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

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Abstract

The application of LED technologies in the industry is gaining more and more popularity.

In case of reconstruction or new construction of an industrial building, it is envisaged that the lighting will be built with LED luminaires. A disadvantage is the use of electronic starting and regulating devices (LED Drivers), which generate high harmonics and thus pollute the electrical power network.

The report presents a long-term study of the harmonic pollutions, generated by LED lighting in a medium brewery industrial building. The study was conducted for 2 months, under different modes of operation of the LED lighting system.

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 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 brewing industry. The research was conducted in a real working brewery.

2 Exposition

The lighting system of a brewery with the following parameters of the hall was studied: length 25 m; width 15 m; height 8 m.

There are 18 industrial LED luminaires (shown in Fig. 1) positioning in the room, at a height of 8 m from the floor. The used luminaires have technical parameters shown in Table. 1

Figure 1. Industrial LED illuminator HighBay LED 100W

Table 1.

Technical characteristics of the tested luminaire

Parameter	***Value***
LED Chip	Samsung
Power Factor	>0.9
Input Voltage	AC: 220-240V
Electrical Power	100 W
Luminous Flux	8000 lm
Type of light	DayLight
Color temperature	4000K
CRI	>80
Working range	-20° to +45°
Protection	IP65
Operating Life	30000 h
Body	Aluminum

In the study hall was realized: average illumination 329 lx; UGR = 9; Uniformity 0.75. The lighting system meets the all requirements of standard EN 12464-1 for interior lighting.

An power network analyzer - BMR Power Line Analyzer PLA33DL (Fig. 2) with very good technical parameters and good measuring accuracy, was used to study the electrical parameters of the power supply network. For measurement of the current there used a current transformer Vemark VSQ-30 30/5 A (Fig. 3)

Figure 2. Power Line Analyzer PLA33DL

Figure 3. Current transformer Vemark VSQ-30

The measurement was conducted for 2 months (February and March 2020), with the recording interval of the parameters being 5 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 - 6 presents the graphical dependencies of the current harmonics of the lighting system.

Table 2.

Measurement of some electrical parameters on lighting system of a brewery

Current parameters

Harmonic, Y	Y_I, % average	Y_I, % Min / Max
1	100	-
3	100,94	90,34 / 115,55
5	71,65	58,47 / 80,62
7	43,73	32,21 / 53,31
9	23,00	13,81 / 38,25
11	15,28	5,00 / 34,12
13	13,97	6,92 / 26,62
15	9,62	4,09 / 19,14
17	5,20	2,10 / 11,65
19	5,25	2,34 / 14,05

P =	1,811	kW
S =	1,890	kVA
cos φ =	0,958	
PF =	0,947	
Q =	-0,441	kVAr

THD I =	48,2	%
RMS =	8,59	A

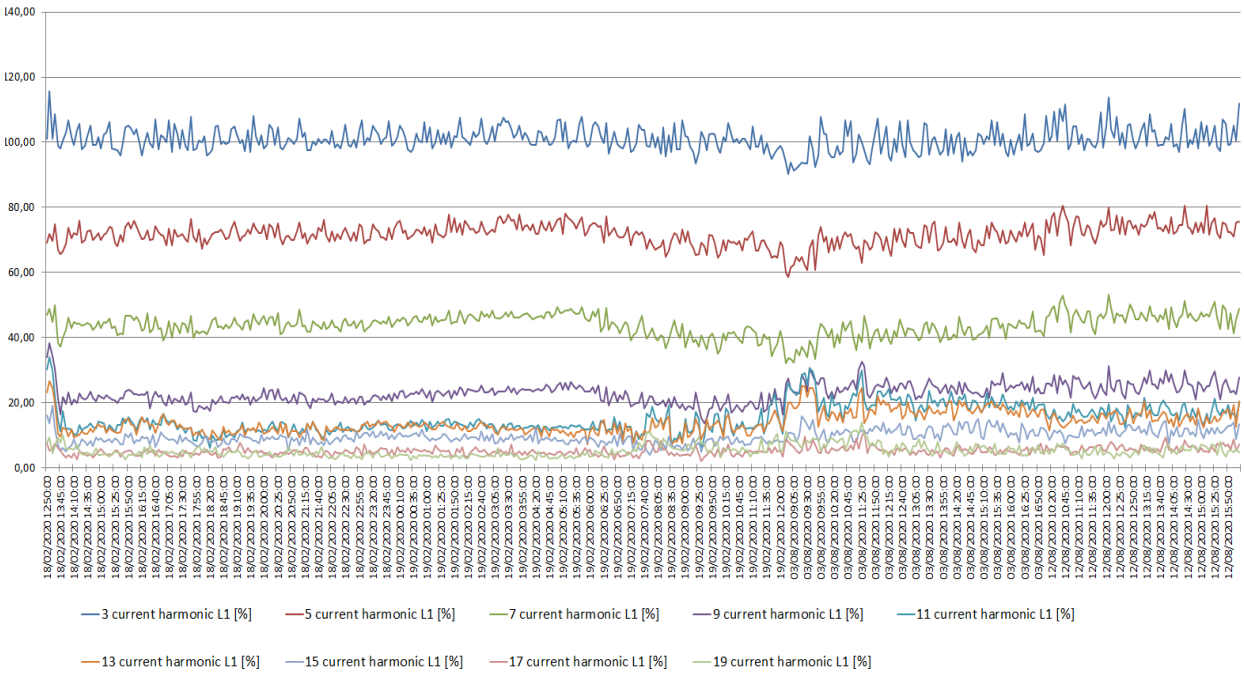
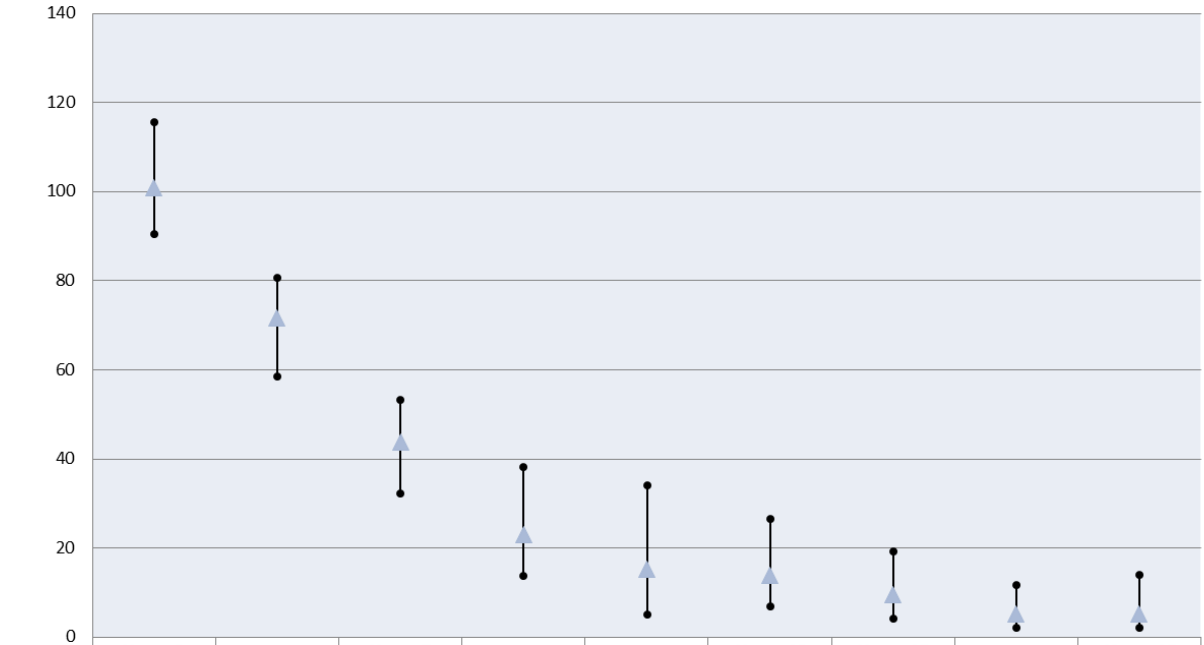


Figure 4. Modification of the harmonic components of the current for the study period



	Harm. 3	Harm. 5	Harm. 7	Harm. 9	Harm. 11	Harm. 13	Harm. 15	Harm. 17	Harm. 19
Min	90,34	58,47	32,21	13,81	5	6,92	4,09	2,1	2,34
Max	115,55	80,62	53,31	38,25	34,12	26,62	19,14	11,65	14,05
Average	100,94	71,65	43,73	23,00	15,28	13,97	9,62	5,20	5,25

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

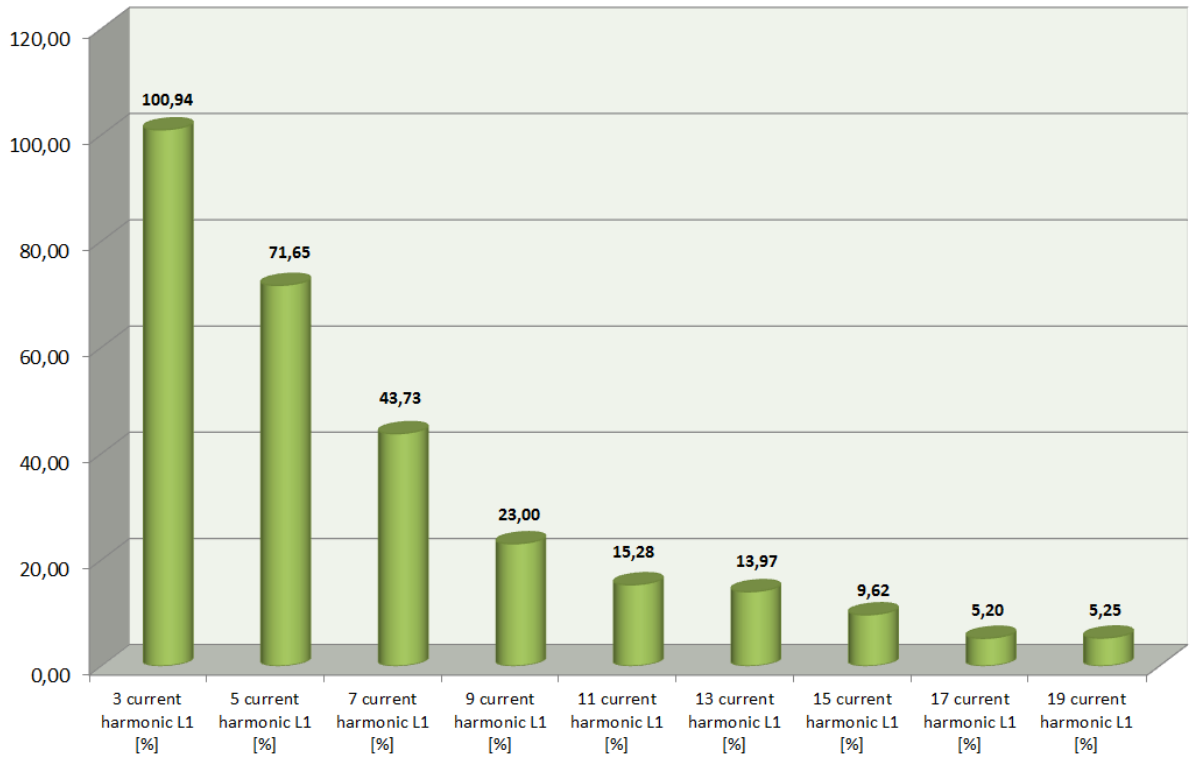


Figure 6. Average values of the harmonic components of the current for the respective harmonic, for the study period

After processing the obtained data, it can be established that the parameter THD_I has an unacceptably high value - 48% (the standard allows a value of up to 25%). Examining all measured harmonics, it can be seen that from 9 harmonics upwards, the values obtained are low and are within the standard.

This means that 3, 5 and 7 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 on brewing industry hall were studied. LED industrial lighting luminaires of 100 watts are used.
2. It was found that the main problem is the generated harmonic current pollutions (THD I = 48.2%), which is very large and must be reduced.
3. 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.

4 References

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