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Long-term research of harmonic pollution, caused by LED lamps in food industry

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Abstract

LED technologies, and in particular industrial LED luminaires, are increasingly entering the industry. Their application in industrial buildings in the food industry is the subject of this study. When reconstructing an industrial building, it is usually envisaged that the lighting will be built with LED luminaires. One of the problems that occur in this situation is the use of electronic starting-regulating devices (LED Drivers), which generate higher harmonics in the power supply network and thus degrade the network parameters.

The report presents a long-term study of the harmonic pollution generated by an industrial LED lighting system in an industrial room for the food industry. The study was conducted for a period of 6 months, under different modes of operation of the lighting system and different temperature regimes in the room.

The obtained data are summarized and systematized. The report presents the summarized results of the study in tabular and graphical form.

It was found that the harmonic pollution resulting from the lighting system significantly exceeds the requirements of the electricity quality standard.

Conclusions and some recommendations from the research are formulated.

Index Terms: LED harmonics, harmonic pollution, LED drivers

1 Introduction

More and more LED luminaires for industrial applications are appearing on the market. Most often, significant attention is paid to their optical system, the properties of LEDs and other lighting parameters. The power supply is often left in the background.

It is noteworthy that drivers with very poor parameters and quality are installed in seemingly expensive luminaires.

The aim of the presented work is to study some of the electrical parameters of an industrial luminaire used in the food industry. The research was conducted in a real operating workshop for production of roasted nuts.

2 Exposition

The lighting system of a workshop for production of roasted nuts with the following parameters of the hall was studied: length 20 m; width 10 m; height 4 m.

There are 30 industrial LED luminaires (shown in Fig. 1) positioning in the room, at a height of 4 m from the floor. The used luminaires have technical parameters shown in Table. 1

Figure 1. Industrial LED illuminator 48W

In the study room was realized: average illumination 373 lx; UGR = 18; Uniformity 0.82. The lighting system meets the all requirements of standard EN 12464-1 for interior lighting.

An power network analyzer – Satec PM135EH (Fig. 2) with very good technical parameters and good measuring accuracy, was used to study the electrical parameters of the power supply network. The power supply network is three-phase. For measurement of the current there used a 3 current transformers (for each phase) Chint BH-0.66 30I, 30/5A (Fig. 3)

Table 1.

Technical characteristics of the tested luminaire

Parameter	*Value*
LED Chip	Samsung
Power Factor	>0.9
Input Voltage	AC: 220-240V
Electrical Power	48 W
Luminous Flux	5760 lm
Type of light	DayLight
Color temperature	4000K
CRI	>80
Working range	-20° to +45°
Protection	IP65
Operating Life	20000 h
Body	Plastic

Figure 2. Power Analyzer Satec PM135EH

Figure 3. Current transformer Chint BH-0.66 30I

The measurement was conducted for 6 months (October 2020 and February 2021), with the recording interval of the parameters being 10 minutes. The requirements of the standards EN 61010-1, EN 61000 were met.

After processing the obtained results, some averaged values of the electrical parameters was calculated and shown in Table 2. Fig. 4 - 5 presents the graphical dependencies of the current harmonics of the lighting system.

Table 2.

Measurement of some electrical parameters on lighting system of a workshop for production of roasted nuts

Current parameters

Harmonic, Y	Y_I, % Phase 1 average	Y_I, % Phase 2 average	Y_I, % Phase 3 average
1	100	100	100
3	13,55	15,26	14,22
5	1,61	3,57	1,46
7	10,79	8,48	11,36
9	7,69	6,11	6,98
11	2,60	3,70	2,98
13	1,00	1,99	1,02
15	1,75	0,67	1,99
17	1,18	0,76	1,10
19	1,61	0,66	1,20
21	0,86	0,68	0,75
23	0,97	1,04	1,27
25	1,41	1,33	1,32

P =	1,455	kW
S =	1,512	kVA
cos φ =	0,962	
PF =	0,948	
Q =	-0,411	kVAr

THD I =	20,1	%
RMS =	6,87	A

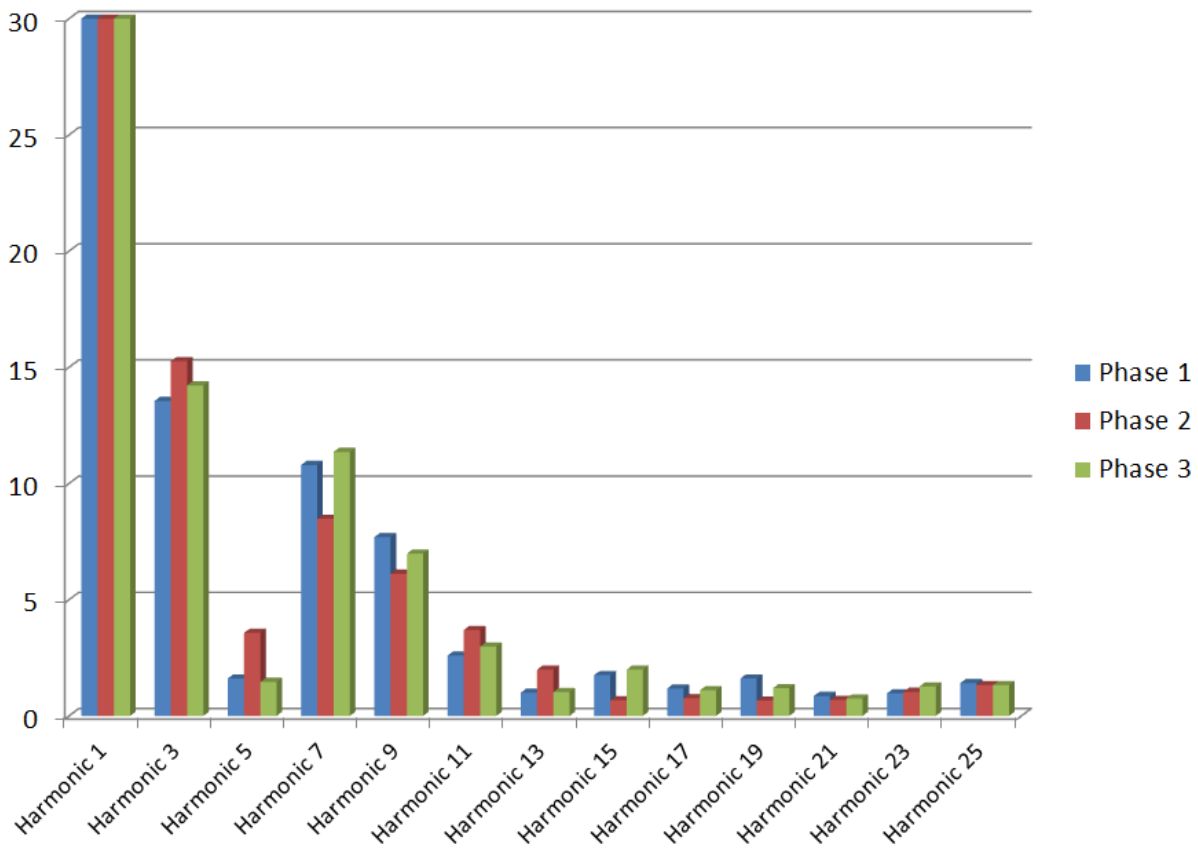
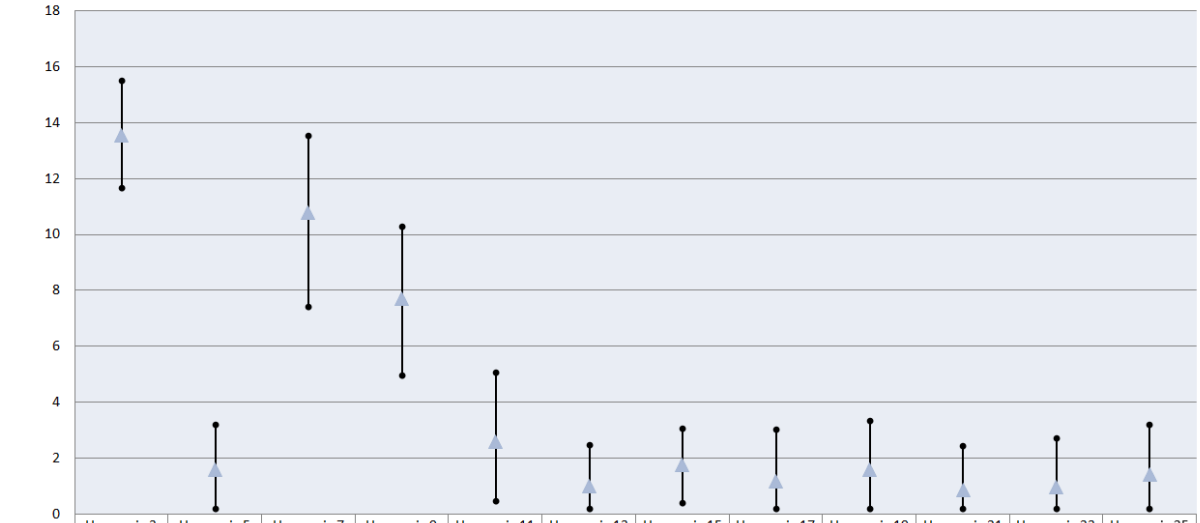


Figure 4. Average values of the harmonic components of the current for the respective harmonic, for the study period



	Harmonic 3	Harmonic 5	Harmonic 7	Harmonic 9	Harmonic 11	Harmonic 13	Harmonic 15	Harmonic 17	Harmonic 19	Harmonic 21	Harmonic 23	Harmonic 25
Min	11,67	0,21	7,42	4,97	0,49	0,2	0,4	0,2	0,21	0,2	0,2	0,2
Max	15,5	3,22	13,53	10,27	5,07	2,49	3,08	3,03	3,36	2,45	2,73	3,2
Average	13,55	1,61	10,79	7,69	2,60	1,00	1,75	1,18	1,61	0,86	0,97	1,41

Figure 5. Deviation of the values of the corresponding current harmonics from the average value for the studied period (for Phase 1)

After processing the obtained data, it can be established that the parameter THD_I has a normal value – 20,1 % (the standard allows a value of up to 25%). Examining all measured harmonics, it can be seen that from 11 harmonics upwards, the values obtained are low and they can be ignored.

This means that 3, 7 and 9 harmonics have a significant influence on the power supply parameters. The increase of the harmonic components of the current leads to: increase of the consumed power; additional heating of the power cables; distortion of the supply voltage sine wave. Regulatory requirements should be introduced for the quality of power supply modules, even at lower power, to prevent the occurrence of such large harmonic pollution of electrical networks.

3 Conclusion

1. The electrical parameters of a lighting system of a workshop for production of roasted nuts were studied. LED industrial lighting luminaires of 48 watts are used.
2. It was found that the generated harmonic current pollutions THD I = 20,1%, which is in middle range and it would be great to be reduced.
3. Regulatory requirements should be introduced for the quality of power supply modules, even at lower power, to prevent the occurrence of harmonic pollution of electrical networks.

4 References

[1] EN 12464-1:2011. Light and lighting - Lighting of work places - Part 1: Indoor work places

[2] EN 61010-1:2010/A1:2019. Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

[3] EN 61000-3-2:2014. Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

[4] S. Tzvetkova, A. Petleshkov, Y. Lozanov and G. Dimov, "Harmonics of voltage and current in an electric power supply system for vertical cement mill," 2020 12th Electrical Engineering Faculty Conference (BulEF), 2020, pp. 1-5, doi: 10.1109/BulEF51036.2020.9326083.

[5] O. L. Petrov, A. K. Musev and A. Y. Yasharov, "Harmonic pollutions generated by industrial lighting systems," 2019 Second Balkan Junior Conference on Lighting (Balkan Light Junior), 2019, pp. 1-3, doi: 10.1109/BLJ.2019.8883618.

[6] Majithia CA, AV Desai, AK Panchal, Harmonic analysis of some light sources used for domestic lighting, Lighting Res. Technol. 2011; 43: pp. 371–380, DOI 10.1177/1477153510394597

[7] Verderber RR, Morse OC, Alling WR. Harmonics from compact fluorescent lamps. IEEE Transactions on Industry Applications, 1993; 29: pp. 670–674

[8] Hristova M., V. Ruseva, D. Dimov. Comparative analysis of harmonic distortions from variable frequency induction motor drives,. The 4th International Symposium on Sustainable Development (ISSD2013) "ENERGY ISSUES AND SOLUTIONS" (1), Sarajevo, 2013, No MAC-1421