The productive environmental laboratory

Brad Meadows is Vice President and Lab Director at the US company BSK Labs, which runs a number of environmental laboratories and service centers. Brad is an analytical chemist and has been working in analytical lab management for 15 years. He shared his experiences with Metrohm ion chromatography with us in the form of concrete facts and figures.

BSK Labs runs a number of environmental laboratories and service centers along the west coast of the US. A total of 70 employees – including microbiologists, chemists, lab technicians, and support staff – make sure that the 200 to 350 samples that come in every week are analyzed. BSK Labs specializes in potable water chemistry, ground water monitoring, storm water runoff, solid waste characterization, and wastewater discharge compliance. The company's portfolio is rounded off with services including project consultation, sample collection, and small public water system operation and management.

The challenges of the environmental lab

One of the most important analysis methods for American environmental labs is the determination of inorganic anions in accordance with EPA 300.1 Part A. In this standard, the United States Environmental Protection Agency (EPA) describes how to analyze various substances including chloride, sulfate, bromide, nitrate, and nitrite not only in different types of water and waste water, but also in solids (following extraction) and leachates, using ion chromatography.

The nature of the samples measured in environmental labs is such that sample preparation is required – this always involves filtering the samples, and in many cases diluting them as well. This is the only way to prevent damage to the analysis system and to achieve accurate results. Sample preparation is expensive for BSK Labs, as it involves a lot of work as well as costly consumables.

Considerations when buying the new system

BSK Labs processes a high volume of samples, including some with a limited shelf life. Reliability is therefore a particularly important criterion when it comes to buying a new system. Economic considerations also play a key role: a new system should pay for itself as quickly as possible; it needs to be generating a return on investment after a year at the latest. A 30-day trial run should demonstrate whether the system offered by Metrohm meets the requirements. BSK Labs tested a Metrohm ion chromatography system with automatic ultrafiltration and dilution.

Fully automated Inline Ultrafiltration protects the separation column – and the budget

At BSK Labs, all samples are filtered before being analyzed. This prevents dirt from the sample contaminating the separation column – which significantly improves its service life. The high volume of samples drove material cost down substantiallly, to only 1 US dollar per filter. However, since each sample requires a new filter, with 14,300 samples a year this still amounts to $14,300 – just for filtration materials.

The integrated ultrafiltration in the ion chromatography system from Metrohm only needs one filter change per day, saving BSK Labs over $12,000 per year. What's more, the ultrafiltration process is fully automated. Compared to the manual filtration previously used at BSK Labs, this saves three minutes' working time per sample. With labor costs of $18 per hour, this again corresponds to savings of around $13,000 per year. Overall, therefore, using ultrafiltration saves over $25,000 in annual expenditure.

Suppressor ROI		
	Metrohm	**ERS**
Replacement cost	$ 0	$ 1,200
Replacements per year	0	4
Regeneration	$ 52 after 1,000 samples	$ 0
Total	$ 750	$ 4,800
Suppressor Savings	**$ 4,050 per year**	

Long-lasting: The Metrohm anion suppressor

Suppression reduces the conductivity of the eluent, resulting in a more sensitive conductivity detection of the analyte. This makes it possible to achieve particularly low limits of detection and quantification. The instrument previously used at BSK Labs (from a different supplier) employed membrane-based suppressors. These suppressors have to be replaced every three months, costing $1,200 each time. The Metrohm Suppressor Module (MSM), on the other hand, is a one-off purchase because it uses ion exchanger particles in a robust micro packed bed for suppression instead of

Filtration ROI*		
	Ultrafiltration	**Syringe Filter**
Filter cost per sample	$ 0.11	$ 1.00
Labor cost per sample	None	3 min
Total	$ 1,586	$ 27,170
Savings	**$ 25,584 per year**	

*Return on investment

Environmental laboratories often need to analyze heavily contaminated samples which must be filtered and diluted first.

membranes. The three suppression cartridges of the MSM alternate between suppression, rinsing, and regeneration, thereby ensuring continuous suppression at all times. The regeneration reagents are not expensive at $52 per 1,000 samples, resulting in total annual costs of $750 for 14,300 samples. This is much cheaper than the cost of replacing a membrane suppressor multiple times.

Columns ROI		
	A Supp 5	**AS4A**
Injections	7,000	1,200
Column cost	$ 1,420	$ 1,751
Total	$ 2,900	$ 20,866
Savings	**$ 17,966 per year**	

High-performance separation columns

With Metrohm columns, BSK Labs achieved better separation of the analytes and a much longer column service life – on average, 7,000 injections compared to 1,200 with the previous columns. There appear to be two factors which are key to the reduced wear on the separation column: Firstly, the Metrohm ion chromatography system provides measuring signals which are four to five times stronger. This results in a much higher detection limit, which makes it possible to reduce the injection volume by a factor of five. Secondly, Metrohm Inline Ultrafiltration removes particles down to a size of 0.2 µm – whereas manual filtration with syringe filters can only remove particles down to 20 µm.

Dilution ROI		
	Metrohm	**Competitive System**
Samples	4,290	4,290
Labor	None	3 min/sample
Total	$ 0	$ 3,861
Savings	**$ 3,861 per year**	

Automatic dilution increases sample throughput

If the determination indicates that the analyte concentration is too high, i.e., outside the permissible determination range, the sample must be diluted and reanalyzed. At BSK Labs, this is the case for around 30% of the samples. Manual dilution takes the lab staff at least three minutes which, with labor costs of $18 an hour, results in annual costs of $3,800.

Automatic Inline Dilution eliminates this expense: the analysis system dilutes the relevant samples fully automatically and then measures them again. This makes the laboratory much more efficient: the daily sample throughput increases and samples with a limited shelf life are always analyzed in good time.

Improved performance

Significant cost savings weren't the only benefit of the Metrohm analysis system for BSK Labs – the 30-day trial run also revealed a number of other advantages. The company was impressed with the robustness of the instrument and with its ability to measure the entire range of samples processed at BSK Labs. Its stable calibration also made it possible to reduce the calibration frequency: the new system only needs calibrating every two to three weeks instead of two to three days. The most impressive features, though, were the high measuring sensitivity and the large linear range of the detector. Thanks to the latter, only 2% of the samples remain outside the measuring range and have to be diluted – compared to 30% with the old system.

Conclusion

The 30-day test proved to BSK Labs that the Metrohm ion chromatography system with automatic Inline Ultrafiltration and Dilution saves both material and labor. Furthermore, it also offers a number of improvements in terms of analysis performance compared to the systems previously used at BSK Labs.

Based on the test run, BSK Labs calculated the annual savings that could be achieved with the Metrohm analysis system and came to a final figure of $50,000. The most significant savings are those for labor and material costs as a result of using ultrafiltration, followed by those resulting from the longer separation column service life.

Metrohm Environmental IC Yearly Cost Savings

$ 51,461	Total Savings
$ 25,584	Filtration Consumables and Labor
$ 17,966	Columns
$ 4,050	Suppressor
$ 3,861	Dilution