Deposit Analysis – Investigating Microbial Problems in a Paper Machine Environment

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ABSTRACT

The complete analysis of a deposit is critical in determining the appropriate deposit control program for a paper machine. On-site evaluations using light microscopy and simple qualitative tests provide preliminary answers to the problem. More detailed information is obtained from semi-quantitative and quantitative laboratory analyses. The resulting data on the deposit combined with system knowledge are essential in choosing and implementing the correct deposit control program.

INTRODUCTION

Deposits that impact paper machine efficiency and runnability are categorized as organic, inorganic, or microbiological. Typically, most deposits will be a combination of all of these. Organic deposits generally are classified into four groups: pitch, stickies, papermaking additives, and white pitch. Inorganic deposits include scale, filler, and other inorganic components. Common scales are calcium carbonate ($CaCO_3$), barium sulfate ($BaSO_4$), alumina ($Al[OH]_3$), and calcium oxalate (CaC_2O_4). Microbiological deposits in a paper machine often contain a variety of organisms, including fungi, filamentous bacteria, single-celled slime- or capsule-formers, and other unicellular bacteria. The type of problematic organism is dependent upon the temperature, oxygen level, nutrients, and pH of the system as well as the fresh water source. Therefore, a thorough analysis of any deposition is critical in determining the appropriate deposit control program(s) for a paper machine.

ON-SITE ANALYSIS

There are several tools and simple techniques that are available for the initial analysis of a paper machine deposit or defect. The first step should be basic macro examinations – odor, consistency, color, and location of the deposit. A dissecting scope or hand-held magnifying glass is useful for the examination of a deposit or paper defect in a non-destructive manner. These preliminary observations will help determine which additional tests will be required to analyze the deposit or defect as well as to categorize the problem by Pareto analysis.

A basic bright field light microscope can be utilized to analyze deposits and defects from 100 to 1000X total magnification range. Initial observations should be made via an unstained wet mount of the deposit. This is a simple technique of placing a small portion of the deposit into a drop of water on a slide, teasing the deposit apart if needed, covering with a cover slip and viewing under the microscope. In addition to non-microbiological components (e.g. filler, fines, and starch particles), higher life forms such as nematodes and protozoa can readily be noted under low magnification (100X). A variety of simple staining is available to visualize fungi, bacteria, and filamentous bacteria. Lactophenol cotton blue and lactofuchsin are protein specific stains; they stain only the microbiological portion of a deposit. The basic stain, crystal violet, is useful to view single-celled bacteria. However, it is cationic; all anionic components in the deposit will also be stained. By viewing a deposit via an unstained wet mount and various simple stains, one can estimate the contribution of microorganisms to the deposit.

Qualitative chemical tests are used to identify various contaminants and components in deposits and defects. The microbio-ninhydrin test [1] stains protein and is a simple procedure to detect microorganisms in defects. This test will also react with proteins left by human contact so careful handling of the defect prior to analysis is important. Other qualitative procedures include the detection of alum, iron, rosin size, starch, oils and greases, and a variety of inorganic scales. Two useful references for the identification of various defects and contaminants are TAPPI Useful Method 589 [2] and B.L. Browning's book, *Analysis of Paper,* 2nd Ed. [3]. Chemical suppliers are often equipped with a portable "spot & speck" test kit and can assist with the on-site testing.

OFF-SITE ANALYSIS

Because most on-site evaluations produce only qualitative results, deposits and defects are often sent to an off-site laboratory for semi-quantitative and quantitative analyses. The majority of the procedures are destructive, and no one procedure will provide the complete answer to the problem(s). Therefore, it is important to provide sufficient quantity of the deposit or defect for a variety of analyses. For inorganic determination, the sample can be ashed [4] and analyzed by inductive coupling plasma spectroscopy (ICP). From the results, the various ash components can be reconfigured by comparison to the ion ratios of common papermaking components. Fourier transform infrared spectroscopy (FTIR) is used to identify extractable organics such as lignin and pitch. One infrared spectroscopic technique that can examine a sample directly with little to no sample preparation is attenuated total reflectance (ATR). For small spots or defects, the FTIR-microscope is often employed. Other procedures to determine organic components are gas chromatography (GC) and high performance liquid chromatography (HPLC). A scanning electron microscope with an energy dispersive x-ray analyzer is a useful tool to determine the distribution and relative concentrations of elements on surfaces or in cross-sections of paper. The key to any analysis is that data from all required testing must be compiled before conclusions can be made on the composition of the deposit/defect. These and other techniques are generally available to the papermaker by the majority of chemical suppliers to the paper industry.

CONCLUSIONS

Microbial deposits in a paper mill process can impact machine efficiency and runnability. Results from both on-site qualitative testing and off-site semi-quantitative and quantitative analyses will provide compositional information on the deposit/defect. These, along with system knowledge and proficiency from your chemical supplier, will provide the correct solution(s) to the problem.

REFERENCES

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