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SPITTING ALGORITHM FOR PRINTER STATUP

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Spitting Algorithm for Printer Startup

Abstract

The StUMP (**St**art-**U**p **M**etis **P**rint Quality) was originally observed in the Poseidon printer during early life printing of the Metis black pen. In cases of printing black and color (CMY) together, the unutilized portion of the Metis die would develop the defect and affect the print swath after long decap time. This issue worsens with pen age.

StUMP is believed to be the result of an interaction between chemicals that leach out from the foam and pigment particles in the black ink. This interaction causes the pigment particles to settle at an accelerated age, and this interaction worsens with time. Increased pigment settling can impact decap performance and cause poor drop trajectory, resulting in puddling on the orifice plate. It has since been shown that this defect is not unique to Mordor ink nor the Metis pen architecture.

An improved spitting algorithm was developed as part of adaptive startup to mitigate the StUMP issue and replenish aged ink in the pen with fresh ink from the printer tank. The algorithm involves burst spitting where the number of drops fired, spit frequency, and delay between each burst are fine-tuned to clear settled pigment. The algorithm has been shown to improve the print quality pass rate of Metis pens by 35%. Because the spitting algorithm is more effective than the current default purge, oftentimes less ink is required to be purged as part of startup. Newer pens may also experience a faster startup. This algorithm would be critical for traditional IPH products that do not carry enough ink on-board to support a large ink purge as part of the startup process.

Description

StUMP is believed to be caused by an interaction between the chemical contaminants in the foam (because of the manufacturing process) and the pigment particles in the black ink. As the pen ages over time, the contaminants leech out and create flocculants with the pigment particles, which accelerates settling and causes print quality defects. The spitting algorithm and startup procedure improves print quality by purging the ink in which the interaction has occurred and refilling the printhead with fresh ink from the printer tank. Unlike the default 12 cc purge, the new adaptive startup spitting algorithm adjusts the amount of ink purged based on the manufacturing date encoded in the bit on the printhead. Older pens require more ink to be purged.

The spitting algorithm works by firing at a high frequency (14 - 30 kHz) and then stopping suddenly for 1.5 - 4 s. This oscillation is also called hammer spitting and it creates a strong enough effect to stir up previously settled pigment in the firing chamber (see Figure 1). The novelty of this algorithm is in the use of hammer spitting. The default 12 cc purge that is currently used is relatively continuous and therefore not as effective at removing settled pigment. A DOE was performed as part of development for the algorithm. Spitting frequency and time delay were found to have the largest impact on effectiveness; spitting temperature and other variables had a vary small impact by comparison.
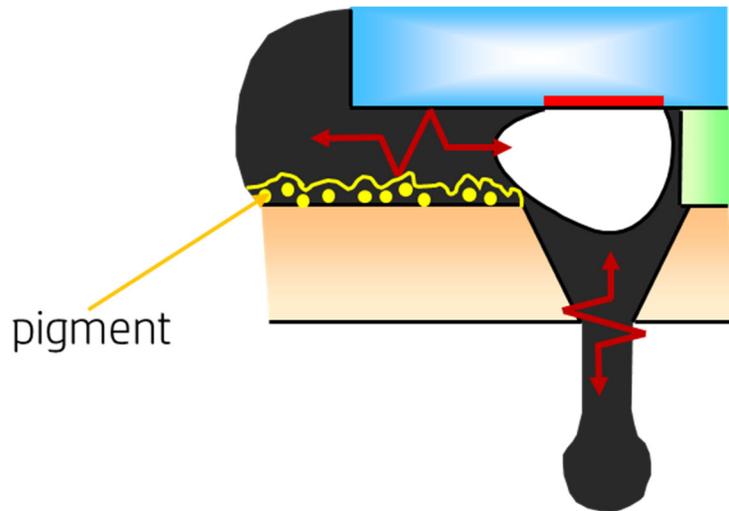
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Figure 1. *Firing at a high frequency and then suddenly stopping creates a hammer spitting effect, which has been shown stir settled pigment.*

The hammer spitting stirs up the settled pigment to then be ejected out of the printhead nozzles and into the spittoon (reservoir for waste or maintenance ink). The purge routine is helpful because settled pigment can accumulate in the chambers of the printhead as it sits in its packaging before use. If this settled pigment is not cleared prior to printing, the customer may notice start-of-swath defects with a negative impact to print quality.

Because the amount of ink purged varies with the age of the printhead, the length of time required for startup to complete also varies as shown in Table 1.

Table 1. *The amount of ink purged at startup is related to the age of the printhead. Most pens will be approximately 9 months old or newer when a customer installs them. The current version of the algorithm and startup process ranges from 10 to 29 minutes. With additional improvements it could range from 10 to 19 minutes (overall faster, especially for older printheads).*

Startup Level	Pen Age	% of Pens at This Age	CCs Ink Purged	Development Target	Current Startup Duration	*Possible New Duration w/ Improvements*
L1	<=6m	50%	5cc	20 min	10 min +/-1	14
L2	7-9m	28%	7cc	20 min	14 min +/-1	15.6
L3	10-12m	12%	9cc	20 min	18 min +/-1	16
L4	13-15m	10%	12cc	20 min	22 min +/-1	17
L5	>15m		15cc	20 min	29 min +/-1	19

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Key Points

- Adaptive startup spitting algorithm varies the amount of ink purged based on the age of the printhead.
- The spitting algorithm works by firing at a high frequency and then stopping to create a hammer spitting effect. This stirs up settled pigment and allows it to be purged from the printhead.
- The algorithm has been shown to improve the print quality of the black printhead by 35%.
- It saves up to 30% more ink compared to the default 12 cc purge.
- It also can complete the startup process up to 25% faster than the default purge routine.

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