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## Automated Weight Dilution of Lubricants

### Abstract

**prepMASS** Station automatically dilutes oil and lubricant samples by weight for elemental ICP analysis. Using inert syringe technology, samples are precisely prepared from the source sample containers into the final diluted sample vials by means of an integrated and fully automated balance. Carryover is eliminated using disposable pipette tips and liquid level sensing for highly accurate and precise dilutions for a wide range of sample types. Upon completion of the weight dilution, a second transfer arm delivers the vial to the analysis rack and the dilution data is recorded. **prepMASS** Station features include:

- Syringe driven dilution to automatically dilute samples by weight.
- Precise, gravimetric dilutions performed in as quickly as 1 minute per sample, allowing laboratories to maintain throughput and reduce repetitive motion injuries in the laboratory.

- Software automatically logs all parameters for each sample processed.
- Robust automated preparation of high viscosity in-service oils and lubricants.

The **prepMASS** Station automates weight/weight dilutions for high-throughput sample preparation, eliminating the need for manual preparation. This note will demonstrate long-term accuracy and repeatability of the **prepMASS** Station, including performance across a wide range of sample viscosities.

## Introduction

Oil and lubricant sample analyses provide vital information to oil companies about raw material purity, lubricant additive condition, and internal or external contaminant ingress during the manufacturing process. Due to the varied nature of these samples, they must first be prepared and diluted prior to analysis. ASTM Method D4951 for ICPOES is commonly used to analyze these samples. This method requires ten-fold sample dilution by weight into a suitable organic solvent.

Laboratories spend vital time on preparing samples by weight, leaving less time for the sample analysis and other important tasks. Automated volumetric sample preparation can save time, but comes with an analytical integrity cost due to inaccurate sample viscosity and density corrections. Automating the gravimetric sample preparation step saves valuable time and assures analytical integrity, without deviating from the requirements of ASTM Method D4951.

## Fully Automated Weight & Weight Dilution Preparation

**prepMASS** Station is an automated sample preparation system for lubricants consisting of an intelligent sample handling system with an integrated syringe pump module (See Figure 1).

**prepMASS** Station automatically prepares weight/weight laboratory dilutions for oil and lubricant samples, while providing high sample throughput. It offers precise dilutions and fully automates all sample preparation steps from the initial sample bottle to the diluted sample vial.

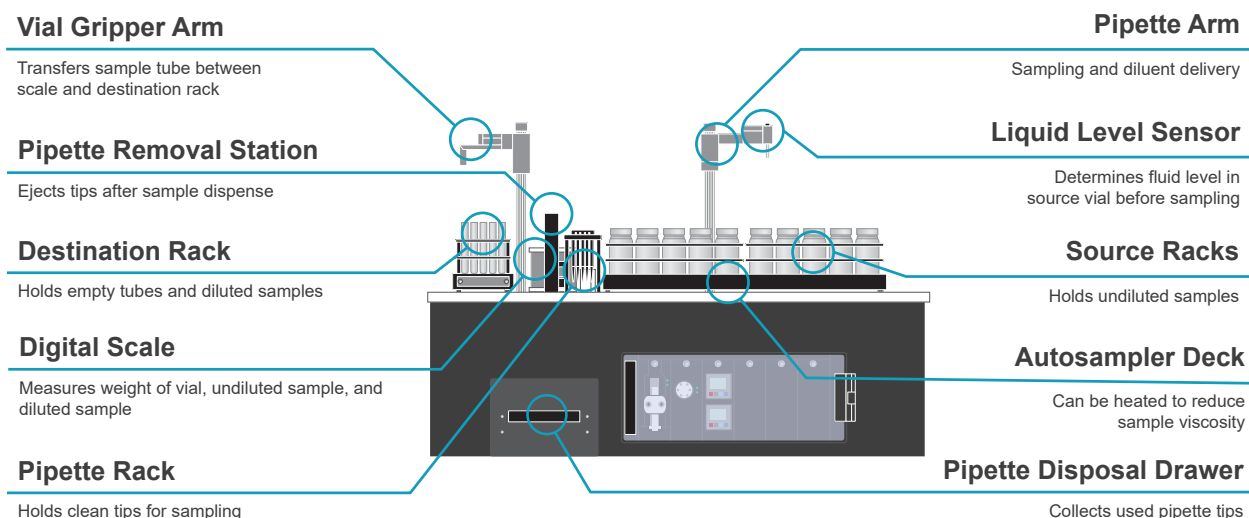
Dilution by weight requires precise control of sample uptake and dispensing, coupled with accurate weighing. **prepMASS** Station uses an innovative liquid level sensor to determine the height of each sample in its source container. By optimizing the sampling depth, pipette tip contamination is eliminated, ensuring the targeted amount of sample is accurately delivered. Simultaneously, sample

vials are moved to the balance position. Once the oil has been accurately weighed, the calculated amount of diluent is dispensed into the vial. The diluted sample is then transferred from the balance back to the destination rack, ready for analysis (See Figure 2).

**prepMASS** Station gravimetric dilution advantages:

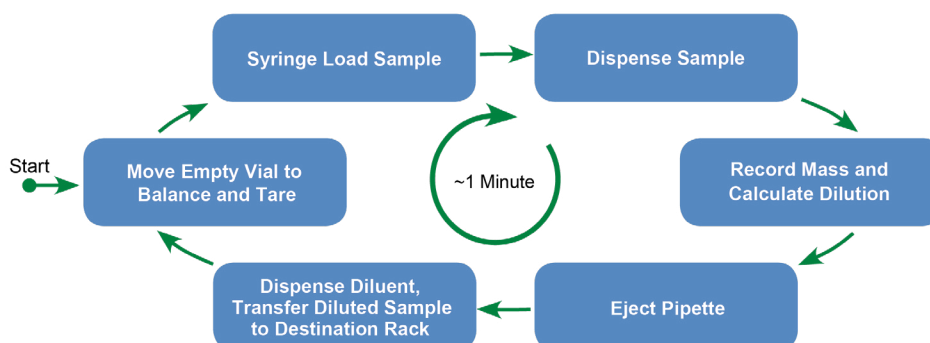
- Eliminates all manual sample dilution, saving valuable laboratory time
- Automates weight/weight dilution, reducing errors
- Allows for custom dilution factors
- Handles a wide range of sample viscosities
- Accounts for differences in sample density by accurately diluting according to measured mass
- Easy-to-use software that controls all sample preparation and dilution logging

### prepMASS Station Features Diagram



**Figure 1.** The main components of the **prepMASS** Station Automated Weight Dilution System are shown above.

## Fully Automated Weight/Weight Dilution Preparation (Continued)



**Figure 2.** The **prepMASS** Station Dilution Cycle. This diagram illustrates the steps applied for each sample preparation.

## Experimental

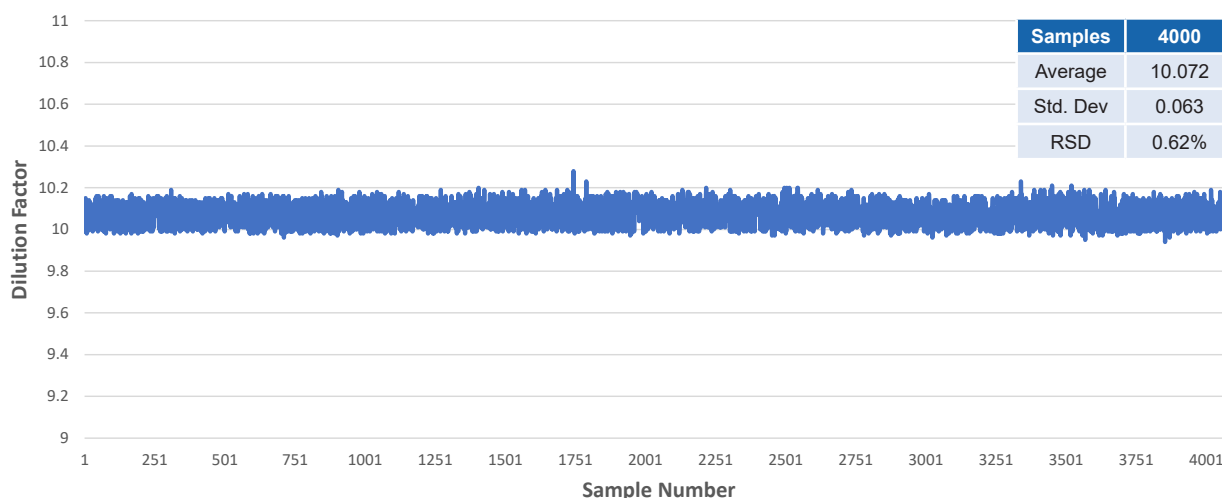
To demonstrate a high level of repeatability with thousands of samples, **prepMASS** Station was used to gravimetrically dilute a 100 cSt oil 1:10 with V-Solv™ ICP solvent (LGC Ltd. Teddington UK) over several weeks. In a separate study, additional dilutions were prepared by weight using

**prepMASS** Station to determine accuracy and precision across a wide range of sample viscosities. For both experiments, ESI's SampleSense FAST UHT-O system was used to rapidly mix and introduce each sample to the ICP for analysis.

## Long-Term Accuracy and Repeatability

4000 samples of 100cSt oil were prepared over a 3 week period. The samples were each diluted 1:10 by weight in V-Solv to a total weight of 1.000 g. **prepMASS** Station showed consistent and accurate results in the calculated

dilution factors. The graph below depicts extremely consistent stability for very small sample aliquots prepared intermittently over a three week period.



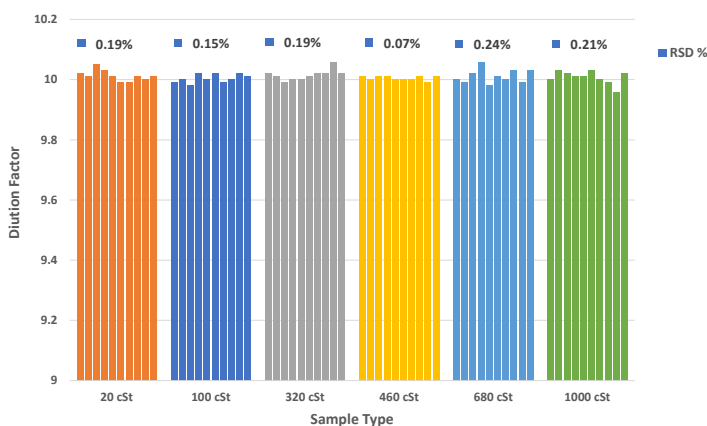
**Figure 3.** **prepMASS** Station dilution results demonstrating accuracy and repeatability for weight/weight dilutions. 4000 samples were diluted 1:10 in V-Solv over a 3 week period resulting in highly accurate and repeatable performance for dilutions.

## prepMASS Station Performance with Different Viscosity Oils

Six oils with viscosities ranging from 20 cSt to 1000 cSt were tested to measure **prepMASS** Station's capability to prepare samples by weight regardless of viscosity (Table 1). Ten samples of each viscosity were prepared.

**Table 1.** Oil samples used for evaluating dilution accuracy across a range of sample viscosities.

Parameter	Values
Oil Types [cSt]	20, 100, 320, 460, 680, 1000
Oil Types [common]	0W-10, ISO 100, Gear 320, SAE 140 Semi-Synthetic, SAE Mineral, ISO 1000
Diluent	V-Solv with Co 226
Dilution Factor	10
Sample Weight	4g



**Figure 4.** Six different oil samples ranging from 20 cSt to 1000 cSt were prepared for ICP analysis. The graph above shows dilution factor accuracy and precision for 10 samples of each oil viscosity analyzed within the range.

## Conclusion

This work demonstrates **prepMASS** Station's ability to quickly perform precise and accurate gravimetric dilution, yielding more consistent results across a range of viscosities when compared with manual preparation.

**prepMASS** Station completely optimizes and automates laboratory oil and lubricant sample gravimetric dilution. The system syringe pump module and intelligent autosampler dilutes oil samples by weight, and transfers them to the destination rack resulting in samples that are ready to analyze. The use of an automated analytical balance and simple, intelligent software allows for automatic dilutions that are both precise and accurate.

The performance shown in this note demonstrates the effectiveness of automated gravimetric dilution, particularly for ICP fluid analysis of variable viscosities. **prepMASS** Station is a highly effective sample preparation system that improves analytical efficiency, minimizes carryover, and provides quick and accurate by weight dilution for all types of oil and lubricant samples. By automating gravimetric sample preparation, in-service laboratories will save valuable time while ensuring analytical integrity, achieving full compliance with ASTM D4951.

## References

ASTM D4951 – 14 : Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry



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