



Bayferrox® New Red

A new generation of red iron oxide pigments

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Agenda

- 1 The Iron Oxide Industry in Transition
- 2 LANXESS IPG's New Plant in Ningbo/China
- 3 The Ningbo Process
- 4 Bayferrox® New Reds



The iron oxide industry in transition

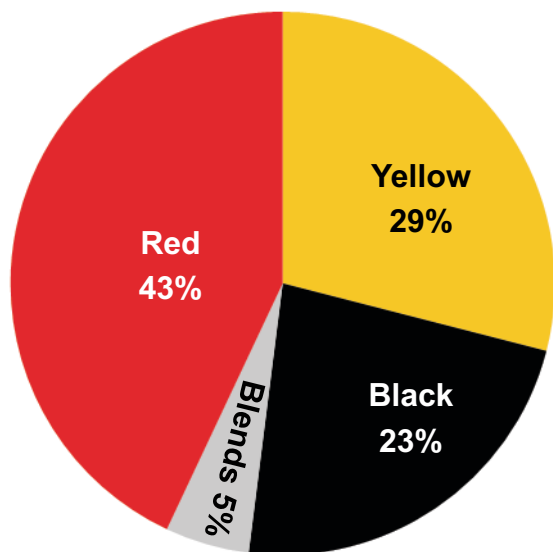
Sustainability main driver for drastic changes in landscape

Synthetic iron oxide pigments – Global market overview

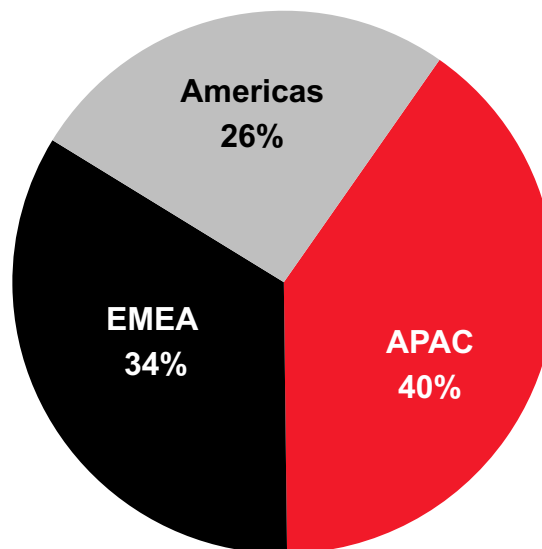
By color / by region / by application

Market for synthetic iron oxide pigments in 2015 (kt in %)

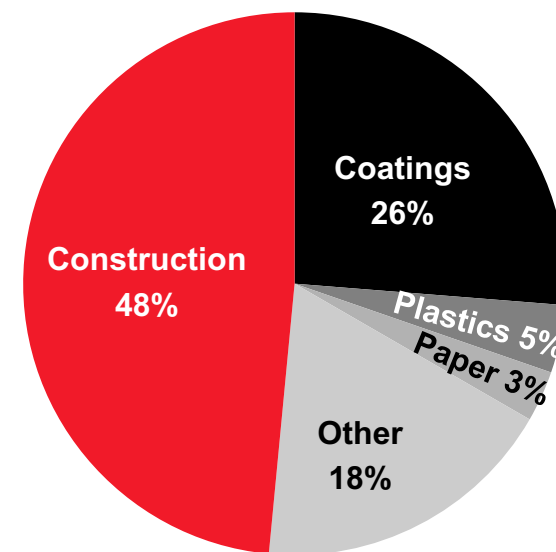
Demand by color



Demand by region



Demand by application



Iron oxide demand – Urbanization and increasing per-capita income have been the main drivers for growing pigment demand globally

More people live inside the circle than outside



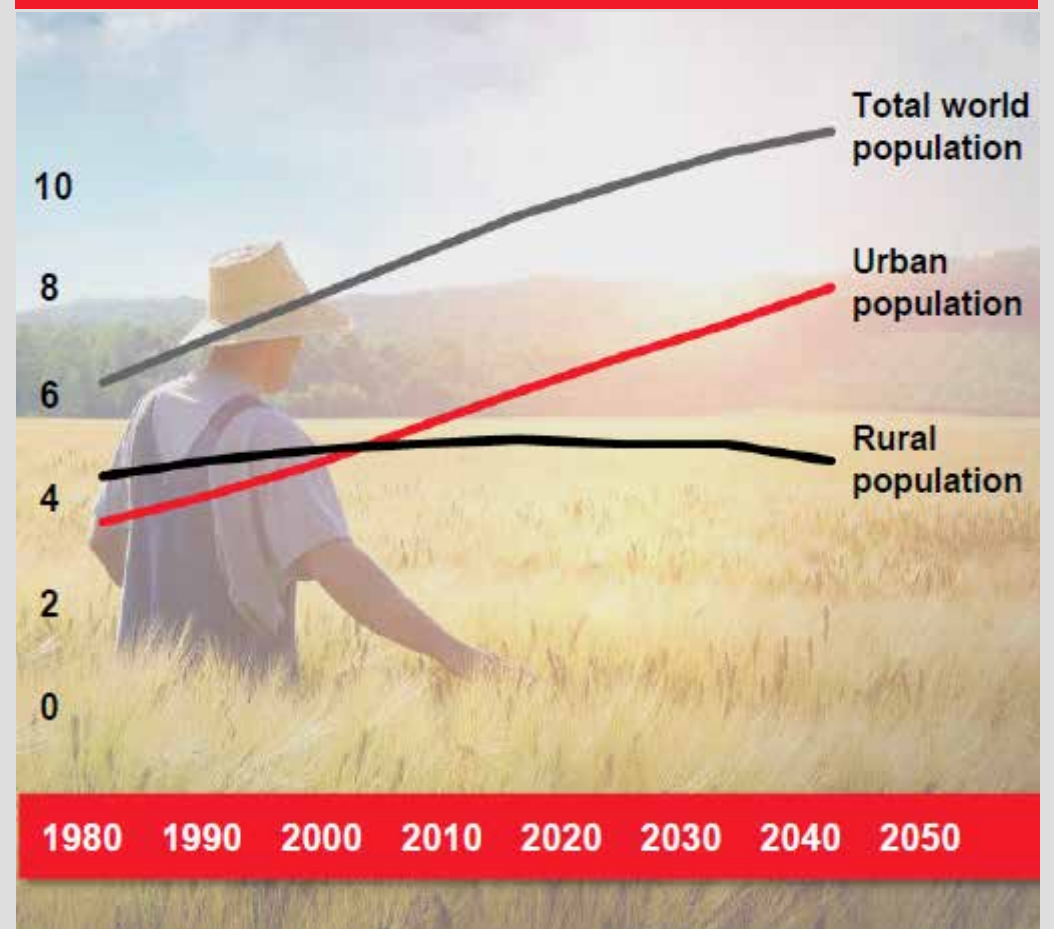
Number of global megacities is set to rise



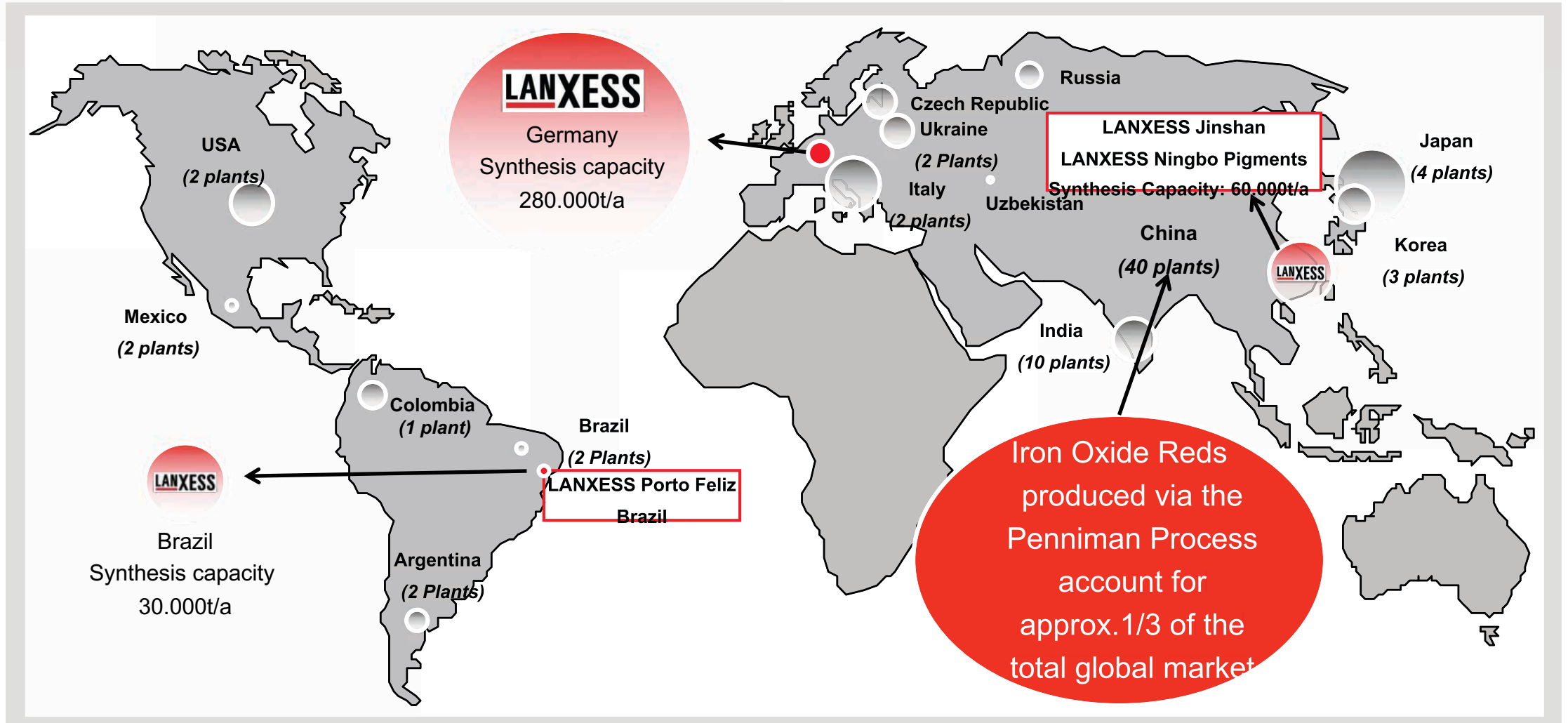
Development of Urban Population



Global migration to cities (in billions)



While synthetic iron oxide production plants are spread all over the world, there are only two real centers of capacities globally – Germany & China



Source: IPG GPM market analysis

Tightening environmental regulations in China are a major driver for the consolidation of the iron oxide industry in China and thus, globally

Sustainability is the key challenge for producers in China



25% of China's
land territory is affected
by permanent smog



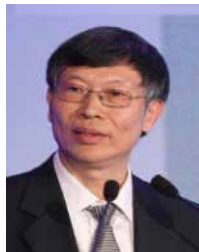
60% of fresh
water resources are
already polluted

- China is the largest producer of iron oxide pigments
- Traditional Penniman process with bad input-output ratio and extreme environmental issues
- ~20 closures of production plants in China since 2012 due to strict environmental protection enforcement measures

Actual situation in China – Chinese government is aware of the fact that they have fallen behind countries with advanced economy and technology standards

China is the largest producer of pigments and paints in the world
BUT:

- Manufacturing scale is generally small
- Industry concentration is low
- Technological innovation strength is relatively weak
- Mostly low quality and low price
- High emissions with harmful environmental influence



Xu Shufan
Ministry of
Environmental Protection (MEP), China
1st Pigments Symposium, Nov 2013

“China’s current industrial structure is irrational because low-output industries with high input, **high energy consumption and high emissions still account for a large percentage of the overall national economic structure.**

.....I think this will have an extremely important significance for the future of pigment production in China, and it has a **very important role in promoting the closure of outdated production facilities in China.**”

Wenchao Zang,
Ministry of Environmental Protection (MEP), China
2nd Pigments Symposium, Nov 2015

“The task of building an ecological civilization has been **included for the first time into the 13th Five-Year Plan.**
In China, we will implement the **most stringent** environmental protection system. Enterprises who fail to meet the standards **will be shut down or regulated to reorganize.**”



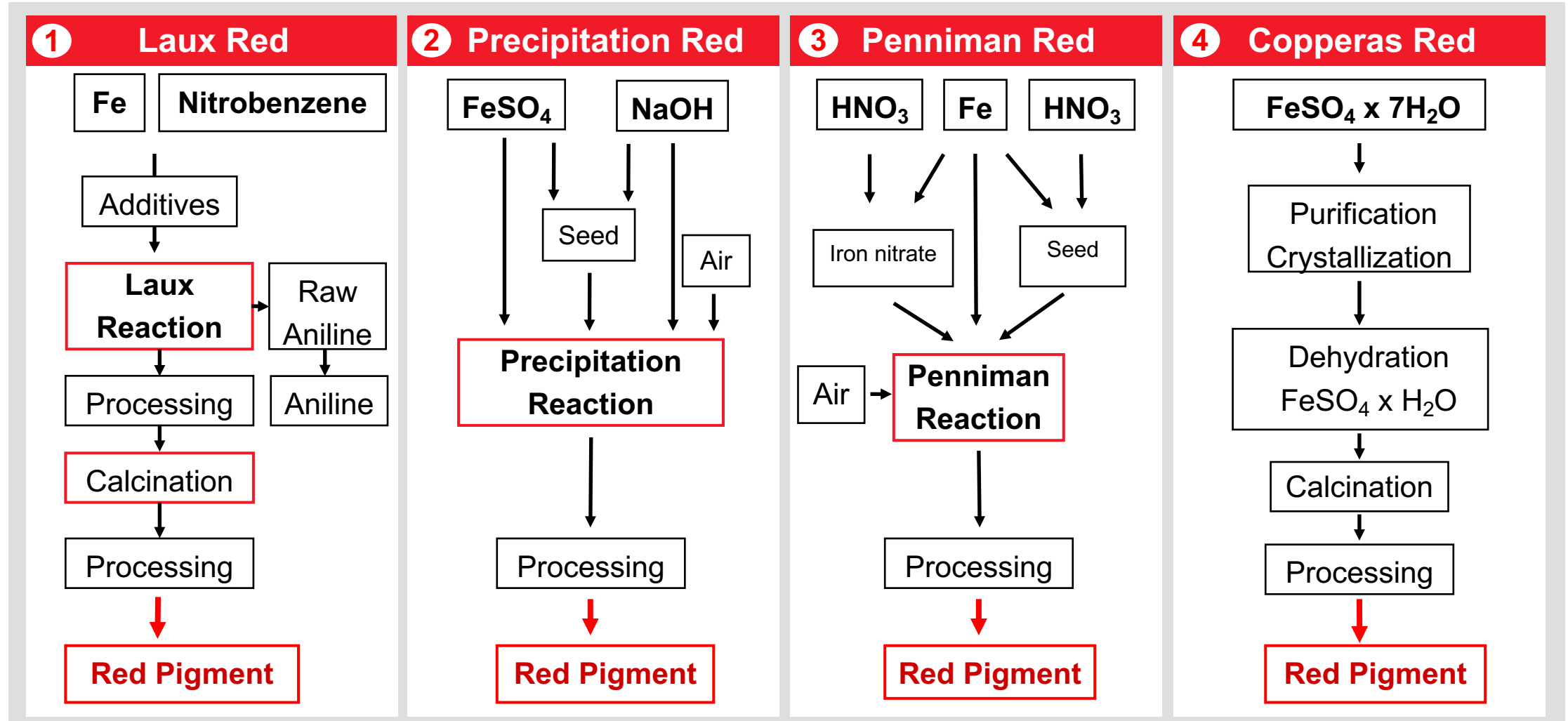
Update - 3rd Pigment Symposium to take place January 2017 in Las Vegas, USA



The LANXESS IPG Ningbo Process

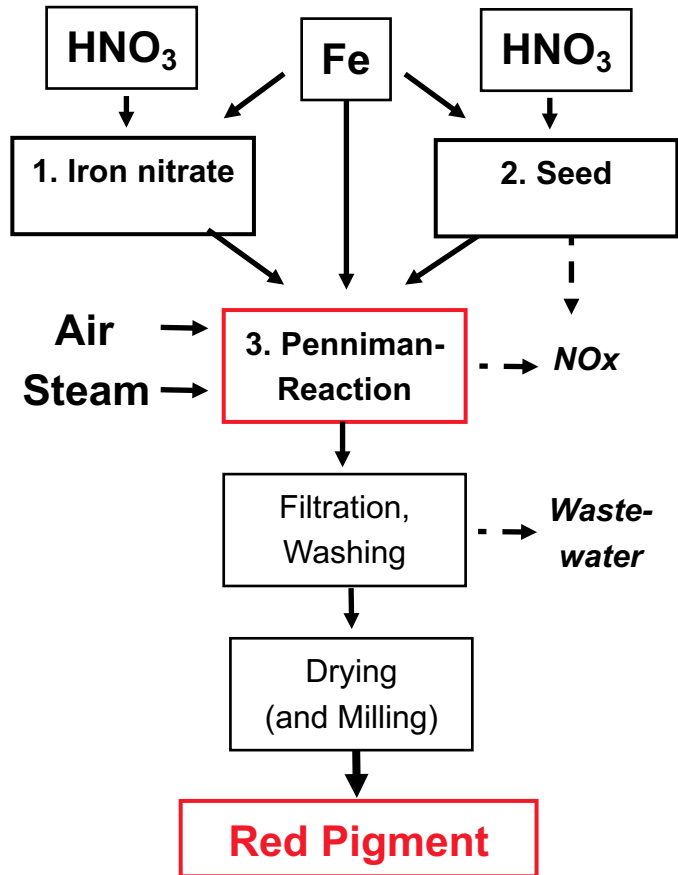
A breakthrough in iron oxide red technology

Traditionally four primary industrial processes were used for the production of synthetic iron oxide red pigments



Chinese producers primarily have been using the Penniman Red Process for the production of synthetic iron oxide red

3 Penniman Process



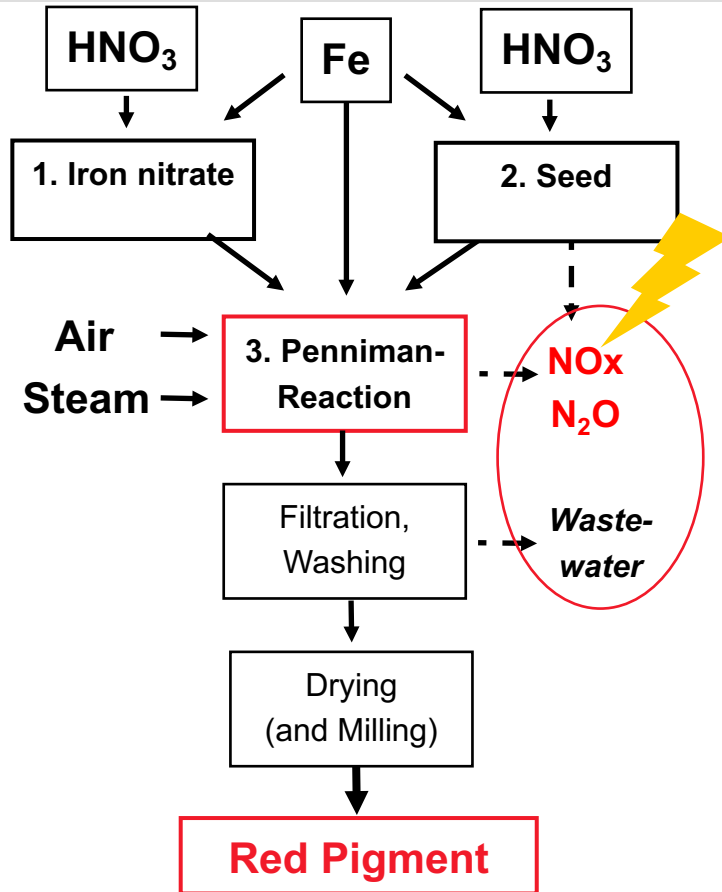
Untreated waste water can cause eutrophication

- The waste water of the Penniman red process contains ammonium nitrate, which is a very potent fertilizer
- Discharging of ammonium nitrate into rivers and lakes leads to eutrophication and thereby to fish mortality and shortage of drinking water supply



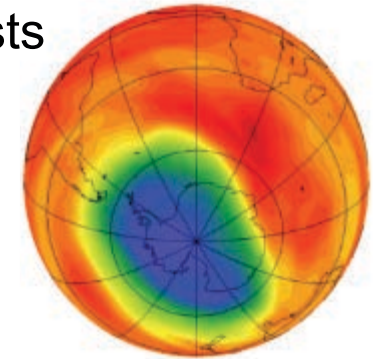
The traditional Penniman Red Process offers a range of very attractive bright red pigments, but it is challenging due to extreme environmental issues

3 Penniman Process



Waste gas emission

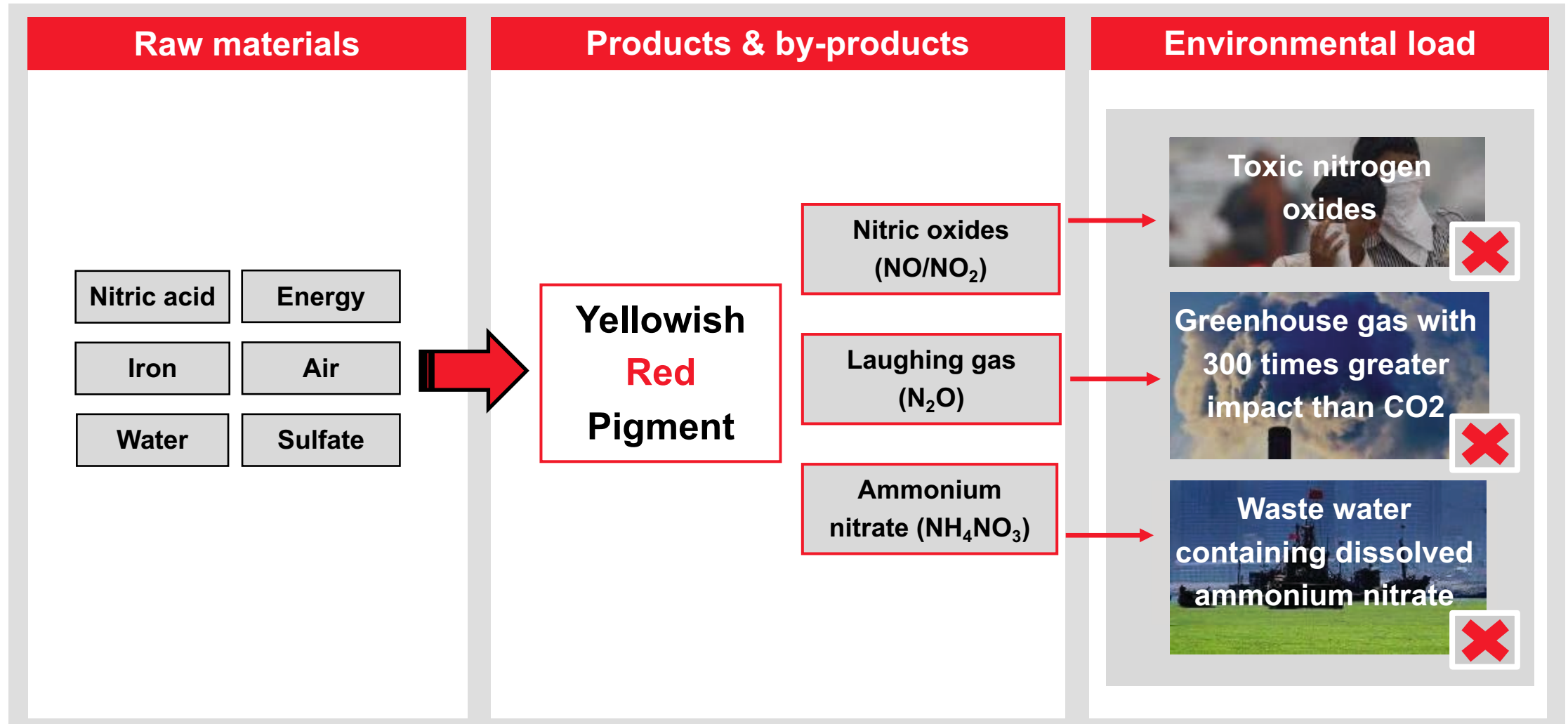
- The waste gas from the process consists of toxic nitric oxides (NO , NO_2) and laughing gas (N_2O)



Laughing gas

- is a strong greenhouse gas with a 310 times higher impact than carbon dioxide
- is also a very potent ozone-depleting substance leading to holes in the stratospheric ozone layer
- is one of the biggest threats to the ozone layer, which protects the earth from UVB radiation

Summary: the traditional Penniman Red Process – produces attractive red shades but toxic nitrogen oxides, laughing gas and ammonium nitrate are emitted



Our Challenge for Ningbo: To supply the global market with the required bright red pigments but to do this in the most sustainable way

Emission

- Avoiding harmful emissions by process optimization
- Recycling of by-products to save raw materials
- Catalytic decomposition of waste gases



Water

- Reduced demand for process water
- Efficient water purification to remove ammonium nitrate
- Re-use of purified waste water in the process (internal recycling)



Energy

- Reduced energy demand by recipe and process optimization
- Recovery of energy by e.g. applying heat exchanger

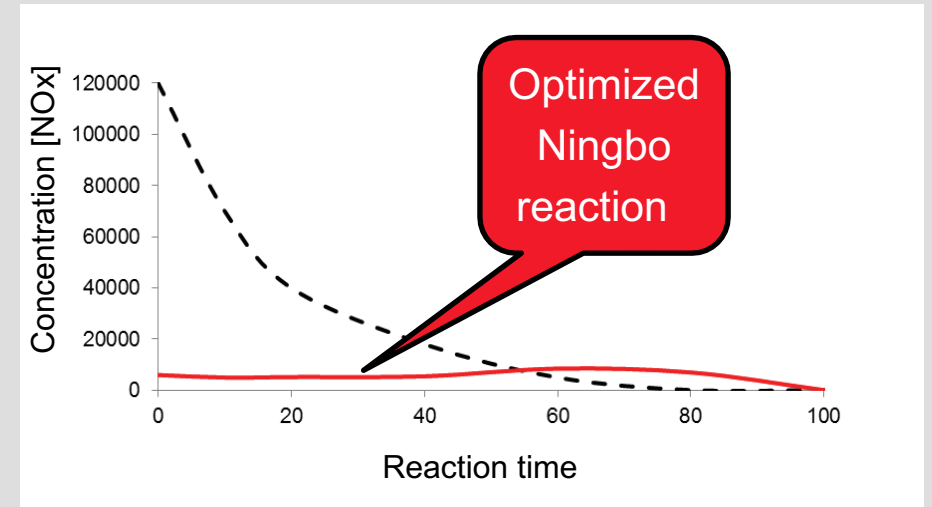


The LANXESS solution: The new Ningbo Process offers successful control and reduction of waste gas emissions, including laughing gas

Reduction of emissions

- Nitric oxides and laughing gas are formed in all three steps of the Penniman red process but especially in the seed formation and the Penniman reaction
- Due to efficient process control, we are able to reduce NOx and N₂O emissions significantly
- Furthermore, our optimized Ningbo Process gives a steady NOx emission during the growth reaction which make the recycling scrubber systems more efficient

Ningbo
Process

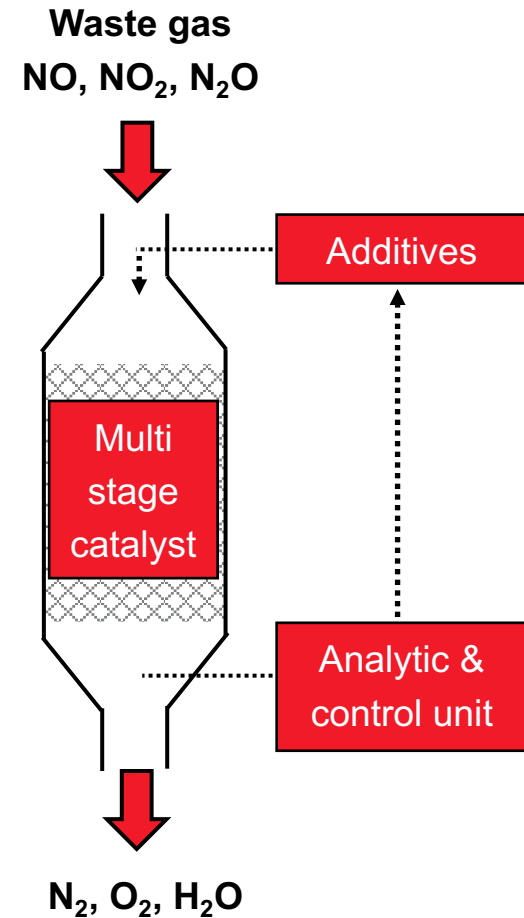


The Ningbo Process – laughing gas and toxic nitric oxides are treated to only emit naturally occurring air components

Catalytic decomposition of nitrogen oxides

- Despite an efficient recycling scrubber system to recycle nitric acid, Ningbo waste gas still contains laughing gas (N_2O) and smaller amounts of nitric oxides (NO/NO_2)
- These are converted in a multi stage catalytic converter into naturally occurring nitrogen gas (N_2), oxygen (O_2) and water (H_2O)

Ningbo
Process



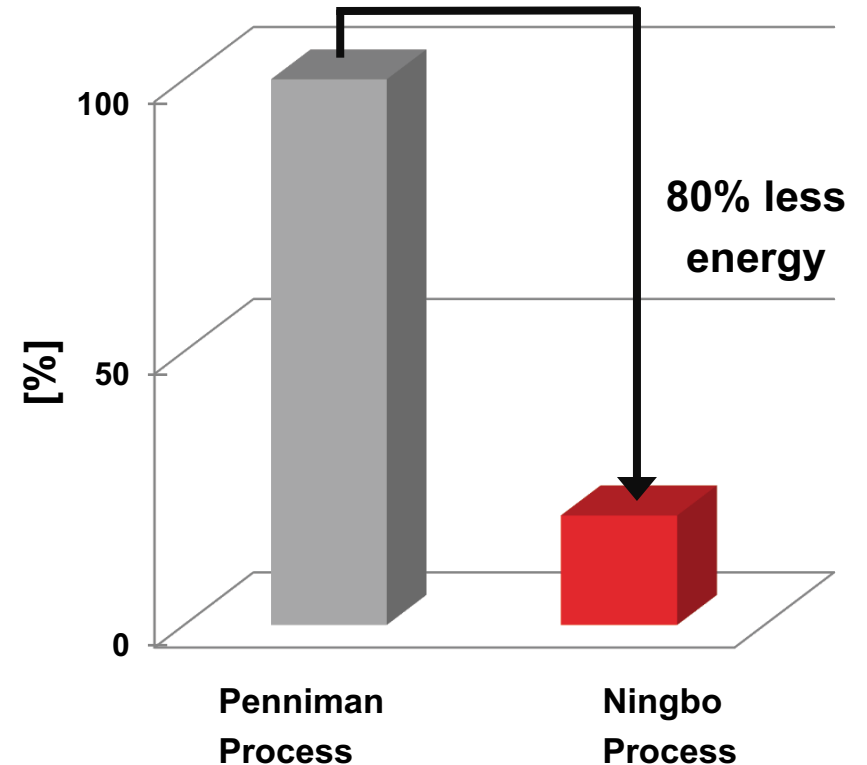
The Ningbo Process – optimized process reduces energy demand by approximately 80%, relative to traditional Penniman production

Energy efficiency

- The Penniman red growth reaction requires large amounts of energy, particularly with regard to steam stripping during the growth reaction
- Due to the unique Ningbo Process and special aeration techniques, energy demand in the growth reaction is reduced by 80%

Ningbo
Process

Reduced energy demand



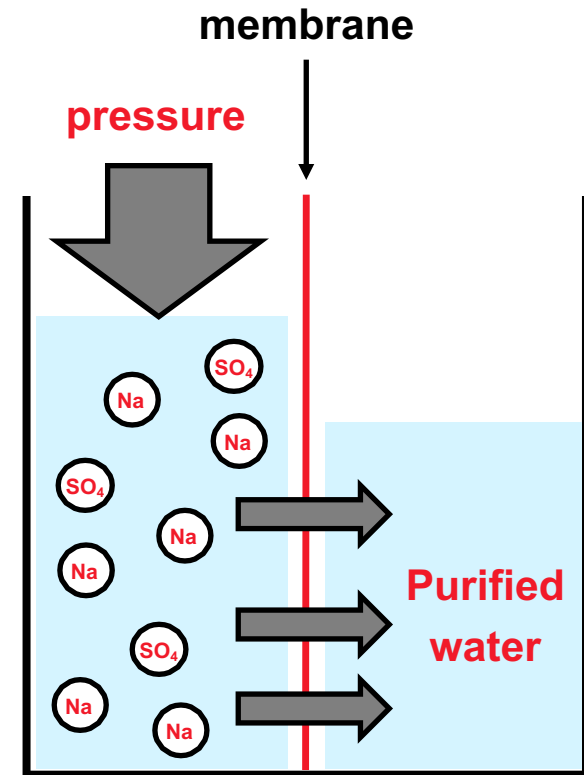
The Ningbo Process – production process water is exhaustively purified and re-used in the process

Recycling of process water

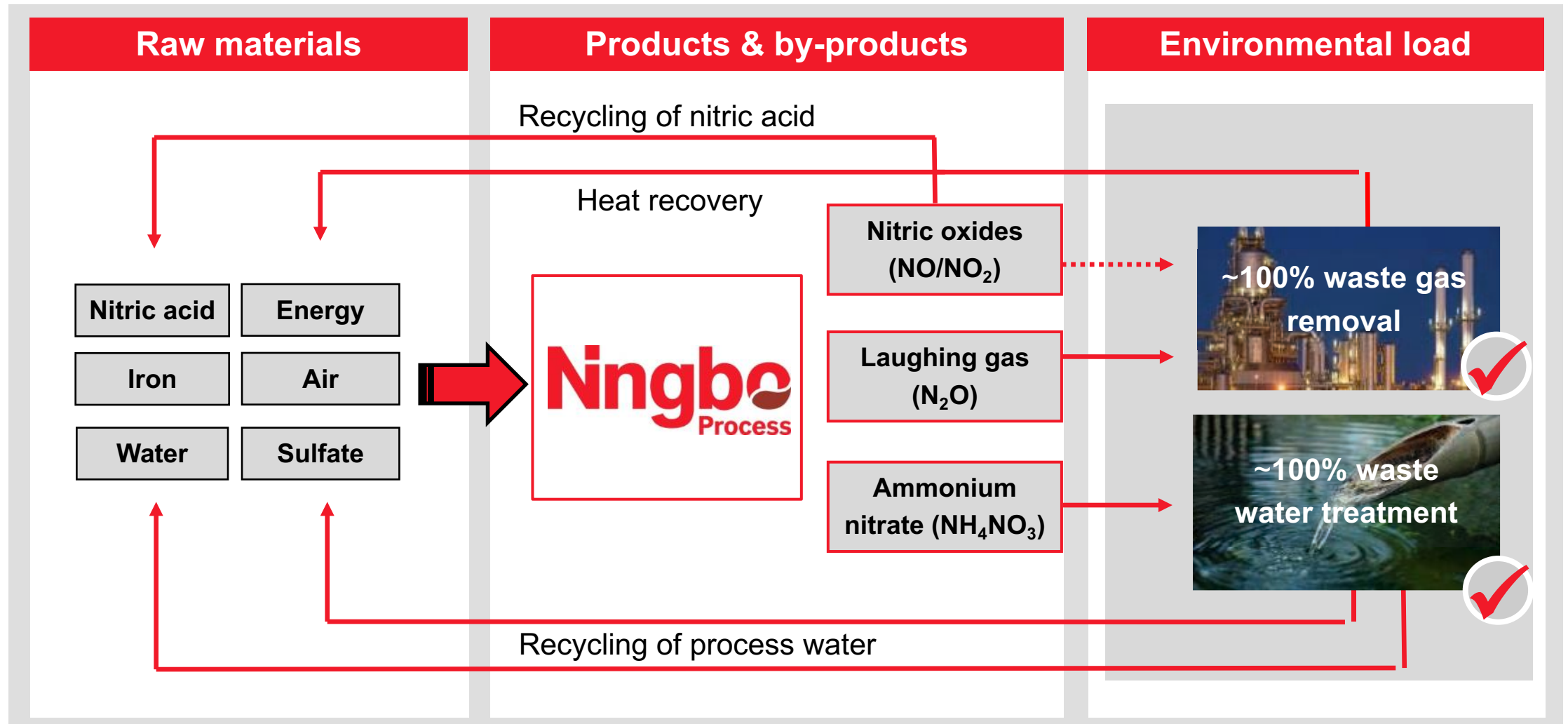
- Due to a higher solids content in our process steps, we have reduced the required water amount considerably
- Used water is subsequently purified in our state-of-the-art water treatment plant by:
 - Sedimentation tanks
 - Biological denitrification process
 - Ultrafiltration and reverse osmosis (RO)
- By reverse osmosis, sulfate-enriched water is a valuable raw material and can be employed back in the process

Ningbo
Process

Principles of reverse osmosis



The patented Ningbo Process – a breakthrough in iron oxide red technology





LANXESS IPG New Reds

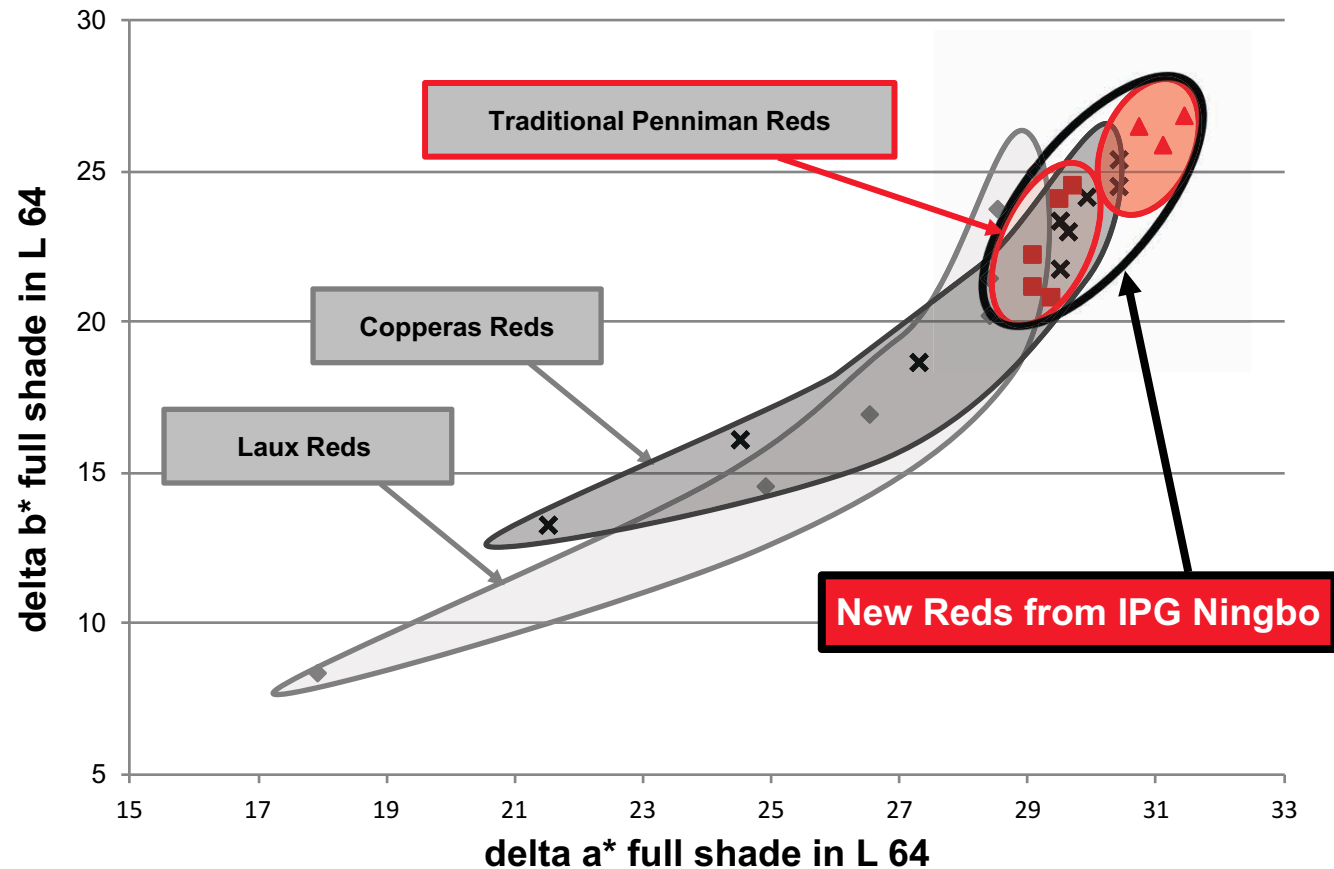
A new generation of red iron oxide pigments

LANXESS Ningbo – three important product streams; New Reds will access new business outside the current color space of our existing Laux grades



The new Ningbo facility enables LANXESS to further extend what is already the broadest range of red iron oxides in the market

LANXESS Inorganic Pigments – New Red

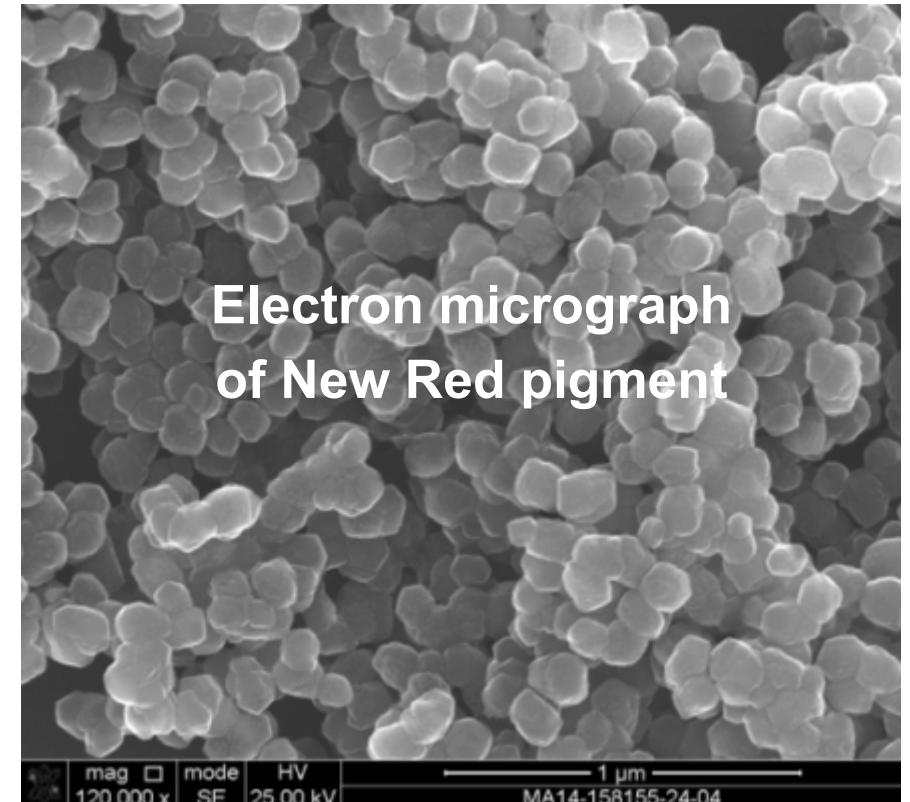
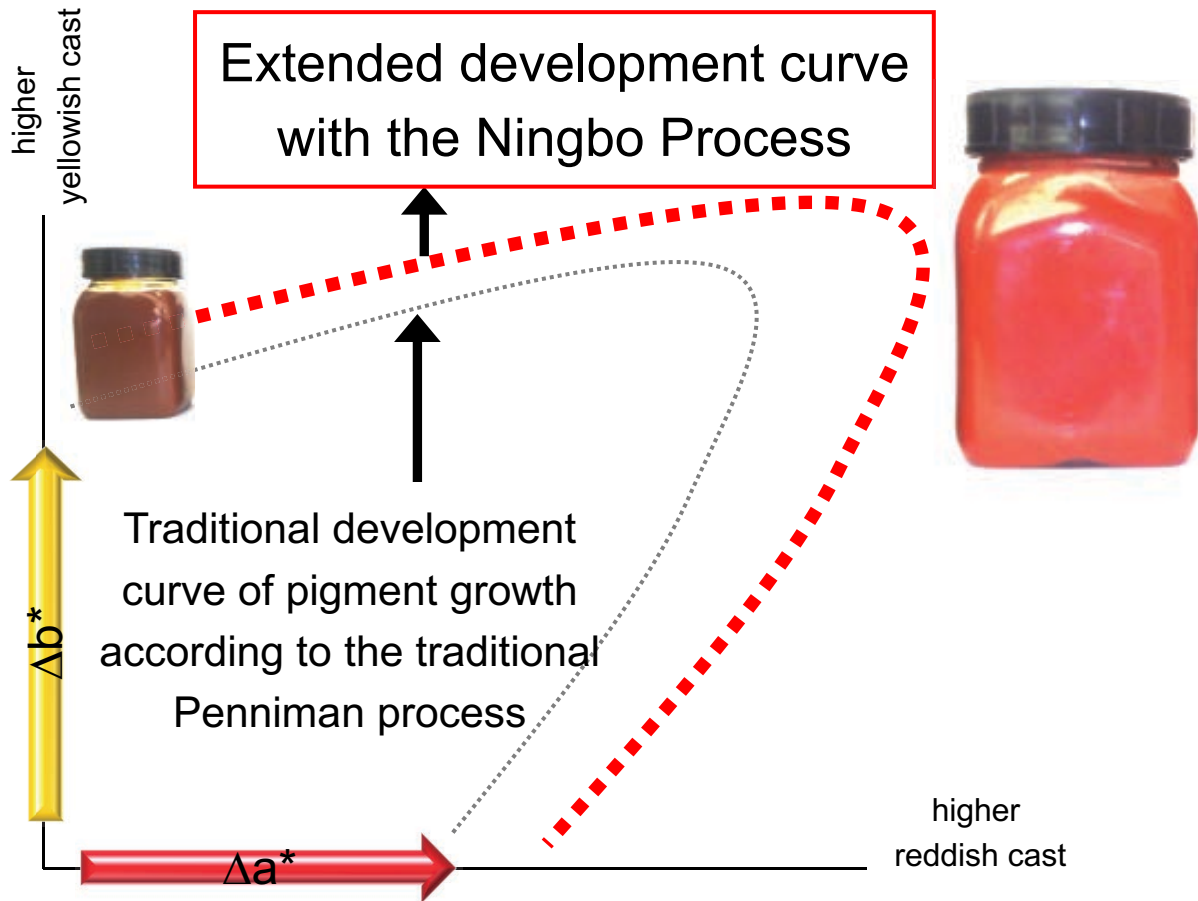


- Flexible, innovative and sustainable production processes enable both traditional Penniman and completely new color space to be achieved
- Proven Bayferrox® quality with the possibility to open the door to new market opportunities
- All grades will comply with existing high Bayferrox® quality standards



New Red properties – Color development can be extended to reach highest chromaticity – products which have never been produced before!

Control of process parameters



A number of key factors are tightly controlled to ensure that Ningbo products are sustainable and meet Bayferrox® quality standards

Selected raw materials



Ferrous
nitrate

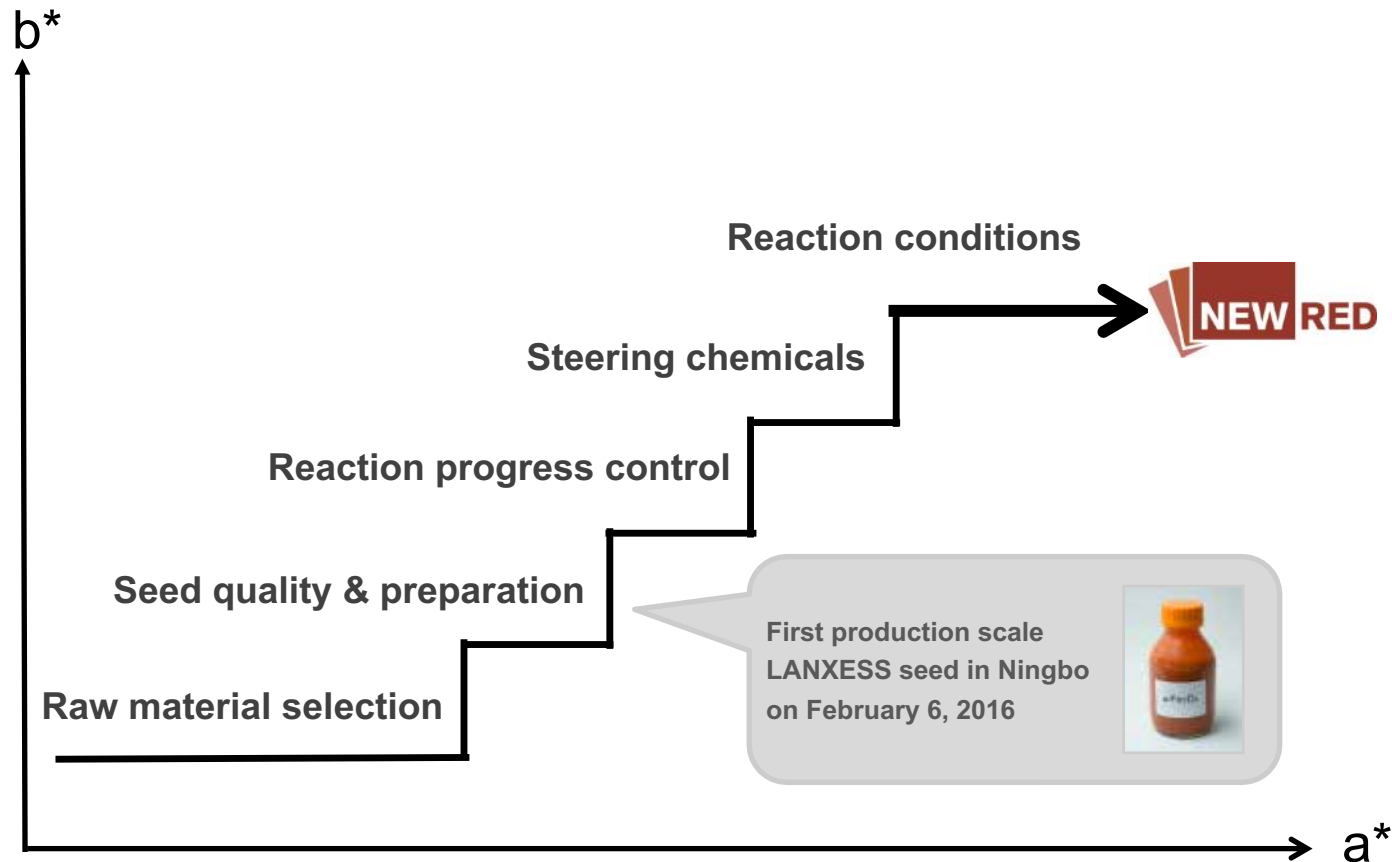


Seed



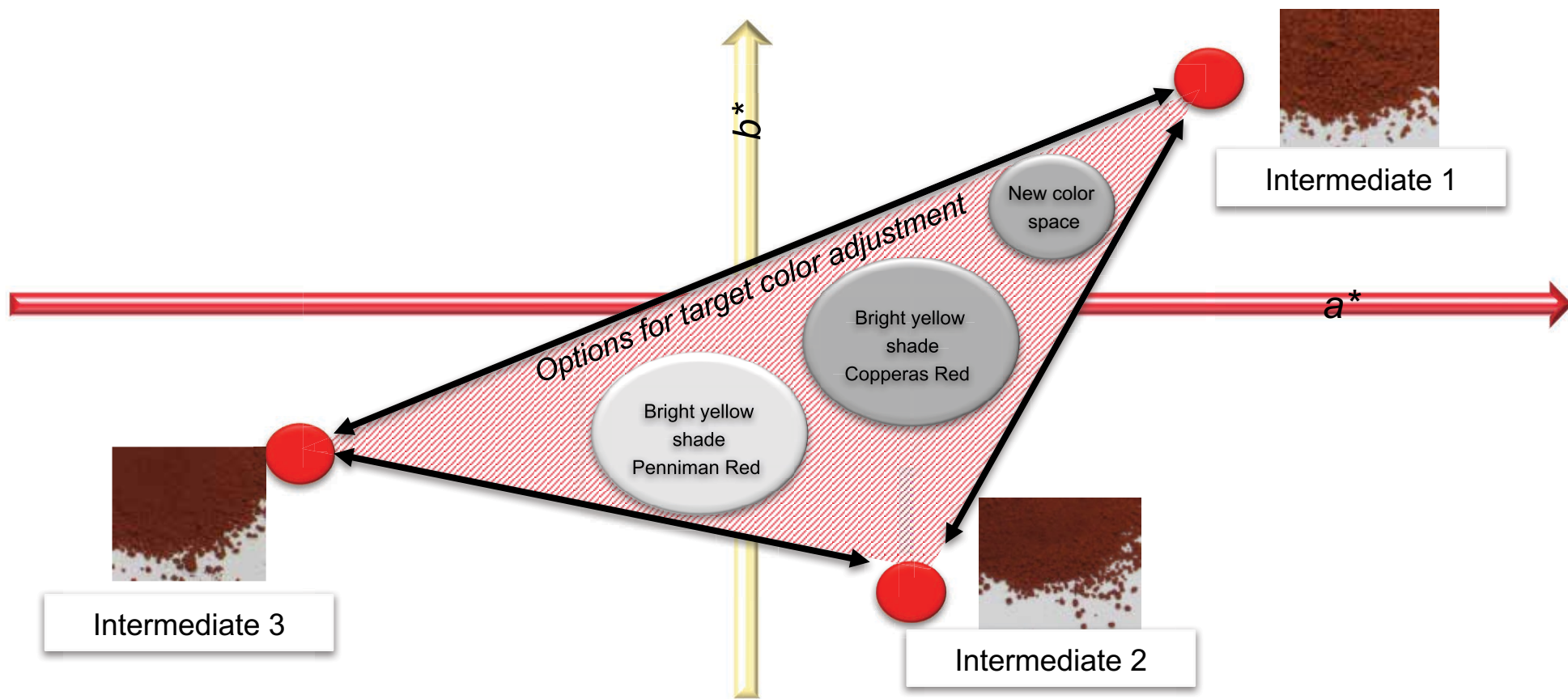
Iron scrap

Key control steps

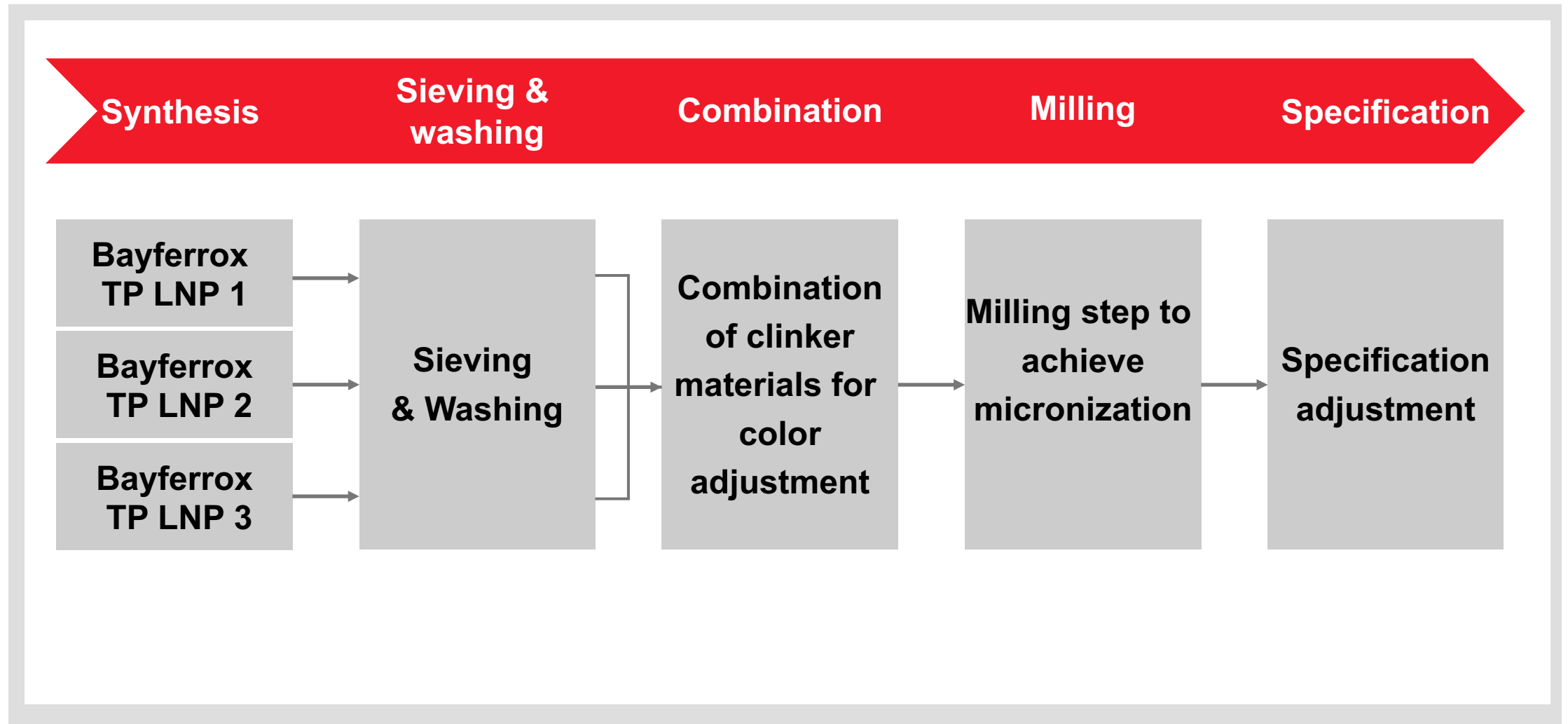


Targeted intermediate grades will be processed to produce the Bayferrox® 500 series; end products will offer both competitor and completely new color space

Target color of New Red pigments



Route for synthesis and desired color



Bayferrox TP LNP 1 with superior coloristic in comparison to market hematite alternative

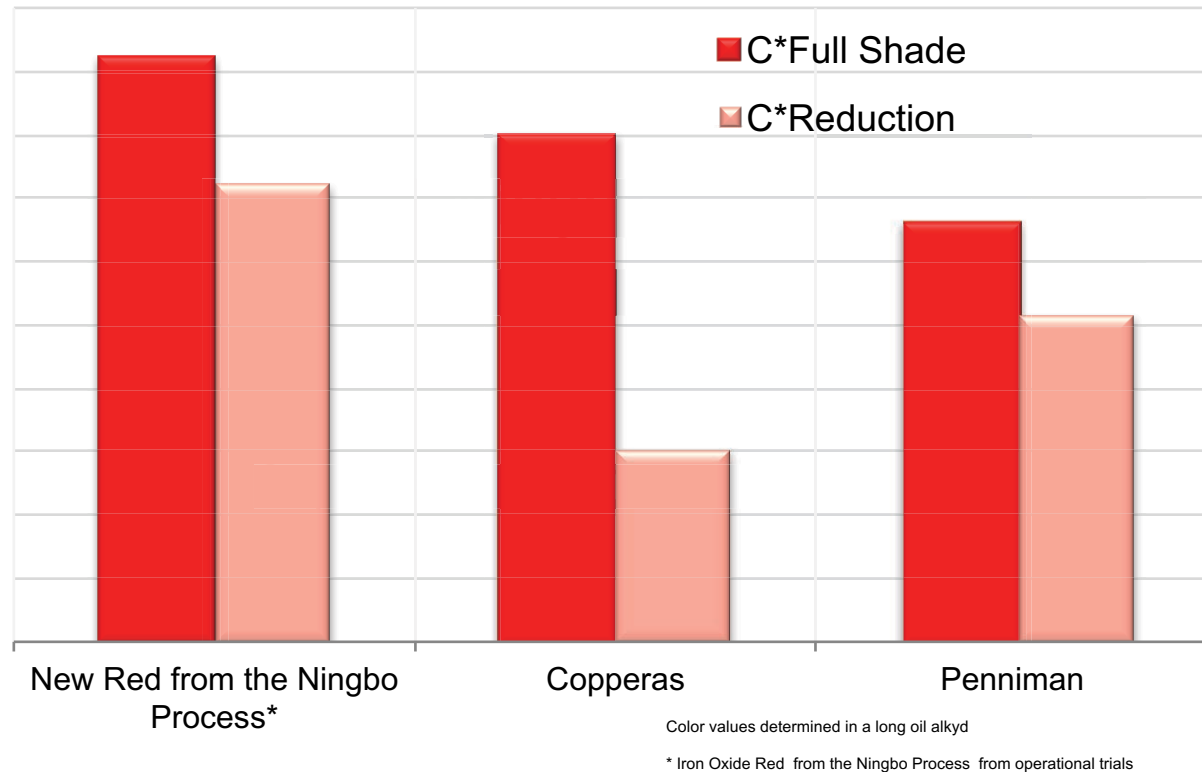


Resin binder: mid oil alkyd
Film thickness: 150µm

Left: Bright hematite
Right: Bayferrox TP LNP 1

New Red Ningbo pigments with high chromaticity

Chromaticity of Bright Red Iron Oxides



- The chromaticity values C^* of selected red iron oxides were determined in a long oil alkyd system
- In both full shade and reduction (1 : 5 with TiO_2), the newly developed iron oxide reds from the Ningbo process show the highest chromaticity value C^* .
- It is noticeable that pigments from the different manufacturing processes do not show consistent C^* values in full shade and reduction.

Summary – Outstanding color and outstanding performance in modern coating systems



New Red from LANXESS

- A range of products made to Bayferrox® quality standards in Ningbo, China using the patented Ningbo Process
- Excellent dispersibility and viscosity behavior in paint and coating systems
- Uniformly shaped particles
- Very narrow particle size distribution
- Further extending what is already the broadest range of red iron oxides in the market
- Including competitor alternatives and highly innovative bright, yellow-shade reds which have never been produced before

LANXESS

A solid red horizontal bar is positioned below the 'LAN' portion of the 'LANXESS' text.

Energizing Chemistry