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An Analysis of Odour Concentration Using Odour Concentration Meter XP-329 at Landfill Vicinity

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Abstract: Odour is an environmental element consisting of organic and inorganic components. Odour is also referred to as properties or quality of a source which effects, stimulates or conceivable by the senses. Hence, odour can be sensed or detected by the sensory organs in the form of aroma, fragrance and offensive smell. Odour pollution is an indicator of a change or altered equilibrium in an ecosystem with adverse effects on health. Thus this empirical study was conducted to detect the concentration of odour and perceptions of adverse effects in the vicinity of the Ampar Tenang landfill. The concentration of the odour was measured by using the Odour Concentration Meter Model XP-329. The odour concentration was observed over three periods i.e., morning, evening and night in various situations. The analysis of the findings indicated obvious differences in concentrations between the periods of the time, particularly after rainfall.

Key words: Odour pollution, landfill, odour concentration, sensory, equilibrium, Malaysia

INTRODUCTION

Odour is a discernable element in the athmosphere which can be a consequence of natural environmental generation or human activities. The generation of odour can be sensed in terms of its fragrance, acidity, acridity and putridness. Each sense of odour can be determined based on odour wheel. Human being has very sensitive odour senses which could detect its presence in the surrounding. Not all odours cause disturbance or annoyance. The smell of fragrance may induce a sense of freshness while putrid and acidic smell may cause discomfort and force one to flee from the offensive environment (AERC, 2001; Nicell and Tsakaloyannis, 2003; ALSCOSMS, 1979; Shusterman, 1992; Vrijheid, 2000).

Studies on odour pollution are still at its infancy stage in Malaysia. Until recently there have not been many investigations on odour pollution specifically on its concentration, intensity and impact on human health. Nevetheless an investigation on odour pollution as a consequence of landfill operation by Sakawi *et al.* (2011) an exception. In developed countries particularly in Europe, studies on odour pollution formed a major component in environmental studies.

The investigation not only limited to techniques of measuring the odour but also on its impact, concentration and method of its control and regulations. Among the notable investigators who conducted odour studies were Shui-Jen *et al.* (2003), Davoli *et al.* (2003) and Drew *et al.* (2007). Among significant studies in Asia were by Shi (2004) in China and Higuchi (2004) in Japan. The typical method of odour measurement used in developed countries was through dynamic olfactometry (Zarra *et al.*, 2008), Gas Chromatography-Mass Spectrometer dynamic olfactometry and electronic nose (Sironi *et al.*, 2007) and sniffing team (Nicolas *et al.*, 2006).

The focus of an odour investigation is often not only confined to odour issues from a landfill but also on odour generated by various other sources. According to Nicolas *et al.* (2006), offensive odour may cause various human and environmental hazards around the area of operations of landfills. Casey *et al.* (2008) study on odour problem in Western Australia indicated that one third of complaints made by the public were about odour pollution. Many of the odour complaints were related to the activities of animal processing (DEP, 2002). A major issue of odour generated from the landfill is its impact on public wellbeing.

Thus, the major focus of this study is the problem of odour originated from the landfill and its impact on public wellbeing in its vicinity. The landfill odor is not only offensive to human beings but also harmful to natural environment. The presence of the odour is an indicator of existence of gases emitted by the wastes at the landfill. The odour problem generated by the landfill wastes inflict

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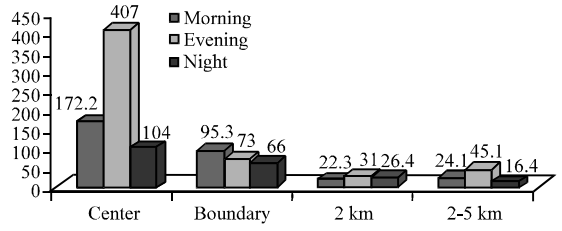

Fig. 1: Comparation of odour concentration in the vicinity of landfill on a regular non-rainy day

major impact on the neighborhood within its proximity. In Malaysia odour pollution is often attributed to landfill, pig farms, chicken farms and oil palm mills. Although, the issues are often highlighted in the media and specific studies are yet lacking. Until now there is no specific guidelines on method of measuring odour concentration, intensity and gaseous components generated from the landfills in Malaysia. In Malaysia, occassionally odour pollution issues are highligted in the media. In an online complaint, many residents of the housing area were particularly offended with offensive odour whenever the winds blew. The problem was compounded by their suffering of nausea and headache due to the wastes solids and leachates leaking from the garbage trucks passing through their residential areas. Based on several incidents of offensive odour reported in the media, odour pollution is indeed a chronic problem which required a careful study on its concentration and intensity so as to provide a more viable and sustainable control management to mitigate the problem. It was also particularly necessary to assist the public to cope with the present odour concentration and to enable them to take precaution in purchasing properties in the proximity of the landfills.

Location of study: Generally, the topography of the Sepang Municipality Council (MPS) in Selangor Malaysia can be categorised into three types: namely hilly, high, low and coastal areas. Although, the length of the coast is far from the landfill, nevertheless it still is a contributor of domestic wastes disposal from the residential areas. The analysis of the high lands also found that around MPS only 0.34% of its area is consisted of 100-150 m height range. About 93.52% of MPS areas have height range of <50 m. Only 6.14% of the areas have the height range between 60-100 m. As for the MPS slope analysis, it was found that about 100% of the area has slope less 12% (UPEN Selangorm in 2005). Based on these findings, it could be established that the areas in the vicinity of the landfill are not of extreme height and slopes. With the overall height of MPS areas <60 m and slope gradients <20 degrees have thus, provide a clear evident that the area of study is of rather low, flat and gently sloped area. Figure 1 shows the location of the landfill and monitoring stations within 2 km and between 2-5 km radii. Table 1 shows the latitude of the location and longitude for 13 monitoring stations of odour concentration around the area of study.

Table 1: Location of sampling stations around Ampang Tenang landfill

Station	Name of locality	GPS rading
AT1	Landfill	N02^{0}49'211"/E101^{0}40'781"
AT2	Border of landfill	N02^{0}49'251"/E101^{0}40'766"
AT3	IKHLAS	N02^{0}49'488"/E101^{0}40'776"
AT4	SK Sg Melut/kg Org Asli	N02^{0}49'935"/E101^{0}41'115"
AT5	Taman Warisan Indah	N02^{0}48'312"/E101^{0}41'269"
AT6	LCC Oil Palm Mill	N02^{0}49'971"/E101^{0}41'277"
AT7	Ladang/kg LCC	N02^{0}50'332"/E101^{0}41'318"
AT8	Kg Org Asli Bakuk	N02^{0}49'429"/E101^{0}41'340"
AT9	Kota Warisan Mainroad	N02^{0}49'249"/E101^{0}42'301"
AT10	SK Kota Warisan	N02^{0}49'565"/E101^{0}42'667"
AT11	Taman Gemilang	N02^{0}51'507"/E101^{0}41'340"
AT12	Taman Delima	N02^{0}51'234"/E101^{0}41'030"
AT13	Taman Amber	N02^{0}50'916"/E101^{0}39'096"

MATERIALS AND METHODS

An odour concentration meter XP-329 series III was the instrument for detecting the odour concentration from the AT landfill. The instrument was available at the air quality laboratory at the Centre of Social Studies, Development and Environment and it was capable to detect odour concentration *in situ*.

The unit of measurement for this insrument is per the scale of ou m^{-3} i.e., the capacity of odour concentration able to be conceived or discerned with a range of reading beginning at 0 ou m^{-3} up to a maximum of 2000 ou m^{-3}. The method for data collection was through the field sampling monitoring of sensitive receivers per location within 5 km radius. The odour concentration was observed over three periods i.e., morning, evening and night in various situations. The readings were recorded for 10 min at each of the sampling station. A total of 13 stations were identified as close to sensitive receivers. A station is located in central of the landifill, at the border, within 2 and 2-5 km radius.

RESULTS AND DISCUSSION

The concentration of odour in the vicinity of landfill on a regular non-rainy day

The concentration of odour in the morning: Based on Table 2, the station for the primary source indicated as the centre of the landfill AT1 recorded the highest odour concentration at 172.2 ou m^{-3}. This is similar to the station located at the border of the landfill which recorded the

Table 2: The concentration of odour in the vicinity of landfill on a regular non-rainy day

	Odour (ou m^{-3})		
Stations	Morning	Evening	Night time
AT1	172.2	407.0	104.0
AT2	95.3	73.0	66.0
AT3	10.2	88.0	6.1
AT4	18.8	26.5	11.2
AT5	20.4	15.8	65.6
AT6	22.7	33.0	47.1
AT7	48.4	09.3	10.4
AT8	13.2	13.2	18.1
AT9	19.2	09.7	22.9
AT10	17.2	143.7	19.9
AT11	28.7	21.2	8.7
AT12	26.9	29.0	8.8
AT13	28.6	21.9	21.9

odour concentration at 95.3 ou m^{-3}. Observation of odour concentration at AT3 up to AT8 within the 2 km radius, indicated a higher concentration recorded at 48.4 ou m^{-3}. The reading of this slightly higher odour concentration was possibly due to the influence of the LCC oil palm mills nearby.

The concentration of odour in the evening: The data recorded at the station on the landfill is the highest at 407 ou m^{-3}. It was the highest reading of odour concentration on normal days throughout the observation. The odour concentration at AT2 showed a lower reading at 73 ou m^{-3}. The concentrations for stations within 2 km radius showed high readings (88 ou m^{-3}) recorded at AT3 opposite the IKHLAS institute and near the mainroad entering the landfill. The lowest odour concentration was recorded at AT7 (9.3 ou m^{-3}) in LCC plantation (Table 2). This condition occurred due to the influence of oil palm mill and distance of the station which is further away from the landifl location.

Odour concentration became gradually receded at stations within radius 2-5 km. The reading at AT10 was found to occur at the highest reading of 143.7 ou m^{-3}. While the lowest concentration was at 9.7 ou m^{-3} at station T9 near the mainroad to Kota Warisan. For station AT10, the concentration was high in the evening, possibly due to the construction work in the area. There were garbage trucks on rounds near the KW primary school during the observation.

This situation also influenced the concentration recorded by the Odour concentration meter which was capable to record all types of gases in the sorrounding atmosphere. Although, the distance of station A10 exceeded 2 km from the landfill, there were other factors in the vicinity which can influence the concentration of odour recorded.

Table 3: The concentration of odour in the vicinity of landfill after a rainy day

	Odour (ou m^{-3})		
Stations	Morning	Evening	Night time
AT1	183.1	83.3	78.3
AT2	71.9	32.5	38.9
AT3	19.0	21.6	18.6
AT4	26.5	24.2	13.1
AT5	26.6	25.6	6.8
AT6	08.8	23.5	17.7
AT7	50.1	22.5	10.1
AT8	23.1	24.2	9.6
AT9	67.2	20.5	7.1
AT10	11.7	22.0	5.8
AT11	08.1	34.6	15.8
AT12	217.7	47.2	18.6
AT13	7.7	24.4	13.3

The concentration of odour in the night time: The night time odour concentration was recorded the highest at AT 1 considered as primary source of odour at 104 ou m^{-3}. While the highest reading of odour concentration recorded at stations within radius of 2 km were recorded at AT5 (65.6 ou m^{-3}) and AT6 (47.1 ou m^{-3}). The higher odour concentration recorded stations AT5 and AT6 within 2 k radius was possibly due to the existence of a nearby oil palm factory which released gaseous steams during night operations.

The concentration of night time odour recorded at the sampling stations beyond the 2-5 distance have shown readings which on average was rather low i.e., between 8.8 ou m^{-3} at station AT11 and the highest only at 22.9 ou m^{-3} at station AT9. The reading at station AT9 was a little higher due to the main road forming the main thoroughfare of Kota Warisan. The concentration of odour recorded was also due to the presence of other gaseous elements which could be sensed but not detectable. Although, other gases were not able to be distinctly recorded, the gases still generate smelly odour, for they were formed the odours of other sources.

The concentration of odour in the vicinity of landfill after a rainy day: The monitoring of post-rain odour was conducted immediately after the rain ceased. Table 3 shows the reading of after rain odour concentration recorded 13 stations on normal day. The overall reading recorded at centre of landfill consistently indicated high reading compared with that of other stations, either within the 2 km or between 2-5 km radius.

The concentration of odour in the morning after rain: The odour concentration recorded in the morning after rain was also highest at station AT1 (183.2 ou m^{-3}). The concentration data recorded on the wastes dumps at 172.2 ou m^{-3} at the centre of the landfill was the same as

the concentration recorded in the morning time. Even though, the concentration reading was recorded high at AT1 on normal non rainy day and after rain; the concentration of odour at AT12 recorded higher reading at 217.7 ou m^{-3}. High concentration of odour occurred due to the infuence of odour originated from the waste treatment nearby the sampling station at Taman Delima which spread into the atmosphere after the rain (Table 3).

The concentration of odour in the evening after rain: The concentration of odour recorded in the evening after rain indicated the same trend. For all stations either at the landfill site within its vicinity or at a distance, all showed gradual decrease in odour concentration level. Even though, the trend wassuch there were also stations which recorded higher odour concentrations compared to other stations within the same distance from the landfill. The increased intensity of odour concentration was due to the proximity of the sampling station to other odour sources such as oil palm plantations, waste treament plant or main sewerage. Based on Table 3, it is clearly indicated that the highest concentration recorded is at AT1 with 83.3 ou m^{-3}. While the concentration of odour for stations within 2 km radius was at an average of 23.6 ou m^{-3} with highest concentration at AT5 (25.6 ou m^{-3}) and lower concentration recorded at station AT3 (21.6 ou m^{-3}). This was similar to concentration for stations within the radius of 2-5 km which recorded less than 25 ou m^{-3} at stations AT9, AT10 and AT13 (Table 3). Stations such as AT11 ad AT12 recorded slightly higher concentrations compared to other stations with 34.6 ou m^{-3} dan 47.2 ou m^{-3}, respectively. The increase in odour concentration occurred due to the influence of odour contributed by the waste, treatment plant nearby both stations.

The concentration of odour at night time after rain: The odour concentration recorded at night time was almost at the same level with those recorded in the evening after rain with generally recorded concentration of less than 100 ou m^{-3}. Only at station on the landfill recorded a concentration at 38.9 ou m^{-3}. The concentration for station within distance of 2 km and between distance of 2-5 km recorded decreasing odour with the increase in the distance from the landfill except some stations which recorded odour concentration a little higher than stations within the same distance due to the influence of odour from other sources.

For instance, the concentration for station AT12 was 18.6 ou m^{-3} was higher than those stations within distance of 2 km to the landfill due to the contribution of

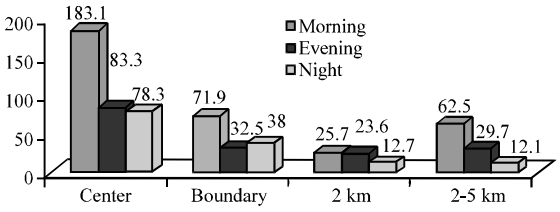

Fig. 2: Comparation of odour concentration in the vicinity of landfill after a rainy day

the odour from the waste treatment plant nearby. The same was with the concentration recorded at sampling station AT7 with a reading of 17.7 ou m^{-3} within distance of 2 km. This may be due to the operation of oil palm mill which emitted smoke into the air at night time after rain during the study (Table 3). In general, odour pollution occurred not only due to offensive smell but also unpleasant smell which was also regarded as odour pollution. The findings of the study indicated that the distance factor did have an impact on the concentration of odour from the landfill. The monitoring stations located in sources area and boundary of the landfill indicated higher concentration for all times of observation and at different times. Morning times showed high concentrations for all times of observations conducted at sources area or at center of the landfill with readings at 172.2 ou m^{-3} (morning), 407 ou m^{-3} (evening) dan 104 ou m^{-3} (night) (Fig. 1).

Meanwhile, the average concentrations for stations within 2 km radius and 2-5 km further from the landfill was higher concentrations compared to the observations at centre of the landfill and at the boundary. Nevetheless, the average concentration in the evening for distance 2-5 km was a little higher at 45.1 ou m^{-3}. This occurred due to the contribution of the garbage collection trucks which passed through, the area of the monitoring stations. In Table 3, station AT10 showed high concentration at 143.7 ou m^{-3} due to the influence of odour from the passing garbage trucks.

The average after rain concentration of morning, evening and night time odour indicated significant differences acording to the distance (Fig. 2). Similar to the average concentration at centre of landfill on normal day, the concentration after rain also indicated an average level of high concentration. Based on Table 3, it is found that the average concentration at the centre of landfill after rain was still high at 183.1 ou m^{-3} (morning), 83.3 ou m^{-3} (evening) and 78.3 ou m^{-3} (night). Based on distance, the average odour concentration for all times decreased gradually as the stations distance increase from the landfill. An exception was the average concentration of morning odour within distance of 2-5 km which was

slightly higher at 62.5 ou m^{-3}. This phenomenon occured due to the new odour recorded at AT12 considered high, at 217.7 ou m^{-3} which was the average of the high concentration in this study. The high concentration was due to the proximity of the station to the waste treatment plant whichgenerated strong odour during the duration of the field study (Fig. 2).

CONCLUSION

This study has therefore, shown real existence of interrelations between odour concentrations and the distance from the landfill. Generally the distance factor influenced the rate of odour concentration in relation to the primary sources. Even though, this study has indicated that the odour concentration was higher at the landfill and in areas within its boundary there were also other factors which influenced the odour concentration in areas further from the landfill. For example there exist other sources of odour such as an oil palm mill, chicken farm and wastes water treament plant.

A study based on human perception (Sakawi *et al*., 2011) also indicated similar phenomena in the vicinity of the landfill and its neighborhood. Distance factor showed responses of the same perceptions. Sensitive receivers who were nearer to the landfill indicated receptions of extremely strong odour. This is in contrast with those living further away whose reception of odour was of lower intensity.

Therefore, the use of Odour Concentration Meter XP-329 series III for the analysis of odour concentration based on field measurement was an important contribution to odour pollution research and a pioneer for studies on the management of wastes sources in Malaysia. The importance of the study on the odour concentration not only limited to the measurement of the concentration but also it may help identify the impact of the odour spread according to the distribution model. Furthermore the data may assist planners to identify the location for development vis a vis odour pollution mitigation by taking into account the impact on the sensitive receivers.

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