LUCHTKWALITEIT

IPL

INNOVATIE PROGRAMMA

Dutch Air Quality Innovation Programme concluded

January 2010

Dutch Air Quality Innovation Programme concluded

After five years the Air Quality Innovation Programme coordinated by Rijkswaterstaat, the Netherlands' Directorate-General for Public Works and Water Management, is transferring its know-how on measures to improve air quality along motorways to the project principals (the ministries of Transport and Environment), knowledge institutes, engineering consultancies and the market. The know-how has been built up in the course of a series of unique and large-scale practical trials carried out under the innovation programme.

Cars are set to become steadily less polluting, certainly in the longer term. Today, though, road traffic is still one of the major sources of air pollutant emissions. And those emissions must decrease. At the European level it has been agreed that atmospheric concentrations of particulates (PM_{10}) must meet European standards by June 2011 and those of nitrogen oxides (NO_2) by January 1st, 2015.

The Netherlands intends to meet those deadlines and the associated standards, which is why the National Cooperative Air Quality Programme (NSL) was created. What this programme essentially comprises is a package of policies to improve Dutch air quality. Besides the NSL, in 2005 the Air Quality Innovation Programme (IPL) was established in pursuit of innovative ways of achieving a further improvement in air quality along the country's national road grid. The programme was implemented by Rijkswaterstaat with the ministries of Transport and Environment acting as project principals.

Rijkswaterstaat

Center for Transport and Navigation

P.O. Box 5044

2600 GA DELFT

Tel: +31 (0) 88 - 7982 222

www.ipluchtkwaliteit.nl

Six measures

Basing itself on international literature and laboratory studies, IPL investigated the full array of potentially promising measures to enhance air quality. These included modified roadside noise barriers, cleaning of road surfaces, catalytic coatings, motorway canopies with air treatment, roadside vegetation and Dynamic Traffic Management.

Unique collaboration between government, industry and knowledge institutes

For the first time in Europe, theories about air quality have been put through their paces in large-scale practical trials. In its four years of activity the Innovation Programme organised a series of competitions to tap into the knowledge and creativity available in the marketplace. The unique collaboration between government, industry, research centres and knowledge institutes has generated valuable information on ways of improving ambient air quality. The practical trials were supervised, evaluated and translated by internationally recognised scientists and experts, which means the results are scientifically and internationally recognised.

Final reports and recommendations on use

A number of the measures tested appear to be eligible for practical implementation. Some of the others would appear to be less effective than first anticipated on the basis of literature and laboratory studies. This is also valuable information, though. Now the government can focus on those measures that look most promising.

For each individual measure, the Air Quality Innovation Programme has collaborated with national and international air quality experts to draw up final reports and recommendations on implementation, allowing the market and knowledge institutes to make full use of all the valuable measurement series brought together by IPL.

Information and database

The final reports and recommendations will be completed in early 2010 and then be available for downloading from the IPL website www.ipluchtkwaliteit.nl or from Kennisplein at www.verkeerenwaterstaat.nl. In addition, a database has been created in which all the measurements obtained during the IPL programme are archived.

Practical proof of impact of noise barriers on air quality

Noise barriers reduce concentrations of nitrogen oxides and airborne particulates along motorways. That is the conclusion drawn by (international) air quality experts based on the measurements obtained during two years of large-scale practical trials. The data were recorded at the Barrier Test Site, the experimental station set up by the Air Quality Innovation Programme, IPL, along the A28 at Putten.

From literature and wind tunnel studies it had already been concluded that noise barriers might make a significant contribution to improving air quality.
In May 2007, IPL therefore organised a competition challenging companies to come up with innovative barrier designs having an additional impact on air quality compared with conventional barriers. This led to a large number of innovative noise barriers. Some of these were tested in a practical setting, others in the laboratory. Nowhere in the world had such large-scale practical trials previously been conducted in the context of air quality.

Barrier Test Site

Besides the glass reference barrier, eight different (noise) barriers were erected at the Barrier Test Site and tested in five rounds of measurements. At three distances behind the barriers the concentrations of nitrogen oxides and particulates were measured. At the locations behind the barriers this led to a reduction in levels of nitrogen dioxide, nitrogen oxides and particulates. The impact of noise barriers on air quality has thus been demonstrated.

Results

The results are valid for the experimental location and the period in which measurements were conducted. Additionally, measurements were performed on a barrier of limited length (100m) in a rural setting. These results cannot therefore be applied one-on-one to an arbitrary location or period, so further study is required.

The results for the four-metre high reference barrier are reported in the table below, which shows the impact on air quality for NO_2 and NO_x at 5, 10 and 28.5 metres behind the barrier. For PM_{10} the impact is shown at 5 and 10 metres behind the barrier.

	average impact 10m [%]	average impact 28.5m [%]
NO_2	14	7
NO_x	20	13
PM_{10}	34	

For the innovative barriers tested at the Test Site no significant improvement of the air quality impact was observed compared with the reference barrier.

Road cleaning: an effective particulate control strategy

Spraying road surfaces with a solution of calcium chloride proves to be an effective means of reducing concentrations of airborne particulates. That is the conclusion drawn by (international) air quality experts based on the measurement data accumulated in a series of practical trials carried out under the Air Quality Innovation Programme, IPL.

In collaboration with the municipality of Nijmegen, in 2006 a practical trial was conducted in which a number of methods of wet-cleaning road surfaces were put through their paces on an urban road. Based on this limited trial, particulate levels were found to be lower with porous asphalt concrete (PAC) than with dense asphalt concrete (DAC) surfaces. In addition, cleaning with a PAC-cleaner limited the resuspension of particulates. Spraying water on the DAC also had a positive effect.

The 'Cleaner, quieter and more homogeneous asphalt' competition

Based on the positive results in Nijmegen, IPL organised a competition for market parties, challenging them to come up with innovative ways of cleaning a motorway. On the A50 south of Apeldoorn three methods of reducing airborne particulates were tested: two dry methods and one involving the spraying of wet road salt (calcium chloride sprayer). The latter proved to have a positive impact on levels of resuspended particulates. Given these promising initial results, it was decided to conduct further trials on this method.

In 2009 extensive trials were therefore carried out with the spraying of calcium chloride on the A73 near Malden. In the experiments a road-salting vehicle is used to apply the salt to the road, just like happens in winter to de-ice road surfaces. In contrast to winter-salting exercises, though, in these trials a calcium chloride solution is sprayed onto the road surface. This salt solution absorbs water, so that the surface remains damp for at least 24 hours. And damp roads absorb airborne particulates. Initial results indicate that spraying the road surface with calcium chloride reduces the share of the road in the background concentration by over 10%. Wet-cleaning of road surfaces thus appears to be an effective means of reducing particulate levels.

Clarity about impact of vegetation on motorway air quality

Virtually no evidence could be found for roadside vegetation of deciduous or coniferous trees having any impact on airborne particulates and nitrogen dioxide in the direct vicinity of motorways. This is the conclusion drawn by (international) air quality experts based on the measurement data obtained during three large-scale practical trials carried out under the Air Quality Innovation Programme, IPL.

Roadside vegetation has an unknown influence on air quality. In the literature there are strong claims of a possible reduction of particulate and nitrogen oxide levels due to the filtering action of the greenery. In addition, vegetation affects wind speed and turbulence, causing pollutant concentrations to rise in some places and fall in others. Given the lack of clarity about the effects of vegetation, IPL carried out practical measurements to assess the real-world impact of roadside vegetation.

Following an initial practical try-out along the A50, two additional trials were commissioned by IPL at different locations along the same motorway. Around Vaassen, measurements were performed on existing roadside vegetation. Near Valburg, 50 km further south, measurements were made on a stretch of vegetation specially planted for the study. The aim of the measurements was to establish nitrogen oxide and particulate concentrations in the vicinity of the motorway[1], to compare the situation with and without vegetation.

Results

The experiments were not aimed at determining how much nitrogen oxide and particulates are absorbed by the greenery. The changes in wind speed and direction are plain to see, though. In summary, it can be said that pollutant concentrations directly along the motorway edge rise, falling again at some distance from the road if trees are planted along it.

Immediately alongside the road the impact of vegetation on air quality is insubstantial. Further away (50-100 m from the road) the effects of roadside trees are positive.

[1] The determining factor is the statutory “validation distance” from the edge of the road (10 m). This means that for a particular air improvement measure to be applied, it must have an impact close to the road’s edge.

DTM helps reduce road traffic contribution to air pollution

According to preliminary studies, certain measures in the realm of Dynamic Traffic Management (DTM) appear to have a positive effect on air quality. Because of the dynamics of both weather and traffic, though, it is hard to assess their precise impact and range of application. This is the cautious conclusion drawn by the Air Quality Innovation Programme, IPL, based on a series of studies. Potential DTM measures include introduction of dynamic speed limits and closure, or opening, of motorway lanes to all traffic or to the most polluting freight vehicles.

Under the IPL programme the air quality impact (particulates and nitrogen oxides) of implementing some of the most promising DTM measures on the motorways around Rotterdam was modelled. The aim was to tackle specific traffic bottlenecks and manage traffic flows on the basis of air quality forecasts. DTM measures can be targeted very precisely in terms of time and place, but are only effective under specific conditions. Based on the results, a series of criteria have been drawn up that such measures need to meet if they are to be effective in improving air quality.

Dynamax

To practically assess the impact of DTM on air quality, IPL teamed up with the Dynamax project set up by Rijkswaterstaat, the Directorate-General for Public Works and Water Management, which is currently conducting trials with variable speed limits on the Dutch motorway grid. On the A58 between Goirle and Tilburg the effects on air quality are being investigated. On days that the predicted daily average particulate concentration threatens to exceed the limit on this road section, the speed limit is reduced from 120 to 80 km/h.

Results

Given the dynamic nature of these kinds of measures and the potential for targeted application at air quality ‘hotspots’, DTM appears to be a suitable means of reducing annual average NO_2 levels and daily average PM_{10} levels. Air quality and traffic flows are both prone to considerable fluctuation. Appropriate DTM measures reduce traffic emissions through a combination of better traffic flow, reduced congestion and routing the heaviest polluters around critical locations.

Motorway canopies and air treatment to improve air quality

Covering a motorway with a canopy is an effective way of improving air quality along motorways. It is feasible to develop light-weight canopies that are structurally sound, safe and sustainable. However, the costs are considerable: between 15 and 70 million Euros per kilometre of 2x3-lane motorway. These are the conclusions drawn by (international) air quality experts based on the measurements obtained during a series of practical trials carried out under the Air Quality Innovation Programme, IPL.

The Programme also examined various different methods of air treatment, encompassing both active and passive dispersion techniques and treatment technologies. In this context, ‘active’ means that outside energy is required, for powering fans, for example. In the passive methods use is made of ‘smart’ canopy or tunnel architecture, allowing the (vehicle) wind and sun to dilute the pollution.

Practical trials

In addition to all the information gathered in the initial phase, two practical trials were also carried out. One of these was a test in the Thomassen Tunnel on the A15 with the Electrostatic Concept developed by BAM and Delft University of Technology. The maximum result measured in the tunnel was a 15% reduction of vehicle-related particulates. With the insight gained in this practical trial and after further system optimisation it is anticipated that the reduction percentage can be boosted further. So although the Electrostatic Concept seems to hold out promise for improving air quality, the system still needs to put through its paces.

Results

Because of the costs and ecological footprint in the case of active air treatment, there are very good reasons for opting for passive dispersion strategies. Cost-effective variants include a canopy with apertures or an open slot in the roof. The advantage of such designs is that the emissions occur higher up and closer to the middle of the road. In many situations this would mean that air quality standards are met.

Bron: Rikkelman Techniek

Improved air quality with coating of titanium dioxide not demonstrated

No evidence has been found that a coating of titanium dioxide applied to roadside noise barriers can improve air quality (nitrogen oxides). This is the conclusion drawn by international air quality experts based on the measurements made during the practical trials carried out under the Air Quality Innovation Programme, IPL.

Based on earlier literature studies and laboratory testing it was anticipated that a coating of titanium dioxide (TiO_2) on noise barriers would convert nitrogen oxides (NO and NO_2) to innocuous nitrate, which would then be flushed into the sewer or groundwater when it rained.

Practical trials along the A1 and A28 motorways

Two series of practical trials were conducted during the course of the IPL programme. First of all, four panels with different coatings were fitted to an existing noise barrier along the A1 at Terschuur. Later, a porous noise barrier optimised for air quality with a coating was erected along the A28 at Putten. At both locations measurements were performed under a range of weather conditions.

The most likely explanations for the low rate of conversion during the trials along the A1 at Terschuur and the A28 at Putten are the short contact time between the air and the barrier, relatively unfavourable meteorological conditions (wind direction, light intensity), the high relative humidity and the frequent low temperatures in the Netherlands. All in all, then, no evidence was found for motorway air quality (nitrogen oxides) being improved by means of a TiO_2 coating on noise barriers.

Publications Air Quality Innovation Programme (Dutch)

1a | Final report Noise barriers

1b | Recommendation on implementation Noise barriers

2a | Final report Vegetation

2b | Recommendation on implementation Vegetation

3a | Final report Road cleaning

3b | Recommendation on implementation Road cleaning

4a | Final report Coatings of titanium dioxide

4b | Recommendation on implementation Coatings of titanium dioxide

5a | Final report Canopies and air treatment

5b | Recommendation on implementation Canopies and air treatment

6a | Final report Dynamic Traffic Management (DTM)

6b | Recommendation on implementation Dynamic Traffic Management (DTM)

7 | IPL-database

8 | Final report Scientific Board

9 | Lessons learned: Measuring and calculation of air quality