w (measured)

Total active power P = (5*20)=100W Apparent power S =(20/.7575) =26.4VA Reactive power Q=(26.4*0.6527)=17.23VAR Total reactive power=(17.23*5)=86.16 Tan φ=0.86 Power factor COS φ=0.758

Now consider the case where I will use 5 CFL, 5 Fan, 1 motor.

Here We will calculate the p.f of five sample-1 bulb, five fan and one motor. Necessary Data is given below.

4.2 Specification of CFL:

1) V=220v
2) P=23w (given)
3) P=20w (measured)
4) Power factor=.7575

Total active power=(5*20)=100w Apparent power=(20/.7575) =26.4VA Reactive power=(26.4*0.6527)=17.23VAR Total reactive power=(17.23*5)=86.16.

4.3 Specification of Fan

Active power=60w

Power factor COS φ=0.8
Sin φ =0.6
Apparent power S=75VA Reactive power=45VAR
Total active power= (5*60) =300W, Total reactive power= (5*45) =225VAR

4.4 Specification of motor

Active power=746W
Power factor COS φ=0.9
Sin φ =0.43
Apparent power S=828.88 VA Reactive power=361.27VAR
Now we will calculate for entire residence:
Power factor COS φ=0.9173
Total active power=100+300+746=1146W Total reactive Power=225+361-88=498VAR Tan φ=(498/1146)=0.43

4.5 Discussion:

Power factor when

1) Only CFL=0.758
2) CFL+ others (FAN, MOTOR) =0.9173

so we see that when the residence is operated with only CFL then power factor is only .758but when the residence is operated CFL and other inductive load then power factor is 0.9173.So we can say that also the power factor is low when we will use only CFL but power factor will be high when use CFL and other inductive load. Now days there are hardly any area where CFL is used alone, as a result use of CFL provide no problem as stated earlier.

4.6 Power factor of a typical residence having

1) CFL + others (FAN, MOTOR)
2) Tungsten filament bulb + others (FAN, MOTOR)

Here I will calculate the p.f of five sample-1 bulb, five fans and one motor and Five Tungsten filament bulb, five fans and one motor. Necessary Data is given below.

1)5 CFL
2)5 Fan
3)1 Motor

And

1) 5 Tungsten filament bulb
2) 5 Fan
3) 1 Motor

We have already calculated the power factor for the first combination and we have seen that power factor is 0.9173(lagging).
Now consider the second combination.

4.7 Specification of Tungsten filament bulb:

Active power=60w
Power factor COS φ =0.9
Sin φ=0.43
Apparent power S=66.66VA Reactive power=28.66VAR
Total active power= (5*60) =300W
Total reactive power= (5*28.66) =143.33VAR

4.8 specification of Fan

Active power=60w
Power factor COS φ=0.8
Sin φ=0.6
Apparent power S=75VA Reactive power=45VAR
Total active power= (5*60) =300W
Total reactive power = (5*45) =225VAR

4.9 Specification of MOTOR

Active power=746W
Power factor COS φ=0.9
Sin φ=0.43
Apparent power S=828.88 VA Reactive
Power=361VAR.
Total active power=300+300+746=1346W
Total reactive power =225+361+143.33=729.33VAR
Tan φ= (729.33/1146)=0.63
Power factor COS φ=0.84

Discussion: It is evident from the above calculation that when we will use CFL fan and motor then power factor is 0.91 lagging. But when we will use tungsten filament bulb, fan and motor then power factor is 0.84lagging.So we can say that also the power factor is low when we will use only CFL but power factor will be high when use CFL and other inductive load. Now a days there are hardly any area where CFL is used alone, as a result use of CFL provide no problem as stated earlier.

CONCLUSION AND DISCUSSION

From result of experiment it is seen that power factor is low when CFL is used alone. To improve the power factor capacitor is connected but experimental result shows that power factor decreases. Then an inductive load(Fan) is connected across the CFL .At this time power factor increases which is above .9.After that a typical residence is considered having only CFL , CFL and other inductive load. It is seen that power factor is 0.75when only CFL is used and .91 when CFL and other inductive load is used. Then a typical residence is considered having.

1) CFL+ others (FAN, MOTOR)
2) Tungsten filament bulb+ others (FAN, MOTOR)

It is seen that power factor is 0.91when CFL + others (FAN, MOTOR) is used and .84 when Tungsten filament bulb+ others (FAN, MOTOR) is used.

So it can be said that use of compact fluorescent lamp is more advantageous then tungsten filament bulb. Because there are hardly any residence or any locality where CFL is used alone. There must be some inductive load.

REFERENCES

[1] Petre–Dorel TEODOSESCO, Mircea BOJAN, Ioana-cornelia VESE, "Study of the improvement of CFL'S POWER Factor by using a valley Fill Filter",*IEEE XPLORE,* Volume: 53 Number: 1,pp.74,2012.

[2] L.W. BURRETT, "THE DISADVANTAGES AND IMPROVEMENT OF LOW POWER FACTOR",*IEEE XPLORE,* Volume: 13 Issue :50,pp.45-47,2010.