Toxicity Test of Liquid Waste from Printing Industry: Before and after Filtration with Zeolite on Common Carp (Cyprinus Carpio L)

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The liquid waste from printing industries contains harmful chemicals, such as a remaining material for the screen afdruk, a residual of paint stencil, and a waste of textile washing process. This study aims to determine the quality and toxicity of waste silk screening against 50% Lethal Concentration (LC_{50}) observations of 0-96 hours on common carp, before and after filtered by the zeolite. Results wastewater filtration stencil is then compared with the quality standards of Other Activities Standard. The standard is issued by Yogyakarta Governor on Regulation No.7 year of 2010, The comparison is based on the parameters of pH, COD, BOD, SS.

The sample of liquid waste is taken from household printing industry which is located at Ponggok, Trimulyo, Jetis, Bantul, Yogyakarta. The research was conducted in three stages: (a) the stage of acclimatization of common carp; (b) toxicity test prior and after filtration using zeolite, namely a preliminary test and the actual test; (c) waste treatment process using zeolite filtration with 0-50 cm thick.

The results show that the optimum thickness of zeolite used for filtration is 50 cm, with improvements pH of 33.4%; COD of 46.00%; BOD of 45.98%; and SS of 52.39%. According to the regilation, the value of pH and BOD are within the permissible value, but the COD and SS is still above the standard. LC_{50} 96 hours prior to the filtration on common carp is at a concentration of 5.66%, whereas after filtration the concentration is at 13.17%. Efficiency of the improvements based on LC_{50} 96 hours is 64.69%.

Keywords: Liquid Printing Waste, Toxicity Test, Zeolite, LC_{50}, Common Carp.

1. INTRODUCTION

Printing services, one of home industries, is developing rapidly in Yogyakarta. This means that the services supports tourism in Yogyakarta which is one of the destinations for travelers. Several unique souvenirs found in Yogyakarta are made by the printing industries. The existence of screen printing industry is generally still in a household scale, resulting in a lack of supervision of the handling of waste generated. Liquid waste printing can contaminate the environment if improperly handled. The waste contains harmful chemicals, such as remaining photoxol (afdruk making material on the screen), the rest of the rubber (printing paint), as well as the waste of textile washing

In order to determine the toxic effects of printing waste water, it is necessary to test the living being with the calculation of Lethal Concentration (LC_{50}). Test animals usually used for this purpose is a common carp (*Cyprinus carpio* L.), because of the sensitivity on aquatic environment changes [1], [3], [8]. Toxicity test includes acute and chronic toxicity tests which are used to evaluate toxic concentration [1], [3] , in this case the waste water and the exposure time that can cause toxic effects on common carp (*Cyprinus carpio* L).

To eliminate the toxic effects of the waste, it is required waste treatment process which is simple and easy to apply by means of adsorption technique using zeolites. Results of the treatment is projected to fulfil the environmental standards. Zeolite is a combination of crystalline hydrated aluminosilicate which contains geo-alkali or alkaline cation, zeolite can absorb gas or liquid and able to separate molecules based on the polarity [2], [7].

The purposes of the work are: (a) determine the quality of printing waste water before and after filtering process using zeolite; (b) define the LC_{50} 0-96 hour printing waste water to *Cyprinus carpio* L) before and after zeolite filtering; (c) optimize the thickness of zeolite for the filtration based on the parameters of pH, COD, BOD, SS; (d) compare the quality of the filtered waste water with the Standard Quality of Industrial Activities Standard based on pH, COD, BOD, and SS which is found in Yogyakarta governor regulation No.7, 2010 [5].

2. METHODS

Waste water sample is taken from household printing industry which is located at Ponggok, Trimulyo, Jetis, Bantul, Yogyakarta. Meanwhile, the test fish used is *Cyprinus carpio* L. The sample is taken from waste water of printing and screen cleaning before disposing into the final sewer using the composite method. This research was conducted in four stages: (a) the stage of acclimatization of common carp (*Cyprinus carpio* L); (b) toxicity test prior to filtration using zeolite, namely a preliminary test and the actual test; (c). waste treatment process using zeolite filtration with 0-50 cm thick; (d) toxicity test after the filtration, which includes a preliminary test and the actual test.

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The data analysis include: (1) the quality of liquid printing waste before and after filtration with zeolite in terms of pH, COD, BOD, and SS. The result is then compared with the Standard Quality of Yogyakarta Industrial Activities Standard according to Regulation No.7, 2010 isued by Yogyakarta governor; (2) optimization the thickness of zeolites; (3) determination of LC_{50} 0-96 hours of waste printing on common carp (*Cyprinus carpio* L) with probit analysis and linear regression [6] on the printing waste before and after zeolite filtration.

3. RESULTS AND DISCUSSION

3.1 Quality of printing waste

After the filtration process with thickness variation of the zeolite from 0 to 50 cm and contact time of 60 minutes, the result is as follows:

Table 1. The quality of printing waste water: before and after filtration

Parameter	Zeolite thickness (cm):						Standard*	Effectiness (%)
	0	10	20	30	40	50		
pH	5,00	5,50	5,50	5,83	6,33	6,67	6-9	33,40
COD(mg/L)	833,33	816,67	743,33	636,67	553,33	450,00	125	46,00
BOD (mg/L	40,23	33,86	31,30	27,70	22,63	21,73	50	45,98
SS (mg/L)	1186,67	1510,00	753,30	705,00	680,00	565,00	50	52,39

(*) Based on Yogyakarta Governor Regulation No. 7 year of 2010 [5].

3.1.1 pH

Table 1 shows the observation data before and after filtration with variation in Zeolite thickness. Meanwhile, Figure 1 presents the comparison of pH before and after the filtration. Based on the table and the graph, zeolite with 50 cm thick able to increase the pH from 5 to 6.67 in turns the effectiveness is 33.4%. The pH moves toward alkali due to the nature of the zeolite-like limestone [4] . In addition, the cation exchange occurs, cation H^+ in the waste water penetrate to the zeolite results OH^- of liquid waste printing increases

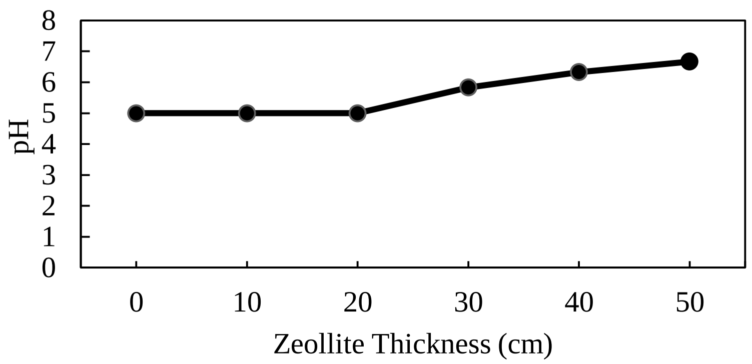

Fig. 1. pH after and before filtration

3.1.2 COD

Based on the observed data as shown in Table 1 and Figure 2, zeolite with 50 cm thick able to reduce the concentration of COD from 833.33 mg/L before filtration to to 450 mg/L after filtration, thus gives the effectiveness of 46.0%. However, the value is still exceed the maximum permissible value of 125 mg / L according the quality standards [5]. With the use of Excel program (as shown in Figure 3), the predicted COD value of 69 mg/L is obtained for zeolite thickness of 100 cm. The use zeolite filtration enables to reduce the concentration of COD in the printing waste water. This is due to capability of zeolites to separate molecules based on size, shape and polarity of the molecules filtered [4], [7]. Organic materials are trapped on the surface of the zeolite and the pores between the zeolite particles.

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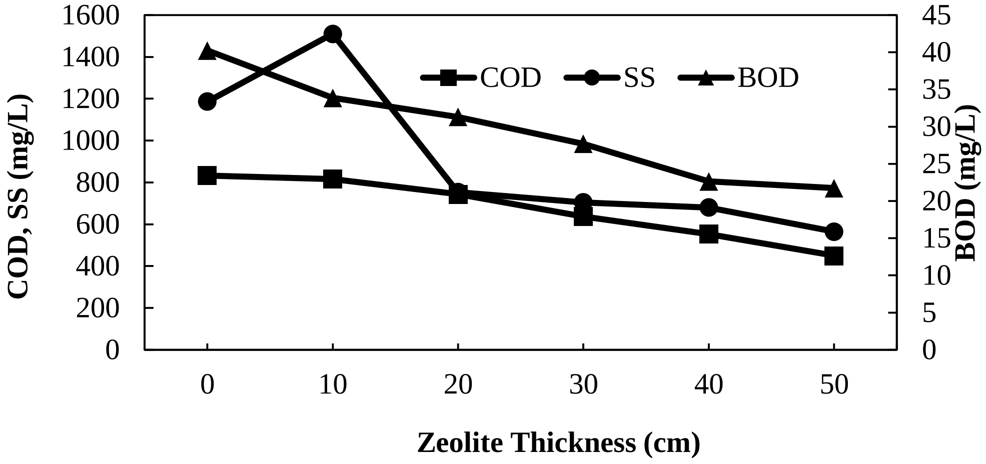

Fig. 2. COD, BOD, SS concentration before and after filtration

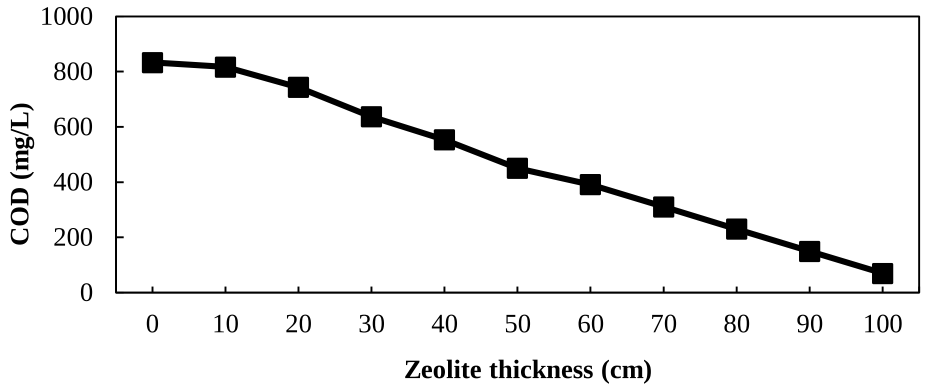

Fig. 3. Predicted COD at different Zeolite thickness

3.1.3 BOD

Figure 2 presents BOD concentration before and after filtration, zeolite with thickness of 50 cm able to reduce the BOD concentration from 40.23 mg / L to 21.73 mg / L, indicates that the effectiveness of 45 , 98% is obtained. Organic materials are absorbed on the zeolite surface. Furthermore, oxygen content increases which is released from zeolite particles. The more the air supply, the more the rate of decomposition by organisms.

3.1.4 SS

The suspended solids (SS) is physical indicator to determine the level of water pollution in the environment. Figure 2 shows SS concentration during this work. SS concentration decreases from 1186.67 mg / L to 565.00 mg / L, thus the effectiveness is 52.39%. The value is below the upper limit according the quality standards of 50 mg / L. A reduction in SS concentration shows that the thicker the zeolite is, the greater the adsorption occurs on the zeolite surface.

3.2 Toxicity test on Common Carp of Cyprinus carpio L

3.2.1 Preliminary test

In a preliminary,concentration used is below 10%. The season for the selection is due to common carp dead after 30 minute to 180 minutes in contact with the waste which the concentration of 0-100%. The death of common carp because of low oxygen dissolved in the waste. Therefore, it is concluded that the toxicity values for preliminary test ranged from 0-10% (0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10%). LC50 96 hours printing waste effluent on common carp prior to filtration is 4.65%, so the concentration of the liquid waste of 4-5% is used for the actual test. Based on linear regression analysis, correlation between the concentration of the liquid waste and the number of common carp mortality in a preliminary test is obtained which the correlation coefficient (r) is equal to 0.915. This may imply that there is a positive correlation between the concentration of the liquid waste and the amount of common carp mortality during 0-96 hours observations, indicates that the death of common carp increases as the liquid waste concentration increases.

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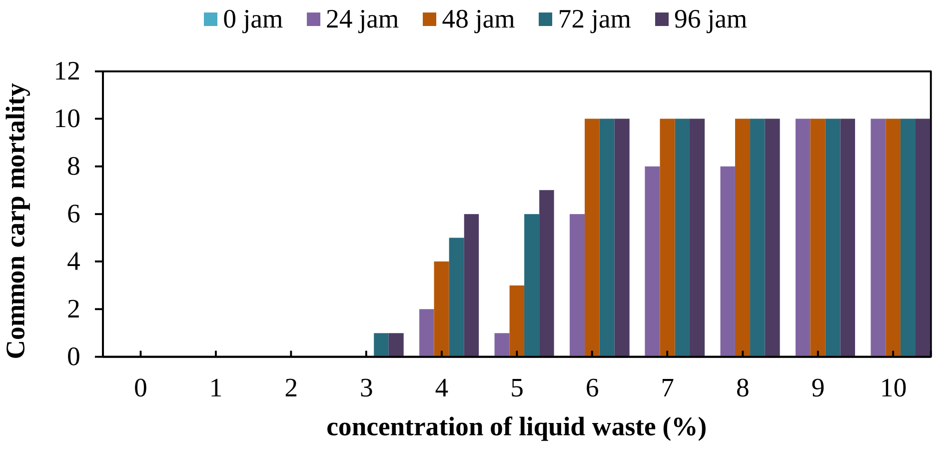

Fig. 4. Common carp mortality during preliminary test before filtration

LC_{50} 96 hour common carp after filtration is 16.40 %%, thus the waste concentration from 10% to 20% is selected. The correlation between the concentration of the liquid waste and the number of common carp mortality is determined with the correlation coefficient (r) of 0.624. Hence there is a positive correlation between the two. The higher the concentration of the liquid waste is, the more common carp dead.

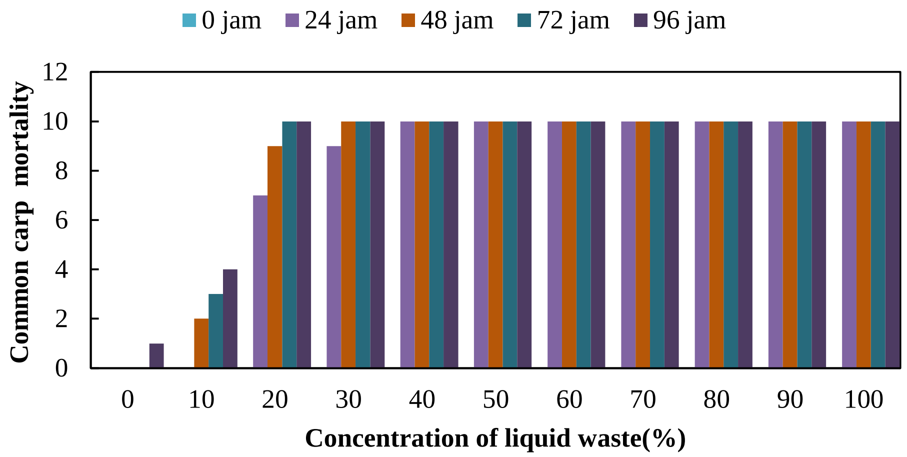

Fig. 5. Common carp mortality during preliminary test after filtration

3.2.2 Actual test

The actual test is a continuation of the toxicity test based on LC_{50}-96 hour during preliminary test. Based on the preliminary test, the concentration of liquid waste for initial actual test is within 4-5%. The variation in concentration during the actual test is 0%, 4%, 4.2%, 4.4%, 4.6%, 4.8% and 5% as depicted in Figure 6. From the probit analysis and linear regression, the values of LC_{50}-96 hour is obtained at a concentration of 5.6% printing waste water

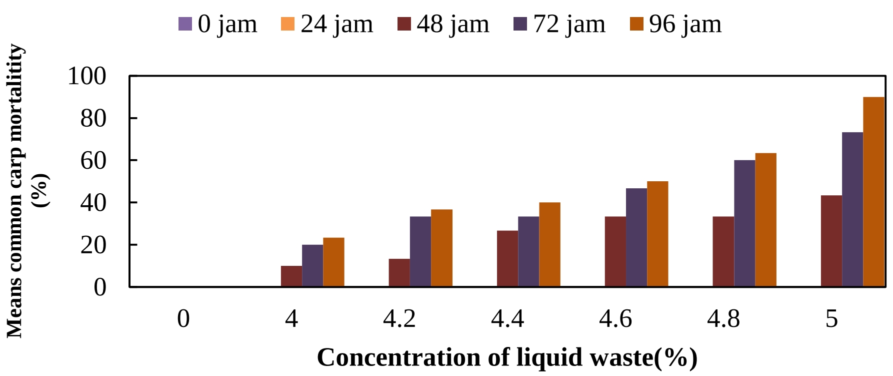

Fig. 6. Common carp mortality during actual test before filtration

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Figure 7 gives the actual test after filtration. The graph shows that the concentration of liquid waste after filtration ranges between 10-20%. The variation of the concentration during the real test is 0, 10, 12, 14, 16, 18 and 20%. From the probit analysis and linear regression, the values of LC_{50}-96 is found at the waste concentration of 13.17%

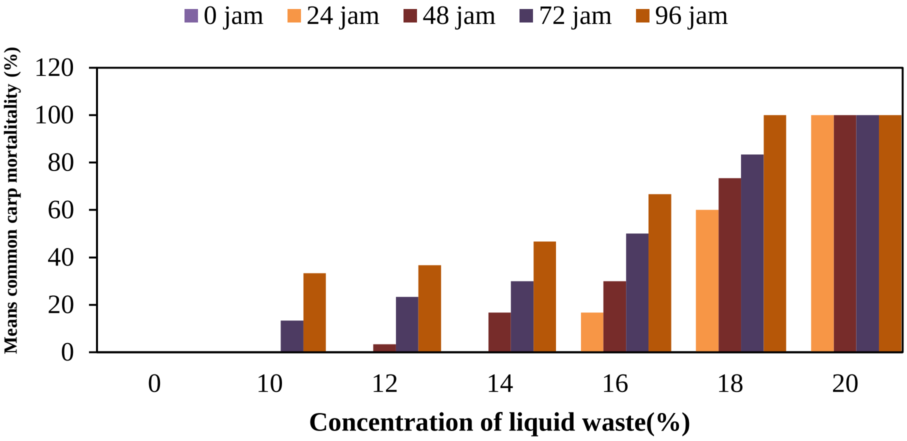

Fig. 7. Common carp mortality during actual test after filtration

Table 2. Value LC_{50} 0-96 hour for actual test

Before filtration	After filtration	Toxicity refinery based on LC_{50} 0-96 hours
LC_{50} 0 hours = 0,00%	LC_{50} 0 hours = 0,00%	0,00%
LC_{50} 24 hours = 0,00%	LC_{50} 24 hours = 20,36%	100%
LC_{50} 48 hours = 5,20%	LC_{50} 48 hours =16,88%	69,19%
LC_{50} 72 hours = 4,64%	LC_{50} 72 hours = 14,58%	68,17 %
LC_{50} 96 hours = 4,65%	LC_{50} 96 hours = 13,17%	64,69 %

Probit analysis is an analysis that uses a procedure of statistics transformation from the percentage of common carp mortality data into probit variation, which in turns together with the waste concentration are used to determine LC_{50} based on the linear regression equation [6].

From toxicity comparison of waste water before and after filtration using zeolite in the actual based LC_{50} 0-96 hours test, the improvement is obtained as shown in Table 2. The reduction of toxicity by 0-96 hour LC_{50} value is equal to 0-100 %. The safety limit of liquid waste for the common carp prior to filtration is at concentration of 0.52% (10% x LC_{50} 48 hours before filtration is 5.2%), while after filtration is at 1.69% (10 % x LC50 48 hours after filtration is 16.88%). The result of LC_{50} 0-96 hours and the safety limit of the batik waste prove that filtration using zeolite can reduce the toxicity of liquid waste from printing industry.

Table 3. Coefficient of correlation

Observation	Before filtration	After filtration
0 hour	-	-
24 hour	-	0,744
48 hour	0,998	0,894
72 hour	0,997	0,987
96 hour	0,988	0,980

From linear regression of the actual test, the correlation coefficient between the concentration of the liquid waste with the number of mortality common carp. Values of correlation between the concentration of the liquid waste stencil before filtrated with zeolite for observation 0-96 hours ranged from 0 to 0.998 and after filtered zeolite ranged from 0 to 0.987 as given in Table 3.

There is no correlation between the concentration of the liquid waste and the number of common carp at 0 hour observation (without and with filtration) and 24 hours observation (without filtration). This due to no common carp is found dead at that concentration and contact time.

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4. CONCLUSSION

a. Filtration of liquid waste using zeolite can improve the quality of waste based on the parameters of pH, COD, BOD, SS. The improvements of pH, COD, BOD, and SS are 33.40%, 46.00%, 45.98%, 52.39%, respectively. According to Yogyakarta Governor Regulation No. 7 year of 2010, the value of pH and BOD are within the permissible value, but the COD and SS is still above the standard.

b. Optimum thickness of zeolite for the filtration is found to be 50 cm

c. Toxicity of the printing liquid waste on common carp based on LC_{50} 0-96 hour is:

1) Before filtration: 0,00% (0 hour), 0,00% (24 hour), 5,20% (48 hour), 4,64% (72 hour), and 4,65% (96 hour).
2) After filtration: 0,00% (0 hour), 20,36% (24 hour), 16,88% (48 hour), 14,58% (72 hour), and 13,17% (96 hour)
3) The percentage of quality enhancement of printing liquid waste on common carp is in the range 0,00% - 100,00%.

REFERENCES

[1] Alkassasbeh, J.Y.M., Heng, L.Y., Surif, S.Toxicity Testing and the Effect of Landfill Leachate in Malaysia on Behavior of Common Carp (Cyprinus carpioL., 1758; Pisces, Cyprinidae). American Journal of Environmental Sciences 5 (3), 2009 ISSN 1553-345X . pp: 209-217

[2] Barloková, D. Natural Zeolites In The Water Treatment Process. Slovak Journal of Civil Engineering. ISSN: 1210-3896. Volume XVI (2) (2008) pp: 8-12

[3] Borgia, V.J.F., Thatheyus, A.J., Acute Toxicity of Effluent from Electroplating Industry to the Common Carp, Cyprinus Carpio Linn. International Journal of Research Studies in Zoology (IJRSZ) Volume 1, Issue 1, June 2015, pp: 10-14.

[4] Isyuniarto, 2005, "Kajian Pengaruh Zeolit dan Ozon Pada Nilai COD, BOD dan Kandungan Cr Dalam Limbah Cair Industri Kulit",. Prosiding PPI – PDIPTN 2005, ISSN 0216-3128, Puslitbang Teknologi Maju – Batan, Yogyakarta 12 juli 2005.pp: 108-114

[5] Peraturan Gubernur Daerah Istimewa Yogyakarta No.7 Tahun 2010 tentang Baku Mutu Limbah Cair Bagi Kegiatan Industri, Pelayanan Kesehatan, dan Jasa Pariwisata

[6] Pratiwi. Y, Tandjung, SD., Sartohadi, J. Uji Toksisitas dan Pengaruh Patologi Air Lindi dari Tempat Pembuangan Akhir Sampah Piyungan Bantul Terhadap Ikan Mas (Cyprinus carpio L) serta Penurunan Toksisitasnya dengan PAC, Jurnal Sains dan Sibernatika, ISSN 1693-7392, Volume 18, Nomor 3, Juli 2005, Program Pascasarjana UGM, pp: 323-336

[7] Rodiyanti, Triyono, S., Haryono, N. Kinetika Filtrasi Limbah Cair Industri Tahu dengan Menggunakan Metode Biofilter Media Zeolit. Jurnal Teknik Pertanian Lampung. ISSN : 2302 - 559X Vol.3, No. 3. 2014. pp: 239-244

[8] Thangam, Y., Jayaprakash, S., Perumayee. M. Effect of Copper Toxicity on Hematological Parameters to Fresh Water Fish Cyprinus carpio (Common Carp). OSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT) e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 8, Issue 9 Ver. I (Sep. 2014), pp 50-60