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# Deinking of HP digital commercial prints

Minedys Macías[a], Gregg Lane[a], Nils Miller[a], Jeffrey Belson[b] and Hou T. Ng[c]
[a]Hewlett-Packard Company, Printing Technology Platforms, San Diego, CA. USA
[b]Hewlett-Packard Company, Indigo Division, Nes Ziona, Israel
[c]Hewlett-Packard Company, HP Labs, Palo Alto, CA. USA

## ABSTRACT

Hewlett-Packard (HP) is actively engaged in external and internal research to ensure that deinkability of the current recycled paper streams is maintained as the percentage of digital prints in deinking mill furnish increases. As part of this effort HP is working to understand how ink and paper interactions for both inkjet and liquid electrophotography affect the flotation deinking process. Results increasingly indicate that paper type and design affect deinking of both types of HP digital prints. Results will be shown for the use of aggregation-enhancing chemistries on the paper as well as different paper coating technologies. In addition, HP is closely examining deinking process parameters used in deinking mills to understand how they interact with our various ink chemistries. The collector chemistry used in flotation deinking plays an important role and herein we will discuss the effect of natural and synthetic collectors on the deinkability of our inkjet technologies.

## INTRODUCTION

Digital commercial printing is experiencing growth because of the many associated benefits, such as reduced costs, print on demand and environmental advantages. It is estimated that digital printing will grow over 55 percent to 2014 with the liquid electrophotographic market to ca. $87 billion and the inkjet market to ca. $44 billion (1). As the content of the recycled paper stream increases in digital prints percentage Hewlett-Packard has committed to ensure a smooth transition for the paper recycling industry.

In the commercial / production printing category Hewlett-Packard products utilize two main digital printing technologies: Thermal Inkjet (TIJ) and Liquid Electrophotography (LEP). Thermal Inkjet technology comprises a water based pigmented ink system delivered by a thermal printhead. An ink droplet is formed when the heated ink expands forming a bubble that forces the ink out of the printhead and on to the paper. LEP technology is based on an ink (ElectroInk®) consisting of negatively charged pigmented resin particles suspended in mineral oil. A latent electrostatic image is produced on the photo imaging plate (PIP) by a scanned array of laser diodes controlled by a raster image processor. The difference in charge between the ink and the PIP attracts the ink to the latter in an image development step. The developed image is then transferred to a heated blanket cylinder which, in a second transfer, releases the image to the substrate.

HP is working to better understand conditions that will positively affect the flotation deinking process for both HP commercial print technologies and to find practical solutions to deink both systems. For example, in digital printing the print property and quality are dependent on ink and media interactions. Furthermore, it is widely accepted that media plays an important role in flotation deinking. It has been reported that paper grade will affect the quality of the deinked pulp (2) and that flotation deinking can be affected by paper coatings (3). HP has recently observed that this interaction extends to the flotation deinking of its digital printing technologies. Herein, we will discuss the effect of deinking process parameters and media on the deinkability of 1) IJ and 2) LEP prints.

## EXPERIMENTAL METHODS AND MATERIALS

### Inkjet Inks

Laboratory scale deinkability testing was carried out on 100% HP Webpress pigmented black ink. INGEDE Method 11 (described elsewhere) with a PTS flotation cell was used as the starting point for testing conditions. Modifications to this nominal method were made as deemed appropriate based on experimental conditions and results, and consultation with industry experts regarding process trends in the deinking industry world-wide. Among the parameters modified are pulping shear, pulping time, pulping consistency and chemical loading. Optical measurements on deinked pulp were carried out as described by INGEDE Method 11. HP pigmented black ink was printed on a variety of media including Xerox Office paper, 2 grades of ColorLok office paper and offset grade thermo mechanical pulp (TMP) paper.

Liquid Electrophotography

HP Indigo partnered with NewPage Corporation to test HP Indigo ElectroInk 4.0 under NewPage Duluth recycle paper mill simulated conditions. Pilot scale testing was configured at Western Michigan University (WMU) Pilot Operations and carried out under the direction of NewPage and Technical and Investor LLC. The composition of the furnish for the deinking trial was 5% HP Indigo ElectroInk 4.0 and 95% mixed office waste recovered paper, the standard furnish used in the NewPage Duluth recycled paper mill. Additional testing of HP Indigo ElectroInk 4.0 was carried out at WMU Pilot Operations using a surfactant based process chemistry, HPES. The basic principles of the HPES chemistry have been discussed elsewhere (4) and the collector chemistry consists of a blend of non-ionic ethoxylated fatty alcohols and an anionic surfactant. The composition of the furnish for the HPES deinking trial was 20% HP Indigo ElectroInk 4.0 and 80% mixed office waste.

## RESULTS AND DISCUSSIONS

Inkjet Inks

A general industry trend is toward low shear pulping conditions to reduce the agglomeration of 'stickies' materials (resins, plastics). In order to investigate the gentle pulping conditions found in a drum pulper two different shear conditions were studied: low shear was simulated via pulping at 62.5 rpm for 10 minutes, using 12% consistency while moderate shear was simulated via pulping at 120 rpm for 20 minutes, using 15% consistency. Figure I shows ink elimination percent of HP black pigmented ink printed on Xerox Office paper as a function of shear. As can be seen higher ink elimination values are obtained when employing lower shear during the pulping stage. A higher shear can promote a higher degree of fragmentation of IJ particles negatively affecting their stability and dispersability. Moreover, HP previously observed that the buffering capacity of wood free media would result in a flotation pH in the range of 10-11 (5). Because this pH range does not represent typical mill conditions more experiments were carried out at a combination of low shear and less alkaline pH, from now on referred to as MM1. The chemical loading for MM1 conditions was modified from that specified by INGEDE method 11 in a representative run to 0.11% NaOH, 0.7% $H_2O_2$, 0.5% $Na_2SiO_3$ and 0.8% oleic acid to give a pulping pH of 9 resulting in improved deinkability as seen from ink elimination, filtrate darkening and luminosity values (Table I).

**Table I. Deinkability results at different shear and alkalinity conditions for HP pigmented black ink printed on Xerox Office paper.**

| Deinkability parameter | 120 rpm, pulping pH = 11 | 62.5 rpm, pulping pH = 9 |
|---|---|---|
| Ink elimination (%) | 30 | 60 |
| Filtrate darkening (%) | 48 | 39 |
| Luminosity (%) | 63 | 71 |

As with analog inks, the media employed during printing will determine the IJ ink holdout. Media containing aggregation enhancing chemistry such as ColorLok will control ink penetration facilitating ink detachment during pulping. Figure II compares the deinkability of HP black pigmented ink printed on Xerox Office paper and two different grades of HP ColorLok paper when using method 11 conditions. Ink elimination, filtrate darkening and luminosity values all improved by the use of ColorLok media. In addition, thermo mechanical pulp (TMP) grades of paper and papers coated with HP technology for high speed printing have shown significantly enhanced deinkability over Xerox office media (Figure III) when using MM1 conditions. Studies are underway to better understand this enhancement in deinkability.

Liquid Electrophotography

Pilot scale simulation of NewPage recycling process conditions using 5% HP Indigo ElectroInk 4.0 shows the ink exhibits a dirt count similar to that of a mixed office waste furnish. Two flotations were conducted using a Voith-Morden cell at a consistency of 1.3%.

As can be seen from Figure IV, the dirt count at the hydrapulper for a furnish containing 5% HP ElectroInk 4.0 is high, ca. 5000 but by the time we reach the 2$^{nd}$ hydrosieve the dirt count has decreased to ca. 200. Figures V and VI show the development of the pulp TAPPI brightness as the process progressed through the various unit operations, for a control (100% MOW) and a 5% Indigo sample, respectively. The recycled pulp meets the quality requirements, including dirt count and brightness, under the simulated conditions of the Duluth NewPage recycling mill. Furthermore, Figure VII shows a recycled pulp with a final average dirt count of 177 ppm when using HPES chemistry to study the deinkability of HP ElectroInk 4.0.

## CONCLUSIONS

Results from the deinkability experiments conducted on HP digital commercial prints show that both, thermal inkjet and liquid electrophotographic technologies are deinkable under the studied conditions. The different process conditions tested reflect the complexity of the industrial deinking processes. The data presented here will be compiled with future data to propose a toolbox of solutions for deinking digital prints: a toolbox that will work for digital printing technologies and across the entire recycled paper waste stream.

## ACKNOWLEDGMENTS

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**Figure I. Ink elimination (%) as a function of pulping shear for HP black pigmented ink on Xerox Office paper.**

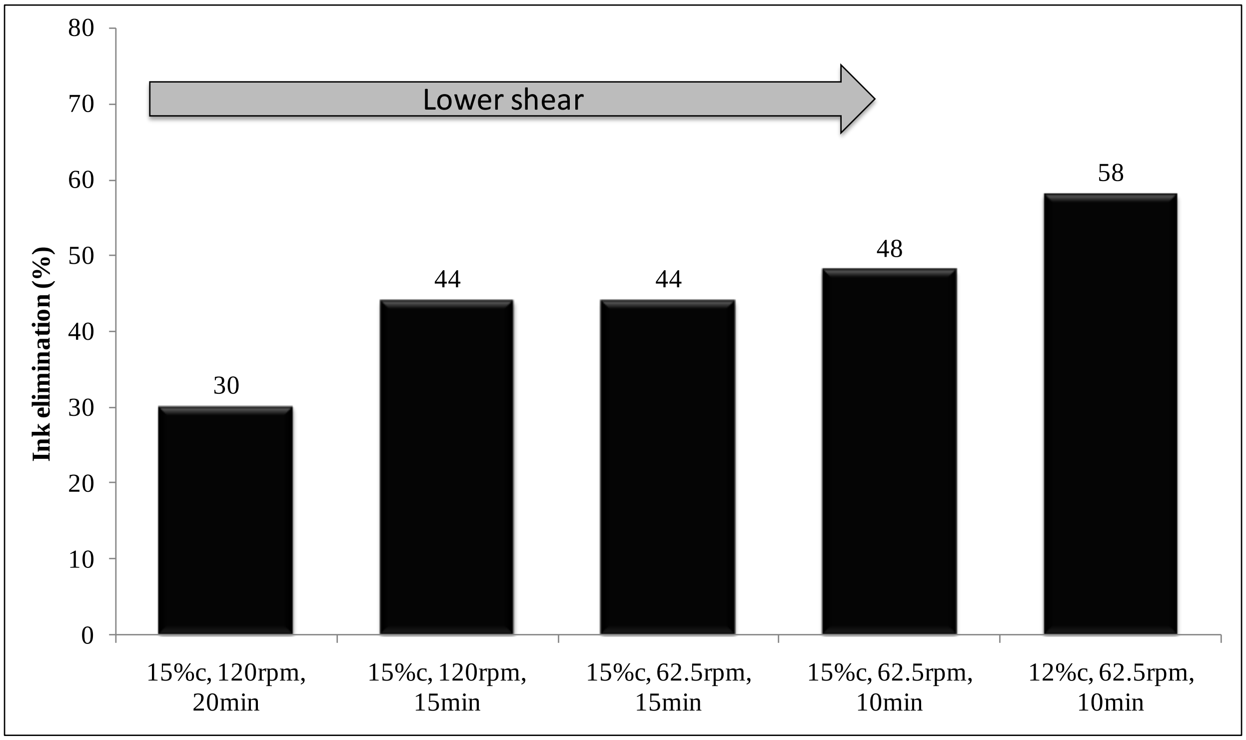



**Figure II. Method 11 deinkability of HP pigmented black ink as a function of printed substrate.**

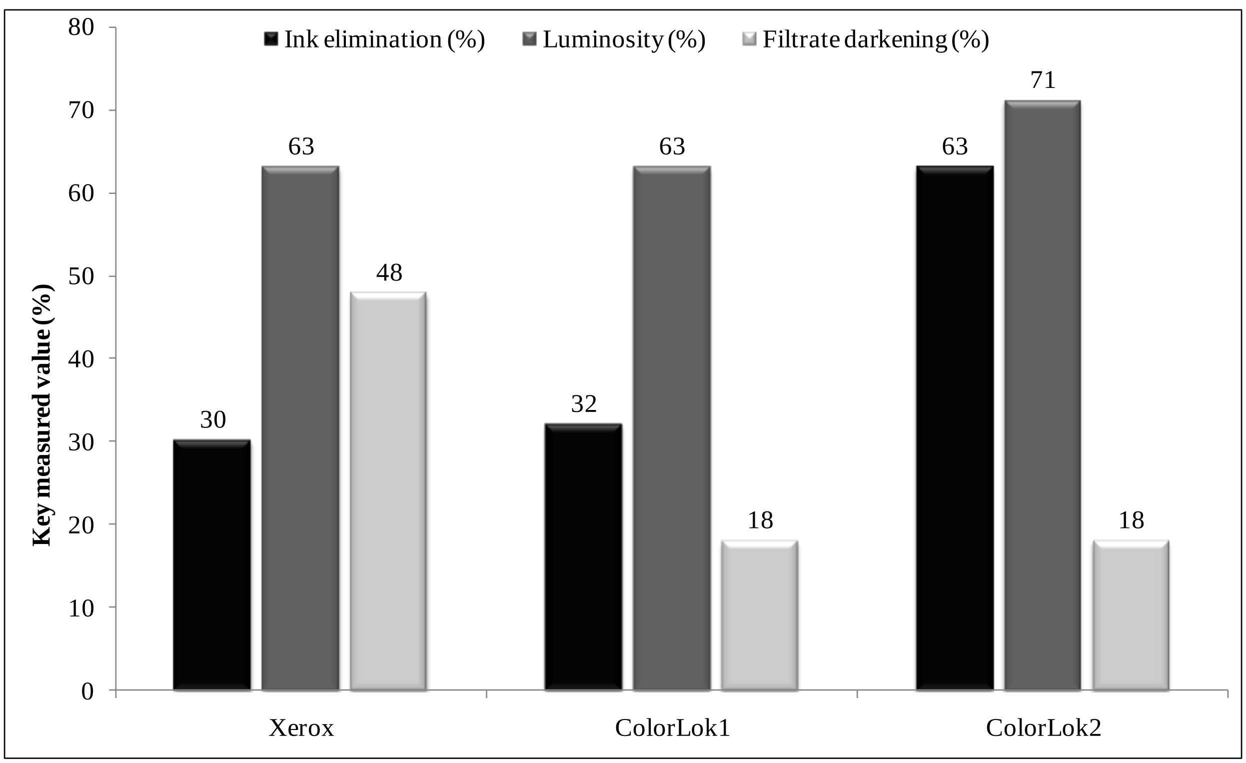


**Figure III. Enhanced deinkability of HP black pigmented ink as a function of printing media using MM1 conditions.**

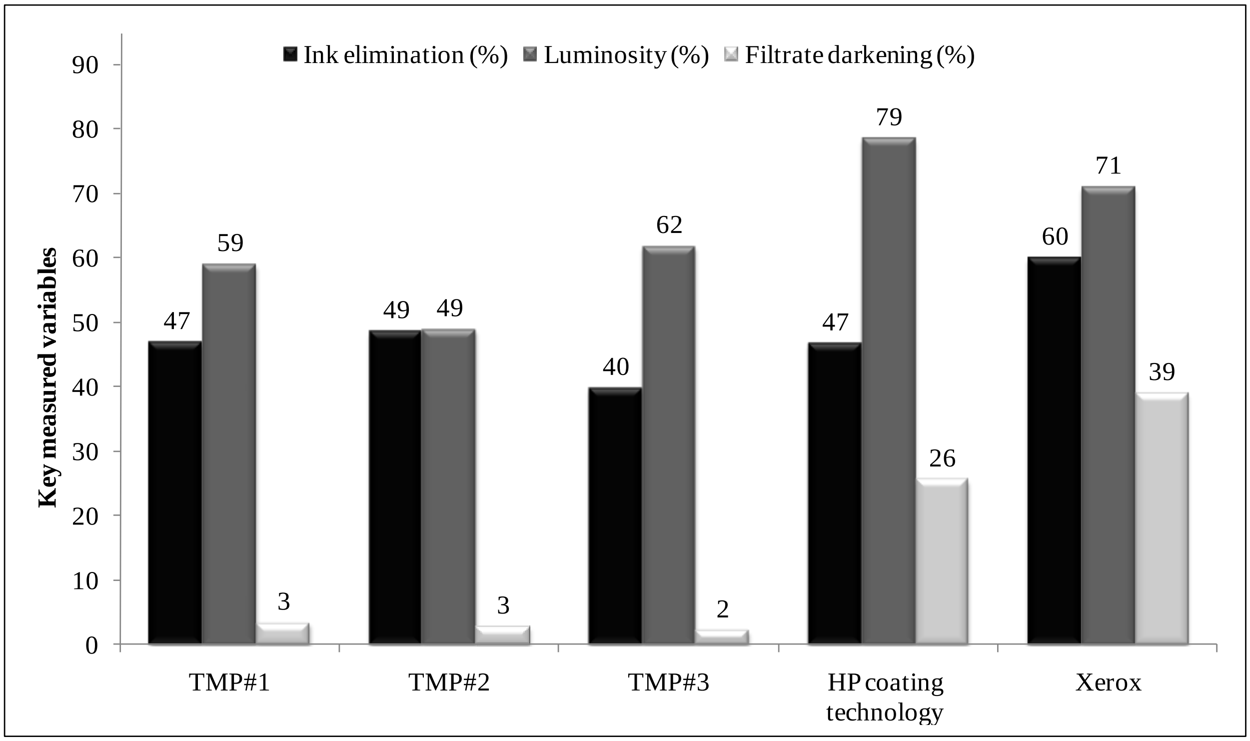



**Figure IV. Dirt count as a function of flotation process stage for pilot scale testing of 5% HP ElectroInk 4.0.**

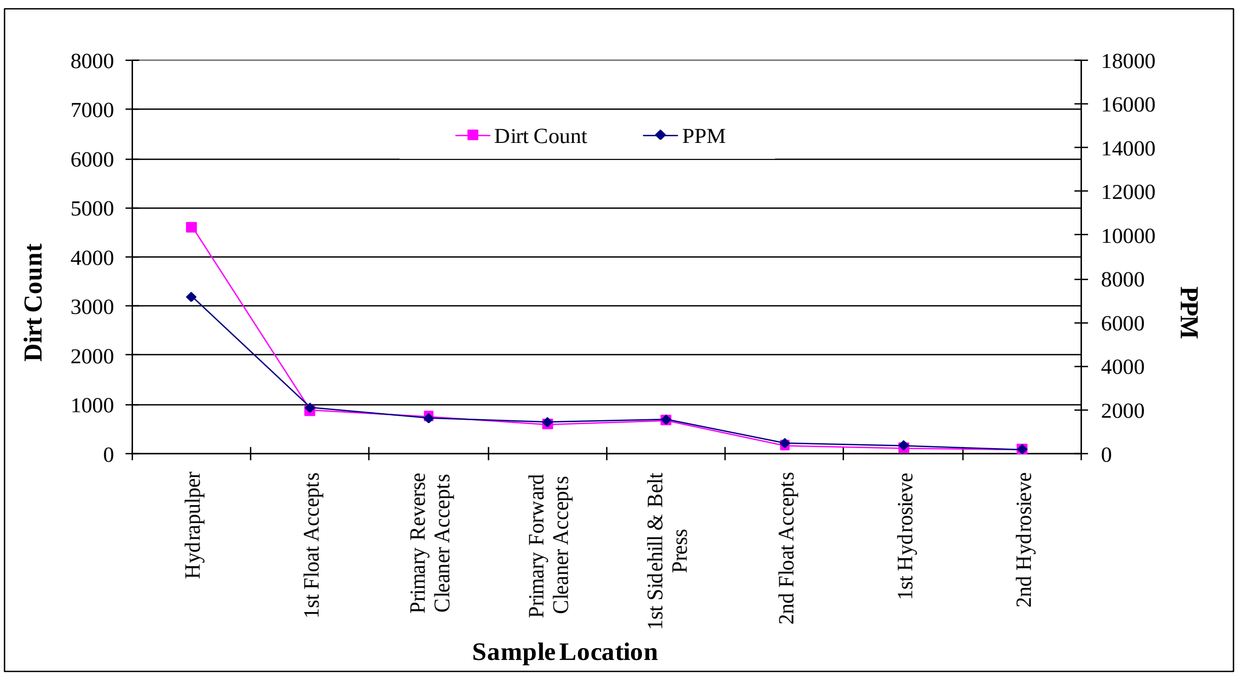


**Figure V. Process brightness trends using a 100% MOW as a control for HP NP deinking trial**

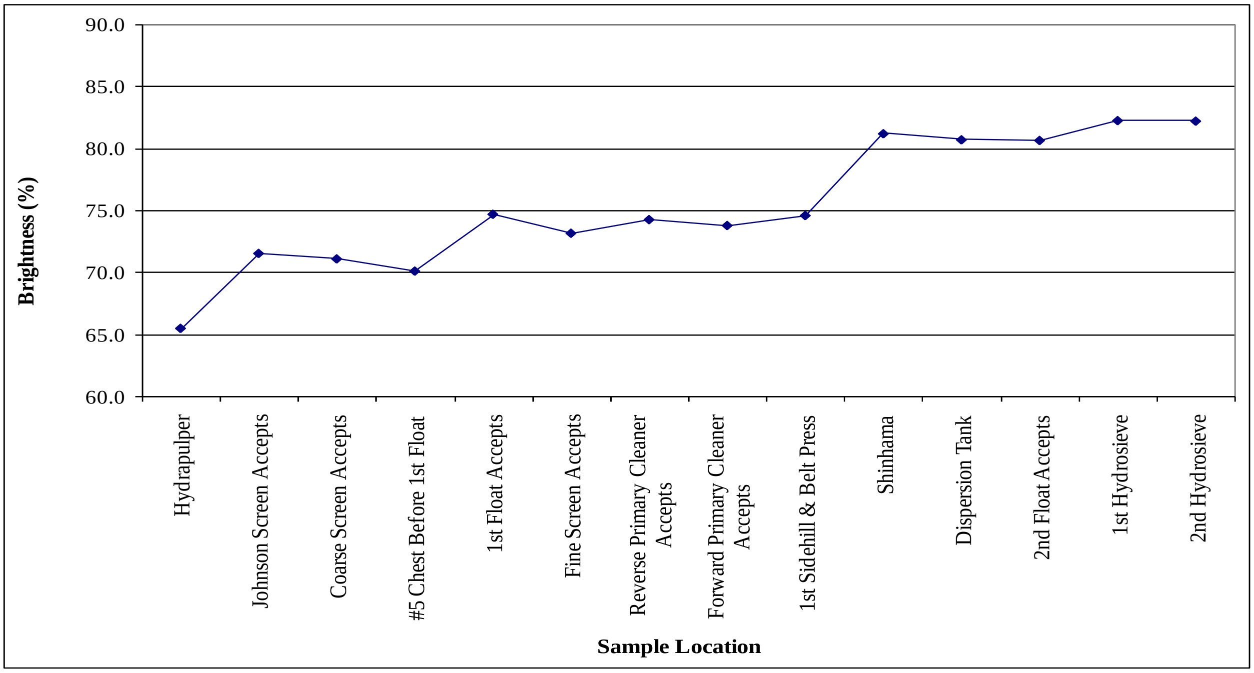



**Figure VI. Process brightness trends using 5% Indigo for HP NP deinking trial**

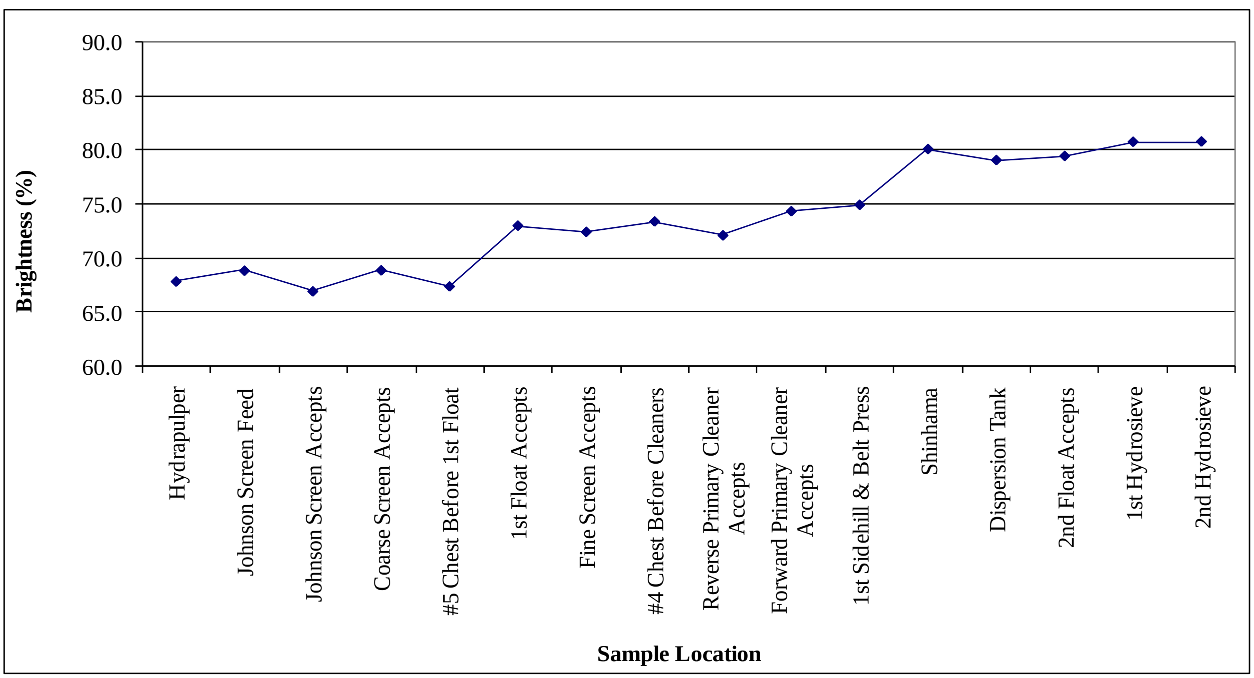
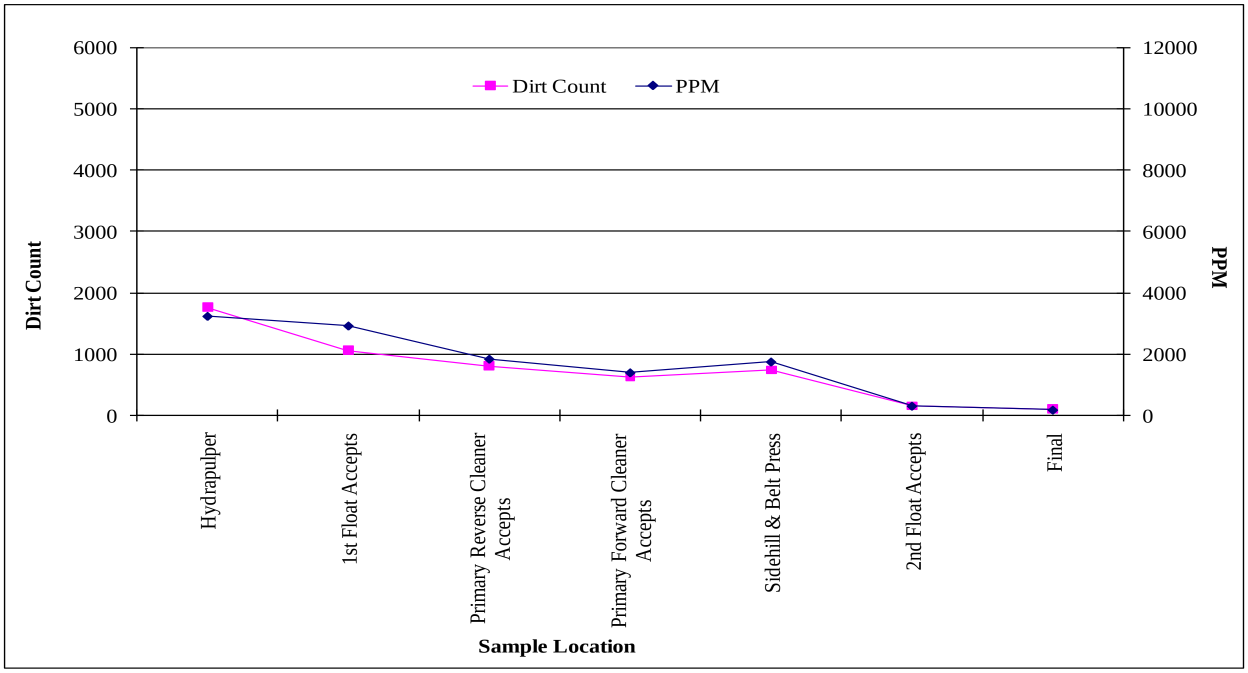


**Figure VII. Dirt count results for 20% Indigo furnish using HPES conditions**

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