Increasing Productivity and Simplifying Sample Preparation With the SIPS Accessory

Flame Atomic Absorption Spectrometry (FAAS) typically involves element-specific sample preparation which can be time consuming and prone to operator-introduced errors. The SIPS 10 and SIPS 20 Sample Introduction Pump System (SIPS) are optional accessories for Agilent's SpectrAA FAAS instruments. They offer a range of powerful features that automate many tedious and error prone sample preparation tasks. These greatly simplify and speed up the sample preparation process, improving productivity and reducing costs.

Combining a SIPS accessory with Agilent's Fast Sequential capabilities results in an easy to use, highly productive and cost effective atomic absorption solution.

Whether you are using an autosampler, or doing manual sample introduction, a SIPS accessory, combined with the SpectrAA software, will automatically:

– Prepare up to 10 calibration standards from a single bulk standard, automating the instrument calibration process

– Intelligently dilute over range samples

– Prepare standard additions calibration from a single standard

– Introduce analytical spikes, using a single standard

– Add chemical modifiers, e.g. ionization suppressants

– Extend the dynamic range of FAAS to that approaching ICP-OES

The SIPS accessory is available in two versions:

– The single pump SIPS 10 provides in-line calibration and sample dilution.

– The dual pump SIPS 20 has the additional capabilities of in-line spiking of samples and in-line sample modification.

How SIPS works

The sample flow rate of conventional peristaltic pumps changes non-linearly with the pump speed. This makes them unsuitable for use to automatically dilute samples. The innovative design of the SIPS' peristaltic pump system ensures that the solution flow is proportional to the pump speed, so the volume of solution being pumped is accurately controlled. To extend the lifetime of the peristaltic pump tubing (and thus lower operating costs), the SIPS will automatically release the pressure on the pump tubing at the end of run.
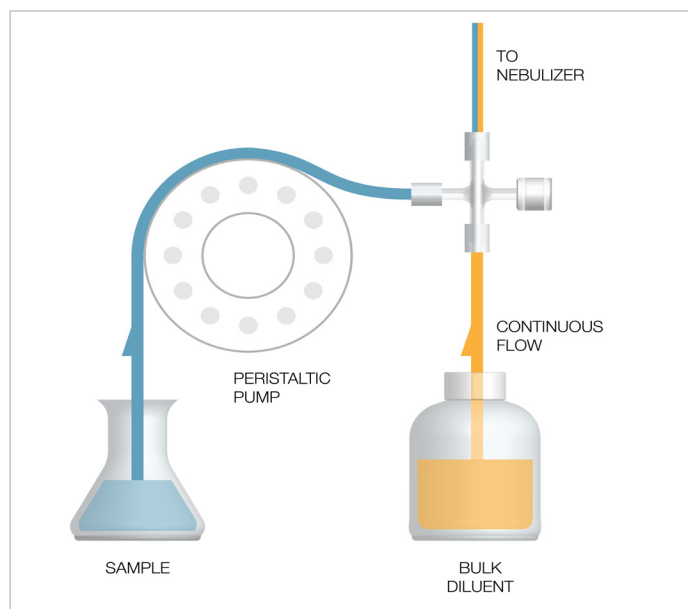
Figure 2. How the SIPS 10 works

The SIPS 10 (Figure 1) combines a small flow of diluent with the sample flowing to the nebulizer. If the pump speed is reduced, the flow of sample is reduced. With a constant nebulizer uptake rate, the diluent flow is thus increased effectively diluting the sample. This simple approach makes automatic calibration and in-line dilution possible, by accurately controlling the pump speed with the SpectrAA software.
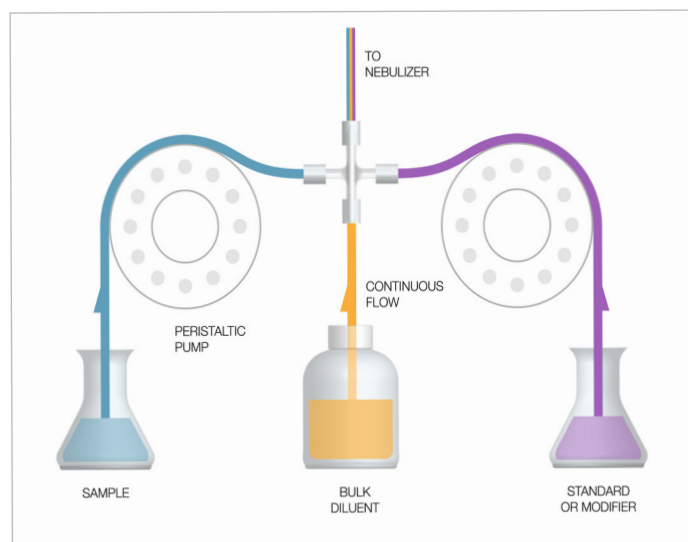


Figure 2. How the SIPS 20 works

The SIPS 20 comprises two pumps (Figure 2). One delivers the sample and the second delivers a standard or modifier to the nebulizer. Controlling the relative speeds of both pumps allows the amount of standard or modifier added to the sample to be precisely regulated. This allows in-line 'spiking' of samples.

No more tedious standard preparation

The SIPS 10 and 20 are capable of preparing calibration standards from a single multi-element bulk standard. This reduces sample preparation time and the risk of operator error during standard preparation, which can lead to costly re-runs.

Using the concentration of the bulk standard, the SpectrAA software can automatically determine standard concentrations to cover the required concentration range.

Figure 3 shows an example of a calibration curve for Cu prepared from a single standard using the SIPS system. It has a correlation coefficient of 1.0000, demonstrating the excellent calibration accuracy that can be achieved with the SIPS.
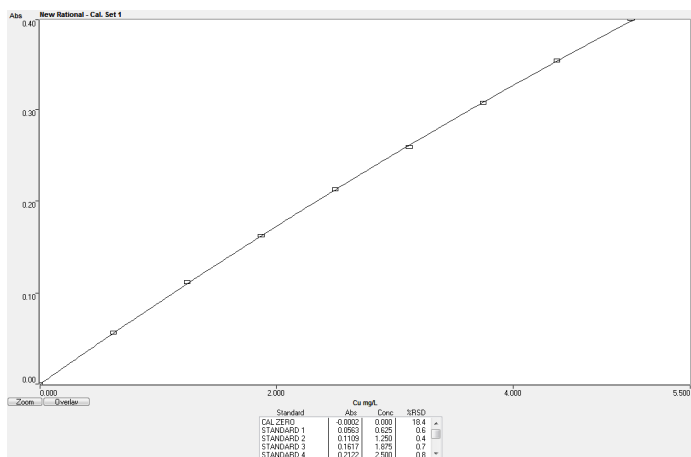
Figure 3. Calibration curve for Cu prepared from a single standard, using a SIPS. The concentrations of the standards were automatically set by the SpectrAA software to cover the required concentration range.

Automatic in-line dilution

The dilution capability of a SIPS extends the working range of AA by automatically diluting samples that are outside the calibrated range. The SpectrAA software calculates the dilution required to bring over range samples into the top half of the calibrated range, where maximum precision and accuracy usually occur. This ensures the integrity of results and eliminates the need for costly re-analysis of samples at the end of a run.

The dilution accuracy of a SIPS is shown in Table 1, demonstrating the ability of the SIPS system to provide accurate results, even at high dilution factors. Figure 4 shows the dilution performance of a SIPS with increasing dilution factors. Excellent dilution accuracy was obtained across all dilution factors with a maximum dilution error of just 1.2%.

Table 1. Typical dilution performance of a SIPS system, obtained by repeating a number of standard measurements on different days under different sequence conditions.

Dilution Factor	1	3-20	20-50	50-200
Standard Conc (mg/L)	5-10	10-100	100-320	200-1000
# of determinations	53	65	25	58
Dilution Error (%)	-1	2	1	-1
Precision (%RSD)	1	1	1	3
Reproducibility (%)	1	1	2	2
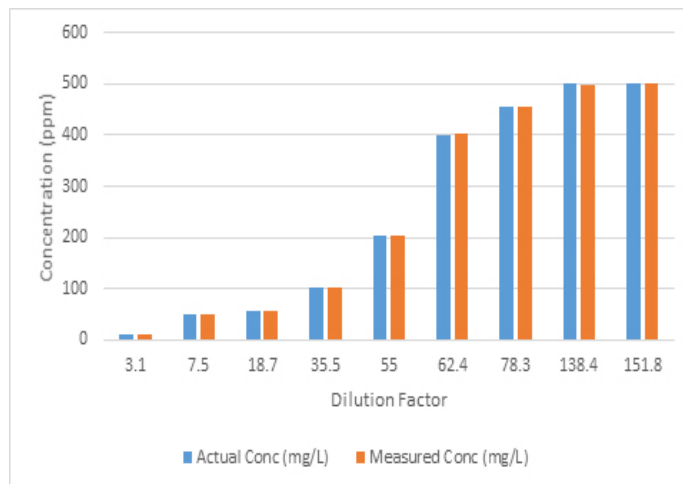
Figure 4. Dilution performance of a SIPS 20 at different dilution factors. Excellent dilution accuracy was obtained with a maximum of only 1.2% dilution error.

Modifier addition

Flame AA methods routinely require the addition of chemical modifiers for accurate results. These modifiers are normally added during the sample preparation process. Using the second pump of the SIPS 20, modifiers can be automatically added during the analysis, taking a repetitive step out of the sample preparation process. The amount of modifier added is controlled by the pump speed, and this pump speed remains constant during sample dilutions to ensure consistent blank correction and matrix modification; something that must be accounted for when adding modifiers manually.

In-line spiking of samples

The SIPS 20 automatically 'spikes' samples in-line, eliminating sample preparation and reducing the risk of sample contamination. One pump introduces the sample, and the second spikes the sample with standard.

In-line standard additions calibration

The dual pump SIPS 20 automatically adds addition standards during the analysis. One pump introduces the sample and the second introduces the standard. The SIPS system automatically adjusts the speed of the second pump to achieve the required additions—eliminating time-consuming sample preparation and reducing the risk of contamination.

When maximum accuracy is required, the SIPS system ensures that the calibration is completed using the linear portion of the curve. Where necessary, the addition standards will be diluted to ensure the absorbance signals fall within the linear range.

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