



**GLOBAL INKJET SYSTEMS**  
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# Challenges in Ink Delivery System Design and Operation

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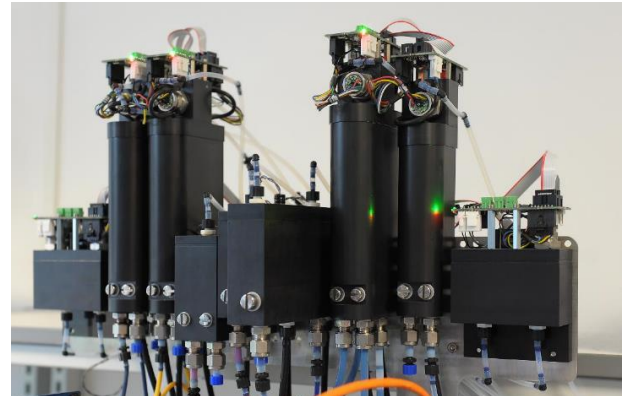
**IMI Inkjet Engineering Conference**  
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# Agenda

- **Main functions and basic requirements of ink delivery systems (IDS)**
- **Flow modes and printhead types**
- **Design options & challenges**
  - Heating
  - Degassing
  - Customizing print bars
- **Typical IDS issues**
  - Diagnosing common issues
  - Troubleshooting and solutions



GIS – Header Tank Options



# Main Functions of Ink System

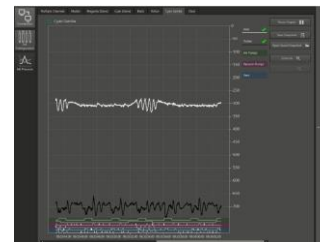
- **Meniscus pressure**
  - Ink pressure inside the printhead
    - Meniscus is formed by a slight negative pressure at the nozzle
- **Air pressure control**
  - Negative air pressures to maintain meniscus pressure of each printhead
  - At different flow rates
  - Scanning XY systems – withstand the acceleration/deceleration of printhead carriage
- **Ink pumping**
  - Control for pumping of ink from bulk ink tank
- **Purging**
  - Positive pressure to the ink in the printhead
    - Low pressure and high pressure purge (required by some printheads)



# Basic Requirements

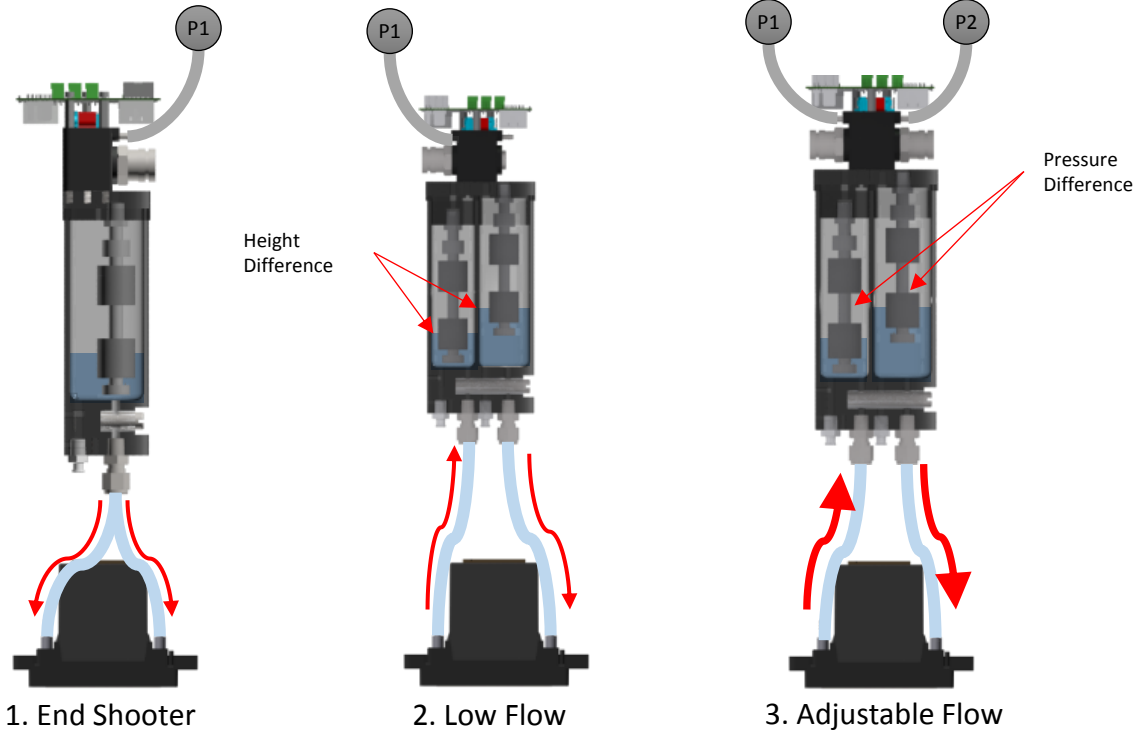
- **Filtration**
  - Minimise chance of particles clogging the nozzles
- **Flow modes**
  - Support for recirculation or no recirculation
- **Degas**
  - Stop air bubbles reaching the printhead/nozzles
  - Avoid air pockets in ink system
- **Heat the ink**
  - For correct operating temperature (printhead dependent)
- **Shared or individual pressure**
- **System monitoring**
  - User friendly GUI
  - Graphing tools – pressure, pump & solenoid activity etc.

**Reliable system for production environments!**





# Flow Modes

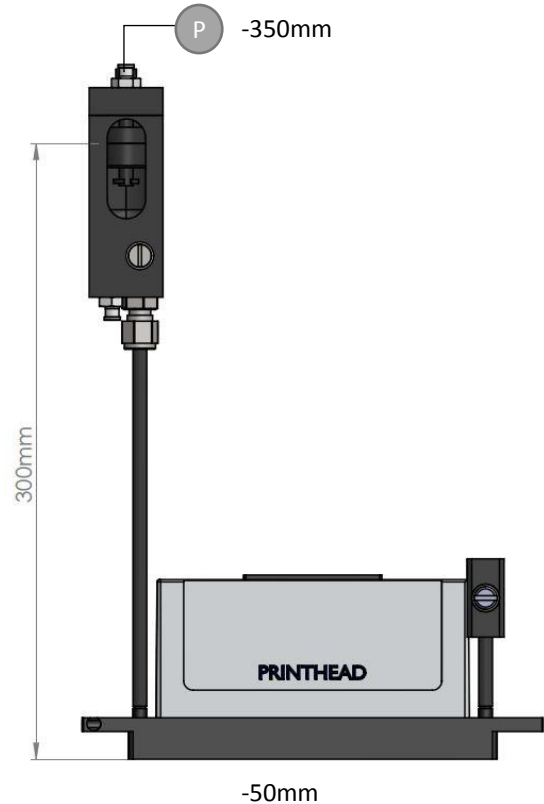




# No Flow/End Shooter

## • Basic characteristics

- Air pressure range typically 250-500mm between header tank and nozzle plate
- In this example, negative pressure P (-350mm) applied to balance the positive head of fluid (300mm) and provide a negative meniscus pressure of -50mm at the nozzle plate

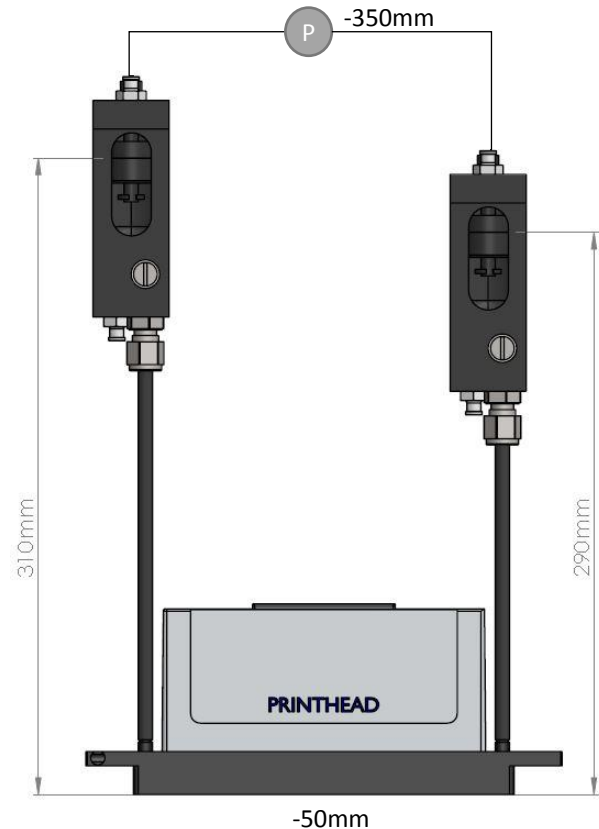




# Low Flow/End Shooter

## • Basic characteristics

- Height difference between the header tanks
- Same negative air pressure applied to both tanks
- System constantly tries to level and creates low flow through the printhead

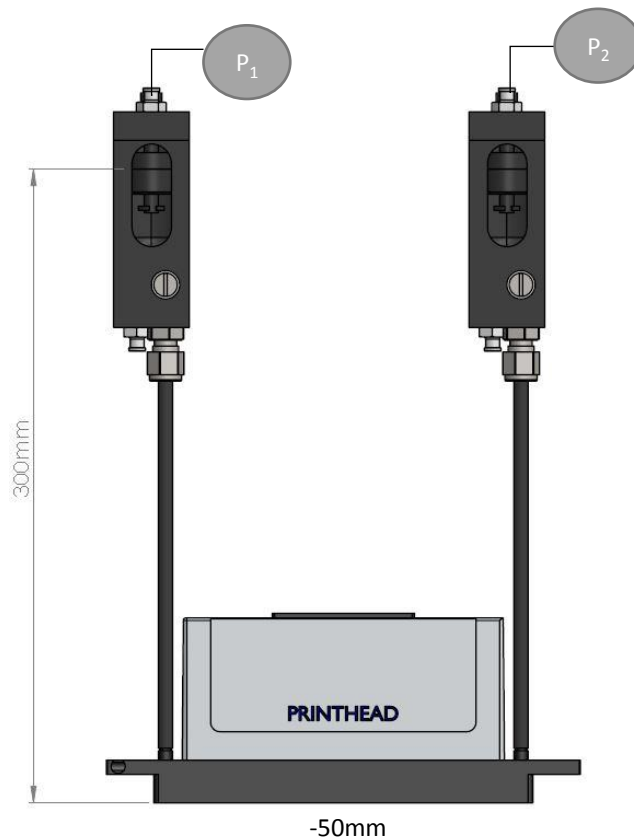




# Controlled/Adjustable Flow

- **Basic characteristics**

- Two pressure values assigned
- Printhead manufacturers tend to specify the pressure difference
- Differential air pressure creates flow through the printhead
- $P_1$  and  $P_2$  both adjustable to vary/control the flow rate







# Printheads & Flow Modes

Example Printheads	No Flow	Low Flow	Controlled Flow
Fujifilm Samba G3L	x	x	✓
Fujifilm Starfire SG1024	x	x	✓
Fujifilm Sapphire 256	✓	(✓)	x
Konica Minolta 1024i	✓	(✓)	x
Kyocera KJ4B-QA/YH	✓	(✓)	x
Kyocera KJ4A-TA/AA/RH	✓	(✓)	x
Ricoh MH5440	✓	(✓)	(✓)
TTEC CF1/CF3	x	x	✓
Xaar 1003	x	x	✓
Xaar 5601	x	x	✓

**Key**  
 ✓ Required  
 (✓) Optional



# Ink Requirements

Ink Type	Typical Ink System Requirements
<b>UV Cure</b>	<ul style="list-style-type: none"><li>• Requires heating (most printheads have heaters and/or use heated mounts)</li><li>• Degassing can be advantageous - best for high frequency/large number of heads. Must be used with care - can make ink over-sensitive to curing</li></ul>
<b>Aqueous</b>	<ul style="list-style-type: none"><li>• (Requires) degassing</li></ul>
<b>Oil based</b>	<ul style="list-style-type: none"><li>• None special</li></ul>
<b>Solvent</b>	<ul style="list-style-type: none"><li>• May require materials compatibility testing</li></ul>
<b>White/ Ceramic</b>	<ul style="list-style-type: none"><li>• Require special pumps due to abrasive ink pigment and particle settling</li></ul>
<b>Fluid Deposition/ Functional Fluid/ Ink Development</b>	<ul style="list-style-type: none"><li>• Requires materials compatibility testing</li><li>• Typically requires small volumes due to high value of fluid– may affect header tank design/size</li></ul>



# Heating

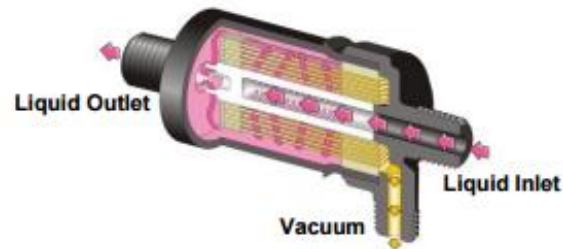
- **Ink performance varies with temperature**
  - Higher temperature
    - Reduces viscosity
    - Increases evaporation
- **Inks have a recommended operating temperature window (consult you ink supplier)**
- **Temperature most critical at the printhead/jetting**

Mode of Heat	Comment	Pros	Cons
<b>In-line Heaters</b>	<ul style="list-style-type: none"><li>• Only work with recirculating systems</li></ul>	<ul style="list-style-type: none"><li>• Provide fast and controllable ink heating</li></ul>	<ul style="list-style-type: none"><li>• Cost</li></ul>
<b>Heated Header Tanks</b>	<ul style="list-style-type: none"><li>• Typically used in no flow or low flow systems</li></ul>	<ul style="list-style-type: none"><li>• Lower cost than in-line heaters</li></ul>	<ul style="list-style-type: none"><li>• Only suitable for low density printing</li><li>• Temperature control less accurate</li></ul>
<b>Heated Head Plates</b>	<ul style="list-style-type: none"><li>• Can be used with all flow modes</li></ul>	<ul style="list-style-type: none"><li>• Provides uniform thermal environment</li><li>• Reduces workload on printhead/ink system heating improving thermal control</li></ul>	<ul style="list-style-type: none"><li>• Thermal expansion</li><li>• Adds cost</li></ul>



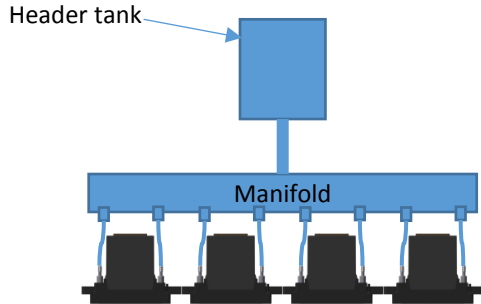
# Degassing

- **(Required) for aqueous inks**
  - Sometimes not used on small systems to save cost
- **Recommended for some UV inks**
  - Typically on large, high print frequency systems
- **Contactors must be right size for flow rate and compatible with ink**
- **Vacuum must be applied**
  - High vacuum for aqueous ink
  - Lower vacuum for UV ink
    - Risk stripping all oxygen out of the ink and cause curing



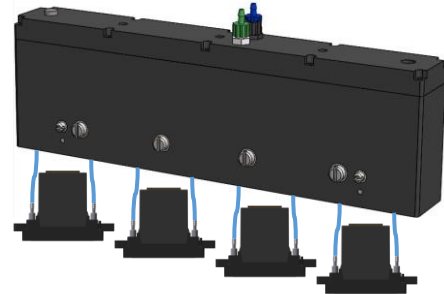


# Large Print Bars – Tank Options



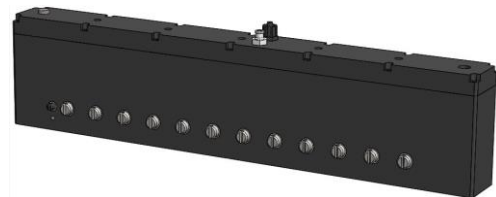
## • Manifold system

- Popular design
- Cost efficient to implement
- Can be prone to air traps
  - Trapped air can sit at top of manifold
- Can be difficult to fill
- Extendable



## • Custom header tanks

- Header tank acts as manifold
- Valve for each printhead
- Equal flow resistance
- Extendable

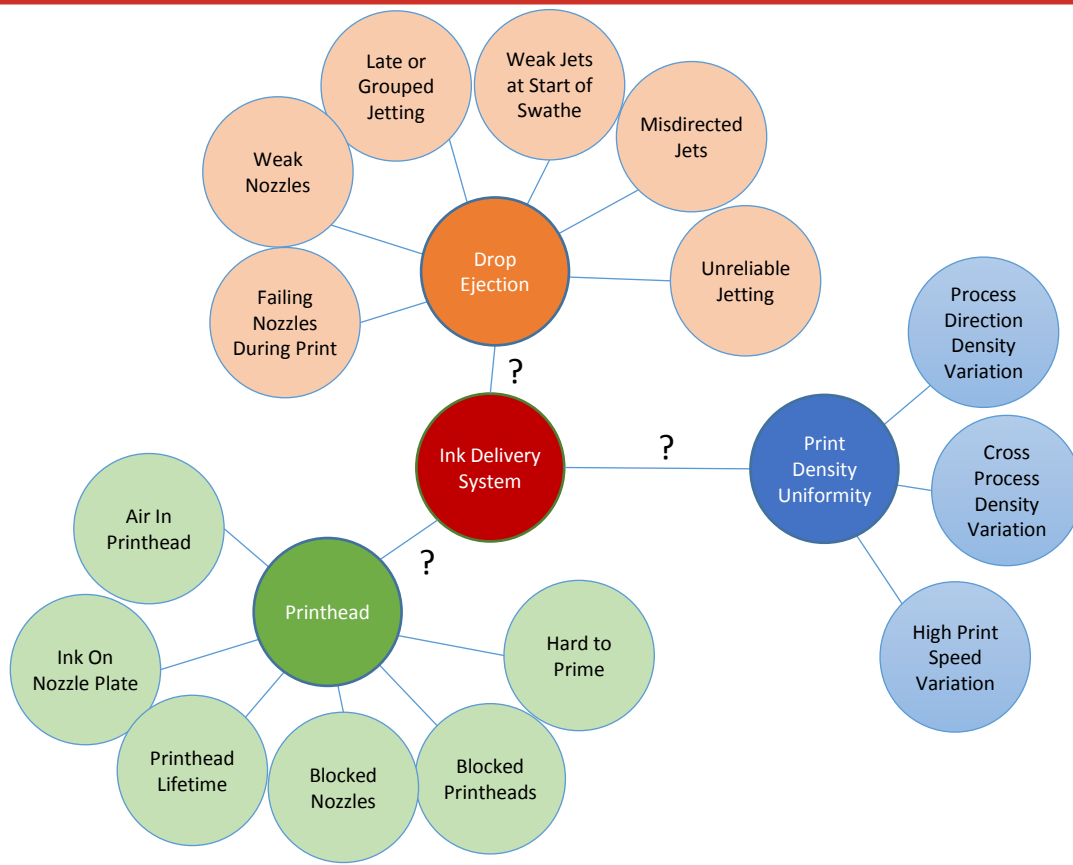




# Typical IDS Issues

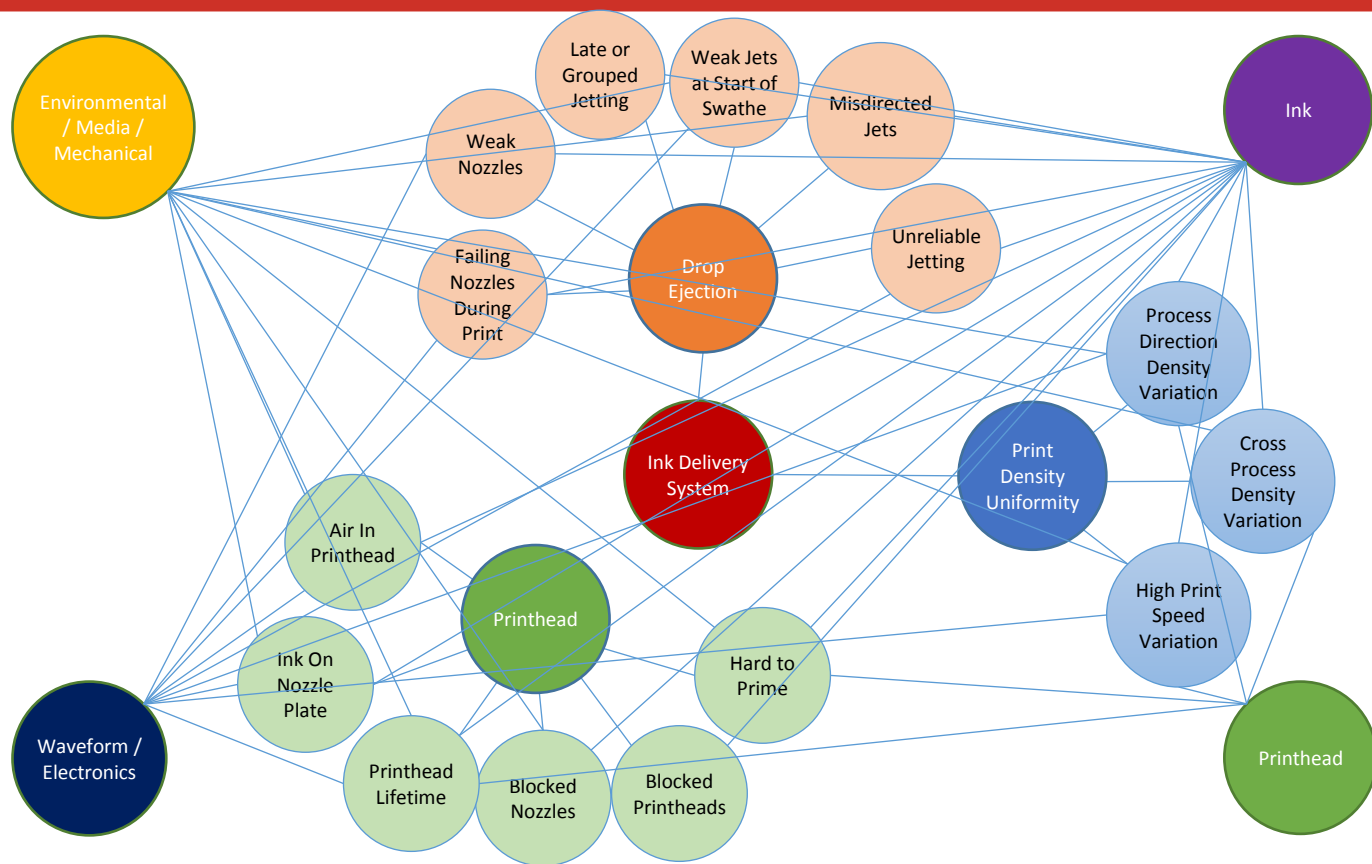


# Common Issues Attributed to IDS





# Common Issues with Alternative Causes







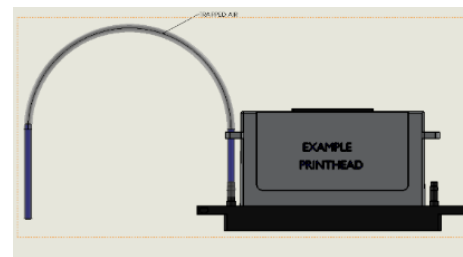
# Trapped Air

## • Symptoms

- Difficult morning start up
- Ink dripping from nozzle plate, even when pressure set correctly
- Intermittent printing
  - Heads may print well for short time until air moves into the head
  - Heads may print well for low density images but fail quickly for high density images

## • Solutions

- Ink degassing
- Avoid tubing with uphill path or loops
- Correct tube size (not too small or too large) – restricted flow can lead to air being sucked into the nozzle as the head fails to pull ink through the system
- Avoid restrictions in valves & fittings





# Materials Compatibility

- **Symptoms**

- Blocked nozzles
- Ink starvation
- Swelling of tubes
- Failure of the system

- **Solutions**

- Can be difficult to fault find
- Can cause expensive problems
- Choose components and do sufficient materials compatibility testing
  - Material can leech into the ink
  - FEP or PTFE



# Poor Pressure Control

## • Symptoms

- Ink dripping at the head or air sucking into the head
- Variations in optical density in the image – volume of ink in each drop is affected

## • Causes

- Vacuum pump on continuously creates loss of pressure
- Dirt in vacuum pump diaphragm
- Vacuum setting incorrect
- Pulses from pump

## • Solutions

- Control of vacuum pressures +/- fluctuations
- Smooth flow control – not pulsing
- Maintain adequate flow of ink – don't run out





# Sedimentation

## • Symptoms

- Heads clog
- Parts of the ink system clog – filters etc.
- Reduced flow to heads

## • Causes

- Heavily pigmented inks (pigment agglomeration)
- Unstable/poor dispersion

## • Solutions

- Recirculating flow mode
- Adjustable flow rate useful
- Avoid pigment collection points
- Use special pumps – resistant to abrasion which can wear internal components
- Agitation of ink – in bulk tank





# General System Unreliability

## • **Causes**

- Unsuitable components e.g. ink pump type
- Poor quality components
- Poor control logic/software

## • **Solutions**

- Appropriate components e.g. ink pump type
- Good quality components
- Tried and tested components
- Implement industry standard control techniques/software



# Summary

- **Insure against future problems by careful design and planning**
  - Materials compatibility, correct components, follow ink and printhead manufacturer guidelines etc.
- **Over-specify on prototype**
  - Simplify and cut cost when proven
- **Low flow use with end shooter printheads is growing**
  - No flow for CMYK
  - Low flow for W
- **Recirculating/controlled flow printheads increasing**
  - More demanding for IDS design and implementation





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**We're moving!** In May, GIS HQ will be moving to new larger premises in Cambridge – further details to be announced soon!

