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INGEGNERIA CHIMICA
MATERIALI AMBIENTE

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Determination of the Degradation of Nitrogen Oxides in the air by Airlite Technology

Introduction

Samples of the Airlite products, provided by AM Technology LTD were tested in order to evaluate its capability for degradation of NO_x in the air. The activity of the samples was determined evaluating NO_x degradation by using an analytical method based on chemiluminescence.

Objective of the measuring

For the measurement of the properties of the samples, an UV lamp with UV filter has been used, with two 15-watt tubes, having spectral emission centred at 365 nm (Biosigma) as in Fig.1. This is the standard lamp used in most of the standard's recommendations.

The test sample was placed in the photo-reactor at a distance from the light source such that the radiating flux at 365 nm (Fig. 1), measured by a radiometer inside the reactor, was ≈ 10 W/m^2 and placed at 1 cm below the test gas entry point.

The gas test was made using air and additional NO_x (sum of mole of NO + NO_2) at a stable total concentration of 550 ppb of NO_x with 1.56 % aqueous vapour in the photochemical reactor, which corresponds to a relative humidity of ≈ 50 ± 10 % at 25 °C.

To guarantee the best measuring conditions, the concentration of the mix of the gases was determined before flowing into the photo-reactor.

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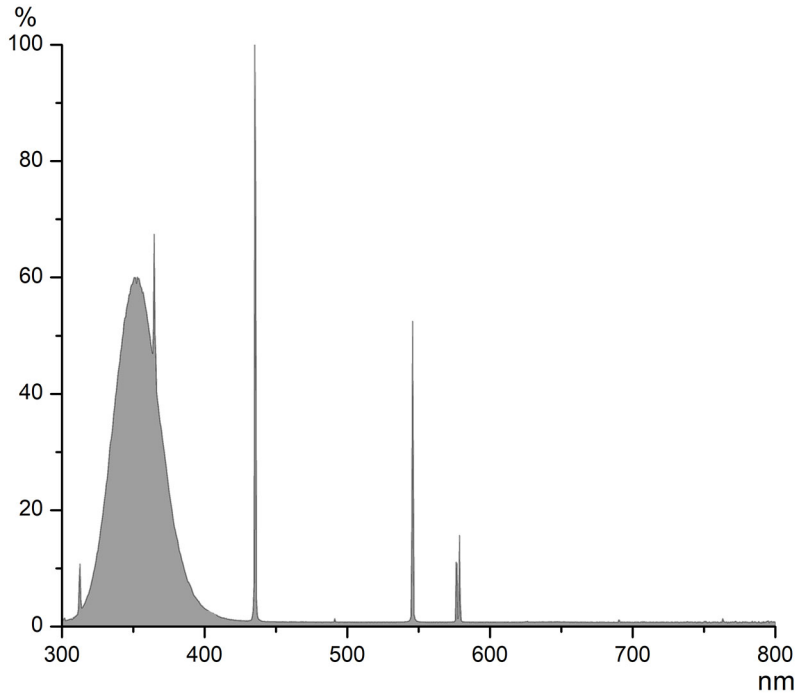

Fig. 1. UV lamp spectral distribution

The test gas flows into the photochemical reactor without irradiation, with a flow rate of 0.508 l/min, until obtaining steady concentration for at least 10 min.

The NO and NO_2 output concentrations under the illumination were registered for 5h.

By using the data registered by a NO_x analyser the amount of NO_x removed has been calculated in $\mu g/m^2$ instead of g/m^2.

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Method 1

Amount of NOx removed by the sample by taking into account the flow supplied and the area of the sample:

$$n_{NOx} = \frac{f}{A}\int\left(\phi_{NOx_i} - \phi_{NOx}\right)dt$$

where:

n_{NOx} is the amount of NO_x removed from the sample provided in $\mu g/m^2$

f is the gas flow provided in m^3/h

A is the area of the sample analysed provided in m^2

φ_{NOxi} is the part of the NO_x volume provided in $\mu g/m^{3*}$

φ_{NOx} is the output part of the NO_x volume from the reactor provided in $\mu g/m^{3*}$

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Method 2
Amount of NOx removed by the sample taking into account the volume of the test gas used and the area of the sample (PICADA Project):

$$n_{NOx} = \frac{V \int (\phi_{NOi} - \phi_{NO})\, dt}{A \cdot t}$$

where:

n_{NOx} is the amount of NO_x removed from the sample provided in $\mu g/m^2$

V is the volume of the reactor

A is the area of the sample analysed provided in m^2

T is the duration of the test in h

φ_{NOxi} is the part of the NO_x volume provided in $\mu g/m^{3*}$

φ_{NOx} is the output part of the NOx volume from the reactor provided in $\mu g/m^{3*}$

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Method 3

Amount of NO_x removed by the sample by taking into account the supplied flow of the area of the sample and the luminous flux (UNI 2007 adaptation):

$$A_F = \left(C_B - C_L\right) \cdot \frac{F}{S} \cdot I$$

where:

C_B and C_L are respectively the NOx concentration in the dark condition and at the end of the test, provided in $\mu g/m^3$

S is the geometric area of the sample expressed in m^2

f is the gas flow provided in m^3/h

I is the dimensionless intensity of the luminous flux, giving by correlating the intensity experimentally measured I^* (W/m^2) at 1000 W/m^2, that correspond to approx.100000 Lux, or the average value of sunlight reaching at noon on a July day:

$$I = 1000/I^*$$

*for the calculation of the concentration in $\mu g/m^3$, taking in consideration the European directives about NO_2, the NO_x is considered as NO_2 than, the conversion to $\mu g/m^3$ is given from: 1ppb NOx = 1.88 $\mu g/m^3$ at 25 °C and 1atm.

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Test report

Test conditions

- T 28 °C
- Relative Humidity 57 %
- Surface of the sample 0.0825 m^2
- Chemiluminescence analyser AC32 M Environnement SA
- Total NOx provided to the reactor 1088 ppb
- Reactor volume 0.012 m^3
- Flux 0.03 m^3/h
- Lamp UVA at 365 nm
- Irradiance 10 W/m^2

Test results

Method 1

NO_x removed by the sample	0.39 ± 0.018	g/m^2 12h

Method 2

NO_x removed by the sample	0.154 ± 0.008	g/m^2 12h

Method 3

NO_x removed by the sample	0.34 ± 0.014	g/m^2 12h

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Considerations

All the three methods, take from literature, show a significant reduction of NO_x by the Airlite samples. Values differs because of different calculations models. With the exception of Method 2, based on old Picada Project assumptions, both Method 1 and Method 3 give values in excess of 0.32 g/m^2 12h.

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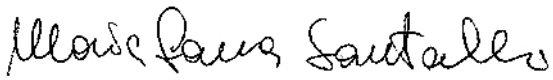
Prof. Dott. Maria Laura Santarelli



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