Process Technology for Digital Inks
Complete Program for Process Engineering of Decorative, Packaging & Functional Inkjet
DIGITAL INKS

Everything at a Glance

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If you were to look around now, you would find many objects that have been printed with inkjet technology.

For years, the Ceramic Industry has used digital printing to decorate tiles using pigmented ceramic ink. Other industrial sectors such as textiles, packaging, glass, functional electronics, amongst others, are also using the technology more and more.

The process of manufacturing digital inks is not just about ultra-fine grinding of suspended particles to sub-micron or nanometer range. It has many more complex processes, such as wetting out, solid / wet mixing, chemical additive interactions, stabilisation, homogenisation, and obviously the fine grinding for the required particle size distribution.

Our accumulated experience and expertise in this application allows us to select the best solutions from our wide portfolio. Our technology is engineered to cover the different stages of ink manufacturing, and the specific requirements of each type of ink.

Hundreds of customers worldwide are guaranteed confidence for the thousands of tons of digital ink produced on NETZSCH equipment.
## INTEGRATED SOLUTIONS

**A COMPLETE 360º PORTFOLIO TO COVER ALL STEPS IN DIGITAL INK MANUFACTURING**

### BY CHEMICALS

<table>
<thead>
<tr>
<th>Water Based</th>
<th>Ceramic Inkjet</th>
<th>Ceramic Tiles InGlass Glazes &amp; Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvent Based</td>
<td>Textile Inkjet</td>
<td>Pigment Dye Sublimation Direct Dyes</td>
</tr>
<tr>
<td>“ECO” Solvent</td>
<td>Industrial &amp; Commercial Inkjet</td>
<td>Packaging Publishing Surface Decoration Wide Format Security</td>
</tr>
<tr>
<td>UV Cured</td>
<td>Additive Manufacturing</td>
<td>Add Manufacturing Electrical Matjet</td>
</tr>
<tr>
<td>UV Hybrid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Melt</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BY PRINTING METHOD

<table>
<thead>
<tr>
<th>Electrophotography</th>
<th>Dry Toner</th>
<th>Liquid Toner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inkjet</td>
<td>Drop on Demand</td>
<td>Continuous Inkjet</td>
</tr>
</tbody>
</table>
COVER ALL STEPS IN **DIGITAL INK** MANUFACTURING

- DRY GRINDING
- PRE DISPERSION
- PROCESS ADVICE
- PRE & FINE WET GRINDING
- PLANTS & ENGINEERING
- LABORATORY
- GRINDING BEADS
- AFTER SALES SUPPORT

**NETZSCH**
There is no question that ceramic inkjet printing processes revolutionized the manufacturing of decorated tiles.

Since the very beginning, NETZSCH has been pivotal in the development of ceramic inkjet technology. The first batch of pigmented ceramic inkjet was produced in December 2005 using a NETZSCH LabStar laboratory mill. Since then, we have been at the forefront of this technology and the first point of contact. The System Zeta®, with an 80 % market share, is the renowned milling system in the industry for the wet grinding of ceramic inkjet inks.

NETZSCH is known worldwide for offering complete solutions for many ceramic applications, not just for ceramic inkjet inks. NETZSCH provides the perfect combination of machines and engineering technology for dry and wet processing of ceramic raw materials, pigments, frits and additives, as well as in-glass inkjet inks, digital glazes and effects.
**CERAMIC INKJET APPLICATION RESULTS** successfully implemented

<table>
<thead>
<tr>
<th>Ceramic application</th>
<th>Product</th>
<th>Working capacity [kg/hr]</th>
<th>Pigment concentration</th>
<th>Quality [μm]</th>
<th>NETZSCH solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>InGlass</td>
<td>Frits</td>
<td>43 grinding paste</td>
<td>70 %</td>
<td>(d_{99} &lt; 1.39)</td>
<td>Zeta® 10</td>
</tr>
<tr>
<td>Glaze Effects</td>
<td>Frits</td>
<td>120 grinding paste</td>
<td>40 %</td>
<td>(d_{95} = 3.3)</td>
<td>Zeta® 10</td>
</tr>
<tr>
<td>Ceramic tile</td>
<td>Ceramic pigment</td>
<td>85-150</td>
<td>--</td>
<td>(d_{50} = 0.5-0.8)</td>
<td>S-Jet® 1000</td>
</tr>
</tbody>
</table>

**Complete program for Process Engineering of**

- Digital Glaze
- Ceramic Inkjet
- Ceramic Pigments
- InGlass Ceramic Inks
- Technical Ceramics
- Minerals and Raw Materials
- Ceramic Masses

**System example with wet mills Zeta® and Steam Jet mill S-Jet®**
The printing of textiles has changed over the years. Screen-printing has been the primary selection for printing, but the use of digital printing is growing quickly.

Digital technology has already become a strong favourite for major textile applications such as fast fashion, displays & banners, apparel fabrics, household and technical textiles.

The majority of digital printing on textile is on polyester fabrics using dye sublimation and NETZSCH Grinding & Dispersing machinery leads the way in the preparation of these inks, as well as the pigmented inkjet inks, which are increasingly in demand.

Since the very beginning, NETZSCH has always been there, helping and learning together with our customers, through the development of new textile inkjet inks. No matter where in the world, our wide network of specialists and services are ready to support them.
TEXTILE INKJET APPLICATION RESULTS

successfully implemented

<table>
<thead>
<tr>
<th>Textile application</th>
<th>Pigment</th>
<th>Working capacity grinding paste [kg/hr]</th>
<th>Pigment concentration</th>
<th>Quality [μm]</th>
<th>NETZSCH solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dye sublimation transfer</td>
<td>Black</td>
<td>7</td>
<td>28 %</td>
<td>$d_{99} &lt; 0.2$ + filtration</td>
<td>NeoS® 10</td>
</tr>
<tr>
<td>Dye sublimation transfer</td>
<td>Magenta</td>
<td>3.5</td>
<td>37 %</td>
<td>$d_{90} &lt; 0.18$ + filtration</td>
<td>Zeta® 10</td>
</tr>
<tr>
<td>Dye sublimation transfer</td>
<td>Cyan</td>
<td>13</td>
<td>20 %</td>
<td>$d_{99} = 0.25$ + filtration</td>
<td>Zeta® 60</td>
</tr>
<tr>
<td>Dye sublimation transfer</td>
<td>Brown</td>
<td>25</td>
<td>30 %</td>
<td>$d_{90} &lt; 0.18$ + filtration</td>
<td>Zeta® 25</td>
</tr>
<tr>
<td>Pigmented</td>
<td>Black</td>
<td>68</td>
<td>20 %</td>
<td>filtration</td>
<td>NeoS® 10</td>
</tr>
<tr>
<td>Pigmented</td>
<td>Cyan</td>
<td>25</td>
<td>25 %</td>
<td>filtration</td>
<td>NeoS® 10</td>
</tr>
<tr>
<td>Pigmented</td>
<td>Yellow</td>
<td>36</td>
<td>29 %</td>
<td>filtration</td>
<td>NeoS® 10</td>
</tr>
</tbody>
</table>

Complete program for Process Engineering of

- Disperse Dye Sublimation
- Disperse Dye Direct
- Pigmented Inks
- Acid Inks
- Reactive Inks

Example line with AlphaNeos NElast design and Epsilon inline disperser

![Image of textile inkjet application setup]
Anyone who has strolled through the Printing Industry exhibitions will have noticed that there is a lot of interest in the possibilities of digital printing for packaging.

Printing digital inks onto different substrates such as corrugated and folded cartons, labels and flexible packaging, is becoming more and more common.

New technologies demand new inks, and NETZSCH, as always, with its complete program of Grinding & Dispersing technology, is ready and able to help inks producers find the optimal process for each specific case.
### PACKAGING INKJET APPLICATION RESULTS

Successfully implemented

<table>
<thead>
<tr>
<th>Packaging application</th>
<th>Pigment</th>
<th>Working capacity grinding paste [kg/hr]</th>
<th>Pigment concentration</th>
<th>Quality [μm]</th>
<th>NETZSCH solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV led corrugated carton</td>
<td>Yellow</td>
<td>55</td>
<td>25 %</td>
<td>$d_{90} &lt; 0.09$ + filtration</td>
<td>NeoS® 10</td>
</tr>
<tr>
<td>UV led corrugated carton</td>
<td>Cyan</td>
<td>43</td>
<td>25 %</td>
<td>$d_{90} &lt; 0.09$ + filtration</td>
<td>Zeta® 10</td>
</tr>
<tr>
<td>UV led corrugated carton</td>
<td>Magenta</td>
<td>52</td>
<td>25 %</td>
<td>$d_{90} &lt; 0.09$ + filtration</td>
<td>NeoS® 10</td>
</tr>
<tr>
<td>UV led corrugated carton</td>
<td>Black</td>
<td>50</td>
<td>25 %</td>
<td>$d_{90} &lt; 0.09$ + filtration</td>
<td>Zeta® 25</td>
</tr>
<tr>
<td>UV led corrugated carton</td>
<td>White</td>
<td>20</td>
<td>65 %</td>
<td>filtration</td>
<td>Zeta® 25</td>
</tr>
</tbody>
</table>

**Complete program for Process Engineering of**

- Corrugated Carton
- Folded Carton
- Flexible Labels
- Water Based Inks
- Solvent Inks
- Eco Solvent Inks
- UV Inks

**Example line with wet mill** AlphaNeos and Epsilon inline disperser including final UV formulation and adjustment
Digital printing is also breaking through sectors formerly bound to more traditional, industrial printing, such as commercial printing, security inks, surface decoration, wood, wallpaper, photobooks and many others.

Printing using inkjet provides flexibility, personalization, and cost savings among other advantages. Liquid toner and other new ink technologies are also increasing their share of the digital printing market.

Printing and ink technologies are evolving, and this brings very diverse inks and substrates, each of them with their own technical requirements and individual needs. NETZSCH mills, dispersers, and classifiers are evolving to meet these innovations. The digital market is not going to stop, and all players have to live up to the new demands.
INDUSTRIAL INKJET APPLICATION RESULTS

<table>
<thead>
<tr>
<th>Industrial application</th>
<th>Pigment</th>
<th>Working capacity grinding paste [kg/hr]</th>
<th>Pigment concentration</th>
<th>Quality [μm]</th>
<th>NETZSCH solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Inkjet</td>
<td>Black</td>
<td>26</td>
<td>20 %</td>
<td>d_{90} &lt; 0.3</td>
<td>ZETA® 10</td>
</tr>
<tr>
<td>Deco paper</td>
<td>Iron oxide</td>
<td>30</td>
<td>27 %</td>
<td>d_{50} = 0.115 + filtration</td>
<td>NeoS® 10</td>
</tr>
<tr>
<td>Deco paper</td>
<td>Yellow</td>
<td>50</td>
<td>21 %</td>
<td>d_{90} = 0.2 + filtration</td>
<td>NeoS® 10</td>
</tr>
</tbody>
</table>

Complete program for Process Engineering of

- Publishing Inks
- Surface Decoration Inks
- Wide Format Inks
- Security Inks

System example with with AlphaNeos and Epsilon inline disperser
Inkjet applications are a fast-growing and dominant trend in the digital inks industry. In particular, the 3D-printing market is currently experiencing a period of very rapid growth.

An ever-increasing number of applications in the automotive and aircraft industries, tool manufacturer and prototype development are using more and more additive manufacturing technologies.

NETZSCH’s extensive machine portfolio includes excellent solutions for classifying the metal powders required for high quality applications of “Additive Manufacturing” and 3D-printing.
METAL POWDER DEDUSTING

classifying plant with High-efficiency Fine Classifier CFS/HD-S

Innovative design of the CFS/HD-S classifier plant with the operation of the classifier air in a closed loop system: A filter is not necessary as the fine product can be almost completely separated out via a cyclone, which is possible due to the high density of the product. The small filter is only used to remove excess air from the closed loop system.
## Machines for Digital Inks Processing

### Dry Grinding & Classifying
- CGS Fluidized Bed Jet Mill
- *S-JET*® Steam Jet Mill
- *SpherHO*® Dry Agitator Bead Mill
- *CONDUX*® Impact Mill
- CFS/HD-S High-efficiency Fine Classifier

### Mixing
- *Epsilon*® Inline Disperser
- *MaxShear*® Inline Disperser
- *OMEGA*® Economic Dispersionizer

### Wet Pre-Grinding
- *Discus*® Formerly LME

### Wet Grinding
- *Zeta*® Formerly LMZ
- *Neos*®

### Laboratory Machines
- *LabStar*
- *MiniSeries*
- *LabCompactPlus*
<table>
<thead>
<tr>
<th>CERAMIC INKJET</th>
<th>TEXTILE INKJET</th>
<th>INKJET PACKAGING</th>
<th>INDUSTRIAL &amp; COMMERCIAL INKJET</th>
<th>ADDITIVE MANUFACTURING</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="CERAMIC INKJET" /></td>
<td><img src="image2.png" alt="TEXTILE INKJET" /></td>
<td><img src="image3.png" alt="INKJET PACKAGING" /></td>
<td><img src="image4.png" alt="INDUSTRIAL &amp; COMMERCIAL INKJET" /></td>
<td><img src="image5.png" alt="ADDITIVE MANUFACTURING" /></td>
</tr>
</tbody>
</table>
Optimized formulation and grinding of pigments is essential to achieve a color with narrow particle size distribution.

Impact on the Production Process and End Product

- Increase the capacity of the wet grinding system
- Reduction in the overall costs of the production process (wet & dry)
- Achieve higher quality compared to processing without this previous step
CGS Fluidized Bed Jet Mill

The jet mill with the Convor® classifier wheel for a fineness of to $d_{97} < 4 \mu m - 5 \mu m$

*S‐Jet®* Steam Jet Mill

Revolutionary patented high-pressure system (40 bar) for a fineness of to $d_{97} < 1,2 \mu m$ (ceramic inkjet).

Working pressure 40 bar. Steam temperature 250ºC - 350ºC

In addition, moist products can be ground and dried simultaneously without any additional pre-drying process for the inlet. Energy efficient processing of other raw materials (enamel, zirconium, etc.)

*Spherho®* Dry Agitator Bead Mill

When fine grinding of powders is required at a low energy consumption, *Spherho®* is the solution.

It operates with small grinding beads, at high stress intensity, giving high throughputs at a fineness in the range of 2-8 microns. The decades of very well proven technology of NETZSCH wet grinding has been now successfully implemented in dry process applications

*Condux®* Impact Mill

A high speed fine impact mill normally equipped for this application with Pin Mill grinding tool. Allows for the dry grinding of products up to a Mohs hardness of 3 - 3.5

*CFS/HD‐S* High-efficiency Fine Classifier

This high efficiency air classifier was developed for ultra-fine, sharp separation, and is often used in conjunction with grinding plants.

The optimized classifier wheel geometry produces the finest cut points and high yields that have not been possible with production scale conventional one wheel air classifiers.

The special dispersion zone directly in close proximity to the classifier wheel uses clean gas to efficiently disperse the material to be classified.
MIXING & DISPERSION

Do not underestimate pre-dispersion. It has a direct impact on the fine grinding process

Multiple Processes in One Step

- Solid feed into liquid phase
- Wetting out pigment surfaces and dispersing agents & additives
- Liquid & additive mixing & homogenization
- Deagglomeration for finer particle sizes
**Epsilon Inline Disperser**

Compact solution for producing homogeneous dispersions with reproducible quality in an inline process. Here, the dispersion process takes place in an atmospherically sealed processing chamber and is thus dust and emission free. The **Epsilon** operates similarly to a feed pump. Through optimal flow control, a negative pressure is created in the processing chamber during operation. This negative pressure is used to draw in the powder, whereby, in combination with appropriate powder delivery, introduction of external air is minimized. The principle of the **Epsilon** is based on the introduction of the powder under negative pressure in a continuous, large liquid surface. Due to the pressure gradient between the supply and delivery sides, the liquid is pressed into the agglomerate structure such that, within a very short period of time, the individual particles of the solid are almost ideally wetted. Because of the low shear rates, the energy input is significantly lower than for conventional rotor-stator systems, which means that a smaller increase in the product temperature is achieved.

**Omega® Inline Disperser**

Successful dispersion requires targeted force in order to separate agglomerated particles. The **Omega®** Economic Disperser applies dispersive forces then and there, where they are especially effective: in the **Omega®** disperser body, energy is transformed into very high speeds under pressure. Turbulence and cavitation in perfect combination with specifically-applied shearing forces ensure maximum dispersion results. In addition, the system can be easily adapted to different operating conditions or formulations thanks to the **Omega®** disperser body, which consists of a nozzle with infinitely adjustable flow properties. The optimum adaptation and increased efficiency not only lead to reduced energy consumption in the production process and thereby less heat development, but also to less wear as compared to traditional technologies.

**MaxShear Inline Disperser**

Compact enough to be included at virtually any point in your process. The self-pumping portable unit features rotor/stator based technology with multiple stator configurations available. Manufactured to extremely precise tolerances to eliminate product bypassing typical of other single stage dispersers. Exceptional high shear performance and powerful pumping action makes the **MaxShear** ideal for emulsifying and processing hard-to-wet materials.
WET PRE-GRINDING

After dispersion and prior to the wet grinding, when product requires extra...
**DISCUS® Grinding System (formerly LME)**

With the DISCUS® grinding system, the movement of the grinding media between the disks is activated and optimized. This leads to a high power input and a grinding efficiency with low specific energy consumption and an uniform impact intensity. With an optimized Dynamic Classification rotor, high throughput rates are achieved.

**MaxShear Inline Disperser**

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WET GRINDING

NETZSCH will help to select the optimal fine grinding system configuration for your specific product and requirements.

Main Goals

- Obtain a fine pigment dispersion into the $d_{50}$ fineness which meets the requirement
- Allowing wet out of all the pigment surface with solvents and chemical additives
- Obtain a PSD as narrow as possible* (*application dependent)
- Keep $T$ (temperature) below max.
- Remove agglomerates and/or coarse particles from ink
- Maintain viscosity within specifications
Grinding System ZETA®

- Peg grinding system with the highest grinding intensity
- Finenesses into the nanometer range
- Narrowest particle size distribution
- Greatest cost efficiency
- Exact reproducibility
- Effective centrifugal separation system
- Logical design for the highest throughput rates Ideal for circulation/multipass operation
- Optimal energy input with effective cooling
- Ideal temperature control
- Universally applicable for every product
- Scale-up possible from laboratory to production machine
- Reliable use of a wide variety of grinding media from 0.1 mm to 3 mm
- You achieve the best product qualities with maximum output and optimal energy efficiency

Grinding System NEOS®

1 Max slotted pipe surface area
2 Optimized grinding media separation
3 Maximum cooling surface to grinding chamber volume ratio
4 New rotor design for efficient power input
5 Optimum grinding chamber cooling with NETZSCH-CERAM C inner tank and optional rotor cooling
LABORATORY MACHINES

For development of new products, for processing small quantities, for quality control and process optimization ...
**LabStar Laboratory Agitator Bead Mill**

Enables scientific academic work on difficult research and development tasks. Impresses with its easy handling.

The laboratory mill *LabStar* enables an exact scale-up to comparable production machines.

*Neos®*, *Zeta®* and *Discus®* grinding system are available in different grinding chamber designs (NETZSCH-Ceram C, NETZSCH-Ceram N, NElast, NETZSCH-Ceram A, Cr-Ni-steel)

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**MicroSeries Laboratory Agitator Bead Mill**

Finest wet grinding technology – the laboratory mills of the *MicroSeries* are an investment in the future for new product developments.

The improved centrifugal separation system of the worldwide known peg grinding system *Zeta®* enables the use of very small grinding media for grinding and dispersing of minimal product quantities.

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**LabCompactPlus. The Module Plant**

The NETZSCH *LabCompactPlus* is available with different laboratory machines, e.g. the High-efficiency Fine Classifier CFS 5 HD-S.

The plant comprises a very compact operating module including feeding, cyclone, filter, blower and electrical control. It is mounted on one single base frame and is delivered completely installed.

The *LabCompactPlus* is especially designed for use in laboratories. The technology of production-size plants which has been channeled into the design of this product guarantees a stable and reproducible processing method.
Business Unit Grinding & Dispersing –
The World’s Leading Grinding Technology

NETZSCH-Feinmahltechnik GmbH
Selb, Germany

NETZSCH Trockenmahltechnik GmbH
Hanau, Germany

NETZSCH Vakumix GmbH
Weyhe-Dreye, Germany

NETZSCH Lohnmahltechnik GmbH
Bobingen, Germany

NETZSCH Mastermix Ltd.
Lichfield, Great Britain

NETZSCH FRÈRES S.A.R.L.
Arpajon, France

NETZSCH España, S.A.U.
Terrassa/Barcelona, Spain

ECUTEC S.L.
Barcelona, Spain

Tramega
Terrassa/Barcelona, Spain

NETZSCH Premier Technologies, LLC.
Exton PA, USA

NETZSCH Indústria e Comércio de Equipamentos de Moagem Ltda.
Pomerode, Brazil

NETZSCH (Shanghai) Machinery and Instruments Co., Ltd.
Shanghai, China

NETZSCH Technologies India Private Ltd.
Chennai, India

OOO NETZSCH Tula
Tula, Russia

NETZSCH Makine Sanayi ve Ticaret Ltd. Sti.
Izmir, Turkey

NETZSCH Korea Co., Ltd.
Goyang, Korea

The NETZSCH Group is a mid-sized, family-owned German company engaging in the manufacture of machinery and instrumentation with worldwide production, sales, and service branches. The three Business Units – Analyzing & Testing, Grinding & Dispersing and Pumps & Systems – provide tailored solutions for highest-level needs. Over 3,500 employees at 210 sales and production centers in 35 countries across the globe guarantee that expert service is never far from our customers.