Lux junior 2009
25. bis 27.9.09 Dörnfeld

Quality Criteria in Lighting Circuits with Non-Homogenous Lamp Structure

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1. Introduction

At last time power quality is more frequent issue of technical discussion. The reason of these discussions has a lot of common with high price for bad quality of electrical energy. The aim of this paper is to show results of measurement of different types of ballasts in a way of power quality of electrical energy. You would like to point on ballast used in public lighting networks which are mostly used. In public lighting networks are using different lamps types of wattage for better efficiency of communications lighting. To switchgear is connecting f. e. 36W fluorescent lamps illuminative streets and 70W and 100W HPS lamps illuminative roads. Power lamps combination we can change harmonics in output from switchgear.

2. Measurement

We measured by network analyzer BK ELCOM 550. Circuit connected by Chroma programmable AC source 61503. Programmable source generated exact sinus voltage 230V. Measured values were analyzed in laboratory environment. Influence of electric lines and cables witch are in public lighting networks was ignored. Connection of lamp included components which you can find in table 1. We measured separately lamps and their combination to find out their affect. The components which we used you can find in many lamps which are now installed in public lighting networks reconstructions in Slovakia and in foreign countries. When we measured combination of lamps, all of them were connected to one node as you can see on scheme of connection (figure 1).

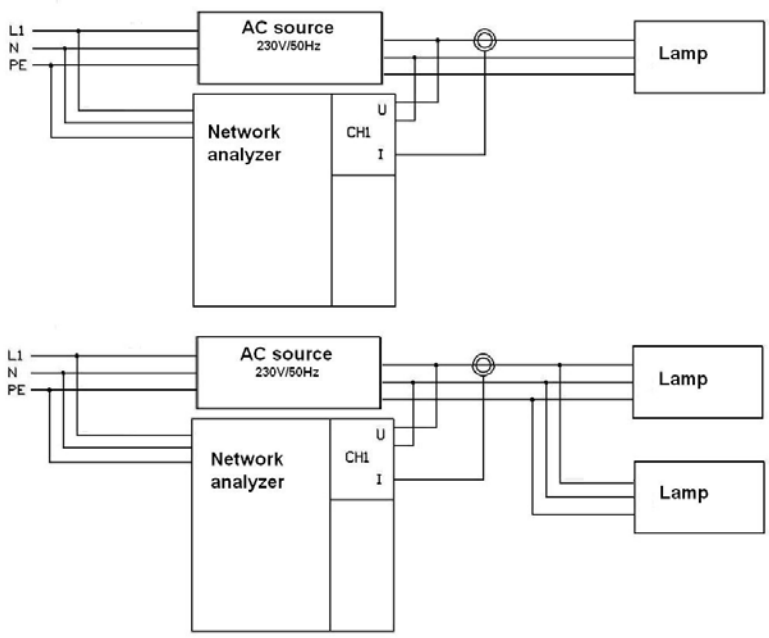

Figure 1 Connection scheme of measured one lamp and more lamps

Table 1. Lamp parameters

Wattage	Starter, capacitor and ballast	Lamp
36W	Starter: Osram St 111 Capacitor: 4,5 μF Ballast: HELVAR L36A-T, 36W, 0,43A, 230V, λ 0,45, tw 130	Osram, Dulux L 36W/840
70W	Starter: LighTronic LSI-70T1 Capacitor: 12 μF Ballast: HELVAR NK 70 LUP, 70W, 1,0A, 230V, λ 0,39, tw 130	Osram, Vialox NAV-(SON) 70W
100W	Starter: LighTronic LSI-150T1 Capacitor: 12 μF Ballast: HELVAR NK 100 LUP, 100W, 1,2A, 230V, λ 0,44, tw 130	Osram, Vialox NAV-T 100W

3. Results of measurements

From figures you can see different distortion of current by individual measurements. It is implication of different components of lamps, mainly inductor and capacitor. Exactly these differences can be used in future network projects, where you can affect harmonics eliminate by compensation of each other.

In measurement is influence of electric lines and cables ignored. They implicate line drop and another distortion of voltage behaviour. Because connection of measurement is done by

exact sinus voltage 230V in the compare with measurement in existing network appear differences.

Current behaviour is strongly affected by harmonics. In installation of huge number of lamps we will summarize harmonics and final effect should by higher.

In combination of lamps we don't count result behaviour as summarize amplitudes individual harmonics connected lamps but as summarize of amplitudes with phases. Induction ballasts are similar harmonics because there are similar inductions and capacitors.

Final behaviour is mostly affected for powerful lamp. As you can see in figures if we combine 36W lamp and 100W lamp than the behaviour depend on powerful lamp. By optimal combination of lamps you can reach better power quality. This is not always possible because using of lamps is depending on lighting calculation. Identification of distortion in public lighting network calculated by measured values can be different in the compare with real values. This can be caused by no exact sinus voltage in real network.

Table 2. Power factor and total harmonic distortion of current

Lamp	PF	THDi
36W	0,916	24,8
70W	0,97	19,36
100W	0,871	18,7
10x36W	0,956	22,7
6X70W	0,975	18,5
2X100W	0,903	17,5
37W + 70W	0,967	20,2
70W + 100W	0,946	19,15
36W +100W	0,907	19,58
36W+70W + 100W	0,938	19,56

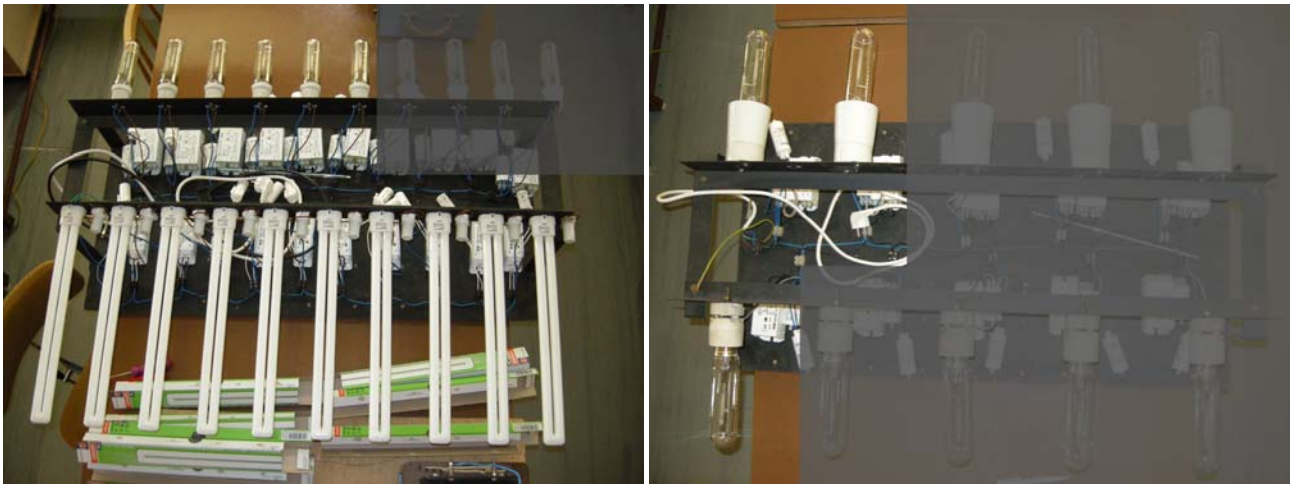

Figure 2 Measured lamps

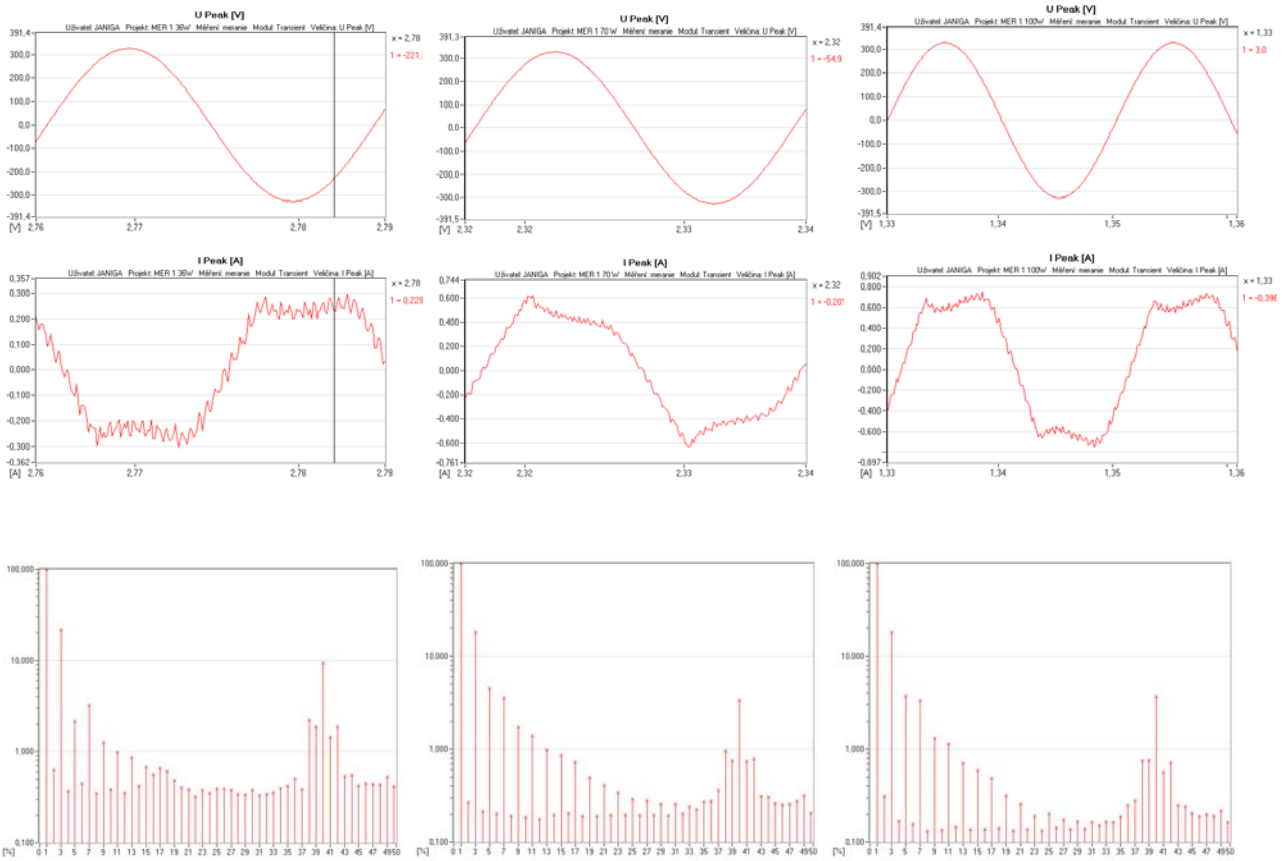

Figure 3. Behaviour by connection of one lamp

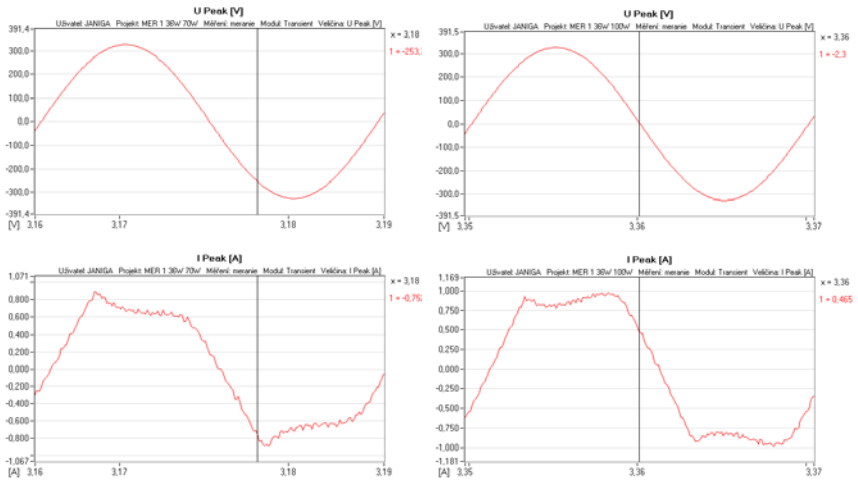

Figure 4. Behaviour by connection of lamps 36W + 70W and connection of lamps 36W + 100W

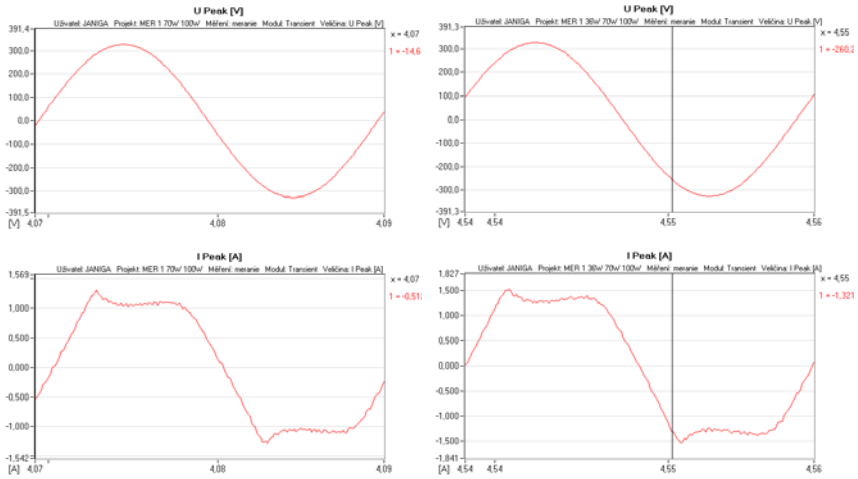

Figure 5. Behaviour by connection of lamps 70W + 100W and connection of lamps 36W+70W+100W

4. Conclusion

From the measured values of individual lamps you can see distortion, which you can change by different combination of lamps. Through these combinations we change harmonics and power factor.

If you accept that middle size city has 2000 lamps with inductive ballast, we can get very important source of distortion. That is the reason why we would like to reduce harmonics.

In the case of breakdown one or more lamps during operation of public lighting networks compensation capacitor will be still connected. This network operation has better power factor but distortion of current is higher. Similar situation happened in older lighting networks, where capacitors lost of most their capacity by the time. In this networks is power factor really small

and harmonics are partly eliminated. In project of new network or their reconstruction is necessary think about triple harmonics. These can lead to overloading neutral wire.

In measured values you can see signification content of harmonics mainly by inductive ballast. If you take, that middle size city has 2000 lamps with inductive ballast, we can get very important source of content of harmonics. For this reason is important to look for way how to particularly reducing them in public lightings networks. If you thing to use lamps with different ballasts may be possible to compensate content of harmonics. But if you use same lamps the contents are not tot up.

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