MICR Laser Printing and High Speed Reader/Sorter Performance

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Abstract

The continued increase in the number of checks printed on laser MICR printers has raised a concern about the MICR print quality produced by these devices and the resulting performance on the various high speed reader/sorters such as the IBM 3890®. This paper shows that with proper toner selection and fuser temperature settings, reader/sorter performance problems are minimized. Toner adhesion enhancement agents in the paper will improve fusing latitude but not dramatically.

The adhesion failures generated by the reader/sorter are very similar to those generated using tape transfer of the toned characters. Good tape transfer measurement results will effectively predict good reader/sorter performance.

In addition an attempt was made to correlate the failure modes of checks rejected by the 3890 to the readout of a conventional waveform check qualifier. The qualifier was unable to detect the same failures.

Introduction

The use of non-impact laser printers to produce MICR documents has become more prevalent because of the ease in which variable data can be processed. The need for pre-numbered check stock has virtually been eliminated and the associated documentation that is typically associated with a financial transaction can be printed along with and often times on the same page as the check. Documents produced in this manner must adhere to all of the present ANSI standards and practices for MICR printing that were put in place years before this printing technology was introduced. This has led to increased demands on the output performance of these devices, particularly character formation and toner adhesion. The majority of MICR documents produced on laser printers are negotiable checks and are required be processed by high speed reader/sorters a number of times without degradation. Predicting how well a set of documents produced by any given laser printer will perform on the commercial reader/sorter equipment is the challenge of the equipment designer and the service engineer who must diagnose any problems encountered in the field.

The specifications for MICR documents are covered under ANSI Standard X9.27.[1] This standard specifies the dimensions and tolerances for the ten numerals and four symbols that make up the E13-B font, in addition to the allowable defects such as edge variations, character voids, extraneous ink, etc. The standard is virtually the same wherever the font is used except for the magnetic signal level limits. The signal level is the relative amplitude of the designated peaks of the voltage waveform of a MICR character relative to the designated peaks (the long vertical strokes) of the On-Us symbol, when read on a standard calibrated tester. The signal level limits in the US (ABA), the UK (APACS), and Australia (APCA) is 50% and 200%, while Canada (CPA) is 80% and 200%.

The typical MICR laser printer is leveraged from a standard laser printer design. The toner and the electrophotographic process of the print engine and often times printer components are modified to meet the stringent requirements of MICR printing. The most important of these requirements is that checks produced on these devices pass the commercial reader/sorters used by the various clearing houses and banks. Pass is typically defined to be a check reject rate set by the institution reading the documents. This is never allowed to be greater than 2%.

The most popular of the high speed reader/sorters are the IBM 3890 series, capable of processing at speeds up to 330 ips, and the Unisys DP1800, which can process at speeds up to 300 ips. Each was introduced in the early 70's. Both the 3890 and the DP1800 use magnetic matrix head technology for reading the MICR line in a check. This is in contrast to the magnetic wave form technology used for character recognition in the lower speed reader/sorters from companies such as BancTec and the most popular check qualifier, the RDM Corporation GT Qualifier. Both the write head and read head design are dramatically different for the two technologies.[2]

In the 3890 the check being processed comes into physical contact with a thin metallic protective tape over both the read and write heads. The velocity of the document over these components may lead to abrasion, or a frictional temperature rise high enough to soften or melt the toner, causing streaking, or both. This mode of failure or cause of rejects should increase as the number of times an individual check is processed. An interesting trend in the industry is that the success of placing waveform check qualifiers at the larger printing establishments and clearing houses has shifted the emphasis from passing the reader/sorter to passing the qualifier first. It should be emphasized that passing one will not guarantee performance on the other.

In a previous paper the authors developed a standard adhesion test based on tape transfer to determine how tenaciously toner sticks to a receiver. The object behind that report was simply to standardize an acceptable test procedure and metric that could be used as a means of performance comparison. There was no attempt to correlate the results of that method to reader/sorter performance. The object of this work was to investigate the relationship between those factors that improve adhesion, as determined by tape transfer, and the resulting impact on 3890 reject rate.

Experimental

With few exceptions, laser printers that print MICR documents use hot roll fusers to fix the image to paper. A hot roll fuser consists of a pair of rollers between which the toned paper passes. The roller in contact with the toned side of the paper is heated, and one roller in the pair is usually soft. When pressure is applied between the rollers, the paper and toner stack passing through the resulting nip will experience both pressure and a temperature rise. The fusing quality of the final image is determined by how well the toner adheres to the paper. Many factors contribute to adhesion quality but for thermal considerations it comes down to being able to transfer enough energy to the toner particle mass to allow the toner polymer resin to soften or melt, coalesce, and attach to the fibers of the paper.

The paper stock that is used for check printing comes in a wide variety of flavors depending on the final application and concern for security features. Paper properties, without a doubt, contribute a great deal to the adhesion quality of the final output, but unfortunately the variability between manufacturers and between papers is large. For this study, check stock from two well-known distributors was used. Each supply check stock with and without a surface additive to enhance toner adhesion, and each of these were used as factors for this work.

The objective of this study was to determine how well offline measurements of adhesion correlate with the IBM 3890 reader/sorter reject rates. A two level, three factor, full factorial designed experiment was used to generate the information. The factors in the experiment were 1) Two different paper manufacturers, 2) Standard 24 #check stock, and 24 #check stock with a toner adhesion enhancement (TAE) additive, and 3) Two levels of fuser temperature. The printer used for this study was a Hitachi DDP-70, fully configured to print MICR documents at 70 prints per minute. The high side of the fusing temperatures were chosen to be at a point within the fusing latitude of the toner where fusing was just good enough to be passable, while the low side was chosen to be well down the curve. The experimental design matrix is shown in Table 1.

Table 1. Experimental design matrix

Exp. #	Paper Mfg.	TAE = 1 Non-TAE =2	Fusing Temp.
1	1	1	Hi
2	1	1	Lo
3	1	2	Hi
4	1	2	Lo
5	2	1	Hi
6	2	1	Lo
7	2	2	Hi
8	2	2	Lo

1050 checks were generated at each experimental design point. Ten sample checks were drawn from each group and used for offline adhesion measurement using the tape adhesion test. The remaining check samples were submitted for reading by a standard 3890 reader/sorter maintained by the Carreker Corp. This machine is carefully maintained and cleaned before each check run to maintain consistency.

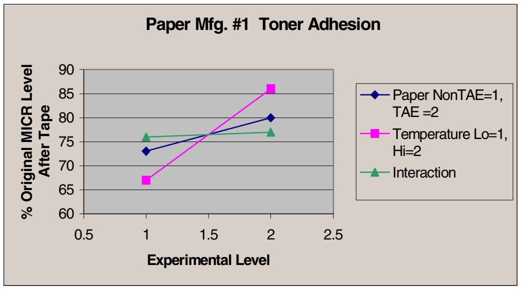
Results

The fuser temperature profile of the Hitachi DDP-70 will vary +/- 8.5 ^{o}F, as the fuser heater lamps cycle to maintain the temperature required. The average high temperature for this experiment was 383^{o}F (195^{o}C) and the average low temperature was 366^{o}F (185.5^{o}C). The optimum average temperature for printing MICR is higher at 395^{o}F (202^{o}C) to ensure optimum adhesion.

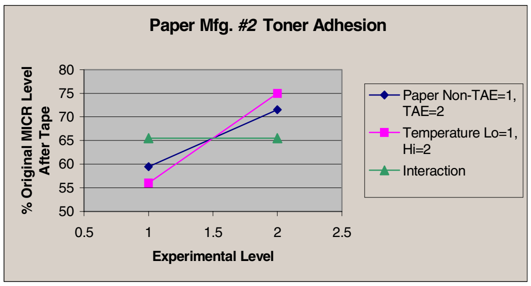
The authors have demonstrated in their previous work that a comparison of the MICR level before and after a tape transfer of the MICR line is a good metric for measuring relative adhesion.[3] In figure 1 the check stock from Mfg. #1 is compared to the check stock from Mfg. #2. For each, their versions of the toner adhesion enhancement are compared at two different temperature levels. The lack of interaction in each case suggests that the toner adhesion enhancement will not compensate for poor adhesion at low fuser temperature settings.

The checks that were sampled for adhesion were submitted for processing on a 3890 reader/sorter. Each group of checks were processed for ten runs each, removing the rejected checks at the end of each run. The reject rate and the reason for failure were monitored for each check after each run. In Figure 2 the average ten run reject rate is compared in the same manner as the adhesion comparison.

The reject rate follows the same trend as the tape adhesion results, with fusing temperature having the strongest influence on preferred performance. There is one interesting difference in the case of Mfg. #1, the adhesion enhancement layer seemed to increase the reject rate.

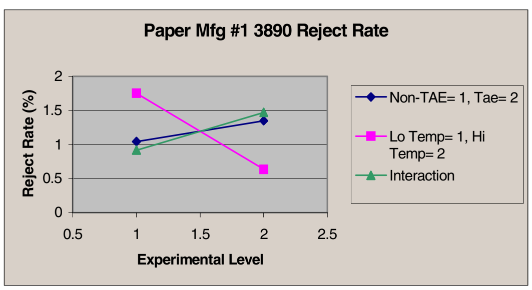


a

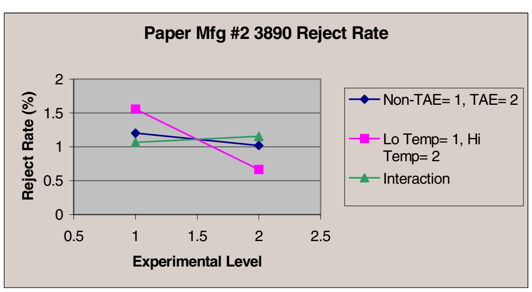


b

Figure 1. Comparison of toner adhesion as a function of temperature and toner adhesion enhancement for a) Paper Mfg. #1, b) Paper Mfg. #2

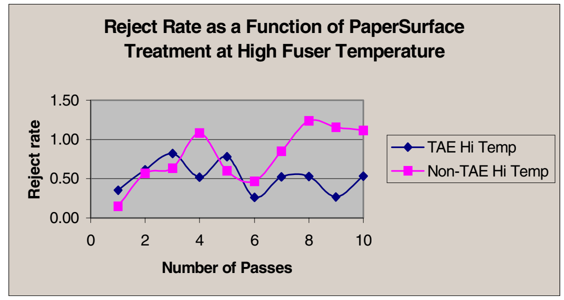


a



b

Figure 2. Comparison of 3890 reject rates as a function of fuser temperature and toner adhesion enhancement for a) Paper Mfg. #1, b) Paper Mfg. #2



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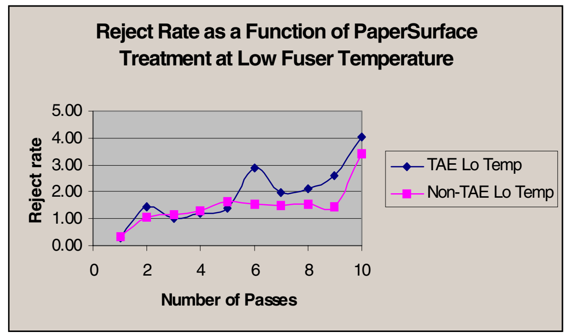

b.

Figure 3. Average reject rate for two paper manufacturers at: a) High fuser temperature and b) Low fuser temperature

Looking at the average reject rate over a selected number of runs on the reader/sorter offers little insight into the actual mode of failure. In figure 3 (a & b) the individual reject rate for each run is plotted for high and low fuser temperature. The parameter for each graph is the Toner Adhesion Enhancement treatment or lack thereof.

The difference in performance becomes more obvious when the data is viewed in this way. Once again the indication is that the TAE treatment only helps at the higher fuser temperatures. The reject rate in all cases starts out low but, depending on the paper and fuser set-up the MICR line deteriorates as the number of runs increase. The nature of the decline can be seen in the following micrographs of the characters after ten runs compared to a character after a tape transfer.

The images in figures 4a and 4b are of characters after ten passes trough the 3890, the former fused at high temperature, and the latter at low fuser temperature, both on TAE paper. Each show a tendency for the toner to smear but the major degradation responsible for poor performance, as shown in figure 4b, is adhesion failure at the paper interface. This is not unlike the failure shown in figure 4c where the degradation is due to a tape liftoff and not the reader/sorter. The most important attribute for good all around performance is to lock the toner to the paper surface. Figure 1a indicates that the adhesion enhancement treatment will assist in doing just this, but only at higher fuser temperatures. When the fuser in the Hitachi DDP-70 is raised to the specified temperature for MICR fusing the difference between TAE and non-TAE becomes negligible and the reject rate remains consistently lower than 0.5%.

a. b. c.

Figure 4. a) Character after ten passes, high fuser temperature, TAE. b) After ten passes, low fuser temperature, TAE. c) Tape transfer of character, low fuser temperature, TAE.

On a final note the checks that were rejected by the 3890 reader sorter were read on an RDM® GT reader and the results compared. 44 rejected checks from the 3890 after ten passes were passed through the GT reader. This reader only saw unrecognized characters on 21 of these checks. 43% of the 3890 rejects were due to the character “8” while the GT reader saw the same character as no more than a visual check at most. There was no correlation between the reason for rejects on the 3890 and the corresponding reads on the RDM® GT reader. This result is not surprising, given that the design of both the read and write head for the two methods of check recognition are radically different.

Conclusion

High speed reader/sorters of the type represented by the IBM 3890 will tend to degrade the quality of the MICR line after repeated passes. The degradation will be exacerbated by poor toner adhesion caused by inadequate fusing. Toner adhesion enhancement treatments for check stock will improve performance but are not effective if the fuser temperature is not adequate. Offline adhesion measurements such as tape transfer can effectively measure adhesion quality and therefore be a predictor of reader/sorter performance, but only when adhesion is excellent. It is difficult, however, to measure any form of degradation of a MICR line with a waveform type qualifier and predict the performance on high speed reader/sorters.

Acknowledgements

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References

1. A. N. S. for Financial Services, X9.27-2000. Print and Test Specifications for Magnetic Ink Printing (MICR).
2. Gerald Abowitz, “Electronic MICR Printing and Check Processing,” Interquest Ltd. Charlottesville, VA. PP 253-275, 1994
3. James C. Maher, Richard Chatfield, Francisco Aponte, Daniel Charles “MICR Performance and the Relationship to MICR Toner Adhesion” IS&T 17th Int. Cong. On Non-Impact Printing: PP 852-855 (IS&T Springfield, VA 2001).