

Ensuring Quality and Reducing Costs in Tobacco Products Manufacturing with Advanced Analytical Technologies

Organization: Swedish Match

Technology: Waters ACQUITY UPLC I-Class System, Xevo TQ-S Mass Spectrometer, and MassLynx Software

BACKGROUND

Swedish Match develops, manufactures, and markets quality tobacco and tobacco related products such as cigars, chewing tobacco, snus, moist snuff, matches, and lighters.

The Group sells products across the globe, with production units in Brazil, Dominican Republic, Netherlands, Philippines, Sweden, and the United States. Swedish Match also owns 50 percent of SMPM International (joint venture with Philip Morris International) and 49 percent of Scandinavian Tobacco Group (STG). Notable brands include General snus, Longhorn moist snuff, White Owl cigars, Red Man chewing tobacco, Fiat Lux matches, and Cricket lighters.

The laboratory operated by Swedish Match's Chemical Analysis and Special Projects Department provides comprehensive analytical testing for several groups within the organization including Tobacco (raw material) Buyers, Product Development, Production, and Quality Control. In order to support such diverse needs, a broad range of technologies are employed such as HPLC-fluorescence, HPLC/RI, LC/MS, GC/MS, Discrete Photometric analysis, and ICP/MS. The laboratory routinely analyzes 50 different substances from 10 compound categories including metals, mycotoxins, aldehydes, nitrosamines, acrylamides, PAHs, alkaloids, and ethyl carbamate, among others.

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Swedish Match corporate headquarters.

CHALLENGE

To meet the demands associated with delivering tobacco products that are safe, consistent and reflect Swedish Match's high brand standards, the Chemical Analysis and Special Projects laboratory faces a variety of scientific, operational, and regulatory challenges. Whether it is addressing a high volume of analysis requests, urgent deadlines, disparate sample types, or the trace detection of contaminants, the laboratory requires the most advanced analytical technologies available.

An analysis of particular interest is that of aldehydes in smoke-free tobacco products (STPs). Aldehydes are included on the U.S. Food and Drug Administration's (FDA) *Harmful and Potentially Harmful Constituents in Tobacco Products and Tobacco Smoke* list and therefore concentrations of the chemical compound in parts per million (PPM) must be determined in the STP. Although GC-MS analysis is a common approach within the industry for the detection and quantification of aldehydes, the laboratory sought an alternative method that would provide higher sample throughput, lower the cost per sample, and have comparable sensitivity.

Additionally, for certain compound classes that were currently being analyzed by GC-TEA (*e.g.* tobacco specific nitrosamines (TSNA)), this method would allow for the elimination of the toxic organic solvents required for GC-TEA sample preparation.

SOLUTION

To meet the desired analytical performance goals, streamline sample preparation, and improve return on investment relative to GC/MS, the Chemical Analysis and Special Projects department implemented an analytical solution comprised of the Waters® ACQUITY UPLC® I-Class System with the Xevo® TQ-S Mass Spectrometer.

The ACQUITY UPLC I-Class System enables rapid, high-resolution separations to help resolve components of interest from complex matrix interference peaks. The technology maximizes peak capacity to enhance MS sensitivity and provides the lowest carryover, complementing MS sensitivity and extending MS linear dynamic range. The Xevo TQ-S is a tandem quadrupole mass spectrometer that utilizes an off-axis ion source technology known as StepWave™. This technology allows for the detection of target compounds at very low concentrations, dilution of samples to reduce matrix effects, and the use of smaller sample volumes if desired. MassLynx® Mass Spectrometry Software facilitates laboratory workflow by providing data acquisition, interpretation, and management capabilities.

A decade ago Swedish Match first adopted Waters' UPLC® technology based on the performance advantages over traditional HPLC. And although technological capabilities were a critical factor in the evaluation and selection of the latest Waters system, just as significant for Swedish Match was their past experience with Waters Global Services. According to the Manager of Chemical Analysis, 'Waters has a very good service organization in Sweden, one that is better than the competitors'.

The UPLC-MS/MS platform is now used by the Chemical Analysis and Special Project department to support the entire manufacturing process including raw materials testing, in-process monitoring and final product quality control.

BUSINESS BENEFITS

The implementation of Waters ACQUITY UPLC I-Class System with the Xevo TQ-S Mass Spectrometer has afforded Swedish Match a number of benefits that have added value to both laboratory and business operations. Examples include:

■ Sample Preparation

GC/MS sample preparation is often laborious and requires the use of hazardous solvents. With UPLC-MS/MS certain compound classes can be analyzed with a 'dilute and shoot' approach, which improves workflow efficiency and reduces solvent usage.

■ Sample Throughput and Productivity

By choosing UPLC-MS/MS for aldehyde analyses rather than GC-MS, run times were completed in six minutes – this is approximately one-third of the time required for GC-MS. The laboratory is now able to run up to 120 samples per day compared to 40 samples per day if they utilized GC/MS – a significant difference in overall capacity.

■ Data Quality

Sensitivity and resolution were shown to be comparable for GC/MS and UPLC-MS/MS methods. Further, aldehyde concentration determinations in STP's using both methods were shown to be in good agreement. According to the Manager of Chemical Analysis, 'the UPLC-MS/MS system provides good selectivity and sensitivity with shorter analysis times.'

■ Operating Costs

As a function of labor expenses, cost of the UPLC-MS/MS aldehyde method is approximately one-third of the GC-MS method. With 3077 analyses completed in 2013, the total sample processing cost would be \$165,000.00 for GC/MS compared to \$55,000.00 for UPLC-MS/MS.

■ Responsiveness and Decision Making

Tobacco Buyers in the field sourcing raw materials send samples to the Chemical Analysis and Special Projects department to obtain a constituent profile of the tobacco of interest prior to securing product. Utilizing UPLC-MS/MS the laboratory is able to complete analyses faster thereby accelerating purchase decisions and ensuring that the raw material supply is adequate to sustain production.

■ Process Monitoring

Any issues encountered during manufacturing related to product composition can be investigated and acted upon more rapidly with the use of UPLC-MS/MS helping to ensure product consistency.

■ Product Quality

UPLC-MS/MS is now used in support of the Quality Control group by quantifying chemical compounds in final product prior to delivery to market.

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