



**LANXESS**

**X BAYFERROX®**  
color for life.

**LANXESS Inorganic Pigments**  
**Sustainability – a matter of principle**



## The 12 principles of sustainable chemistry

LANXESS is one of the world's leading manufacturers of synthetic iron oxide pigments, and has production plants on five continents. The largest iron oxide production plant in the world is in operation at the LANXESS site in Krefeld-Uerdingen in Germany. Together with the plants in Porto Feliz in Brazil and Jinshan in China, LANXESS has a synthesizing capacity of more than 350,000 metric tons, which, with the additional blending and milling facilities, offers global availability of the product.

The high-quality iron oxide pigments, marketed under the core brand Bayferrox®, are manufactured using high-tech, state-of-the-art processes which are subject to the same HSEQ directives all over the world. All production facilities are certified to DIN ISO 9001 and ISO 14001 and are regularly monitored.

Sustainable practices and Responsible Care vis à vis the environment and society are an integral part of LANXESS's corporate guidelines. Production processes have always been designed to conserve resources and the environment – and to be safe and sustainable. They are subject to constant improvement.

Because of its commitment to operate all plants and processes according to the principles of sustainable chemistry, it is natural that LANXESS should comply with the 12 globally accepted principles of "green chemistry" published by P. Anastas and J. Warner in 1998.

We are absolutely convinced of the correctness of our actions and of the fact that, as a sustainably operating supplier, we can offer our customers added value. In the following section, based on the 12 principles of green chemistry, we would like to illustrate with the aid of concrete examples how we operate on a day-to-day basis in accordance with our commitment to sustainability. That is precisely what makes LANXESS a very special partner in the pigments industry.

GREEN CHEMISTRY: THEORY AND PRACTICE by Anastas and Warner Fig.4.1 p.30  
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# >01

**It is better to prevent waste than to treat or clean up waste after it is formed.**

### **The ecological and economic use of residual substances**

At all its production sites, in Krefeld-Uerdingen, Porto Feliz and Jinshan alike, LANXESS uses efficient processes to clean and recycle process water.

In Krefeld-Uerdingen, for example, an innovative process has been developed for cleaning process water containing residual iron. This uses a fluidized bed technology that is quite unique in the iron oxide pigments industry and enables the precipitated iron compounds to be turned into high-quality black pigments. Thanks to this highly developed and sophisticated technology, several thousand metric tons of black pigments can be produced and the corresponding amount of waste can be avoided. Subsequently, the wastewater is so clean that it can be discharged directly into the river Rhein.



# >02

**Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.**

### **Processes that benefit us and the environment**

All LANXESS processes are designed in such a way that pigments are produced with a high yield.

With the aid of efficient and proven synthesis engineering, a yield of nearly 100% is achieved using the precipitation process for the production of Bayferrox® yellow pigments. Iron sulfate solution and sodium hydroxide solution are used in exactly the ratio required for the reaction. In addition, supply of the atmospheric oxygen needed for the synthesis has been technically optimized and the pH is accurately controlled during the reaction. In this process, virtually all of the iron raw material is converted into pigment, resulting in optimal use of the resources.

Yellow pigments are also manufactured in very high yields at our other production plants in Porto Feliz and Jinshan.



# >03

**Wherever practicable, synthetic methodologies should be designed to use and generate substances that possess little or no toxicity to human health and the environment.**

### **The commitment to quality and sustainability**

The processes developed by LANXESS Inorganic Pigments – some of which have been established for over 80 years – are environmentally friendly and are operated according to the strictest safety requirements. They are also subject to constant optimization.

The production processes used to manufacture these safe, environmentally harmless pigments ensure consistently high quality and conserve natural resources at the same time. They comply with the stringent environmental and safety requirements of the internal LANXESS directives and with all legal regulations.

These principles are strictly complied with not only at the main production site in Krefeld-Uerdingen but also in Porto Feliz and Jinshan. All the production sites are certified to the strict quality and environmental standards DIN ISO 9001 and ISO 14001.



# >04

**Chemical products should be designed to preserve efficacy of function while reducing toxicity.**

### **Protection of the environment and the benefits for mankind**

LANXESS iron oxide pigments are not hazardous. In chemical terms, they are comparable with naturally occurring iron oxides. With regard to their color, however, they are superior to their natural counterparts because of their higher purity and their particle morphology. In addition, synthetic iron oxides are, under normal conditions, stable and virtually insoluble in water – an important requirement for safe handling and environmentally friendly processing.

Furthermore, LANXESS has developed a number of innovative iron oxides that, for example, help to enhance vehicle safety, improve the corrosion protection of steel, and are used to remove toxic elements from drinking water.



# >05

**The use of auxiliary substances (e.g. solvents, separation agents) should be made unnecessary wherever possible and innocuous when used.**

### **Natural solutions**

With the processes employed by LANXESS for the production of iron oxide pigments, the only solvent used is water. This ensures maximum safety in the production, processing and isolation of the finished pigments.

The fact that only water is used is also of benefit to the environment, because without toxic organic solvents there is no need for any costly, energy-intensive recovery processes.

At all our production sites, the water is reused in several stages of the process before being finally fed into a special wastewater treatment unit, thus making optimal use of the water – the most valuable resource of all.



# >06

**Energy requirements should be recognized for their environmental and economic impacts and should be minimized. Synthetic methods should be conducted at ambient temperature and pressure.**

### **Saving and utilizing energy**

Energy is an increasingly important resource, which LANXESS uses very conscientiously and responsibly at all its production sites.

An outstanding example of this is the Laux process in Krefeld-Uerdingen. It is currently the only industrially used process in the world for the production of iron oxides that does not require any energy at all during the synthesis, but itself releases energy in the form of heat. This heat is used to generate steam or hot water to dissolve the iron sulfates or wash the pigments – a process that is currently unmatched in terms of its energy efficiency.

All the production plants at our sites use state-of-the-art technology for manufacturing iron oxide pigments. In Jinshan, for example, the use of special filter presses enables the subsequent drying time – and thus the energy consumption – to be reduced by more than 20%.



# >07

**A raw material or feedstock should be renewable rather than depleting wherever technically and economically practicable.**

### **The intelligent use of raw materials**

The sustainable use of raw materials is a key priority for LANXESS.

For iron oxide production at Porto Feliz, Brazil, for example, sugarcane waste is being used as a source of energy. The new, on-site power plant, which was completed in 2010, runs on bagasse, a fibrous component of sugarcane that is left over after sugar production. The production of energy through a highly efficient combined heat and power generation technology (cogeneration) provides for a high level of utilization of this organic raw material. Energy generation for the site is thus completely CO<sub>2</sub>-neutral. This means that the amount of CO<sub>2</sub> released during energy production corresponds to the amount of CO<sub>2</sub> absorbed by the sugarcane plant during growth. Consequently, CO<sub>2</sub> output at the site is reduced to virtually zero. As from 2010, CO<sub>2</sub> emissions will be around 44,000 metric tonnes lower compared to 2002 levels.



# >08

**Unnecessary derivatization (blocking group, protection/deprotection, temporary modification of physical/chemical processes) should be avoided whenever possible.**

### **Superfluous things that can be avoided**

The synthesis processes used by LANXESS at all its production sites are controlled in such a way that the iron oxides are already in a pure form in the desired crystal modification. Examples include goethite (yellow), hematite (red), magnetite (black) and lepidocrocite (orange). This eliminates the need for the complicated separation of modifications or a derivatization.

All this results from a wealth of experience and know-how amassed over a period of more than 80 years, the use of cutting-edge technology, optimal process control by trained staff, plus a constant drive to improve.



# >09

**Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.**

### **The benefits of sound processes**

The processes used by LANXESS for the production of iron oxides result in high yields and involve relatively mild reaction conditions. The use of catalysts is generally of no significance here.

Catalytic processes are only used when it really makes sense – for example to remove pollutants from waste gases. Gaseous sulfur dioxide (SO<sub>2</sub>), for instance, which is produced as an incidental by-product during the manufacture of red iron oxides, is converted in a desulfurizing plant into sulfuric acid. Activated carbon serves as the catalyst. The sulfuric acid is concentrated using waste heat and then used as a raw material in the pigment process, sparing both the environment and valuable resources.



# > 10

**Chemical products should be designed so that at the end of their function they do not persist in the environment and break down into innocuous degradation products.**

### **Products and their natural deposits**

In terms of its percentage by weight, iron is the second most frequently occurring element on Earth, and at 5%, is the fourth most common in the Earth's crust. In enriched form, it occurs very frequently as magnetite and hematite in giant ore occurrence in various regions of the Earth.

Chemically, the iron oxide pigments produced by LANXESS are comparable with these natural deposits and thus are equally safe for the environment.



# > 11

**Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.**

### **Controls and how we carry them out**

All LANXESS production processes are controlled and monitored by the very latest analytical and physical methods. Continuous measurement of key process parameters enables individual steps in the synthesis process to be reliably controlled.

This also applies to the streams of waste air and wastewater, which are monitored using state-of-the-art analytical techniques. Possible malfunctions are recognized, and the uncontrolled release of substances can be prevented.

LANXESS also relies on the very latest technologies for quality control.



# >12

**Substances and the form of a substance used in a chemical process should be chosen so as to minimize potential for chemical accidents, including releases, explosions, and fires.**

### **Safety, and how it is ensured**

All LANXESS production processes worldwide are subject to the same high safety standards.

All production plants are designed in such a way that the uncontrolled release of substances cannot occur; continuous monitoring provides for additional safety. Fire and explosion protection measures are an integral part of project engineering and modernization concepts.

The effectiveness of the safety measures is assured and documented by regular safety checks. In this respect there are no differences between the sites because LANXESS follows these principles all over the world.

We do not make any compromises on either economics or ecology.

We are convinced that companies will only be able to operate successfully in the future if they act sustainably toward the environment and society.

This is and will remain an indispensable element of our business philosophy.

If we can support you in any way in your sustainability efforts, please feel free to get in touch.

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#### Health and Safety Information:

Appropriate literature has been assembled which provides information concerning the health and safety precautions that must be observed when handling the LANXESS products mentioned in this publication. For materials mentioned which are not LANXESS products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be followed. Before working with any of these products, you must read and become familiar with the available information on their hazards, proper use and handling. This cannot be overemphasized. Information is available in several forms, e.g., material safety data sheets, product information and product labels. Consult your LANXESS representative in Germany or contact the Regulatory Affairs and Product Safety Department of LANXESS Germany or – for business in the USA – the LANXESS Product Safety and Regulatory Affairs Department in Pittsburgh, Pennsylvania.

#### Regulatory Compliance Information:

Some of the end uses of the products described in this publication must comply with applicable regulations, such as the FDA, BFR, NSF, USDA, and CPSC. If you have any questions on the regulatory status of these products, please consult your LANXESS representative in Germany or contact the Regulatory Affairs and Product Safety Department of LANXESS Germany or – for business in the USA – your LANXESS Corporation representative, the LANXESS Regulatory Affairs Manager in Pittsburgh, Pennsylvania.

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