

TECHNICAL NOTE

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Analysis for Water-Soluble Paper

REFERENCE: Lyter, A. H., III, "Analysis for Water-Soluble Paper," *Journal of Forensic Sciences*, JFSCA, Vol. 25, No. 2, April 1980, pp. 380-381.

ABSTRACT: A relatively simple examination of suspect water-soluble paper residue can be performed by using chemical testing and microscopic and instrumental procedures, and meaningful results can be obtained. The consistency between test results of individual constituents and actual residues indicates the reliability of the technique and makes positive conclusions possible.

KEY WORDS: criminalistics, papers, chemical analysis

Water-soluble paper is frequently used in unlawful wagering activities and the forensic science laboratory may be called on to analyze the material. It should be noted that the substance is not actually soluble in water, but it disperses very quickly and finely, leaving a residue or suspension. We propose an analytical scheme for identifying this type of paper product.

Water-soluble paper is a combination of carboxymethyl cellulose (CMC), cellulose fibers, and various inorganic substances. Important to the characterization of water-soluble paper is the detection of CMC. Two different methods are used to analyze the suspect residue for CMC. The residue should be separated into two parts, one for microscopic and instrumental testing and the other for chemical testing.

Chemical Testing

That portion of the suspect residue used for chemical testing should be dispersed in water to a concentration of approximately 1 part residue to 25 parts water, by weight. The diluted residue is divided into two parts, and 2 or 3 ml of a 1% aqueous solution of cupric sulfate is added to the first suspension. The appearance of a flocculent precipitate indicates the presence of CMC [1]. The second suspension is made acidic with two or three drops of concentrated sulfuric acid, and a few drops of 2,7-dihydroxynaphthalene are then added. This will produce a blue color because of the glycolic acid formed from the CMC, when present. This color can be quantitated colorimetrically [1]. Positive results to these tests should be considered not as identification of water-soluble paper but as an indication of the presence of CMC.

Presented at the 29th Annual Meeting of the American Academy of Forensic Sciences, San Diego, Calif., 15-18 Feb. 1977. Received for publication 29 June 1979; accepted for publication 10 Sept. 1979.

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Microscopic Examination

A small portion of the suspect residue is placed on a standard microscope slide and allowed to dry. Two drops of Graff's C-stain are added and then a cover slip is used [2]. Under transmitted light at a magnification of 400× with no polarization, two distinct species appear. Comparatively long red fibers are consistent with cellulose fibers while amorphous purple objects indicate the presence of CMC. The proportion of red fibers to CMC is important for a valid conclusion; when CMC is present in a fraction greater than one half, water-soluble paper is indicated.

Instrumental Examination

An infrared spectrum can be obtained from the dried suspect residue either by forming micro-KBr pellets or by using a diamond-cell attachment. The micro-KBr (3 mm) infrared spectra of alpha pulp, CMC, and water-soluble paper in the areas 1200 to 1700 cm^{-1} and 600 cm^{-1} should indicate the combination of CMC and cellulose fibers with the characteristics of CMC dominating.

X-ray fluorescence examination was performed on standard reference samples of water-soluble paper and yielded results consistent with known amounts of inorganic additives in the products.² Because of contamination of seized samples, this type of examination was deemed not useful and was not performed on suspensions. However, this examination can be of benefit on unused seized stock.

Results and Discussions

Water-soluble paper dispersed in water and examined by these techniques behaves the same as the individual constituents. Chemical and microscopic techniques were used to test for CMC and yielded the expected results. The addition of cellulose fibers to CMC did not affect the results of these tests. It should be emphasized that the presence of CMC does not confirm the presence of water-soluble paper; however, CMC in combination with cellulose fibers in a proportion greater than one half is highly indicative of water-soluble paper.

The use of infrared spectroscopy was helpful in corroborating the results of the previous examination. Interferences resulting from contamination of the water or solution in which the residue is found may occur. The presence of foreign materials such as writing ink or printing ink will make the color-dependent tests more difficult but will not prevent characterization. The elimination of these colored materials is possible with pyridine extraction and filtering, but the existence of such contamination should be noted.

References

- [1] Browning, R. L., *Analysis of Paper*, Marcel Dekker, Inc., New York, 1977, pp. 274-275.
- [2] Graff, J. H., *A Color Atlas for Fiber Identification*, The Institute of Paper Chemistry, Appleton, Wisc., 1940, pp. 13-14.

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