The Air Quality Challenge

Introduction

Air quality is a principal factor impacting upon the welfare, health and climate on our planet. The subject is complex considering the emissions from many sources (natural and man-made), the atmospheric chemical reactions of these emissions and the trans- boundary air pollution between continents.

There are two main challenges:

Ozone formed by photochemical reaction between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in sunlight.

Particulates, PM2.5, which are primary such as emitted in diesel engine exhaust, and secondary formed by chemical reactions in the atmosphere such as ammonium sulphates, ammonium nitrates and secondary organic aerosols.

Ozone occurs as a haze after a few days of sunshine in spring and summer. It is a powerful irritant that can inflame the lung passages, and damage our health. In contrast, Ozone in the stratosphere protects us from ultraviolet radiation.

Particulates-mainly fine particles of less than 2.5 microns, PM2.5 -can penetrate the passages in the lungs. It is believed that it is the number of small particles rather than their chemical composition which most affects our breathing.

In Europe, two main bodies, the European Commission and the United Nations Economic Commission for Europe, are setting targets for emissions, including NOx, NMVOC (Non Methane VOC), SO2, NH3 and PM2.5. These take the form of ceilings on each these emissions for all countries in the EU-28 for 2020 and 2030 (the EC National Emissions Ceiling Directive-NEC). The UNECE Gothenburg Protocol, which goes beyond the EU, covers emissions ceilings for Norway, Ukraine, Switzerland, Russia, Canada and the US as well.

Ozone and its Control

Ozone is not just an urban event as the relatively high levels of nitrogen oxides in cities, largely from vehicle exhausts, act to neutralize the effect of the sunlight on VOCs and reduce the formation of Ozone in urban areas. For this reason, Ozone peaks are usually found downwind of towns and cities. Furthermore, Ozone knows no international boundaries with Europe experiencing high levels of pollutants transported from Asia and the United States. Background Ozone levels are therefore increasing and European Ozone levels continue to exceed both the European Commission Ozone Directive and World Health Organization Ozone Standards.

Results from Air Quality Ozone Models are used to determine the correct emissions reduction strategy (1). In the US in the early 1990s the level of VOCs was underestimated by a factor of three or more because super emitters-the 10% of road vehicles which produce 50% of emissions- and, biogenic emissions from

trees and plants, were often ignored in calculations. The strategy chosen was to reduce VOCs when, in fact, NOx reduction would have been the correct approach.

Europe has reduced man-made VOCs substantially since the 1990s with Solvent VOC emissions and Mobile Source emissions now each reduced to some 2Mtonnes. This should be compared with Biogenic emissions now estimated at 13Mtonnes or more in the European Union (2). European Industry, both Motor Manufacturers, and Solvent Producers have played their full part in reducing VOC emissions.

European States are now predominately NOx limited-in that **Ozone reduction responds more to NOx reductions** -and that is the way forward. In real terms, this puts the pressure on Vehicle exhaust emissions-particularly the diesel engine with much higher levels of NOx than its gasoline engine counterpart.

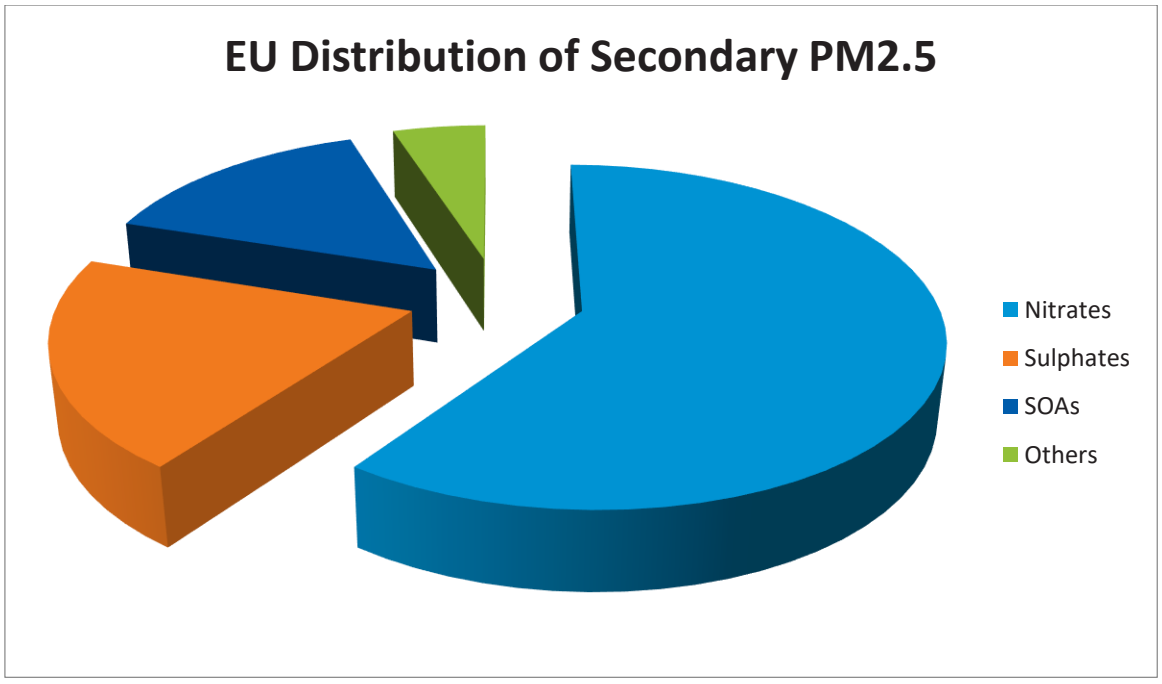
Recent work by the European Environment Agency demonstrates that over 40% of NOx emissions (3) come from mobile sources. By far the majority of this 40% originates from diesel engines.

The challenge now in Europe is the further reduction of NOx.

Particulates and their Control

In summer months in Europe, urban Particulates of small diameter (PM2.5) consist of primary particulates which originate mainly from the tailpipe of diesel engines. These constitute approximately 50% of the total PM2.5.

Secondary particles, the most important of which are inorganic formed by the oxidation of sulphur dioxide and nitrogen oxides with ammonia, producing ammonium sulphates and nitrates, constitute the remaining 50% of PM2.5. These inorganic secondary aerosols are dominated by ammonium nitrates which account for at least 30% of PM2.5 following the continued decline of sulphur dioxide in European air.



Secondary organic aerosols (SOAs) are formed in much smaller amounts from the chemical degradation of hydrocarbons (principally terpenes from Biogenic sources) in the atmosphere.

The European Commission is encouraging the reduction of ammonia emissions (4) as a result of regulation related to the National Emissions Ceilings Directive (NEC) and the Integrated Pollution Prevention and Control Directive (IPPC) which impact on agricultural activities. These Ammonia regulations are being implemented by national legislation in individual European Member States.

These reductions of Ammonia supplemented by further reductions of Nitrogen Oxides will enable secondary PM2.5 to be reduced substantially.

THE WAY FORWARD FOR IMPROVING EUROPEAN AIR QUALITY

The clear challenge in improving European air quality is a further reduction in Nitrogen Oxides from all Member States. The reduction in NOx will reduce European Ozone and, importantly ammonium nitrates, a main component of secondary particulates (PM2.5).

Further reductions in ammonia from Agriculture will also have a real impact on bringing particulates into line with European standards for PM2.5.

Whilst NOx reduction will put pressure on mobile sources, particularly the diesel engine, the end result will be improved air quality and quality of life in the EU28 Member States.

Further reductions in VOCs from both Mobiles Sources and Solvents will help to improve air quality, yet it has to be noted that man-made VOCs are small by comparison from those from trees and plants (Biogenic sources).

Finally, it has to be understood that Ozone and PM2.5 know no international boundary, and all countries both within and outside Europe (5) have to work together on the “Air Quality Challenge”.

John Pearson December 2016

References

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