IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 12, Issue 6 Ver. III (Nov. – Dec. 2017), PP 05-10
www.iosrjournals.org

Cost Comparison in LED Lighting and Selection Criteria in LEDs

Olcay PALTA[1], Selman YILDIRIM[1], İbrahim YAPICI[1], Muhammed EREN[1], Zeki İlcihan[1], Erdem AYBAY[2],Gamze GENCER[1*]
[1]*Department of Technical Vocational School, Bitlis Eren University, Bitlis, Turkey*
[2]*Department of Foreign Languages, Bitlis Eren University Bitlis, Turkey*
**Corresponding Author: gamzegencer1313@gmail.com*

Abstract: *In this study, LED selection criteria, comparative technical data of LEDs and other lamps and price analyzes are evaluated. In addition, today's development of LED technology is examined and the reasons for using LED lamps in lighting are mentioned.*
Keywords: *LED lighting, Selection criteria, Cost comparison*

Date of Submission: 01-12-2017 Date of acceptance: 18-12-2017

I. Introduction

Nowadays, lighting technologies are developing all over the world much faster than before. From the perspective of energy consumption, the most important development in recent years is LED-based lighting [1-4]. LED systems are preferred in almost all areas of lighting as they are long lasting, highly efficient and controllable, they can easily be installed, they don't include mercurial, they offer many colors and flexible solution opportunities and they are constantly expanding their market share [5-7]. The lighting devices from past to the present are shown in Figure 1.

Figure 1. Lighting devices from past to the present

As a light source, LEDs are comparable to fluorescent and HID systems in terms of efficiency, smart controllability and applicability. Although this lighting, called Solid State Lighting (SSL), offers many advantages, the armature and control systems still need more improvement in terms of optimal efficiency [8-11].

LED lighting systems are advantageous in creating these control schemes with their lighting plenitude sensors, dimming and color changing features, and their ability of wired and wireless connection to the central control system. LEDs are used in aeronautical and automotive lighting, brake lights, signs and traffic signs [12-14].

Solid State Lighting

LED, Light Emitting Diode, is a semiconductor light source. Stimulating electrons by applying the voltage, the LED starts to radiate. This effect is called "electroluminescence" or "electroluminescence". Electroluminescence was discovered by British researcher H.J Round in 1907. The first LED considered father of today's LEDs was made by Nick Holonyak Jr., working in General Electric Company in 1962 [15-21]. The a yypical LED are shown in Figure 2.

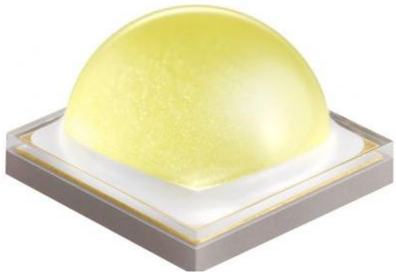

Figure 2. A Typical LED

LED's Working Principle

LEDs start to emit light by turning on starting from an average of 10mA and 1.5V value. The emission power of light emitting diodes decreases in proportion to time. When the output power drops to half of normal power, the diode economically completes its life [22-27].The intensity of light emitted by the LED increases in direct proportion to the current passing through it. However, this increase is linear to a certain value of the current [28-31]. If the diode current exceeds the point where the linearity called the threshold value is broken, the diode will overheat and break down.

LED's Selection Criteria

Important criteria for selection of LED lighting systems are listed below [32-52]..

- Led Index:

The LED index or its form of display (sheath) are vital part of the LED selection and it is a process that determines both optical index and color and light output. While some chips are a single circuit, others can be part of a group in a sheath called a bind. Each single circuit can have different color and brightness, the LEDs in the bind are fed from the same driver and behave exactly the same.

- Color Rendering Index

The success of light sources to show colors of the objects they illuminate is determined by the ''Color Rendering Index CRI'' or ''color difference index Ra'. The maximum theoretical value of CRI is 100. Light sources are classified as medium color-difference-indexed if their color difference index in between 50-70, good color-difference indexed if it is between 70-90, and perfect color difference indexed if it is between 90-100. The CIE divides color difference index in 5 main groups.Color difference index and efficiency factors of lamps are inversely proportional to each other. Figure 3 shows the CRI-upper 50 and CRI-lower 81 of the CRI.

Figure 3. CRI-upper 50 and CRI-lower 81

- Color Temperature

Color temperature is specified in 0K. The lowest temperature is expressed as light yellow LEDs or warm white. As 0K value increases, white LEDs which look brighter are called cold white. Yellow and red are warm colors, blue and green are cold colors. The ideal color temperature depends on the place of use. For example, a cold white LED is ideal for a jewellery window or hospital lighting. Warm white LEDs are suitable for illuminating homes and hotel lobbies. Neutral (warm white) gives good result for store and office lighting. Figure 4 shows the color temperature in LED lamps.

Figure 4. Color temperature of LED lamps

▪ Cooling System

The poor heat distribution results in loss of efficiency, shortening of LED's life and deterioration of color transition. The LEDs usually breakdown at 125 ° C, so it is tried to keep the temperature of the connection point below 125 ° C. There are 4 basic elements to consider for temperature;

- ambient temperature,
- cooling material,
- drive current,
- array of bind or LEDs

There are two types of cooling systems, active cooling and passive cooling, for heat removal. There is a fan system in active cooling and extra power is consumed. Passive cooling is usually done with a metal core. The LED sectional view is shown in Figure 5.

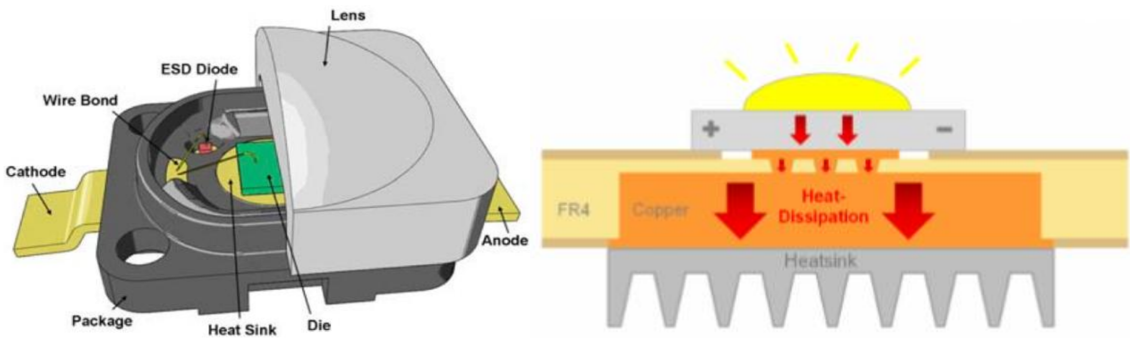

Figure 5. LED sectional view

▪ Light diffusion angle

Light flux spread around 1800, with lenses this light is limited within the desired interval. Light diffusion angle is defined as the angle at which 50% of the light from the LED is located.

▪ Light flux output (Efficiency Factor)

The Efficiency Factor expresses lamp efficiency as a lumen per watt. . Although the current flowing over the LEDs is constant, due to the increased ambient temperature caused by characteristic features of the diodes their efficiency factors decreases. This drop can vary between 0.3% and 0.7% for each grade according to the type of materials LEDs are made of.

Economic analysis in LED lighting

LEDs have advantages compared to incandescent lamps, such as lower energy consumption, longer life, robustness, smaller sizes, faster switching, higher durability and reliability [52-63]. Compared to a compact fluorescent lamp that emits the same light, they need more stable current and heat management. Figure 6 shows the comparison of Leds to other lamps in terms of price and efficiency factors [64].

	60 Watt Incandescent	40 Watt, 4'-0" Fluorescent T-12	50 Watt Halogen Bi-Pin Base	13 Watt CFL Bulb	32 Watt, 4'-0" Fluorescent T-8	9.5 Watt LED Bulb
Bulb Information						
Lumens	850	2,600	1,200	800	2,800	800
Watts	60	40	50	13	32	9.5
Lumens per Watt (LPW)	14	65	24	62	88	84
Life Span (hrs)	1,000	20,000	2,000	8,000	20,000	25,000
Price per Bulb	$0.50	$2.00	$2.50	$5.00	$2.50	$10.00
Analysis						
kWh of electricity used over 25,000 hours	1500	1000	1250	325	800	238
Cost of electricity to operate for 25,000 hours (at $0.11 per kWh)	$165	$110	$138	$36	$88	$26
Bulbs needed for 25,000 hours of use	25.0	1.3	12.5	3.1	1.3	1.0
Cost to buy light bulbs for 25,000 hours of use	$12.50	$2.50	$31.25	$15.63	$3.13	$10.00
Cost to operate for 25,000 hours	**$177.50**	**$112.50**	**$168.75**	**$51.38**	**$91.13**	**$36.13**

Figure 6. Comparison of LEDs to other lamps in terms of price and efficiency factor [62].

II. Results and Discussion

Lumens per Watt shows how efficient a bulb is at converting power into light. At 10 lumens per watt, a 100 watt bulb is not very efficient. The energy lost is converted into heat, which is why incandescent bulbs are much hotter to the touch than CFL or LED bulbs. The efficiency of CFL bulbs in converting energy into light falls between that of incandescent and LED bulbs. As LED bulbs continue to improve, CFL bulbs will likely be phased out. For homeowners, LED bulbs are the most efficient bulbs at converting energy into light. LEDs aren't always a 'slam dunk' though – for commercial buildings, 4' 0" t-8 fluorescent tubes are more efficient than LED bulbs.

The last three rows in the chart show the important differences between bulbs. Incandescent, florescent, and CFL bulbs don't have the same lifespan as LED bulbs, so you'll have to purchase additional bulbs as the old ones burn out. Those extra bulbs cost money. To get 25,000 hours of use from 60-watt incandescent bulbs, you'll have to spend $12.50 in bulbs, more than the cost of one LED. The Cost to Operate number provides the best approximation of the total value of the bulb. LED bulbs win this comparison hands-down. Despite the high up-front costs of LED bulbs, their low cost of operation and long lifespan mean that they are a much better investment than incandescent, fluorescent, or halogen bulbs.

III. Conclusion

Today, the lighting sector is developing rapidly. The biggest development in the lighting sector is seen in the LED lamp sector. LED lighting should be used for economical energy consumption. As seen in Figure 6, LED lighting is 1.5 times lower than the lowest cost lighting.Instead of individual feature control in the selection of LED lamps, 6 basic features should be evaluated together.

References

[1]. Atiç, S. 2016, Energy Efficiency Studies and Optimum Solutions in Lighting, International Conference On Natural Science and Engineering (ICNASE'16, Kilis), 2748 – 2751.
[2]. Cengiz, M.S. Warm-up analysis in solid-state LED Lighting, International Conference on Multidisciplinary, Science, Engineering and Technology, October 27-29, 2017, Bitlis
[3]. Cengiz M. S., Mamiş M. S. Kaynaklı M. 2016. Practical Approaches in Vehicles When Providing Solar Energy and Vehicles Working With Solar Energy, International Conference on Natural Science and Engineering, pp. 2284-2290, March 19-20, Kilis, Turkey
[4]. Kaygusuz, A., Keleş, C., Alagöz, B. B.,, Karabiber, A. K.,, "Renewable energy integration for smart sites," Energy and Buildings, vol. 64, pp. 456–462, Sep. 2013.
[5]. Karabiber, K., Keleş, C. Kaygusuz, A., Alagöz, B.B. "An approach for the integration of renewable distributed generation in hybrid DC AC microgrids," Renewable Energy, vol. 52, pp. 251–259, Apr. 2013.

[6]. Kaynaklı, M. 2016, Sabit Mıknatıslı Alternatörün Kullanılabilirliğinin Test Edilmesi, International Multidisciplinary Congress of Eurasian, 2016, pp. 474-479, Odessa.
[7]. Efe S.B., Cebeci M., 2013. Power flow analysis by Artificial Neural Network, International Journal of Energy and Power Engineering, 2(6):204-208. DOI: 10.11648/j.ijepe.20130206.11.
[8]. Efe S.B., Cebeci M., 2015. Artificial Neural Network Based Power Flow Analysis for Micro Grids, Bitlis Eren Univ J Sci & Technology, 5(1);42-47.
[9]. Gencer, G., Eren, M., Yildirim, S., Kaynaklı, M., Palta, O., Cengiz M.S., Cengİz. Ç., Numerical Approach to City Road Lighting Standards, International Conference on Multidisciplinary, Science, Engineering and Technology, October 27-29, 2017, Bitlis
[10]. Cengiz M. S., Mamiş M. S., Kaynaklı M. 2017. The Temperature-Pressure-Frequency Relationship Between Electrical Power Generating in Stirling Engines, International Journal of Engineering Research and Development, 9(2), pp. 60-64.
[11]. Alagöz, B. B., Kaygusuz, A., Karabiber, A. K., “A user mode distributed energy management architecture for smart grid applications,” Energy, vol. 44, no. 1, pp. 167–177, Aug. 2012.
[12]. Karabiber, A.K., 2017. The Technical Revisions Required to Prevent Electricity Theft, Çukurova University Journal of the Faculty of Engineering and Architecture, 32(3), pp. 121-130.
[13]. Cengiz, M. S., Mamiş, M. S., Yurci, Y. 2016. Cost Comparison of Constant and Tracking System PV Panels with Stirling Motor-Operated Systems, BEU Journal of Science and Technology 6,1, pp. 26-28.
[14]. Cengiz Ç. 2016. A Research on Smart Grids in Turkey, International Conference on Natural Science and Engineering, pp. 2273-2277, March 19-20, Kilis, Turkey
[15]. Cengiz Ç. 2016. Electricity Generation from Solar World, International Conference on Natural Science and Engineering, pp. 2259-2264, March 19-20, Kilis, Turkey
[16]. Parlakyıldız Ş. Gençoğlu MT. 2016. Reazilation of the Dynamic Test and Measurement System for Railway Electrification Systems, International Conference on Natural Science and Engineering, March 19-20, Kilis, Turkey
[17]. Atiç S. 2016. Energy Efficiency Studies and Practical Solutions in Industrial Plants, International Conference on Natural Science and Engineering, March 19-20, Kilis, Turkey
[18]. Cengiz M. S. Mamiş M. S. 2015. Price-Efficiency Relationship for Photovoltaic Systems on a Global Basis, International Journal of Photoenergy, 2015(2015), Article ID 256101, 12 pages
[19]. Parlakyıldız Ş. 2016. Frequency-Load Problem In Power Systems, International Conference on Natural Science and Engineering, March 19-20, Kilis, Turkey
[20]. Cengiz M. S, Mamiş M. S. 2015. Use of Solar Energy in Electric Vehicles. International Journal of Engineering Technologies, 123-128.
[21]. Atiç S. 2016. Energy Efficiency Studies and Optimum Solutions in Lighting, International Conference on Natural Science and Engineering, March 19-20, Kilis, Turkey
[22]. Yurci Y. Cengiz M. S. 2016. Smart Grid on Optimization, International Conference on Natural Science and Engineering, pp. 2325-2329, March 19-20, Kilis, Turkey
[23]. Atiç S. Parlakyıldız Ş. İlcihan Z. 2015. Smart Meter and Turkey, Bitlis Eren Univ J Sci & Technology 5(2), pp. 92–96.
[24]. Cengiz, Ç. Atiç, S.,Parlakyıldız, Ş., Palta, O., El, E. Akıllı sayaçların şebeke entegrasyonu ve Türkiye uygulaması, 1. uluslararası avrasya enerji sorunları sempozyumu, (28.-30.05.2015), İzmir.
[25]. Kaynaklı, M.,Palta, O., Cengiz, Ç. 2016, Solar Radiation and Temperature Effects on Agricultural Irrigation Systems, 6, 1, pp. 53-58.
[26]. Cengiz M. S. 2014. System Optimization On Smart Grid, International Journal of Electrical and Electronics Engineering, 1(8), pp. 28-32.
[27]. Cengiz M. S. 2014. Evaluation of Smart Grids and Turkey, Global Advanced Research Journal Of Engineering Technology and Innovation, 3(7), pp. 149-153.
[28]. Cengiz M. S., 2013. Smart Meter and Cost Experiment, Przeglad Elektrotechniczny, 89(11):206-209.
[29]. Yildirim, S. Kaynaklı, M. Yapici, İ. Gencer, G. İlcİhan, Z., Cengiz M.S., Cengiz Ç. Pruduction Stages of Solıd State Lighting Apparatus, International Conference on Multidisciplinary, Science, Engineering and Technology, October 27-29, 2017, Bitlis
[30]. Yapici, İ. Eren, M. Gencer, G. Yildirim, S. Cengiz, Ç. Kaynaklı M. Cengiz, M.S. Driver circuit effects in LED Lighting Systems, International Conference on Multidisciplinary, Science, Engineering and Technology, October 27-29, 2017, Bitlis
[31]. Cengiz M. S, Mamiş M. S. 2016, The Determination of the Optimum Parameters for Maximum Efficiency in Solar Tracking systems with Stirling Engine, International Conference On Natural Science and Engineering (ICNASE'16, Kilis), 2109 – 2118.
[32]. Efe, S.B., Effects of Faults on Power Flow Analysis for Microgrids. 8th International Ege Energy Syposium May 11-13,2016 Afyonkarahisar, pp. 971-976.
[33]. Efe S.B., Cebeci M., Erdoğan H., Öztürkmen G., 2015. A Novel Approach to Power Flow Analysis for Grid Connected Micro Grid, IEEE The 13th International Conference on Engineering of Modern Electric Systems (ICEMES2015), 11-12 June 2015, Oradea, Romania. Garrity T.F., 2008. Getting smart, IEEE Power Energy Mag. 6(2):38-45. (Garrity 2015)
[34]. Parlakyıldız, Ş. 2016, Implemented Railway Safety Tests On High Speed Trains, , International Conference On Natural Science and Engineering, Kilis, 1852 – 1856.
[35]. Efe, S.B., Cebeci, M., Artificial Neural Network Based Power Flow Analysis for Micro Grids. Bitlis Eren University Journal of Science and Technology, 5(1), pp.42-47, 2015.
[36]. Parlakyıldız, Ş.2016, Frequency-Load Problem In Power Systems, International Conference On Natural Science and Engineering (ICNASE'16, Kilis), 1846 – 1851.
[37]. Cengiz M. S., Mamiş M. S., 2015. Endüstriyel Tesislerde Verimlilik ve Güneş Enerjisi Kullanımı VI. Enerji Verimliliği Kalitesi Sempozyumu ve Sergisi, pp. 21-25, Sakarya, Türkiye
[38]. Cengiz M.S., Mamiş M. S., Solution Offers for Efficiency and Savings in Industrial Plants, Bitlis Eren Universty Journal of Science & Technology. 2015, 1, pp. 24-28.
[39]. Atiç, S. 2016, Energy Efficiency Studies and Practical Solutions in Industrial Plants, , International Conference On Natural Science and Engineering (ICNASE'16, Kilis), 2752 – 2756.
[40]. MS Cengiz, MS Mamis, M Akdag, Ç Cengiz, 2015, A review of prices for photovoltaic systems, International Journal of Technolgy Physical Problems of Engineering 7 (3), 8-13
[41]. M. S. Cengiz, M. S. Mamiş, M. Akdağ, and Ç. Cengiz, “A review of prices for photovoltaic systems,” in Proceedings of the 11th International Conference on Technical and Physical Problems of Electrical Engineering (ICTPE '15), pp. 300–305, Bucharest, Romania, September 2015.
[42]. Efe S.B., 2015. Harmonic Filter Application for an Industrial Installation, IEEE The 13th International Conference on Engineering of Modern Electric Systems (ICEMES2015), 11-12 June 2015, Oradea, Romania. DOI:10.1109/EMES.2015.7158395.

[43]. Cengiz, Ç. Kaynaklı, M. Gencer, M. Eren, M. Yapici, M. Yildirim S. Cengiz M.S. Selection Criteria and Economic Analysis of LEDs, International Conference on Multidisciplinary, Science, Engineering and Technology, October 27-29, 2017, Bitlis

[44]. Eren, M.,Kaynaklı, M., Yapici, İ., Gencer, M., Yurci, Y., Cengiz Ç.,Cengiz. M.S. Numerical Analysis of Maintanance Factor for Tunnel and Road In Solid State Lighting, International Conference on Multidisciplinary, Science, Engineering and Technology, October 27-29, 2017, Bitlis

[45]. Cengiz MS, Cengiz Ç, IOT and Lighting Automation. Imeset International Conference, 12-14 July 2017, Baku.

[46]. Yurci Y., Cengiz Ç., Yapıcı İ., Cengiz M.S., Yıldırım S., Eren M., Palta O., Atiç S. Analysis of energy productivity in LED illumination by active or passive methods. Imeset International Conference, 12-14 July 2017, Baku.

[47]. Yurci Y., Yıldırım S., O Palta., Cengiz, Ç., Atiç, S., Yapıcı, İ., Cengiz, M.S., Eren, M. Numerical analysis of LED illumination productivity parameter. Imeset International Conference, 12-14 July 2017, Baku.

[48]. Yıldırım S., Yapıcı İ., Atiç S., Eren M., Palta O., Cengiz Ç., Cengiz M.S., Yurci Y. Numerical Analysis of Productivity and Redemption Periods in LED Illimunation. Imeset International Conference, 12-14 July 2017, Baku.

[49]. Efe SB. 2015. Harmonic Filter Application for an Industrial Installation, IEEE The 13th International Conference on Engineering of Modern Electric Systems, 11-12 June, Oradea, Romania.

[50]. Efe S.B., Cebeci M., 2015. Mikro Şebekenin Farklı İşletme Koşulları Altında İncelenmesi, 6. Enerji Verimliliği Kalitesi Sempozyumu (EVK2015), 4-6 Haziran 2015, Sakarya, Türkiye.

[51]. Eren, M.,Palta, O., Cengiz, Ç., Yapıcı, I., Yurci, Y., Yıldırım, S., Cengiz, M.S., Atiç, S., Academical apprach to LED lamp or LED bulb confusion. Imeset International Conference, 12-14 July 2017, Baku.

[52]. Cengiz M.S., Eren M., Cengiz Ç., Yıldırım S., Yapıcı İ., Yurci Y., Atiç S., Palta O. Numerical analysis of warming and warming problem in LED lamps. Imeset International Conference, 12-14 July 2017, Baku.

[53]. Yapıcı I., Yıldırım S., Cengiz Ç., Atiç S., Palta O., Yurci Y., Cengiz MS., Eren M., A study about preparing regulations regarding LED Illimunation. Imeset International Conference, 12-14 July 2017, Baku.

[54]. Yurci Y.. Türkiyede Akıllı Şebekeler Üzerine Bir İnceleme, International Multidisciplinary Congress of Eurasian, 2016, pp. 51-55, Odessa.

[55]. Cengiz, M.S., Yurci, Y. Tarımsal Sulamada FV panellerde Verimlilik Değerlendirmesi, International Multidisciplinary Congress of Eurasian, 2016, pp. 576-581, Odessa.

[56]. Parlakyıldız, Ş., Gençoğlu, M.T., Kaynaklı, M. 2016, Destek Vektör Makineleri ile Türkiye'nin Uzun Dönem Elektrik Arıza Tahmini Ve Modellemesi, International Multidisciplinary Congress of Eurasian, 2016, pp. 92-96, Odessa.

[57]. Ceylan, H., Parlakyıldız, Ş. An approach to estimate occupational accidents using least-squares support vector machines, Kuwait J. Sci. 44 (3) pp. 83-91, 2017

[58]. Palta O., Cengiz, Ç. Kaynaklı, M. Solar radiation and temprature effects on agricultural irrigation systems, Bitlis Eren Journal of Science Technology, 2016

[59]. Kaynaklı, M., Palta O., Yurci Y., Cengiz, Ç. Cooperation of Conventional Electric Power Grids and SmartPower Grids, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), vol. 11(6), pp. 23-27, 2016.

[60]. Yurci, Y., Kaynaklı, M., Palta, O., Efe, S. B., Cengiz, Ç. The Performance Cost Effect of the SCADA System on DistributionNetworks, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), vol. 11(6), pp. 32-38, 2016.

[61]. Parlakyıldız Ş. Gençoğlu MT. Kaynaklı, M.Dıyarbakır ilının güneş santrali yatırımı açısındandeğerlendırılmesi, (28-30.09.2016), İnternational Regional Development Conference,2016.

[62]. https://greatercea.org/lightbulb-efficiency-comparison-chart/

Olcay PALTA "Cost Comparison in LED Lighting and Selection Criteria in LEDs." IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) 12.6 (2017): 05-10.