

Common Defects in Digital Printing

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Overview

- Ambient Influences
 - Humidity
 - Temperature
 - Sunlight & UV
 - Abrasion
 - Chemical Resistance
- Common Defects in Digital Printing
 - Nozzle outs
 - Misfiring
 - Route Causes & Symptoms



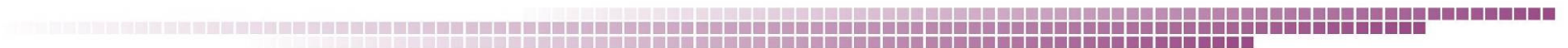
Humidity & Vapor pressure

Humidity is the concentration of water vapor in the air. The concentration can be expressed as absolute humidity, specific humidity, or [relative humidity](#).

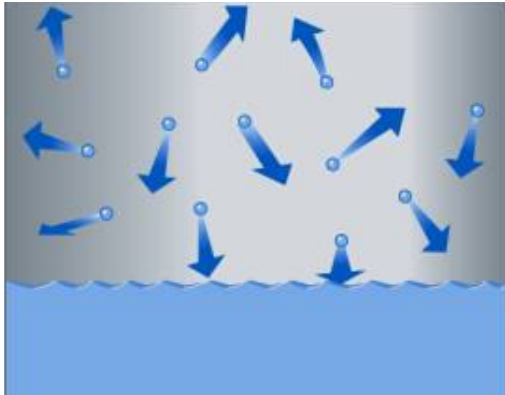
Relative humidity is the common measuring tool.



High humidity - As humidity rises (at a constant temperature) the vapor pressure increases. Although we have two distinct systems, one is hydrophobic and the other is water (no apparent influence should exist), the vapor pressure of the water suppresses the ink from drying.



Humidity & Vapor pressure cont.



The force applied on the solvent, by the water vapors, prevents the solvent vapor from leaving the liquid phase. Hence achieving equilibrium at lower solvent vapors in the air, less drying!

At **high humidity** we will **have trouble drying** the solvent on the media.



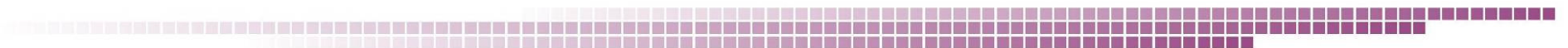
Humidity & Vapor pressure cont.

Low humidity – After the introduction of high humidity, low humidity is fairly easy. **Fast drying** of the solvent occurs. This will lead to nozzle drying during printing. High temperature has a similar influence to the drying rate, but also effects viscosity. Without proper maintenance this could **lead to nozzle blockage**.



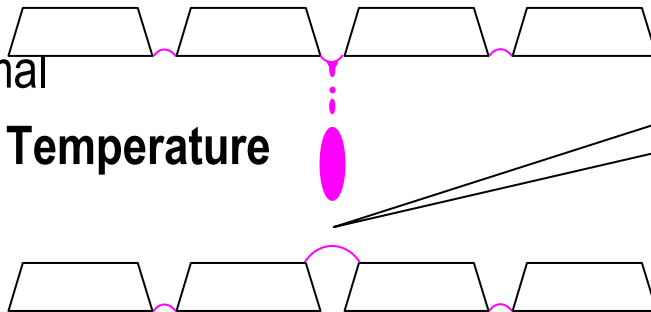
Temperature & Viscosity

- Viscosity – **As temperature increases the viscosity decreases.** The inks are carefully designed with a specific viscosity to ensure optimum performance.
- If the ambient viscosity **increases** outside of the prescribed operating range, this will lead to nozzle **firing instability**.
- If the temperature **decreases** below the prescribed operating range, this will lead to nozzle **starvation**.
- Both these conditions could lead to permanent blockages if maintenance is not done to recover this in a reasonable time period



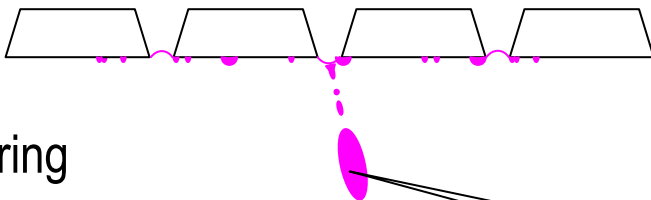
Temperature & Viscosity cont.

- Normal
- Low Temperature

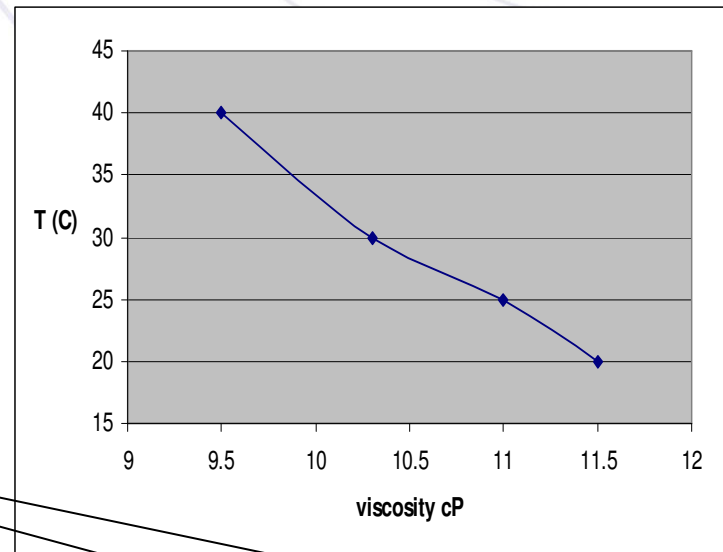


High viscosity leads to resistance of the ink flow into the print head, which results in starvation of the nozzle and consequentially mis-firing

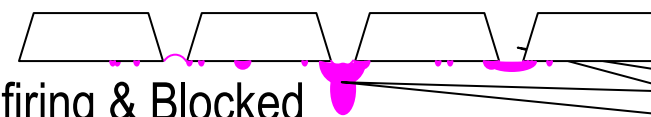
- Starvation
- High Temperature



- Misfiring



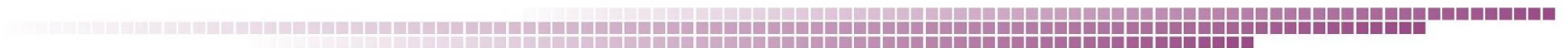
- Non-firing & Blocked



Low viscosity leads to excessive satelliting, which could interfere with firing and lead to blocked, non-firing or mis-firing nozzles

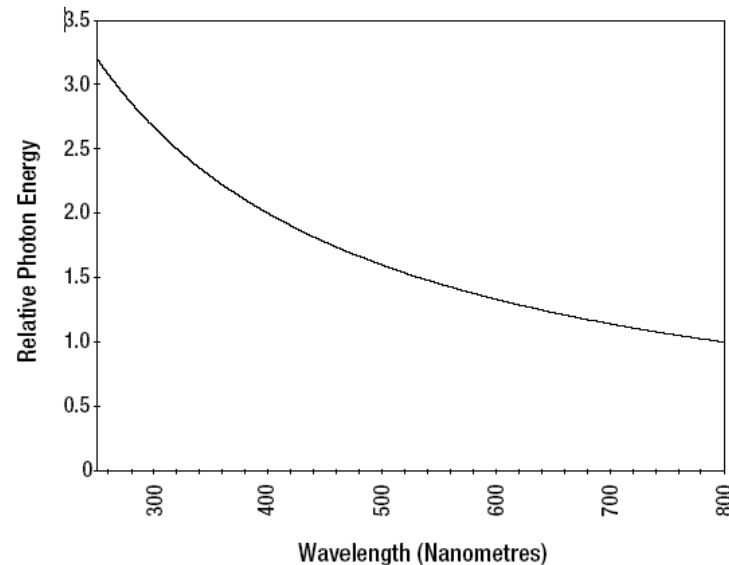
Temperature & Drying rate

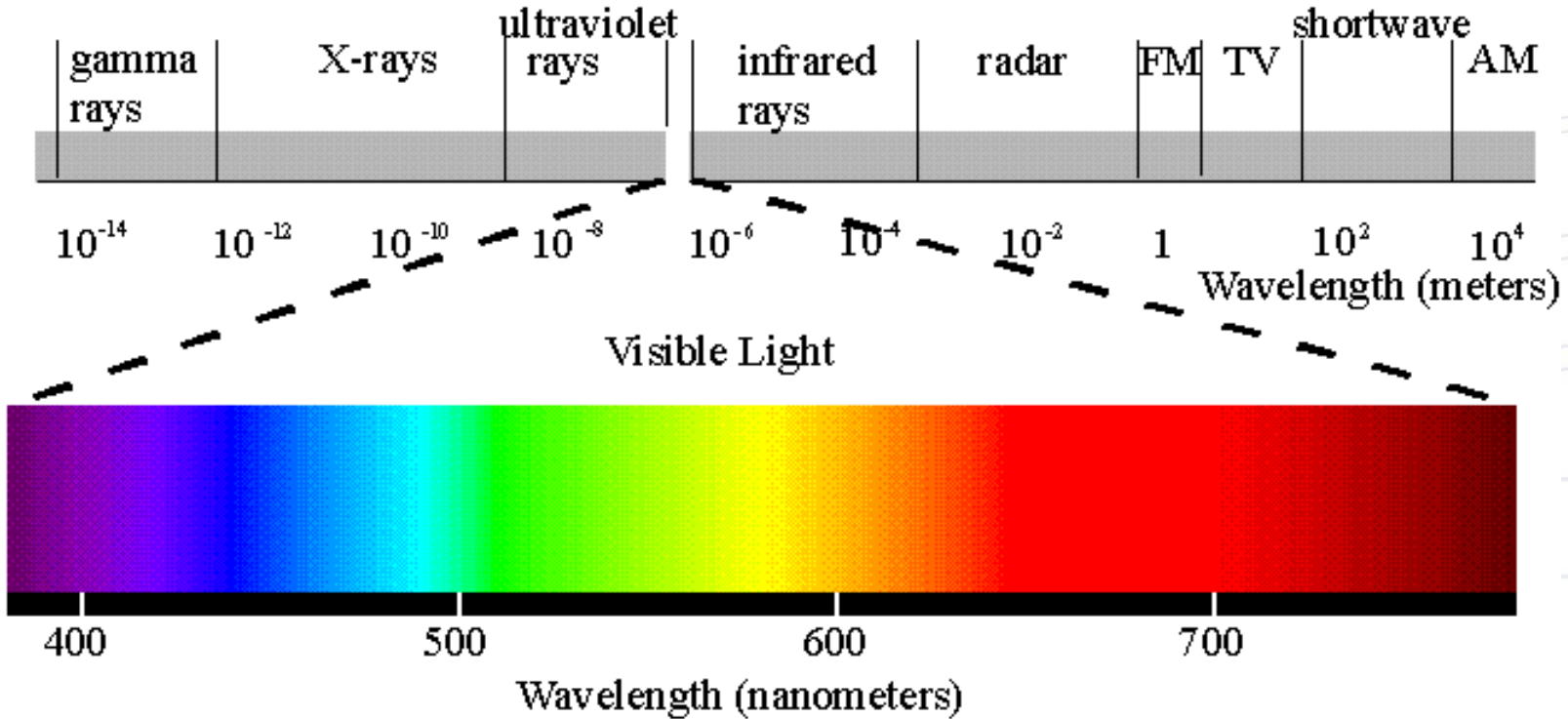
- Drying – As the temperature elevates the drying rate is faster, obvious! But why?
 - Temperature is a term use to describe heat, rather Energy. When we add heat to any system we induce the molecules of that system to vibrate and rotate (fluctuation) thereby repelling one another. This new unstable system will “encourage” the departure of molecules from the liquid phase to the gas phase.
 - Temperature is a secondary factor in drying rate after humidity



Sunlight & UV

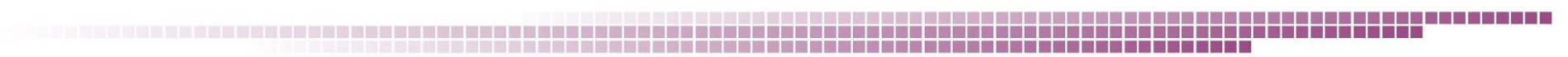
- **Sunlight** in the broad sense is the total spectrum of electromagnetic radiation given off by the Sun, from IR to visible and UV.
- **Electromagnetic radiation** is a propagating wave in space with electric and magnetic components, simply saying Energy.





wave length (nm)	color
380 - 420	violet
420 - 440	indigo
440 - 500	blue
500 - 520	cyan
520 - 565	green
565 - 590	yellow
590 - 625	orange
625 - 710	red
710 - 740	magenta

The electromagnetic spectrum



Sunlight & UV cont.

- **Ultraviolet (UV)** radiation is electromagnetic radiation of a wavelength shorter than that of the visible region.
- The Sun emits ultraviolet radiation in the UVA, UVB, and UVC bands, but because of absorption in the atmosphere's ozone layer, 99% of the ultraviolet radiation that reaches the Earth's surface is UVA.
- In essence the shorter the wave length the higher the energy it contains (Planck's equation), but the shorter the penetration depth.



Sunlight & UV cont.

- So how does it effect the ink?
- All matter absorbs energy. The energy is then converted to chemical reaction (usually oxidation) or physical reaction (electron transition), which brakes down the previous molecule to a new one with different physical and optical properties.
- The optical properties of materials (atoms and molecules) is determined by there structure and orbital orientation...(quantum physics), we will stop here!



Sunlight & UV cont.

- Why are dyes more susceptible to light and uv than pigments?
- Dyes are salt based colorants, meaning when no solvent is present (after evaporation) a crystal form is achieved. This crystal molecule is much less stable than the organic molecule because of its metallic and halogen molecules. Therefore the absorbance of energy will effect this system at a much higher rate.



Abrasion

- Abrasion is a phenomenon caused by the mechanical action of rubbing, scraping or erosion. Since intimately related to scratching and slip, it is not surprising that many slip aids also function as mar and abrasion-resistance additives. Abrasion resistance is actually a combination of basic factors such as roughness of the surface, elasticity, hardness and in some cases, thickness.
- Abrasion is the shear force applied on the surface area. That force causes molecules to deform and in extreme cases to break from each other as they are no longer capable of binding together (>cohesion forces).

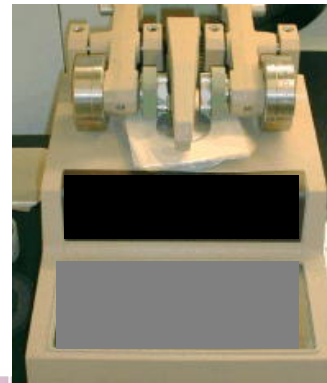


Abrasion cont.

- Why do we test abrasion?
- Wind (along with airborne solids) and other physical actions cause this phenomena.



- How do we measure abrasion?
- A simple test is conducted using an apparatus as shown, simply counting the cycle number of the abrasion platform and measuring the reduced OD.



Chemical resistance

- Can be defined as the ability to withstand contact with specified chemicals without a significant change in properties. Meaning not having a chemical reaction. In our case the ability of a polymer to withstand cracking, crazing, swelling, breakdown or dissolving when in contact with organic fluids or hydrocarbon greases (petrol etc.).
- Acid rain, sunlight and UV, gas exhaustion, petrol spill, etc. All cause chemical reaction and degradation.



Chemical resistance cont.

- The study of chemically resistant materials is very vast and includes a very large data base gathered. We can find materials specifically designed to withstand the presence of any particular matter.
- In the field of inkjets there are many manufacturers with a wide variety of materials that are suitable for our application with a good chemical resistance.



Common Defects in Digital Printing

- Nozzle Clogging is one of the most abused terms in the digital printing industry as this would imply a particle of some sorts getting stuck inside the nozzle hole. The reality that these occurrences are very rare and nozzle outs(non firing nozzles) or more commonly caused by other factors. Let's review some of these factors:
 - **Nozzle Outs**
 - Blockage
 - Starvation
 - Firing instability
 - Drying
 - Puddling
 - **Misfiring**
 - Puddling
 - Fibres

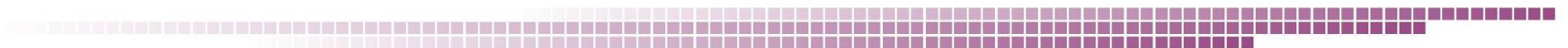


Blockage

- As just mentioned Blockage would imply a particle getting stuck in the orifice hole or nozzle.
- When we look at IDS (Ink Delivery Systems) we can see that designers take care to prevent this from happening by adding filters in the lines to capture these particles before they reach the print heads.
- It is possible that this occurs however, and could indicate a badly manufactured or an expired ink.
- Ink has a shelflife to ensure that the product is used before agglomeration or viscosity changes occur. When a product is used outside of this period, it creates risk which could lead to blockages.
- The phenomenon can be seen as a nozzle out even after print head maintenance has been done.

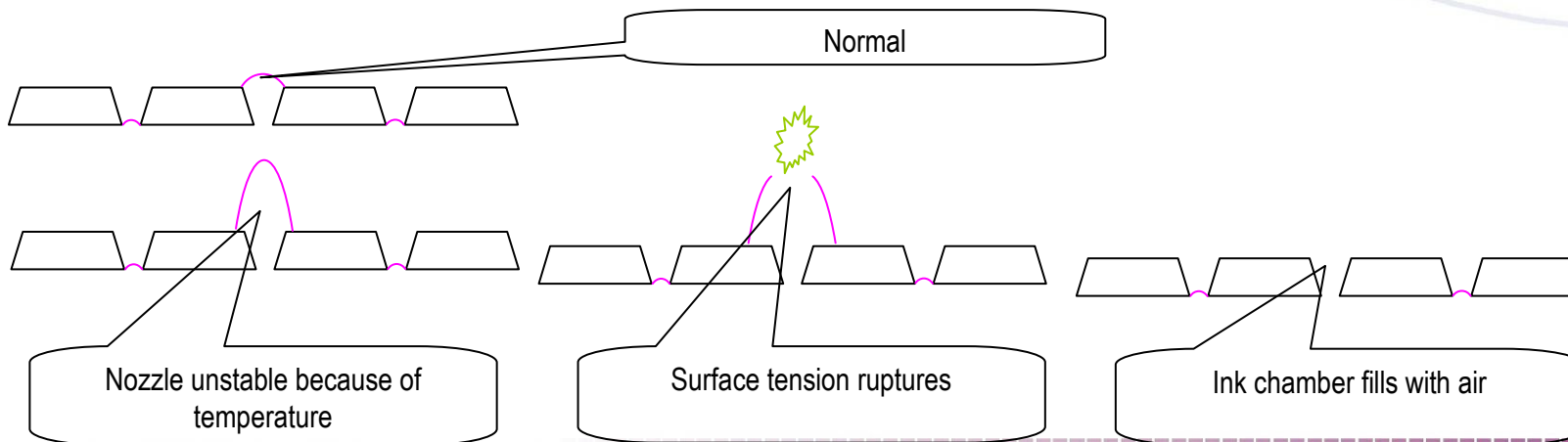
Starvation

- Starvation occurs when the ink has **too much flow** resistance influencing the refill rate of the print head under high demand conditions. In practical terms, this occurs when the ink **viscosity is too high** or there is a **blockage** in your system. You want to print 100% ink density (or high). The print head then consumes too much ink for the refill rate to keep up. The nozzle chamber then literally runs out of ink and starves. This then leads to a nozzle out.
- The one characteristic of this phenomenon is that the nozzles tend to auto recover after a short time without the need for maintenance.
- Blocked filters/dampers, pinched pipe and so on. Could lead to this phenomenon
- Low temperatures would also lead to this occurrence as it would result in raised viscosity.



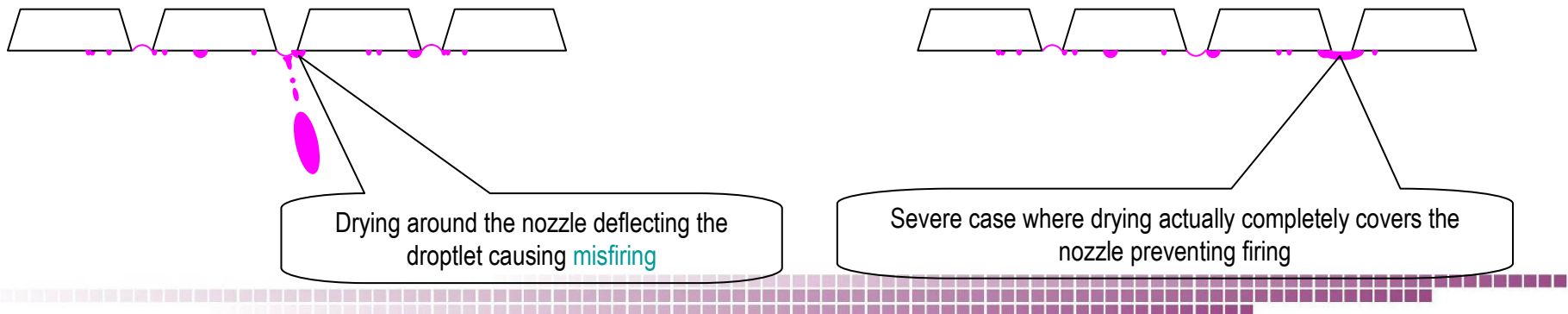
Firing Instability

- Firing instability occurs when the **viscosity** of the ink is **too low**. This leads to excessive movement of the surface at the nozzle (meniscus) and could rupture this Surface Tension(ST). Air would then enter the nozzle from the front and the ink chamber would empty. Without ink in the chamber the print head would then not be able eject a droplet and a nozzle out occurs
- A characteristic of this phenomenon is that there tends to be excessive sateliting, and nozzle outs after the print. This does not auto recover and maintenance is required to correct the nozzle status.
- Temperature is the primary factor causing this type of failure.



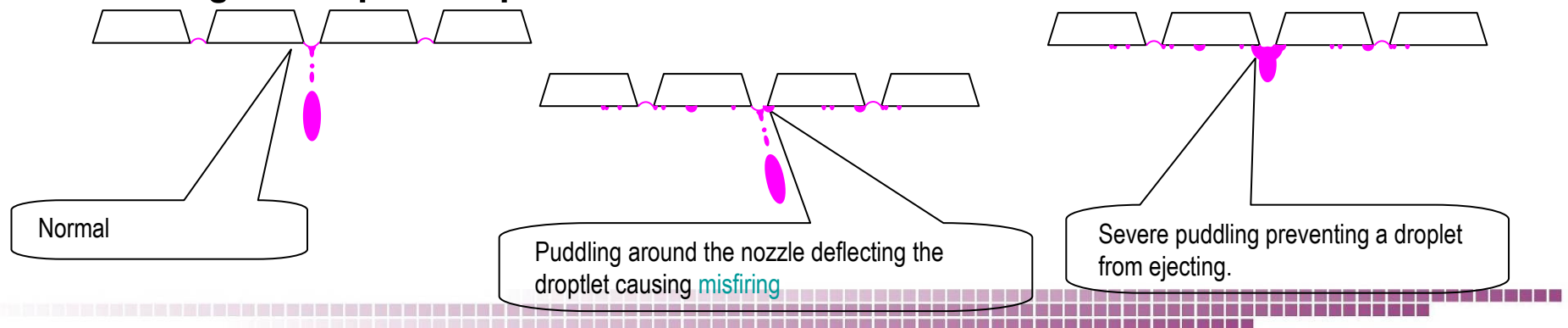
Drying

- This phenomenon occurs when the small satellite droplets trailing the main droplet falls back onto the faceplate of the print head. These satellites then dry and accumulate on the faceplate and around the nozzle. This could then lead to interference of the droplet being ejected leading to nozzle outs or misfiring
- A characteristic of this phenomenon is gradual deterioration of the nozzles during printing showing up as lines in the print. The nozzle print would have missing or mis-aligned nozzles. This does not auto recover and maintenance is required to correct the nozzle status.
- Low humidity is a primary factor causing this, with high temperature a secondary factor.



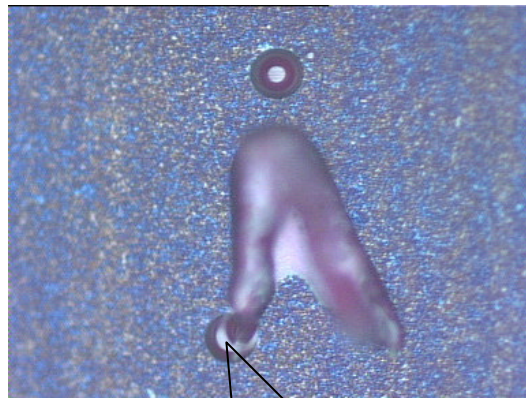
Puddling

- This phenomenon occurs when the small satellite droplets trailing the main droplet falls back onto the faceplate of the print head. These satellites then do not dry and accumulate on the faceplate and around the nozzle. This could then lead to interference of the droplet being ejected leading to nozzle outs or misfiring
- A characteristic of this phenomenon is gradual deterioration of the nozzles during printing showing up as lines in the print. The nozzle print would have missing or mis-aligned nozzles. However the nozzle status would auto recover after a short while without maintenance.
- Good print head maintenance is required, specifically a clean and non-damaged faceplate to prevent this.

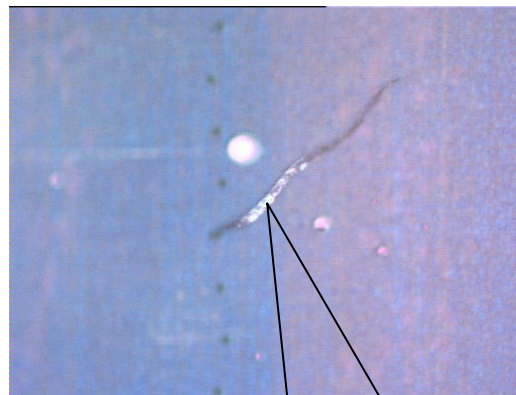


Fibres

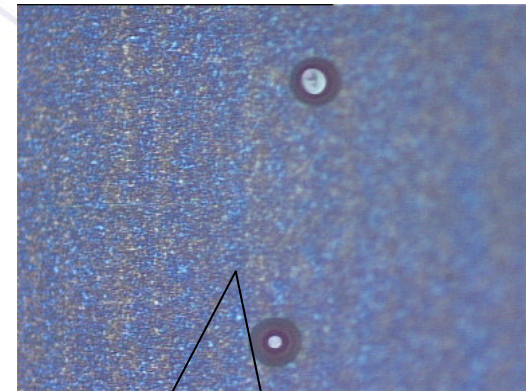
- **Fibres interfere with the droplet ejection trajectory leading to mis-firing nozzles. The source of the fibres could be media, dust, hair, and so on.**
- **A characteristic of this phenomenon is directionality issues during printing. After maintenance the nozzle mis-firing may or may not recover as the fibres may be lodged inside the nozzle itself.**
- **The environment plays a big role in printer reliability and Image Quality.**



Fibre lodged inside nozzle



Fibre on the faceplate, not in nozzle

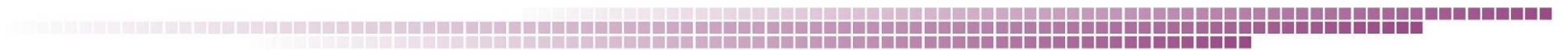
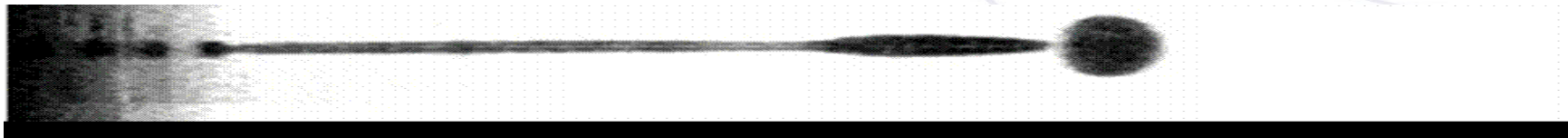


Good condition of the faceplate





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Thank you

