Journal of Engineering
Research and Education
Vol. 6 (2012) 97-104

A study on odour nuisance near open dump landfill

Tengku Nuraiti Tengku Izhar*, Norlia Mohamad Ibrahim[2], Nurul Asikin Mokthi[3]

[1,2,3]School of Environmental Engineering, Universiti Malaysia Perlis, Kompleks Pusat Pengajian Jejawi 3, 02600 Perlis.

Keywords: *Odour, Odour nuisance, Open dump landfill.*

INTRODUCTION

After burial of solid waste, anaerobic condition is quickly established with the depletion of oxygen and aerobic microorganism [1,2,3,4,5,6]. Landfill gas will be generated in sites that receive biodegradable organic matter such as food, paper, wood, plastics, textiles, vegetation, and so on. Biochemical degradation of organic materials, especially cellulose and hemicellulose, by action of aerobic (presence of oxygen) and anaerobic (absence of oxygen) microorganisms in the landfill will produce landfill gas [4]. Landfill gas is a mixture of methane (CH_4), carbon dioxide (CO_2), and small quantities of other gases including nitrogen, hydrogen, and hydrogen sulphide. Production and accumulation of landfill gas within the landfill raises gas pressure in landfill above atmospheric pressure. Therefore, the pressure gradient will serve as a driving force that will cause the gas to diffuse out of the landfill into the surrounding soil strata or into the air. The least resistance paths where diffusion is likely to occur are through cracks, landfill cover, and the surrounding top soil [7,8]. Generation of landfill gas will lead to safety concerns associated with the migration of a potentially explosive gas into surrounding areas, a detrimental effect on vegetation, odour generation, and contribution of gases to the greenhouse effect. Atmospheric concentrations of CH_4 are an active trace gas; these have increased steadily for several hundred years [9]. CH_4 and CO_2 are both greenhouse gases that contribute to global warming. CH_4 is an extremely potent greenhouse gas in which global warming potential (GWP) is 25 times more powerful than CO_2 [10,11]. According to the Intergovernmental Panel on Climate Change or IPCC (2006) [12], GWP of methane is 23 times stronger than CO_2 over a period of 100 years.

With a population of over 25 million, Malaysia is a humid tropic country with high temperature and rains throughout the year. Approximately 17,000 tonnes of solid waste are generated in Peninsular Malaysia daily; this is expected to increase to

*) For corresponding e-mail: nuraiti@unimap.edu.my

over 30,000 tones of solid waste by 2020 as a consequence of the growing population [13]. According to reports, 75% of waste was collected in 1998. In 2007, waste generation was approximated at 18,000 metric tonnes of domestic waste daily, one of the highest waste generators in the world [14]. The collected waste is transported to landfill sites for disposal; the remaining waste is sent for treatment at incinerators, recycling, and reprocessing. Certain wastes are dumped illegally. Malaysia wastes composition is mainly organic/food waste, paper, textile, wood, plastic, rubber, glass, and metal. Table 1 shows Malaysian solid waste composition in 1995, 2001, and 2004.

Table 1 Malaysia waste composition in 1995, 2001, and 2004

Waste Composition	Percentage (%)		
	1995	2001	2004
Organic/food waste	32.0	29.5	35.72
Paper	29.5	26.8	16.61
Waste yard and wood	3.4	3.9	5.1
Textile/leather	7.0	13.6	13.85
Plastics	16.0	12.5	22.19
Rubber	2.0	1.9	0.89
Glass	4.5	2.7	3.2
Metals	4.3	1.9	2.44
Others	1.3	5.3	0.0
Total	100	100	100

Source: [15,16,17]

In Malaysia, total methane emissions from the waste sectors is approximately 1.3 million metric tonnes (mT) per year compared to total methane emission in Malaysia of 2.2 million mT estimated in 1994 [18]. The most significant methane (CH_4) emission sources are landfill gas from municipal solid waste (53%), followed by biogas from Palm Oil Mill Effluent or POME (38%). Less significant sources include swine manure (6%) and industrial effluent (3%). Total carbon dioxide (CO_2) emissions are estimated to be roughly 27 million mT, approximately 19% of the total greenhouse gas emission in Malaysia in 1994. Waste and wastewater treatment and discharge will produce non-methane volatile organic compounds (NMVOCs), nitrogen oxides (NO_x), and carbon monoxide (CO) as well. Landfill gas movements into the atmosphere occur because the gases seep out from the permeable cover of the landfill. These gases will stay in the air and disperse initially to the nearest habitat. Surface emissions begin to occur from 5–7 cm from the landfill surface. Rabl et al. (2008) indicated that ingestion may arise from seafood, fresh water fish, milk, and meat that have been exposed to the pollutant's emission pathways [19]. Movement of pollutants is subtle and may not manifest its impact until years later. Human beings will be threatened with a health risk and habitats will be endangered.

Nowadays, odour which refers to unpleasant smell is considered an important environmental pollution issue. Odour is perceived by brains in response to chemicals present in the air. Odour is one of the effects that those chemicals have on human. Human have a sensitive sense of smell and can detect odour eventhough the chemicals that are present is in very low concentrations. The subject of odour is a highly complex and the response of an individual to odour exposure is highly subjective: their reaction will depend on issues such as how strong it is, what it smells like, how often and when it occurs and in what context. Emission from landfill may constitute a substantial nuisance for neighboring residents. For example; hydrogen sulphide smell like rotten egg odour. The health effects of hydrogen sulphide are respiration problem, skin irritation, eye irritation, coughing and headache. Odour nuisance can lead to both physical and mental effects (health effect and negative experiences). It is not been able to determine a direct relationship between the odour of substances and the toxicity of the substances, expressed as pathogenic effects. However, people have observed non-toxicological physiologic reactions by odours acting upon the central or peripheral nerve system. From questionnaires, it can determine that periods of odour nuisance often go together with headaches, nausea, sleep disturbances, loss of appetite and stress.

MATERIALS AND METHODS

Selection of Respondent

Respondents of the survey are the residents live within five km radius from Padang Siding Landfill, Arau, Perlis. All respondents resides at <0.9 km, 1-1.9 km, 2-2.9 km, 3-3.9 km and >4 km is included in the survey. The population is identified by the information provided by Kangar Municipal Council on the population in Perlis. Different sampling techniques were applied at the residential area in order to avoid bias in conducting the survey. Systematic sampling relies on arranging the target population according to an ordering scheme and then selecting the target at regular intervals using that order list. Systematic sampling starts at random start and will proceed with the selection of a certain elements and moved forward. For residential area with small number of houses, all residents will include in the survey.

Questionnaire

Questionnaire developed based on inquiry such as social diversity, gender, institutional, behaviour and public participation. Data were collected through a designed questionnaire that used Likert scales style responses. The scales were; 1 – Strongly disagree (Strongly unfavourable to the statement), 2 – Disagree (Unfavourable to the statement), 3 – Normal (did not agree or disagree with the statement), 4 – Agree (70% Agree with the statement) and 5 – Strongly Agree (90% Agree with the statement). Data obtained from the questionnaire is generally information on respondent toward issues concerning solid waste and odour. The questionnaire also

asked question related to demographic issues and respondent background because these are factors that influence the attitude of respondent towards odour nuisance. A total of 50 questionnaires were carried out within 5km radius of the landfill. The respondent of study involved are the residents within 2km radius from landfill. The respondent were interview in the vicinity of their home during the survey to ascertain perception on odour impacts. They were requested to answer the questionnaire based on their perception on odour at their residential area. From 50 respondent 30% males and 70% female. Minimum ages of respondent was 15 year old and maximum is between 35 until 39 year old (22%). A pilot study was conducted to certain the relevancy of the questionnaire to the objectives of the study and the response, opinion and attitude towards the questionnaire was designed and also ensure they understand and response correctly to the questions asked. Several questionnaires set were sent or discussed with the relevant parties to ascertain their appropriateness. Amendments were made to the questionnaire based on the feedback received from this pilot study. For the pilot study, 20 copies of questionnaires were targeted to test the result that reliable or not.

Statistical Analysis

In the statistical analysis, the level of agreement from respondent are test by using t-test and Anova. t-test was used to compare odour nuisance with the characteristics of respondents. t-test is used to compare the probability the characteristics of respondent will influence their response. Three requirements in t-test are; only one independent variable, only two level for independent variable and only one dependent variable [20]. The comparison distribution for a t-test for independent means is a distribution of difference between means of samples. ANOVA is used when the respondent characteristics with means from several (>2) groups will be differ in their perception towards odour nuisance. The perception of odour were compared across different distances. Prevalence of odour perception was calculated simultaneously by radius. The radius is divide into five group, from 0-1km, 1-2km, 2-3km, 3-4km and 4-5km. The perception of odour emission was study across zones by comparing the level of the agreement. (five categories : strongly disagree, disagree, normal, agree, strongly agree).

Wind Profile

Weather is one of the environmental component that may influence the frequency and intensity of odour received by the respondent. The influence of weather such as wind direction, wind speed, temperature and humidity can affect concentration of odour carried from landfill. The wind direction is measured using E-sampler. The measurement was conducted for three days to get the best data to show the wind profile in Arau. The instrument is located at the landfill to represent the wind profile at the landfill to nearby area. The primary purpose of the E-Sampler is to gather useful data about the environment. Information about airborne particulate

concentration, ambient temperature, ambient pressure, relative humidity, wind speed and wind direction.

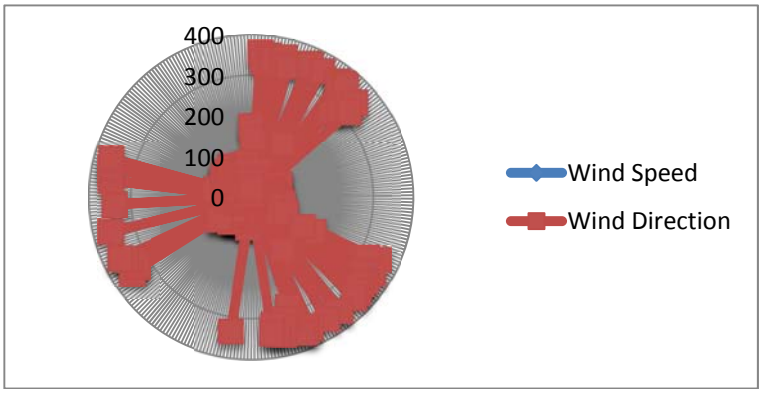

Figure1: Wind profile

RESULTS AND DISCUSSIONS

Level of Agreement

The level of agreement shows the result of the respondent agreement on odour as nuisance. Table 2 show the frequency of respondent based on the level of agreement. Result shows the mean of the agreement level of respondent. The results of odour recognition shows that, the mean of the level of agreement is 3.56. it shows, respondent agree about the recognition of odour from the landfill. The respondent is strongly agreed with the recognition of odour from the starting of development of landfill which is 22 responses. From question on the effects on daily activities, respondent did not agree neither agree with the statement. the mean on level of agreement of the statement is 2.82. The value is between the two and three, it means the respondent is not agreed with the effect on daily activities. The respondent is disagree with the need of medical checkups. They disagree with the effects of the respiration problem, skin irritation, eye irritation, coughing, and headache.

Table 2 Level Of Agreement On Effects Of Odour Based On Radius

DISTANCE		Odour recognition	Effects on daily activities	Respiration problem	Skin irritation	Eye irritation	Coughing	Headache
0-1km	Mean	5.00	5.00	3.70	4.00	1.90	3.70	2.70
	Std. Deviation	0.00	0.00	0.68	0.82	1.52	0.83	1.26
1-2km	Mean	4.50	4.10	3.00	3.30	4.20	3.50	3.60
	Std. Deviation	0.97	0.87	1.15	1.33	1.39	1.08	1.42
2-3km	Mean	4.10	2.80	2.40	1.80	1.30	2.30	2.40
	Std. Deviation	0.99	1.32	0.97	0.79	0.68	1.06	1.35
3-4km	Mean	1.60	1.10	1.50	1.80	1.90	1.30	1.50
	Std. Deviation	0.69	0.32	0.85	0.63	0.74	0.67	0.71
4-5km	Mean	2.60	1.10	1.10	1.40	1.40	1.70	1.50
	Std. Deviation	0.51	0.32	0.32	0.69	0.97	0.82	0.71

Effect of Odour Emission Based On Radius

The respondent perceptions based on the radius are divided into five categories. The radius divide from zero to one km, one to two km, two to three km, three to four km, and four to five km. Table 3 shows the respondent perception of odour based on radius.

Table 3 Level agreement of the respondent on effects of odour

Section	Strongly not agree	Not agree	Natural	Agree	Strongly agree	Mean
Recognise odour from landfill	5	9	11	3	22	3.56
Effect on daily activities	20	5	3	8	14	2.82
Respiration problem	19	7	14	8	2	2.34
Skin irritation	16	12	9	9	4	2.46
Eye irritation	27	7	6	2	8	2.14
Coughing	17	7	12	12	2	2.50
Headache	19	9	14	2	6	2.34

The result shows that mean and standard deviation of the level of agreement. For the distance of zero to one km, the respondent agree on the odour recognition, effect of health, effects on daily activities, respiration problem and skin irritation.The respondents that live at one km until two km is agree with the odour recognition from the development of landfill (4.5), effect on daily activities (4.1), eye irritation (4.2), coughing (3.5) and headache (3.6). The major effect is eye irritation. This maybe occurs at the residential area where wind direction is direct to their house. The probabilities of the effects to occur is high because the physiological response on eye irritation is 10 ppm for hydrogen sulphide.

CONCLUSIONS

The study shows that, odour originated from landfill activities give impact on resident live on 0-1 km,1-2 km and 2-3 km. The respondent mostly agree on the effect of odour on daily activities such as business, sleeping, eating and relaxing. There are also the effects on skin irritation. All respondents disagree with the effects on eye irritation except people live on one to two km radius from landfill. Besides, all the respondent disagree with the effects on coughing and headache.

REFERENCES

[1] J. Bogner and K. Spokas: *Landfill methane: rates, fates and roles in global carbon cycle.* Chemosphere, 26, (1993), p. 369-386

[2] G. Tchonobanoglous, H. Theisen and S. Vigil in: *Integrated Solid Waste Management Engineering Principles and Management Issue.* Singapore: McGraw-Hill, (1993), p. 3, 226

[3] T.H. Christensen, R. Cossu, and R. Stegmann in: *Landfilling of Waste: Biogas.* London: Spon, (1996)

[4] J. Petts and G. Eduljee in: *Environmental Impact Asessment for Waste Treatment and Disposal Facilities*. Singapore: John Wiley & Sons, (2004), p. 30-34

[5] R.E. Hester and R.M. Harisson in: *Environmental and Health Impact of Solid Waste Management Activities.* United Kingdom: The Royal Society of Chemistry, (2002) p 3–9, 17–33

[6] N.J. Themelis and P.A. Ulloa: *Methane generation in landfills* Renewable Energy, 32, (2006), p. 1243-1257

[7] G.J. Farquhar and S.A. Rovers: *Gas Production from landfill decomposition.* Water Soil and Air Pollution, 1073, (1973), p. 493

[8] J.F. Rees: *The fate of organic carbon compounds in the landfill disposal of organic matter* Journal of Technology and Biotechnology, 30, (1980), p. 361

[9] R.J. Cicerone and R.S. Oremland: *Biogeochemical aspects of atmospheric methane*. Global Biogeochemical Cycles, 2, (1998), p. 299–327

[10] C. He: *A catalytic/sorption hybrid process for landfill gas clean up.* Industrial and Engineering Chemistry Research, 36, (1997), p. 4100-4107

[11] P. Foster, V. Ramaswamy, P. Artaxo, T. Berntsen, D. Fahey, J. Haywood, J. Lean, D. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schultz and R.V. Dorland, R.V. in: *Changes in atmostpheric constituents and in radiative forcing Tech.rep., In Clmate Change 2007: Physical Science Basis.* 4th Assessment Report. Intergovernmental Panel on Climate Change, (2007)

[12] IPCC in: IPCC Guidelines for National Greenhouse Gas Inventories 5th Volume. Intergovernmental Panel on Climate Change National Greenhouse Gas Inventories Program, (2006)

[13] UNDP in: Malaysia Developing A solid Waste Management Model for Penang, Malaysia. United Nations Development Programme, (2008)

[14] T.K. Ong in: More Landfills to be Built. *The Sun Magazine*, (2007)

[15] M.I Ridhuan in: *Sanitary Landfill Development in Malaysia* Short Course on Practicality of Landfill Design, School of Civil Engineering, Universiti Sains Malaysia, (1995)

[16] R.H.B. Dini, A.A. Hamidi and K. Savinder: *The Effectiveness of Physiochemical Treatment for Leachate from Ampang Jajar Landfill Site, Seberang Perai, Malaysia,* Modern Landfill Technology Management, Japan Society Of Waste Management Expert (JSWME), Fukuoka Japan, (2011) p 111-118

[17] S.A.F. Syed Mohd in: *Characteristics Study of Municipality Solid Waste from Pulau Burung Landfill.* Final Year Project, School of Civil Engineering, Universiti Sains Malaysia, (2004)

[18] MEWC in: *Study on Clean Development Mechanism Potential in the Waste Sectors in Malaysia* Final Report. Ministry of Energy, Water and Communication, (2004)

[19] A. Rabl, J.V. Spadaro, and A. Zoughaib: *Environmental Impacts and costs of Solid Waste: A Comparison of Landfill and Incineration.* Waste Management & Research, (2008), p.147-162

[20] R. Ho in: *Handbook of univariate and Multivariate Data Analysis and Interpretation with SPSS.* United States of America: Chapman & Hall/CRC, (2006), p. 203,204