

UV inkjet ink technology

Design and manufacture of high performance inks at
Fujifilm Speciality Ink Systems in the UK



Designing high performance inkjet inks



Rapid advances in inkjet technology continue to change the way print is produced. Inkjet is now a viable alternative to traditional processes in many wide format, packaging and industrial applications.

A key factor in the growth of inkjet in these markets has been the ability to print with UV-curing inks - a technology that was pioneered by Fujifilm.

UV inkjet is a fast growing technology, set to dominate these markets with its incredible productivity, quality, application range and versatility.

Intimate knowledge and experience of inkjet development has allowed Fujifilm to anticipate and understand the performance requirements for inkjet inks and to design products that meet them.

When designing an ink, Fujifilm carefully blends a range of cosmetic, functional and operational properties, combining these to produce inks that are formulated for precise applications.

Colour

A wide colour gamut is critical to enable a printer to accurately reproduce intended colours in the print. Graphics also need to be vibrant for visual appeal and impact.

Reliability

Inks must jet reliably, printing high quality work for long periods with minimal intervention.

Consistency

Inks must be totally consistent, producing the same high quality images and colours in every print and between every manufactured batch.

Performance

Inks must be durable, with properties such as light-fastness and physical adhesion tailored to the specific application of the finished print.

Economy

Inks must allow printers to run their operations in an efficient and cost-effective manner, providing their customers with high quality print at a reasonable price.



Front cover image shows ink drop formation on the journey from printhead to substrate.





Ink development at the heart of our business

At Fujifilm Speciality Ink Systems, one of the core skills is ink design, with an unmatched understanding of ink chemistry, print applications, media, printheads and UV curing. Fujifilm's design capability encompasses R&D resources, a legacy of ink formulation and vast manufacturing experience.

Fujifilm's present success stems from its knowledge of several industries, designing inks for screen, narrow web and wide format inkjet, and the experience it has amassed over decades of listening to its customers and providing products to meet their challenges.

The company set a major technological benchmark during the 1970s when it launched its first instant curing UV ink for screenprinting.

In 1999 it commercialised UV curing inkjet inks that fuelled the world's first UV flatbed inkjet printers created by Inca Digital. Marrying the well-known UV benefits with flatbed inkjet technology opened a whole new market, one that grew so rapidly that it won a Queen's Award for Enterprise for its role in commercialising the technology.

As a pioneer in the field, Fujifilm will continue to invest to stay at the forefront of inkjet technology - "We launched it: we'll lead it."

Pioneering ink development for over sixty years

- 1950 Sericol business founded, supplying early screen print consumables
- 1968 Created the world's first thin-film solvent inks that made screen printing a viable production process
- 1978 Launched first UV-curing screen inks
- 1999 Commercialised the first UV digital inkjet inks
- 2005 Sericol acquired by Fujifilm
- 2007 Launched Onset, the world's fastest wide format flatbed inkjet printer at 700m²/hr
- 2013 Invested €5m in expansion of digital ink production facilities



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Our innovation made UV inkjet a reality.”

*Dr Carole Noutary
Digital Inks Development, Fujifilm Speciality Ink Systems*

The ingredients of world-class Fujifilm UV inkjet ink

- 60 years industry expertise
- research and development investment
- printhead supplier partnerships



- high quality raw materials
- quality assured manufacturing
- proprietary production technology



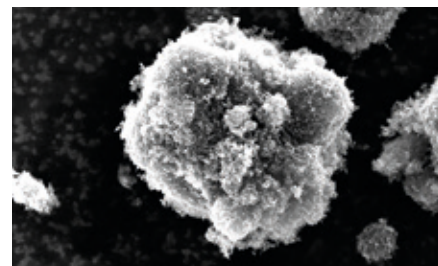
Extending the colour gamut



Colour is the most important aspect of an ink. A printer needs a wide colour gamut for faithful reproduction of images and to match spot colours. Prints with rich colour have more impact and are saleable. To produce an ink with strong, vibrant colours and a wide colour gamut is theoretically simple - you just add more of the colouring pigment...

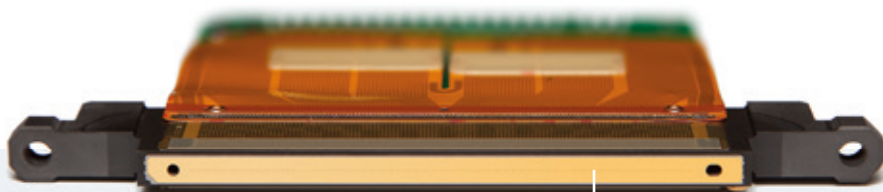
...but the challenges of inkjet are microscopic

Each inkjet printhead contains hundreds of ultra-fine nozzles which are just microns wide. Any large particles in an ink can cause blockages in the nozzle or in other parts of the head, resulting in misfiring nozzles or even printhead damage. Printheads can cost thousands of pounds and bad prints don't sell. Also, to pass through the printhead, the viscosity of the ink needs to be low.



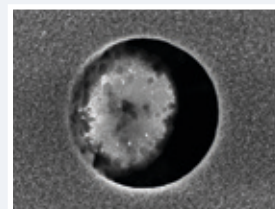
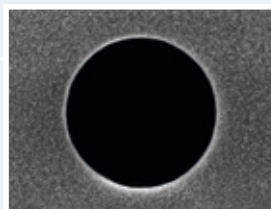
Pigment particles stick together

Colour pigment is made up of clumps of particles that have to be broken down small enough to pass through an inkjet nozzle. But it's not enough just to make the pigment clumps smaller because in a low viscosity liquid there is a tendency for the particles to agglomerate or stick back together. Pigments are also subject to gravitational settlement.



A printhead at actual size.

A printhead nozzle at 2500x magnification (left image) - it is just 25 microns in diameter, half the width of a human hair. Particles that are too large or don't have the right properties can cause blockages and printhead damage (right image).





Fujifilm Micro-V dispersion technology

Micro-V is a unique Fujifilm technology that breaks down pigment particles and ensures they are held in stable dispersion in the ink.

It enables high concentrations of colour pigment to be effectively dispersed and stabilised, resulting in an ink with high colour intensity that resists both agglomeration and gravitational settling - so the ink has high colour strength as well as being stable and reliable.

A proprietary Fujifilm dispersion technology is used to coat the individual pigment particles that are separated during the dispersion process.

This coating gives the particles a tendency to repel each other and therefore prevents pigment agglomeration. A molecular bonding agent is used to provide a link between this dispersion coating and the ink binder, or 'vehicle', in order to stabilise the pigment particle in the fluid and prevent gravitational settlement.

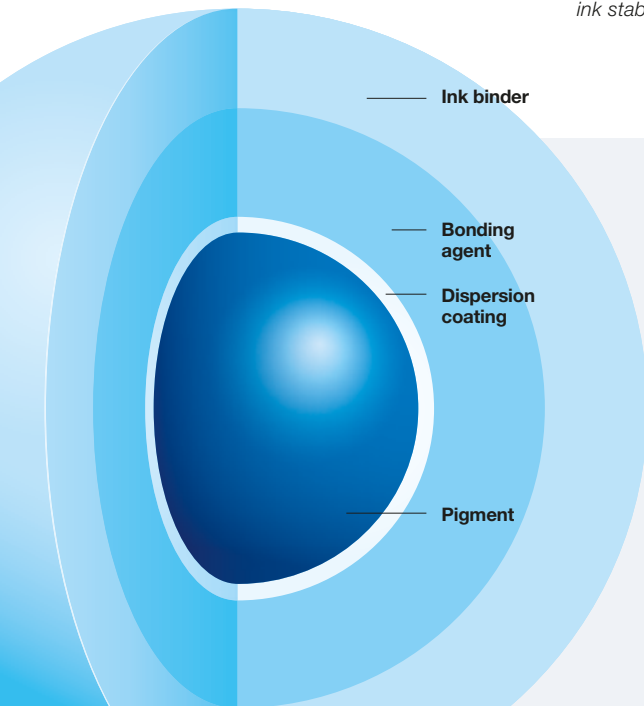
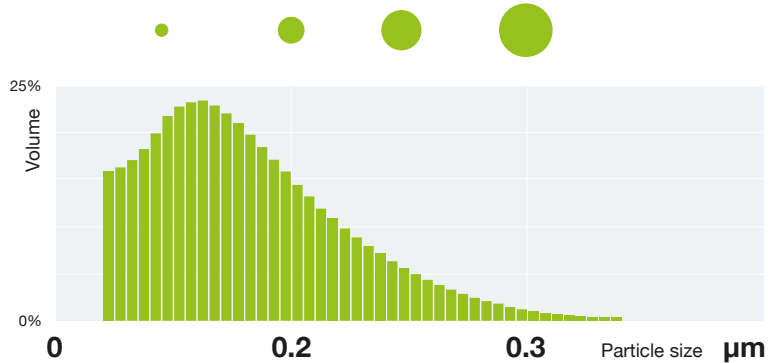
After Micro-V dispersion, pigment particles have an average particle size of less than 200 nanometres - 0.2 microns. They start roughly the size of a grain of salt and are ground down in size to smaller than a human cell.

The benefits of Micro-V dispersion are:

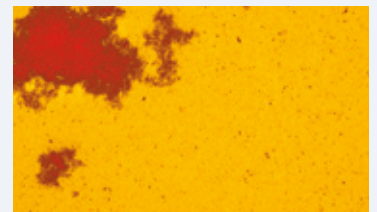
- ▶ Improved and standardised colour management
- ▶ High impact prints with vibrant colours
- ▶ Easier to achieve difficult spot colours
- ▶ Perfect colour consistency between each container of ink
- ▶ High pigment strength enables printing of a thinner ink film so using less ink and saving money
- ▶ Inks have a longer shelf-life
- ▶ High quality pigments provide outdoor durability

When Fujifilm designs an ink, it starts with the colour - the pigment dispersion. This is combined with polymers, oligomers, and other liquid components to impart the finished ink properties and enable it to be cured by UV light.

The Micro-V process grinds pigments to the optimum size for jetting, colour loading and ink stability.



These images at 400x magnification illustrate the quality of the dispersions produced by Fujifilm Micro-V dispersion technology against lower quality dispersions. Micro-V produces a fine, stable dispersion (left image). The lower quality dispersion is unstable and pigment particles clump together (right image).





The formula for high quality ink

As inkjet is a true digital process there is no opportunity for a printer to make any adjustment to the ink. This means that inks have to work perfectly every time, even after months in storage, and so formulations must meet precise performance specifications.

Since the launch of UV inks, and through continuous R&D investment, Fujifilm chemists have learned a huge amount about UV ink design. Combining printhead and performance specifications with in-depth application expertise, they create inks that are tailored to a specific application and optimised to work perfectly with a particular printhead.

They consider properties like printed finish, adhesion to the printed material, flexibility and finishing, while controlling particle size, viscosity and surface tension to produce inks that jet reliably.

Inks are rigorously tested in the laboratory and in production environments where prints are tested for jetting reliability, print quality, production performance and weathering to ensure they meet Fujifilm's stringent performance and quality assurance standards.

Uvijet



Uvijet, one of Fujifilm's UV ink brands, is used in some of the world's most powerful inkjet printers.





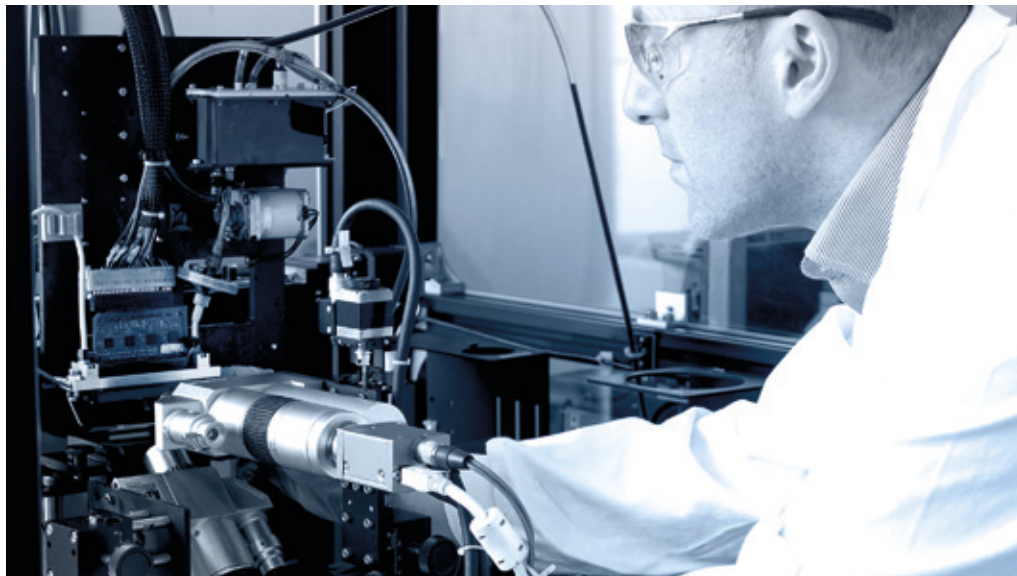
Every drop matters

In theory, inkjet technology is simple. A series of ink drops are jetted from a piezoelectric printhead onto the substrate beneath, without any direct contact. Tiny dots of different coloured ink make up near-photographic quality images.

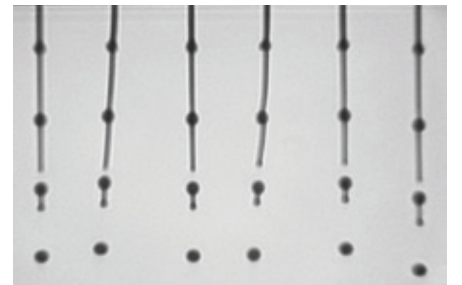
However, the most powerful wide format inkjet printers in the world today use full-width, metres-wide arrays containing hundreds of print heads. They jet billions of drops per second, each directed to a precise location, producing hundreds of square metres of high-resolution print per hour.

The demands on printheads and ink performance are very high, but to jet well and reliably they must be designed for each other.

Fujifilm Speciality Ink Systems partners with printhead manufacturers, including its sister company, Fujifilm Dimatix, to develop optimum ink chemistry for specific printheads. As part of the design process, the printhead jetting patterns are tailored to the ink to achieve the best performance and reliability.

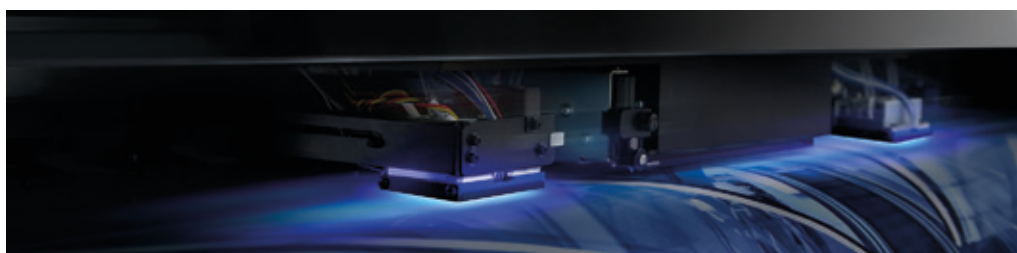


Fujifilm ink with excellent jetting properties.



Inferior ink with poor jetting performance.

These images show ink drop formation on the journey from printhead to substrate. To achieve the best image quality a printer must fire a drop at the print surface to land with pinpoint accuracy and in perfect shape. Only good ink design, tuned to the printhead, makes reliable jetting possible.



UV inks are cured almost instantly by a dose of UV light. Photo-initiators in the ink react and cross link, or polymerise, forming a dry film. Because UV ink cures rapidly, printers can work quickly and economically.



Quality assured manufacturing

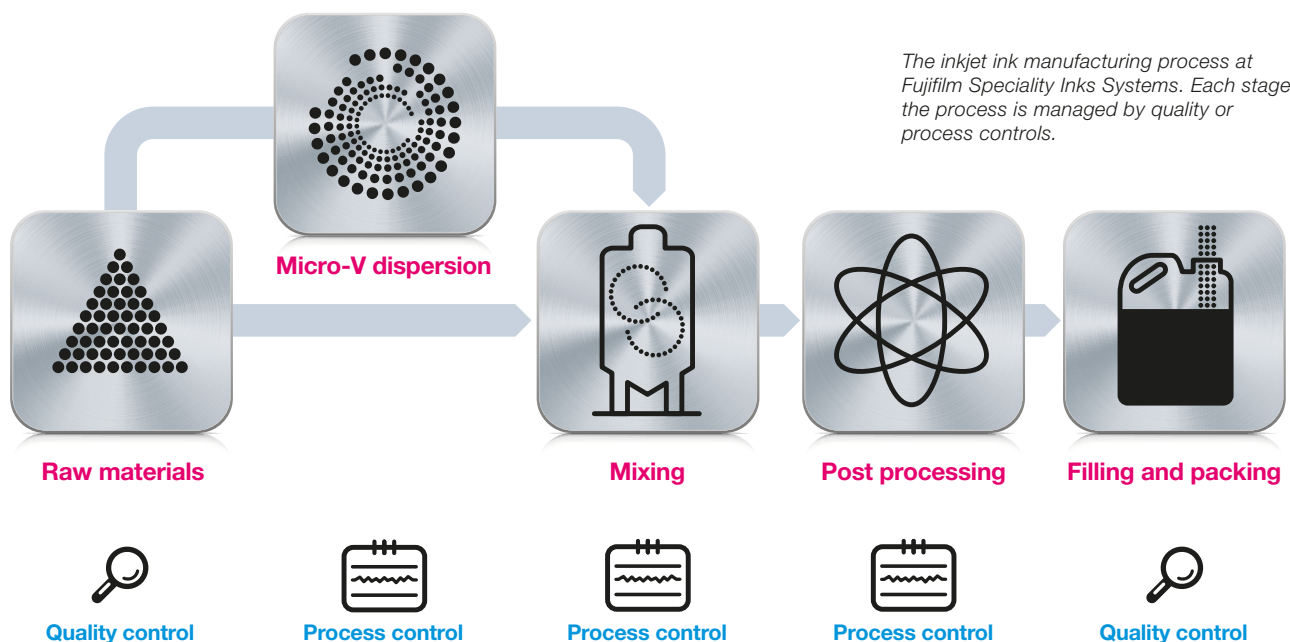
Fujifilm uses a sophisticated manufacturing process where the need for consistent high quality permeates the entire production process. The fundamental aim of this process is to make sure that the product is right first time, every time.

Raw material selection and consistency are key parts of the process and Fujifilm has established close business partnerships with its suppliers. These

partnerships make sure that raw materials meet an agreed specification and that suppliers operate appropriate quality systems in order to maintain consistency of product and continuity of supply.

Production of inkjet inks at Fujifilm is carried out in a process controlled operation. This recognises the equal importance of both the ink formulation and the production process, and

provides controls over every aspect of manufacture to ensure consistency. All the parameters such as milling and stir times, speeds and temperatures are tightly specified and monitored. Vessels, machines, operators, materials and locations are all bar-coded to record specific operations. A final quality control process is used to confirm that key performance parameters are within defined limits.



The inkjet ink manufacturing process at Fujifilm Speciality Inks Systems. Each stage of the process is managed by quality or process controls.



State of the art manufacturing at Broadstairs in the UK

In 2011 the Fujifilm Speciality Ink Systems manufacturing facility won the Best Process Plant, "Best Factory Award". This independent assessment, judged by Cranfield School of Management, is testament to the process controls that enable production of Fujifilm's high quality inkjet inks.

In 2013 Fujifilm made a €5m investment in a new digital ink manufacturing plant and upgrade to its already considerable R&D resources. The new premises has a footprint of 1800m², with the capacity to produce 6000 tonnes of digital ink a year, keeping Fujifilm at the forefront of UV inkjet technology.



Raw materials

Fujifilm works in partnership with its raw materials suppliers, ensuring that these materials meet an agreed specification.



Micro-V dispersion

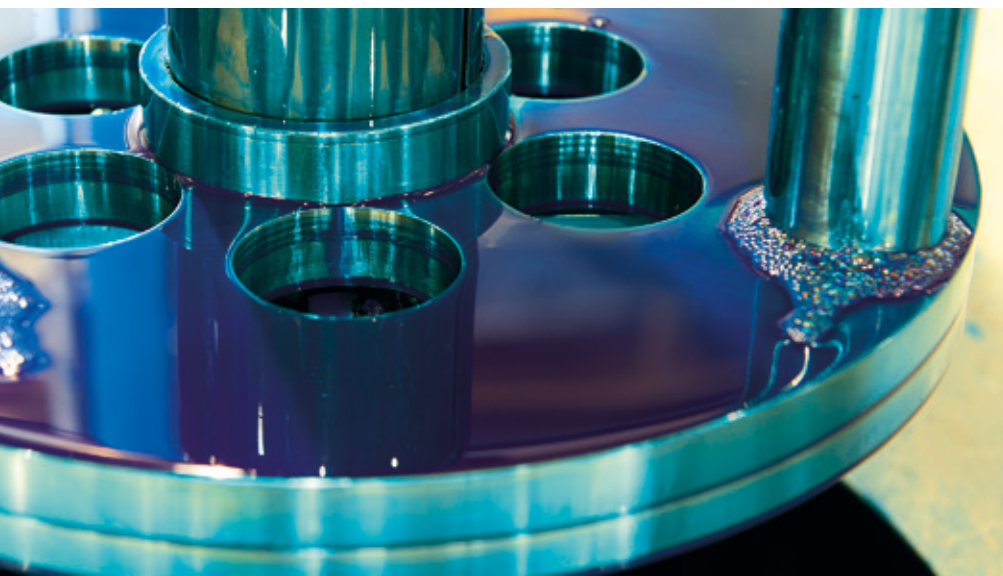
Colour pigments are dispersed to reduce the size of particles down to less than 200nm – far smaller than a human cell. Fujifilm's proprietary Micro-V dispersion process takes over 30 hours.

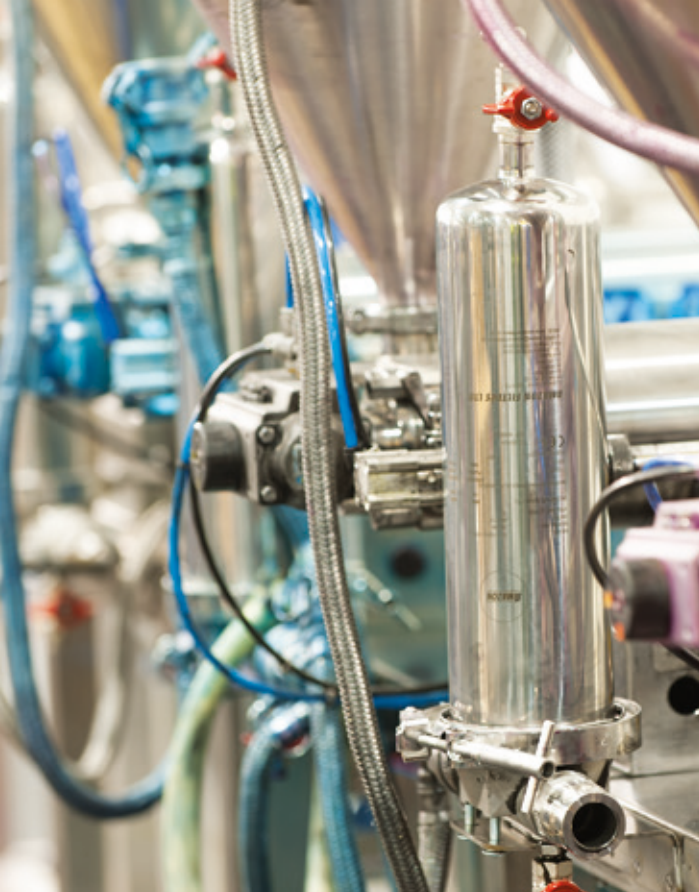




Mixing

The pigment dispersion is blended with the other components in the formulation in massive, powerful mixing vessels capable of producing 4 tonne batches with automatic raw material feeds. Fujifilm is also expert at small batch production, with hundreds of different products being produced across its screen, narrow web and inkjet ranges. These are produced by the tonne and the manual addition of ingredients is carefully controlled by bar-coding and process control.





Post-processing

Post-processing is the final part of the Micro-V dispersion process and is designed to equalise pigment particle distribution within the finished ink. This helps to reduce the likelihood of particle agglomeration and settlement, optimising jetting reliability.



Automated filling and packing

To deal with high production volumes the filling and packing process is semi-automatic. Inks are packaged in a variety of containers from 250ml RFID tagged pouches and cartridges up to 10 litre packs for high productivity wide format printers.



Reducing the environmental impact of ink production

Underpinning the expansion of the inkjet production facilities is Fujifilm's commitment to the environment. It has invested significantly in alternative methods of reducing its environmental footprint in its next generation manufacturing site.

Reducing energy use

'Waste' energy in the form of heat from production processes and compressed air generation via a bespoke new heat exchange system is used to provide 70% of the heating required for the factory. In addition, a new boiler plant incorporates modern, high efficiency modulating condensing boilers that use 40% less fossil fuels than conventional heating systems.

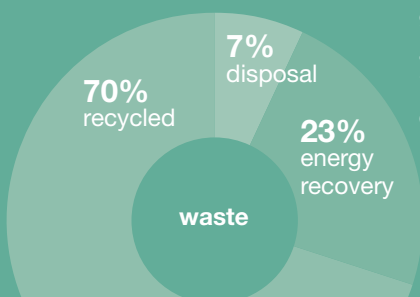


Reusing waste

93% of the manufacturing packaging and production waste is reused, with 70% recycled and 23% going to energy recovery.

ISO accredited

This work has played its part in Fujifilm Speciality Ink Systems being accredited to the Environmental standard ISO 14001, in addition to the Quality standard ISO 9001.



Looking ahead

Like the technology that uses it, inkjet ink will develop at an ever-increasing pace. Whatever the challenges, though, Fujifilm is uniquely capable of meeting them head on.

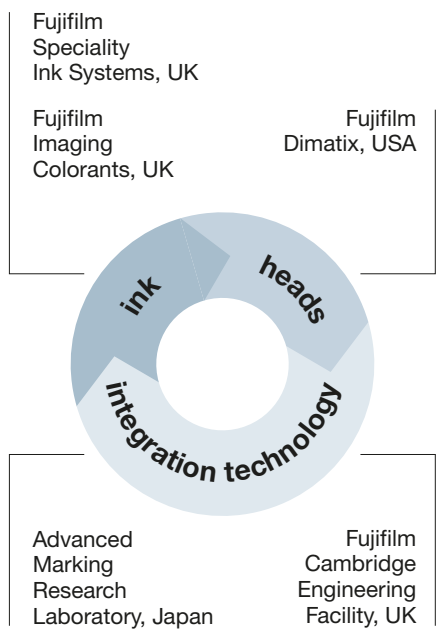
Printheads will continue to evolve with smaller drops jetted at higher frequency to address the trade-off between higher speed and increased print resolution.

Technology must keep pace to meet these demands and will require close cooperation between ink companies and head manufacturers.

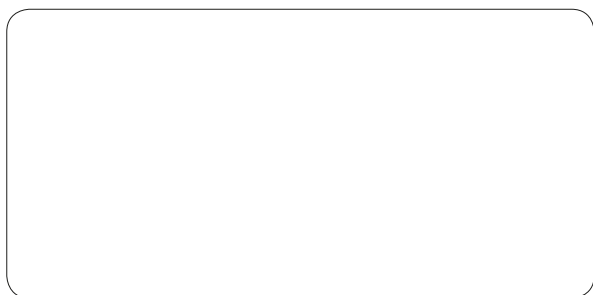
Fujifilm is uniquely positioned to develop tomorrow's inkjet technology with head, ink and fundamental technology development available in house.

Fujifilm Dimatrix is a leading inkjet head supplier that offers class leading heads, all of which incorporate Fujifilm technology. Fujifilm Speciality Ink Systems produces some of the world's best inkjet inks. These businesses are supported by fundamental technology development groups including the Advanced Marking Research Laboratory in Tokyo, Japan and the Fujifilm Cambridge Engineering Facility in the UK.

Fujifilm's ability to combine the skills, experience and technology expertise within these immensely powerful printhead and ink technology groups means it is ideally placed to develop the inkjet printing systems of the future.



Please contact your local Fujifilm partner or visit www.fujifilm.eu/print



For further information:

- Web** www.fujifilm.eu/print
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