Annual NO_x to NO_2 Conversion using Jenkin Method

For long term impact assessment, the annual NO_2 concentrations are estimated using project specific empirical relationship derived from the latest available monitoring results from Environmental Protection Department's (EPD) General Air Quality Monitoring Stations (AQMS) (Yuen Long, Tap Mun, North, Tuen Mun) and Roadside AQMSs (at Mong Kok and Central).

The empirical relationship is described by a fitted curve of the selected annual NO_2 and NOx monitoring data through the formula below[1, 2]:

$$[NO_2] = \frac{-Z \pm \sqrt{Z^2 - 4[NO_x][OX]}}{2}$$

Where

$$Z = ([NO_x] + [OX] + {}^{J}/_{K})$$

[NOx] = NOx concentration

[NO_2] = NO_2 concentration

[Ox] = Sum of NO_2 and O_3 concentration

J = Photolysis rate of NO_2

K = Rate coefficient of the reaction between NO and O_3

The recent 5 years annual average data from the AQMSs are summarised in **Table 1**. Scattered plot for recent 5 years annual average NO_2 versus NOx concentrations of the selected AQMSs is shown in **Figure 1**. It is found that the curve would fit the monitoring data when J/K is 18.7 and [Ox] is $99\mu g/m^3$ without any underestimation and they are within typical value range in Hong Kong. The range of annual average [Ox] from the selected AQMSs is $75 - 116 \, \mu g/m^3$.

The fitted curve obtained was adopted for the annual average NO_x to NO_2 conversion. The curve is slightly higher than all the annual average data obtained from the selected AQMSs. The annual average NO_2 concentration predicted using the fitted curve obtained based on the measured annual average NO_x obtained from AQMSs are presented in **Table 1**. The annual average NO_2 concentration predicted are higher than the measured annual average NO_2 concentration so that there is no underestimation of the annual average NO_2 concentration.

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1 Jenkin M E, 2004a. Analysis of sources and partitioning of oxidant in the UK – Part 1: The NOx-dependence of annual mean concentrations of nitrogen dioxide and ozone. Atmospheric Environment, 38, 5117-5129.

2 Environment Agency UK 2007. Review of methods for NO to NO2 conversion in plumes at short ranges (https://www.gov.uk/government/publications/review-of-methods-for-no-to-no2-conversion-in-plumes-at-short-ranges)

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Table 1 - Annual Average NOx, NO$_2$ and O$_X$ Concentration ($\mu g/m^3$) in Recent Five Years (Year 2017 – 2021) at Selected EPD AQMSs

Air Quality Monitoring Station	Year	Measured NO$_2$ (ug/m^3)	Measured NO$_x$ (ug/m^3)	Measured O$_3$ (ug/m^3)	Measured O$_X$ (NO$_2$ + O$_3$, ug/m^3)	NO$_2$/NO$_x$
Yuen Long	2017	41	61	45	86	0.67
	2018	43	63	43	86	0.68
	2019	44	63	53	97	0.70
	2020	32	49	43	75	0.65
	2021	40	56	49	89	0.71
Tap Mun	2017	10	12	74	84	0.83
	2018	11	13	72	83	0.85
	2019	10	12	80	90	0.83
	2020	9	11	71	80	0.82
	2021	10	12	75	85	0.83
Central	2017	80	176	27	107	0.45
	2018	80	186	25	105	0.43
	2019	80	172	36	116	0.47
	2020	68	151	35	103	0.45
	2021	68	150	32	100	0.45
Mong Kok	2017	81	164	24	105	0.49
	2018	79	163	27	106	0.48
	2019	78	154	32	110	0.51
	2020	74	162	30	104	0.46
	2021	70	139	32	102	0.50
North	2021	36	51	57	93	0.71
Tuen Mun	2017	46	70	43	89	0.66
	2018	47	68	46	93	0.69
	2019	47	69	51	98	0.68
	2020	40	55	48	88	0.73
	2021	44	59	49	93	0.75

Note:

[1] North AQMS is a new AQMS set up by EPD since July 2020.

Figure 1 - Fitted Curve of the Selected Annual NO$_2$ and NO$_x$ Monitoring Data

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