



MINERAL PAINTS – THE PHOTOCATALYTIC DIFFERENCE

TECHNICAL INFORMATION

UK AIR QUALITY

Air pollution has negative impacts on human health and the natural environment. Whilst levels in the UK have been declining, there are more measures which need to be taken, specifically with regard to Nitrogen Oxides.

Nitrogen Oxides are produced by industrial and traffic pollution, are irritants and affect the human respiratory system. In the presence of VOCs, Nitrogen Oxides can react and create ozone, which is a highly reactive form of oxygen and a significant health risk even at low concentrations.

In terms of the paint industry, the effects on air pollution should be considered from the manufacture of the materials through to the resultant affects of material application i.e. the release of VOCs. Using natural mineral paints alone has a positive effect on air quality.

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NITROGEN OXIDES

- Even at low concentrations Nitrogen Dioxides are harmful to health
- Harmful to respiratory tract and irritating to the mucous membranes of the respiratory system
- Increases the sensitivity to infectious diseases
- Despite reduction measures that have been introduced often the limits set are still exceeded in many places



REDUCTION OF POLLUTANTS BY PHOTOCATALYSIS

The term photocatalysis describes an operating principle.

- The word 'catalysis' designates the acceleration of a chemical reaction or conversion by a substance (catalyst), which is not consumed in doing so.
- The 'catalyst' remains stable.
- 'Photo' means, that the substance acting as the catalyst (or 'accelerator') is activated by the light.

In photocatalysis, a substance ('catalyst') is stimulated by light ('photo') to initiate or accelerate a chemical reaction, without being consumed.

POLLUTANT DECOMPOSITION BY PHOTOCATALYTIC TITANIUM DIOXIDE

- Photocatalysis can be used for many building materials, including paints.
- The catalyst is a very fine titanium dioxide pigment.
- The photocatalytically active pigment (catalyst) can decompose organic substances and inorganic gases into harmless components by oxidation processes.
- This effect can be used to degrade air pollutants.

TITANIUM DIOXIDE

Titanium dioxide (TiO_2) is the tenth most common element of the Earth's crust which is 0.43 % of the Earth's surface. TiO_2 is a non-toxic mineral.

It occurs naturally in three crystalline shapes - brookite type, rutile type, and anatase type.

- Brookite type has low photocatalytic activity.
- Rutile type has high reactivity and is commonly used for white pigment in paint, toothpaste, etc.
- Anatase type has highest overall photocatalytic activity, ideal for self-cleaning coatings.

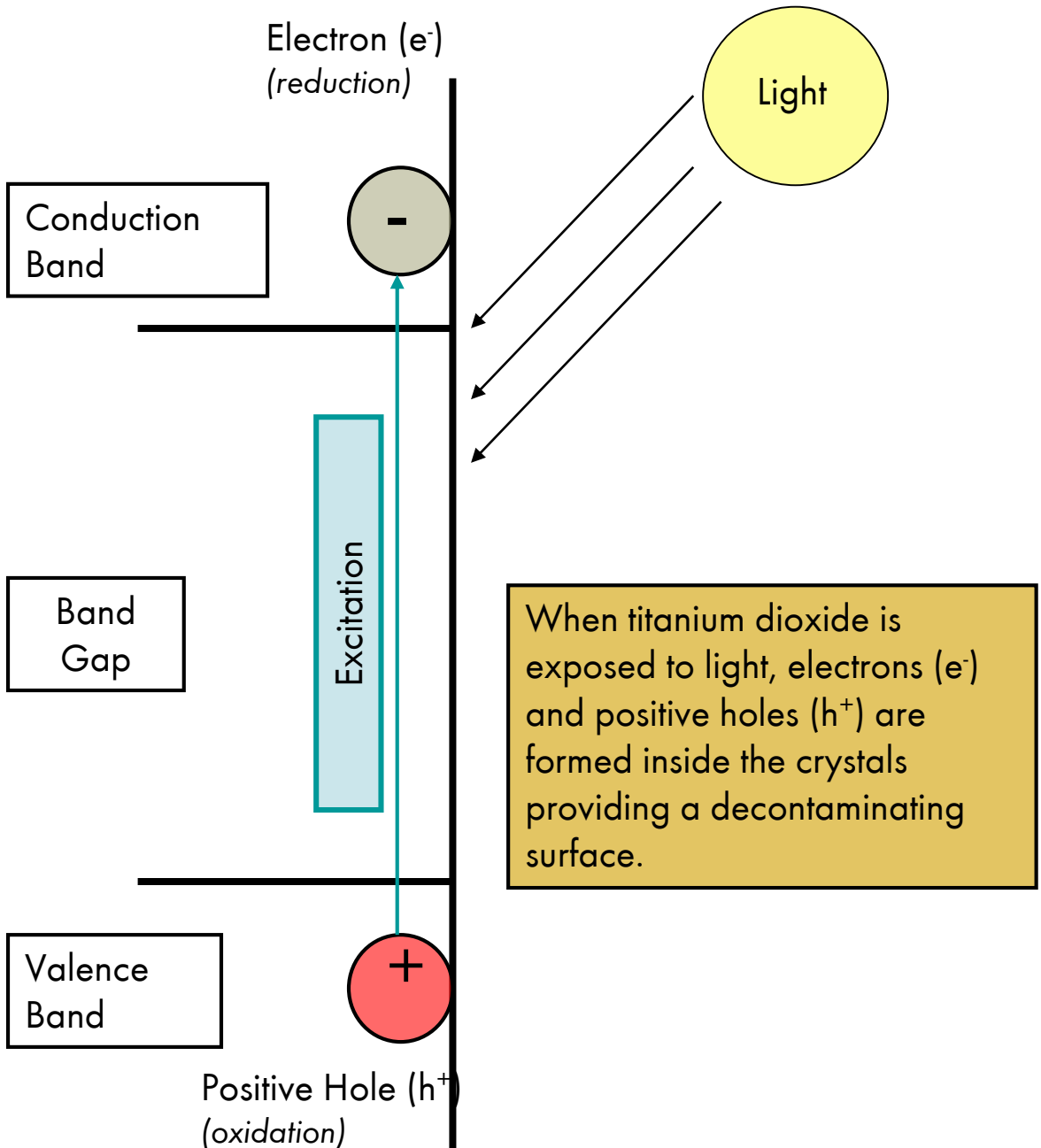
Natural
Anatase



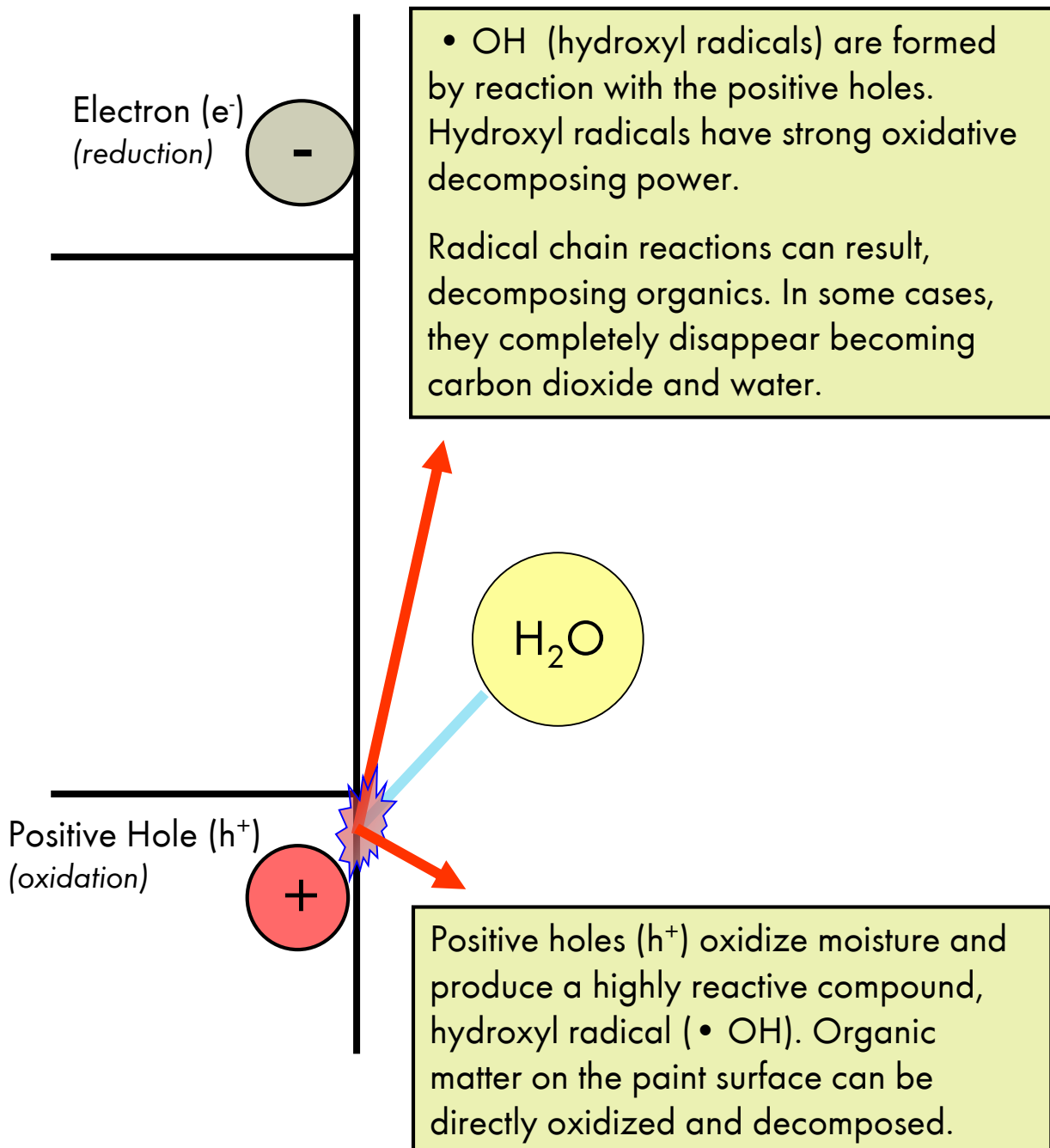
Natural
Rutile



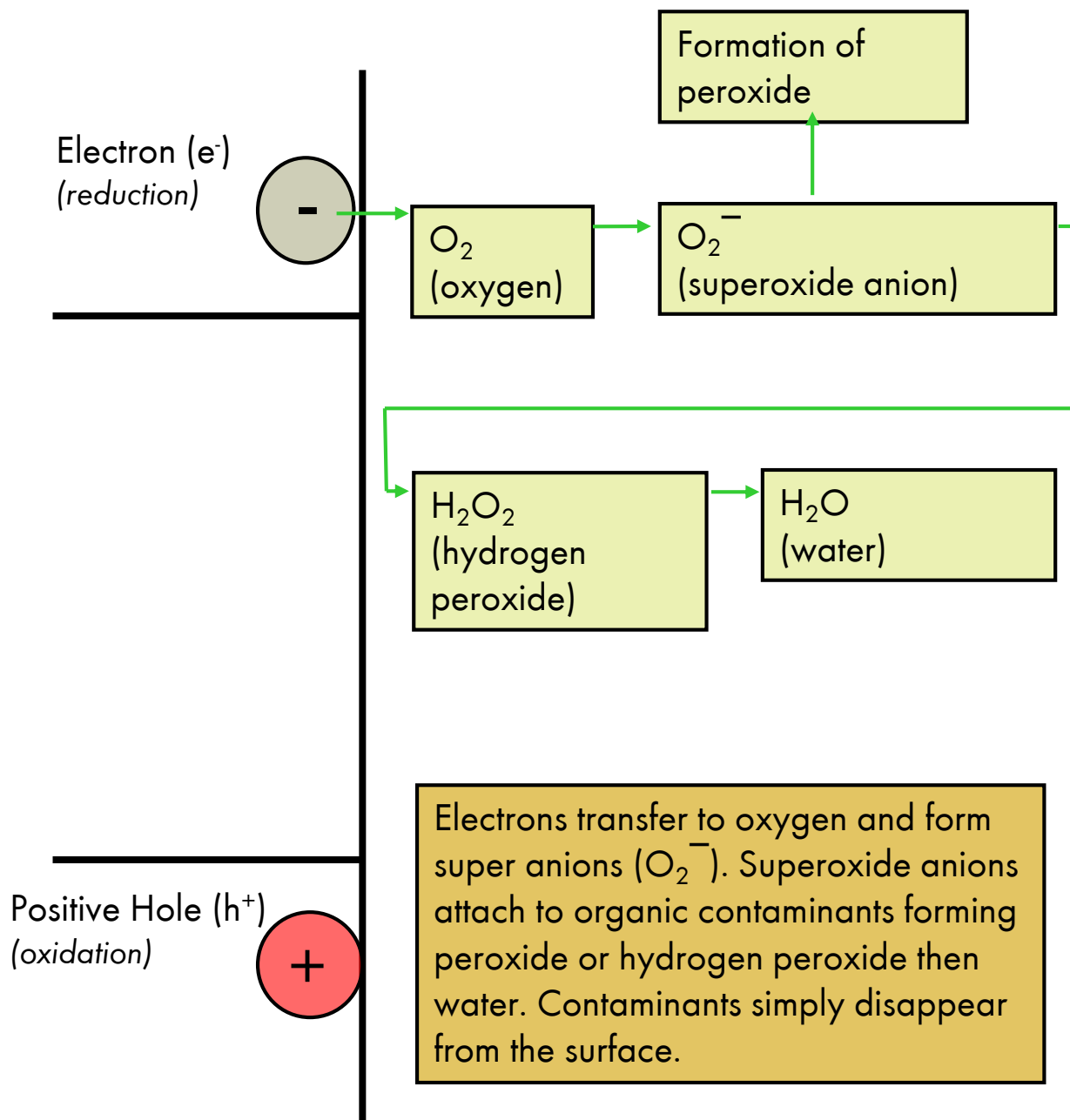
HOW IT WORKS - ACTIVATION



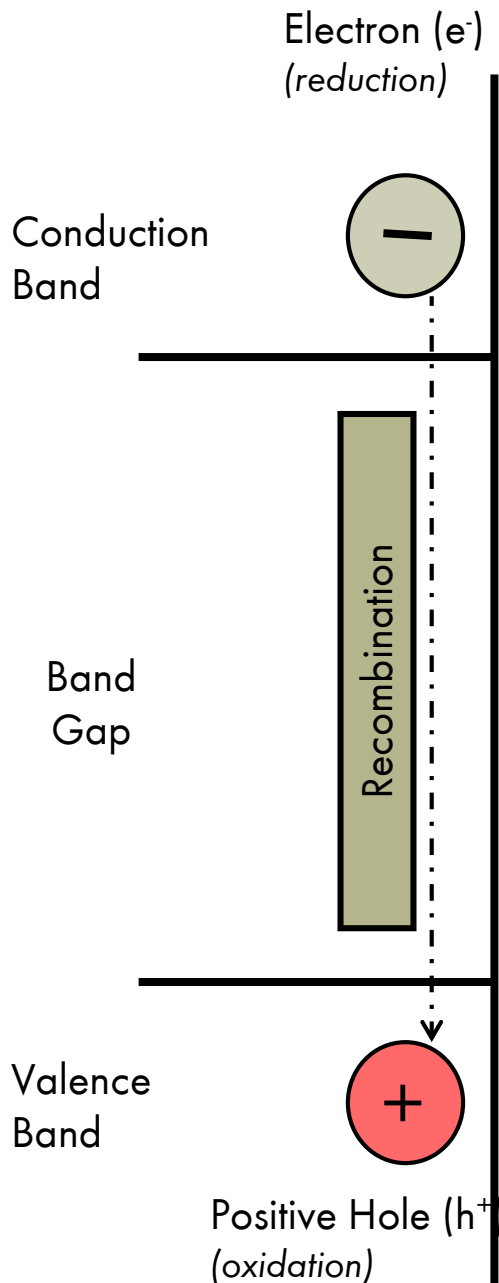
OXIDATION MECHANISM



REDUCTION MECHANISM



HOW IT WORKS - AT REST



When darkness prevails, electrons (e^-) slowly return to the positive holes (h^+) they left behind, extending the photocatalytic efficiency for a while longer.

MINERAL PAINTS

Mineral paints are different to conventional film forming coatings because they are manufactured using natural earth oxide pigments and potassium silicate. They do not contain any harmful ingredients such as VOCs, solvents or petrochemicals and have no detrimental affect on either the substrate, environment or air quality.

When applied to mineral substrates, mineral paints penetrate into the surface creating a microcrystalline structure which provides an integral protective and decorative finish. This crystalline structure allows free passage of moisture vapour, eliminating blistering and flaking of paint. Mineral paints also protect the surface from the ingress of moisture.

The crystalline structure also maximises the surfaces area for photocatalytic reaction.

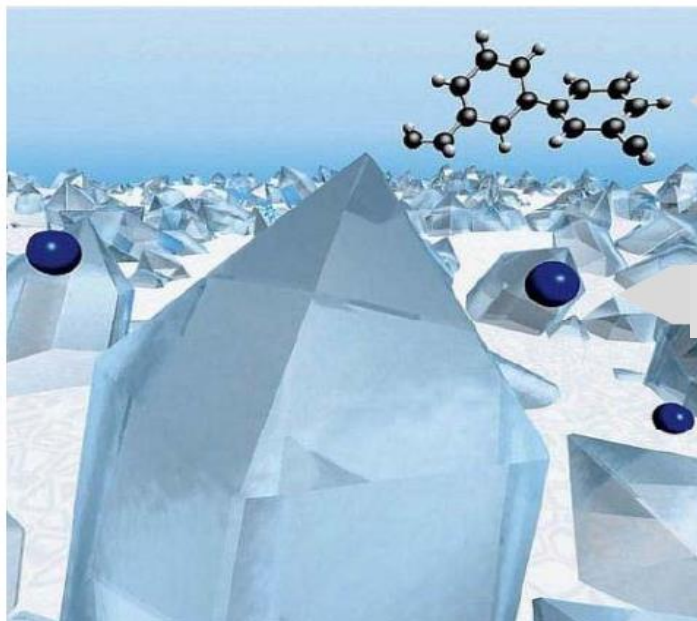


MINERAL CRYSTALLINE STRUCTURE

The photocatalytic processes take place at the open, crystalline structure of the embedded titanium dioxide.

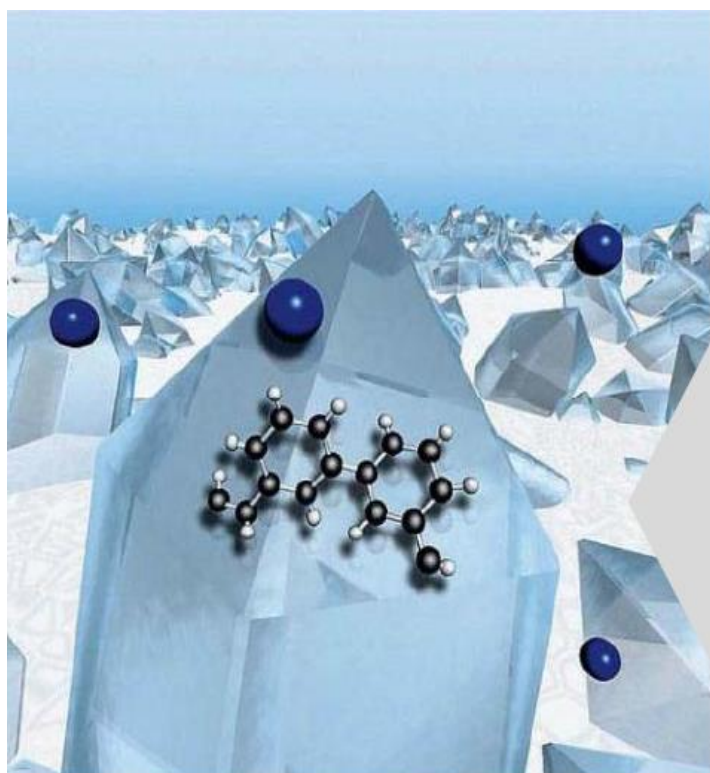


VISUALISATION



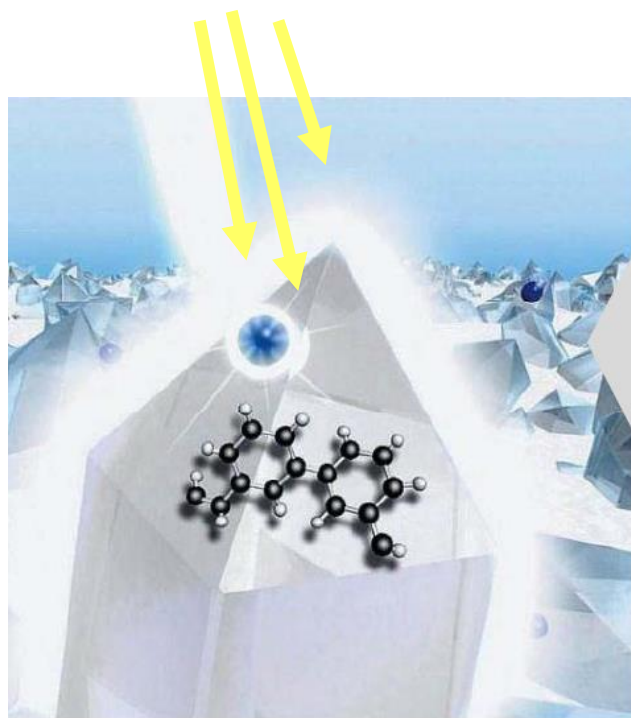
Pollutant molecule

Oxygen

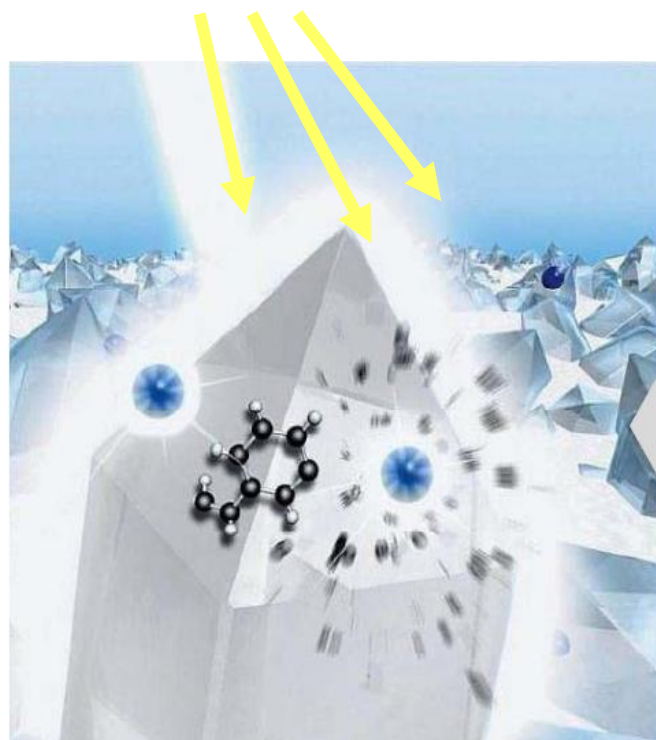


Air pollutants, such as nitrogen oxides or VOCs adhere to the photo-active surface

VISUALISATION

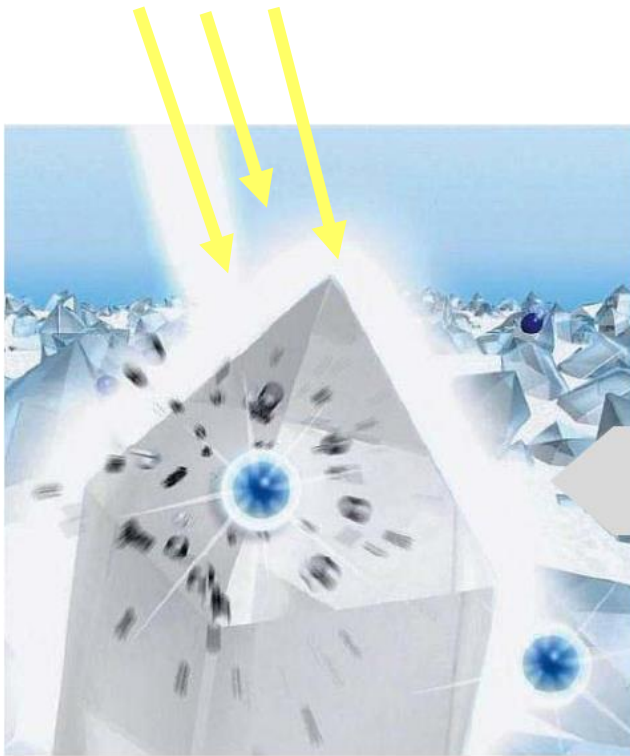


Light supplies the catalyst with energy – and the catalyst transfers it to the oxygen



The oxygen becomes activated and is able to break apart the pollutant molecule

VISUALISATION



The pollutants are degraded



The catalytic effect remains active as long as the photoactive pigment is supplied by the light with energy

WHAT KIND OF POLLUTANTS ARE DEGRADED?

Pollution by industry and road traffic for example:

- Nitrogen Oxides (NOx)
- Ammonia gas (NH₃)

Harmful indoor gases like for example out-gassing from furniture or cigarette consumption:

- VOCs (Benzene, Toluene)
- Formaldehyde, acetaldehyde
- Aromatic polycondensates

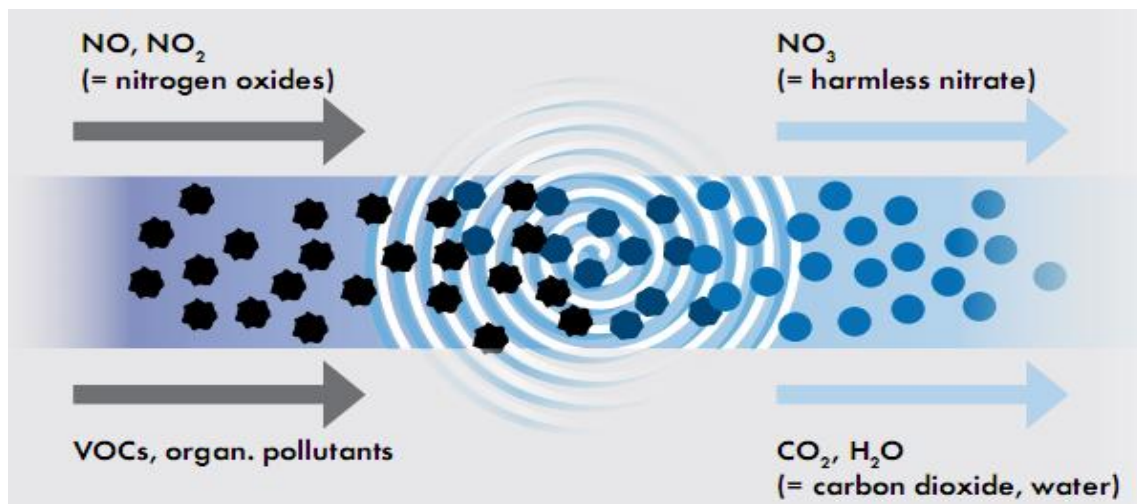
Organic particles or grease-like soiling for example:

- Stearates (i.e. soap, deodorants, lubricants etc)

Even bacteria and fungi can be clearly reduced by the photocatalysis

REACTION PRODUCTS

Reaction products are harmless like nitrates, carbon dioxide and water.



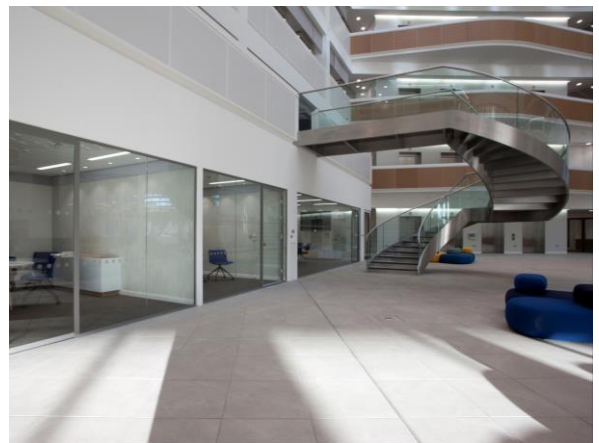
KEIM SOLDALIT-ME & KEIM ECOSIL-ME

- Photocatalytic high performance mineral silicate paints for internal (KEIM Ecosil-ME) and external (KEIM Soldalit-ME) application
- MiNox effect - reduces noxious gases and odours, transforming them into natural substances
- Contain a high-class photocatalyst - Anatase Titanium Dioxide
- Improves air quality
- Mould and fungi resistant
- Suitable for people with allergies
- Benefits for both health and the environment
- Long life protective and decorative finishes.

KEIM SOLDALIT-ME

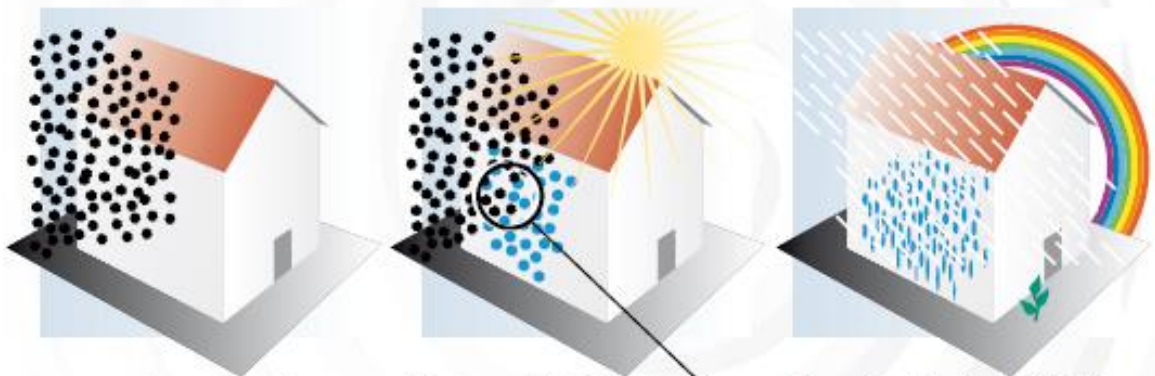


KEIM ECOSIL-ME



HOW DOES KEIM SOLDALIT-ME WORK?

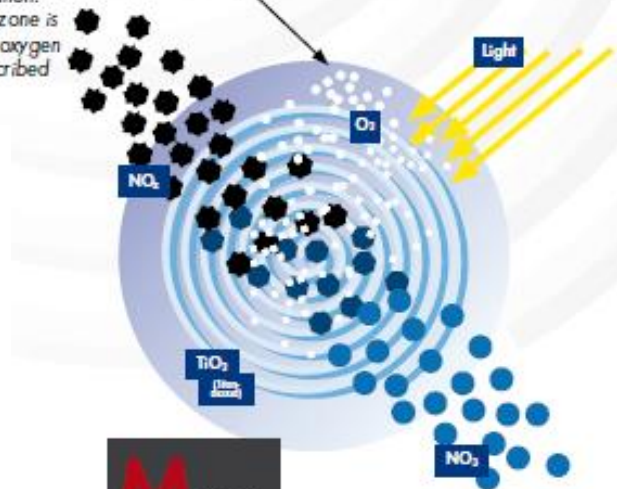
Degradation of pollutants by means of photocatalysis (schematic diagram)



Nitrogen oxides are deposited on the surface of the paint

When exposed to light the nitrogen oxides are turned into harmless nitrate (NO₃) by means of oxidation. Furthermore, ozone is converted into oxygen during the described reaction.

The easily soluble nitrate (NO₃) is then washed off the surface by rain.



The catalyst titanium dioxide is not consumed. As long as the crystals are supplied with energy by electromagnetic waves (light), the process remains active.

CHALLENGE - PHOTOCATALYTIC PAINTS & EFFICIENCY

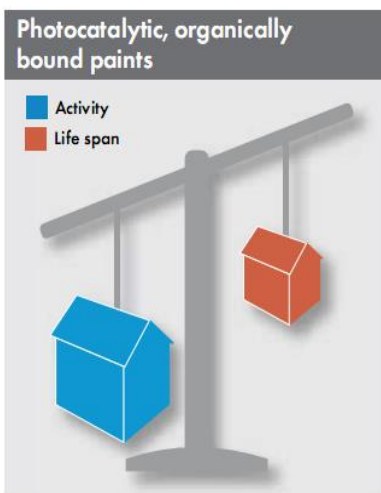
The efficiency of photocatalytic building material is determined by:

- the quality of the photocatalyst,
- the amount of the photocatalyst used,
- the availability of the photocatalyst on the building material surface.

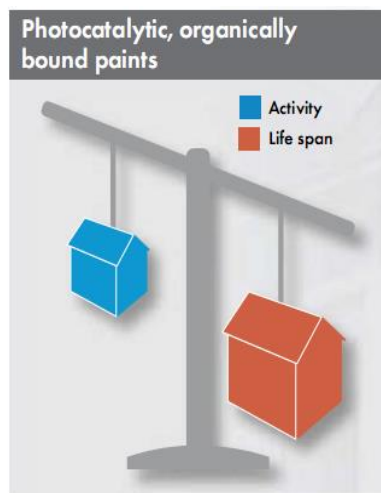
The photocatalytic effect has the capability to decompose organic substances. This virtually has a "self-destruction effect" in conventional organic based paints. The consequences are chalking, premature weathering and a correspondingly much shorter service life of the coating.

PHOTOCATALYTIC MINERAL PAINTS – HIGH PERFORMANCE SOLUTION

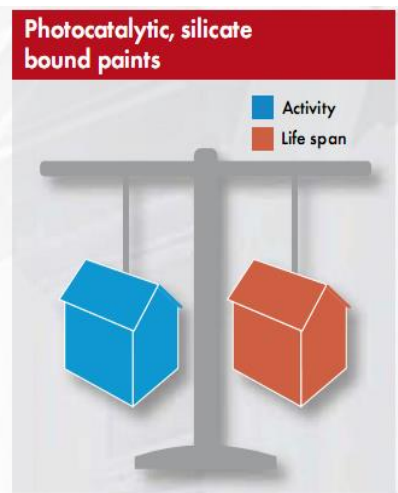
- The higher the contact surface between the pollutant and the photocatalytically active surface, the better the effect.
- High specific material surface = high contact surface
- The micro-structured surface of sol-silicate paints is very good



Either ... good activity (sufficient pigments) but, very reduced life span.



or ... good life span but, no optimal activity (insufficient pigments)

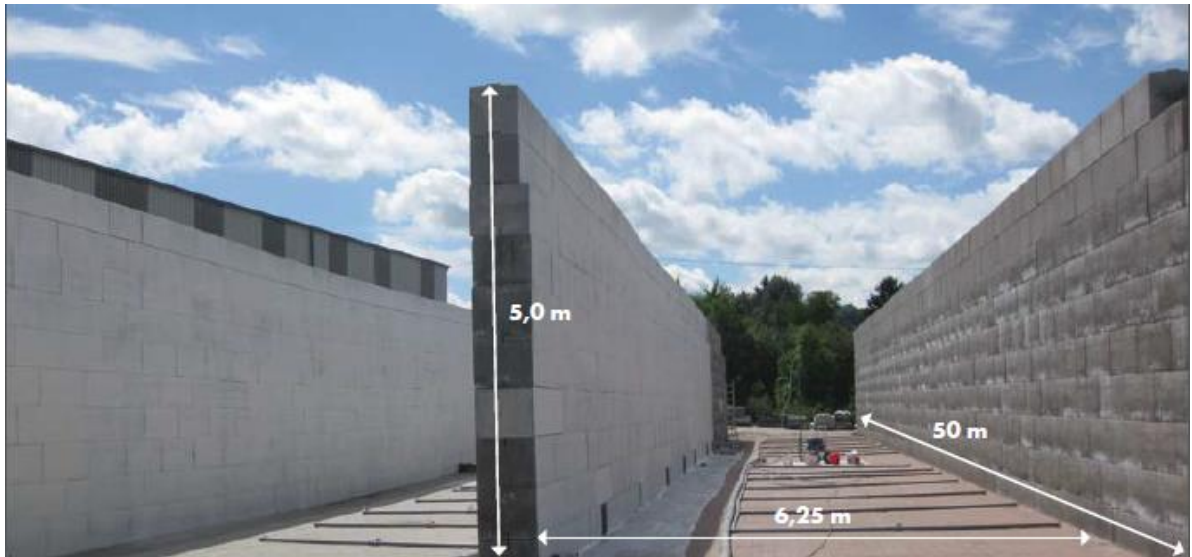


Good life span, optimal activity

KEIM SOLDALIT-ME - UNDER PRACTICAL CONDITIONS - STREET CANYON



KEIM SOLDALIT-ME - UNDER PRACTICAL CONDITIONS



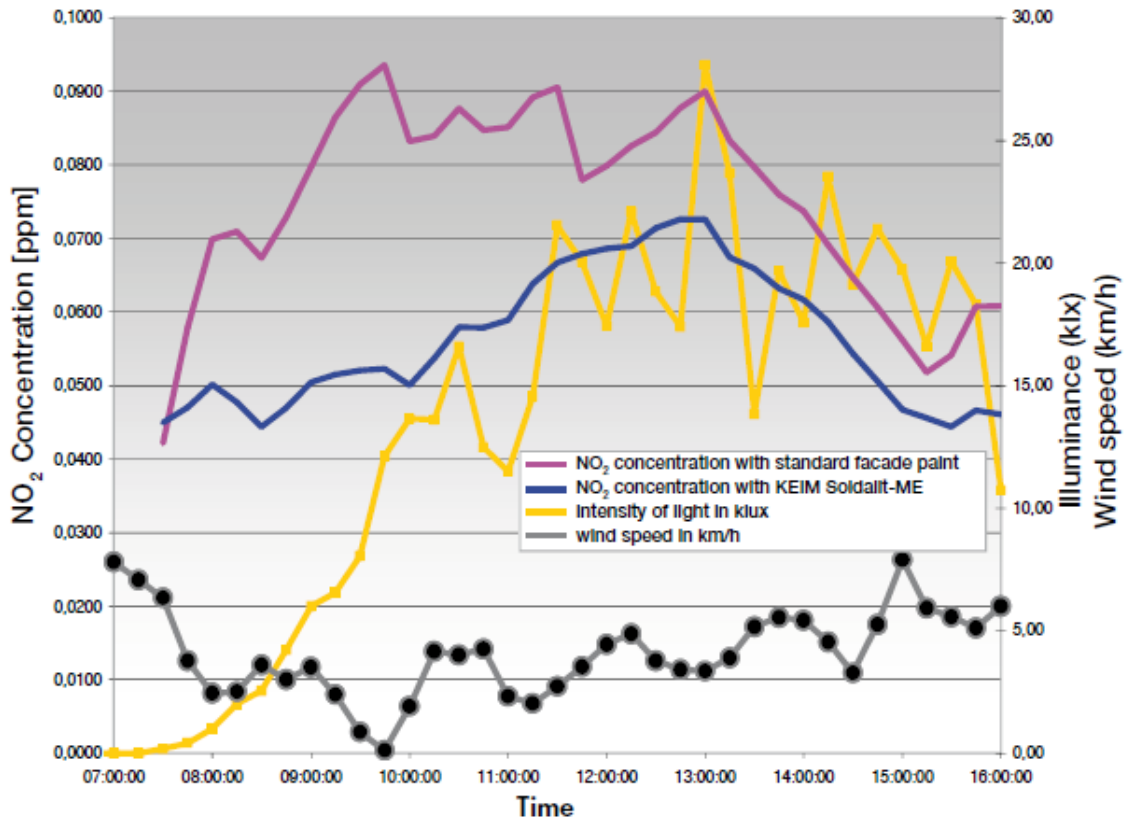
KEIM Soldalit-ME has been tested outdoors in direct comparison with another standard masonry paint. During the test the canyons were continuously exposed to nitrogen oxides and the pollutant gas concentration in both canyons was measured at a height of 3m over the duration of the test.

The degradation rates in practice are strongly influenced by wind strength and wind direction as well as by solar radiation.

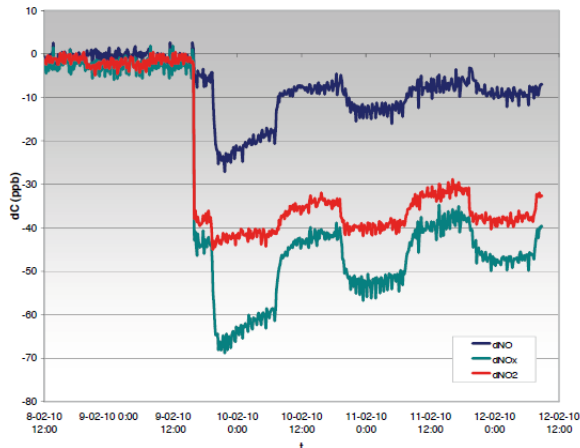
In the defined period, the street canyon test showed that KEIM Soldalit-ME leads to practical NO_2 reduction rates between 10 - 50 %.



OUTDOOR NO₂ TEST – KEIM SOLDALIT-ME



Laboratory test regarding NO₂ reduction with Soldalit-ME
Concentration difference between the inlet and the outlet of the reactor



Proof instead of promises!

PREMIUM
is our Standard.



EFFECTIVENESS OF KEIM SOLDALIT-ME

KEIM Soldalit-ME has been proven in outdoor tests to reduce Nitrogen Dioxides (NO₂) concentrations by up to 50%.

In Amsterdam, on the A10 Autobahn (Motorway) KEIM Soldalit-ME was used onto the noise reduction barriers and demonstrated an average reduction of 4.4g NO₂ per square metre on a smooth surface per year. For a textured surface this effect significantly increases as the surface texture creates a greater contact area.

- Average family car/small van emits approximately 5600g NO₂ per year.
- Approximately 32 million cars in the UK, equating to 179m kg of NO₂ being emitted into the environment every year.
- Just 1272 square metres of surface painted with KEIM Soldalit-ME could offset the NO₂ emissions of each vehicle every year.

When tackling Nitrogen Oxide pollution in the UK, any technique which significantly reduces this type of pollution should be considered to ensure improvement to the natural environment and public health.

Whilst photocatalytic mineral paints cannot, on their own, cure the problem, they are a significant step in the right direction, both in terms of air quality and protection of the environment, as well as changing our reliance on conventional, potentially damaging paint materials.

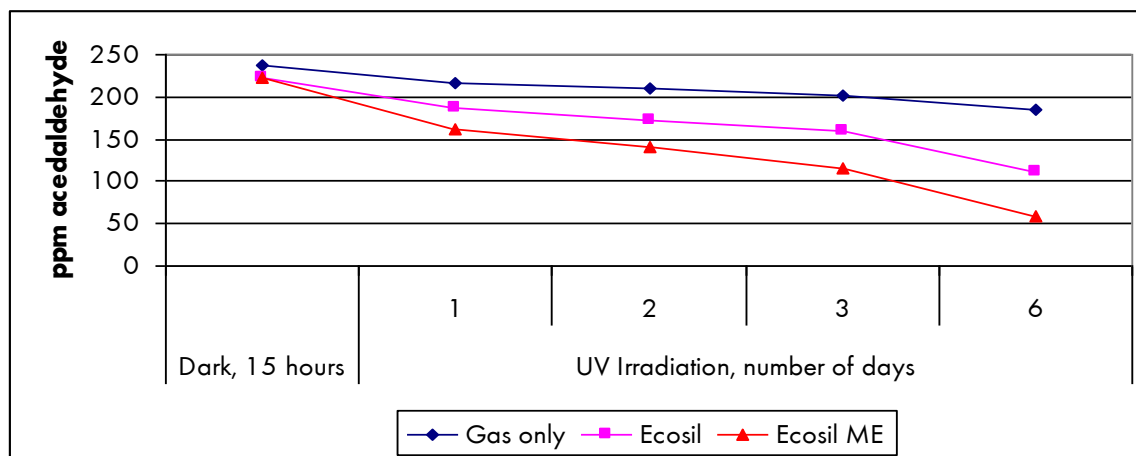


TEST REPORT – KEIM ECOSIL, KEIM ECOSIL-ME

Coated Glass Plates with Photocatalytic TiO₂

Photocatalytic activity evaluation result - (Acetaldehyde gas (Initial gas concentration: 250 ppm))

Samples	Acetaldehyde gas (ppm)				
	In dark	UV irradiation (day)			
	15 hrs	1	2	3	6
KEIM Ecosil	223	186	172	159	111
KEIM Ecosil-ME	222	161	140	115	59
Gas Only	238	217	211	201	184



Sample size : 150cm² (15 x 10 cm)
 Gas/concentration : Acetaldehyde gas/250 ppm
 Vessel : 3,000ml Gas bag
 Light Source : 40W Black Light
 UV Intensity : 2mW/cm² (Measured by TOPCON UVR-2)
 Temp./Humidity : 30°C/50%
 Measurement : Multi gas monitor

KEIM SOLDALIT-ME – PG1

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Subject
Letter Report

Examination of the efficiency of KEIM Soldalit-ME for the degradation of nitrogen oxides

1. Objective

Examination of the efficiency of KEIM Soldalit-ME for the degradation of nitrogen oxides.

2. Procedure

The tests are carried out in a flow reactor. This reactor consists of a half glass globe on a glass plate. The volume of the (half) globe is approximately 50 litres. During the test, the air is continuously stirred using a large metal fan. The workpieces, glass plates sized 30x30 cm, are positioned on the base of the reactor.

The tests are conducted as follows:

- The reactor is continuously supplied with an air flow of a defined composition of NO and NO₂.
- After a few hours, the concentration of NO and NO₂ settles to a steady state. The difference between the concentration of the incoming air as opposed to that of the outgoing air is a decisive factor for the efficiency of the paint. The greater the difference, the more efficient the paint.
- During the examination a gas mixture consisting of 240 ppb NO and 40 ppb NO₂ was continuously blown into the reactor. This mixture has the same composition as exists near motorways.
- The examination lasted several days. The samples were subjected to UV radiation for 12 hours at 24-hours intervals in order to simulate a daily outdoor air situation.

Nederlandse Organisatie voor
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KEIM SOLDALIT-ME – PG2

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- OSRAM Vitalux bulbs (OSRAM Vitalux 300 W E27ES) were used for exposure to ultraviolet light. The UV light intensity was approx. 8.5 W/m².
- The experiment was carried out in the reactor with and without samples in order to test how far the reactor wall itself already absorbs NO and NO₂. The correction for this “blank effect” was taken into account, but is very low for NO_x in all cases.

In Fig. 1 the measuring setup is depicted as a diagram.

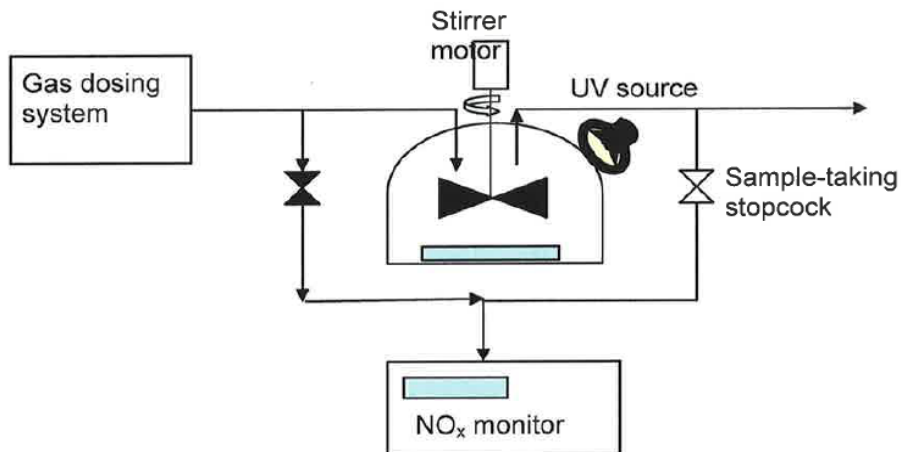


Fig. 1 Diagram of the test setup. The sample lies on the base of the reactor. Air contaminated with harmful gas of a defined composition is continuously blown into the reactor. The concentration of NO, NO₂ and NO_x in the incoming and outgoing air is established alternately every 5 minutes.

3. Results

The difference in concentration between the incoming and the outgoing air is identified as dC . This indicates how much harmful gas (NO, NO₂ or NO_x) reaches the plate and is converted there.

KEIM SOLDALIT-ME – PG3

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Concentration difference between the input and output of the reactor

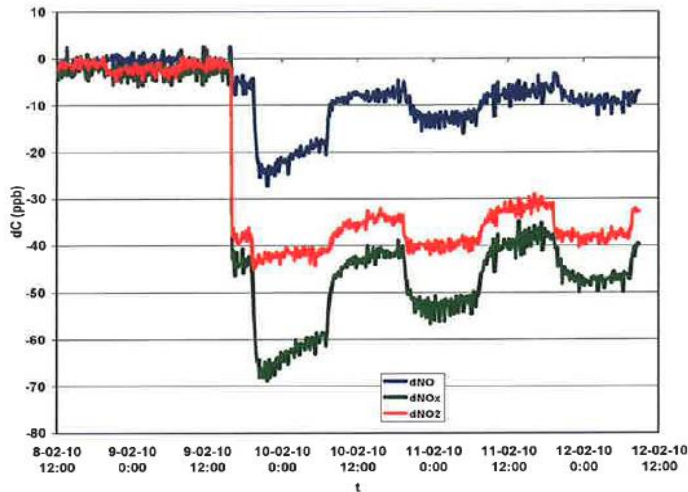
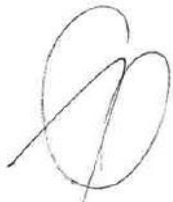


Fig. 2 Concentration difference for NO, NO₂ and NO_x between incoming and outgoing flows.

During this test the entire quantity of NO₂ is degraded. During the test it is established that the activity is slightly reduced. This is a result of an agglomeration of nitrate. As the painted area has not been rinsed (sprinkled), a nitrate agglomeration on the paint is assumed.



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