

SASS[®] 2400

Low-Volume Wetted-Wall Air Sampler



successfully used to detect the airborne viral pathogens that cause exotic Newcastle disease and hoof-and-mouth disease, as well as strains of avian flu virus (1).

OVERVIEW

The SASS[™] 2400 collects particulates and water-soluble chemical vapors from the air. These materials are extracted from sampled air and trapped in a small volume of liquid that can be removed, in part or in total, at any time for analysis. Distilled water is typically the sample liquid of choice – no additives or surfactants are required for high efficiency. Trace aerosol concentrations can be amplified by extending the sampling time from minutes to hours or more.

The SASS 2400 draws air through a convenient tube stub protruding from the unit's exterior shell. This adapter allows the mounting of useful accessories such as flexible intake tubes, filters and nozzles. The exhaust air outlet uses a threaded adapter that provides equally easy discharge routing. A built-in peristaltic pump can be used to transfer liquid samples to an external analyzer for immediate analysis, or to a sample vial filling station integral to the unit. The filling station is convenient for dispensing all or a part of the liquid sample into a dropper bottle of the type used with lateral flow bioassay tickets.

The sampler is microcontroller-based and can function as a stand-alone unit or connected to other sampling, detection or communication systems via RS-232 or wireless link. Purpose-designed software allows for streamlined integration with Research International's RAPTOR and BioHawk biodetectors. The extensive use of microcontroller-based circuits coupled with electronic flash memory allows overall system operating characteristics to be easily tailored to customer requirements. Reprogramming of the sampler's operation may be performed noninvasively at any time over the RS-232 link.

Electric power consumption is only 9 watts, minimized through the use of a high-efficiency brushless fan and by using natural airflow through the cyclone structure to drive water recirculation. Weight and power consumption figures are far below other aerosol collection systems of comparable sophistication and collection efficiency, and may be further reduced for specialized applications such as Unmanned Air Vehicle (UAV) applications.

INTRODUCTION

The SASS[®] 2400 is our smallest wetted-wall aerosol particle collection system. It is designed to operate with a much lower air flow and fluid sample volume than the SASS 2300, while still employing the highly successful wetted wall aerosol collection strategy that has received U.S. Department of Homeland Security Certification under the U.S. Safety Act of 2002.

The cyclone used in the SASS 2400 operates at a 40 LPM air processing rate and requires only 1 ml of fluid, whereas the larger SASS[®] 2300 processes 325 LPM of air and requires 4 to 5 ml of sample fluid. Water loss through evaporation is correspondingly reduced: Makeup water sources will last longer, or can be reduced in size.

Extremely long collection periods continue to be a product highlight – sample fluid is maintained at a constant amount independent of collection time, ambient air temperature, or relative humidity, providing unsurpassed monitoring capabilities in environments ranging from farmyards to hospitals to battlefields.

This is the only wet-type air sampler technology that has been shown able, in concert with real-time PCR, to efficiently collect and identify airborne viruses. It has, for example, been



OPERATING PRINCIPLES

A schematic representation of the SASS 2400 is shown in Figure 1. The cyclone has four main sections: a cyclonic cup, stripping column, cistern, and water feedback loop. A high-efficiency, brushless centrifugal blower at the cyclone exit pulls air into the unit. When the SASS is turned on, the blower is activated and a water charge is injected into the cyclonic cup from a fresh water reservoir. Incoming air enters at the cup perimeter, creating strong vortex action and a rapidly swirling film of water on exposed surfaces. The water film passes across the air inlet region, forming a water curtain through which air must pass.

Concurrently, a centrally located port in the cup base injects additional water. This location is subject to high air shear, and fluid discharged from the port into the cup will be in the form of a fine spray. The cup plays a major role in collection of sub-micron particles and molecular species due to the intimate two-phase contact provided, whereas larger respirable particles are captured in both the cup and a stripping column to be described.

The air stream then flows from the cup into a stripping column connected to the cup's upper surface. As air enters the smaller diameter stripping column it increases in rotational velocity, enhancing particulate collection through centrifugal action. The inner surface of the stripping column is also wet by fluid outflow from the cup. The airflow rate and column inside diameter have been designed so that adequate shear force is produced to create a cocurrent upward flow of water on the column wall. The stripping column is operated beyond the so-called 'flooding limit,' meaning that liquid introduced at the base of the column cannot flow opposite to the upwelling air, and, in fact, must flow up the stripping column. Water flows from the stripping column into a larger diameter cistern section located above the stripping tube. Due to parasitic shear forces created by the rotating airflow, water transitioning from the tube to the cistern is flung outward to a water trap zone where a rapidly rotating water ring is formed. Water in the ring flows back to the cyclonic cup by way of a liquid feedback tube. This water is re-injected into the cup via the previously mentioned port, where it is once again available to collect additional particulates.

The nominal liquid sample inventory needed to wet all key surfaces is only 1.0 cc, and is automatically maintained by a proprietary liquid level control circuit described below. Fluid re-circulation rates have been measured to be in the range of 1 to 2 ml/minute. This means a typical 1 cc water inventory is re-circulated through the unit from 1 to 2 times per minute of operation.

Aerosol collection characteristics are similar to those of the SASS 2300, with significant particle retention over very long collection periods of up to several hours. Collection efficiency is typically 70% for three micron particles, decreasing to 50% at a particle size between 1 to 2 microns, and approaching a maximum of about 90% as particle size increases. The maximum particle size that can be collected is essentially unlimited. To prevent clogging of the liquid feedback tube, it is recommended that objects of greater than 1 mm diameter be excluded from capture through the use of an external filter or screen cover on the inlet.

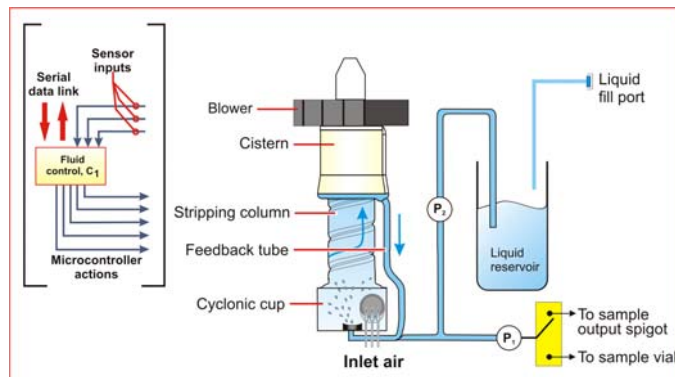


Figure 1: SASS 2400 fluid management system.

Fluid Control Subsystem

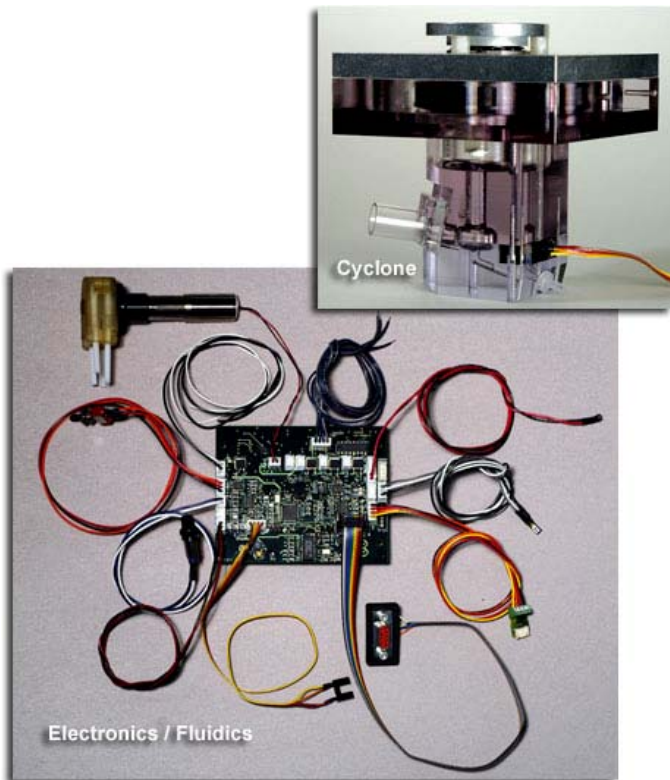
The particle extraction process involves intimate mixing of incoming air with recirculating sample water. All water would be lost in a short time if no attempt were made to compensate for evaporation. To prevent dry out, the liquid volume is monitored with a proprietary sensor attached to the water feedback tube. When the sample water inventory falls below a preset level, a microprocessor-controlled peristaltic pump meters a small amount of clean water into the re-circulation loop from an onboard water reservoir to bring the level back to set point. Water inventories can be maintained at the nominal 1 cc setting with an accuracy of ± 0.15 cc for periods of hours to days (U.S. Patent 6,532,835). Since the re-circulation loop does not use a mechanical pump, power consumption is minimized, delicate organisms are not damaged, and cleaning is simplified.

Samples may be removed at any time using an onboard peristaltic pump. When the unit is operated manually, air flow is stopped during the sample transfer process to allow fluid films to collect as a pool in the bottom of the unit. If the unit is being operated remotely via the serial digital link, air sampling may continue during the sample transfer process. The user can in either case elect to discharge the sample to an onboard sample vial or to a discharge spigot at the rear of the instrument.

SASS 2400-OEM

The SASS 2400-OEM is a minimum-parts version of our smallest wetted wall aerosol particle collection system (Figure 2). The SASS 2400-OEM is supplied as a partially-assembled kit without case: The kit is less costly and allows users to integrate RI's smallest sampler into a custom aerosol collection system.

The OEM version of the SASS 2400 includes:



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SPECIFICATIONS for SASS 2400 and 2400-OEM

<u>Characteristic</u>	<u>Description</u>
Operating principle	Multi-stage wetted-wall cyclone with enhanced particulate collection.
Air collection rate	40 LPM using 30,000 hour life brushless fan.
Particulates collection range	1-10 μm . 70% collection efficiency at 3 micron particle size.
Concentration ratio	40,000/min., nominal.
Liquid inventory	1 cc; set at factory, but adjustable by user. Proprietary control loop maintains a constant liquid volume in the sampler, independent of collection time, temperature or humidity; useful for concentrating trace airborne analytes.
Make-up water	1.3 liter on-board reservoir; supplemental off-board reservoirs may be used in fixed installations: 0.1 cc/min typical evaporation rate at 20C/50% RH.
Physical size	18.4 cm x 21.3 cm x 34.3 cm (7.2" W x 8.4" D x 13.5" H).
Weight	3.7 kg without battery, 4.7 kg with battery (8.2/10.4 lbs). Add 1 kg (2.2 lbs) for 1 liter of water.
Air inlet	15.4 mm diameter tube stub. It is recommended that third-party accessories have an airflow channel of comparable diameter or larger.
Humidity range	Non-condensing conditions.
Operating temperature	Above freezing conditions to 66 $^{\circ}$ C.
Power source	12 VDC BA-5590/U primary battery; or BA-5390/U extended life primary battery; or UBI 2590 rechargeable battery; or 82-265 Volt (47-63 Hz) AC lump-in-cord power supply.
Power consumption	Power consumption 12 V @ 0.75A, 9 W
Sample extraction	On-board 12 cc/min peristaltic pump, manual or remotely controlled. Vial filling module included. Air sampling may continue during extraction.
System controls	Microprocessor controlled. RS-232 or optional wireless link for remote operation or reprogramming. Additional TTL and motor drivers available.
Sound level	70 dB (A).
Package	Lightweight two-piece molded plastic shell with swivel-style carrying handle.
Decontamination	Auto-flush protocol using onboard water, or manual flush with detergent and/or disinfectant. Disposable high-performance pull-through fan module.
Accessories	Carrying case; inlet hose; 8cc sample bottles; sample bottles; rechargeable battery and charger.
Approvals	U.S. Dept. of Homeland Security certified under U.S. Safety Act of 2002

Research International reserves the right to change specifications without prior notice.

