

A "MAGIC" Water Condensation Particle Counter

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A portable, water-based condensation particle counter (WCPC) uses a new temperature-moderated laminar flow condensation method with a self-sustaining wick. It operates in any orientation, and can function for extended periods without addition of working fluids. Called MAGIC, for moderated aerosol growth with internal water cycling, this miniature WCPC operates from a combination of the water vapor recovered from the sampled airstream, and from that recovered internally. There are no water reservoirs, yet it is capable of days to weeks of unattended operation. It may be tipped or shaken without affecting the measurement.

The sustained operation is achieved through MAGIC's three-stage design, with a single wetted wick throughout. As described by Hering et al (2014), the first stage is a "conditioner" and is generally operated with slightly cooled walls to regulate the temperature and relative humidity of the flow. The second stage, referred to as the "initiator", is relatively short with walls that are warmer than that of the conditioner. This initiator stage provides the water vapor that creates the super-saturation to initiate droplet growth. The third stage, called the "moderator", has cool walls similar to the first stage. This third stage captures the water vapor released by the initiator stage without significant change to the saturation profiles. The stages are lined with single wick that provides wetted surfaces throughout. Once the wick is wet, instrument operation is sustained through a combination of water vapor removed from the sampled air flow and internal capture of added water vapor.

Calibration data are shown in Figure 1, where the reference is the TSI Model 3025, an ultrafine butanol-based condensation particle counter (CPC). The test aerosol is ammonium sulfate. MAGIC was operated with a temperatures of 5°C, 45°C and 5°C, for the conditioner, initiator and moderator, respectively. The detection efficiency is 50% at 4.5 nm.

For two weeks of unattended operation, and without addition of water, the portable WCPC was compared to the TSI-3788 ultrafine WCPC while sampling ambient air. During the first 48 hours of this period the correlation between the portable WCPC gives $R^2 > 0.99$, with regression slope of 0.95. Over the entire two-week period the correlation decreases to $R^2 = 0.97$, with regression slopes of 0.89.

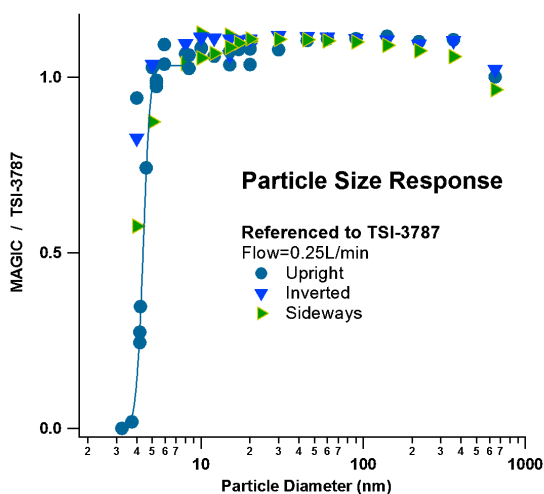


Figure 1. Calibration of the MAGIC CPC with ammonium sulfate aerosol, as compared to a TSI-3025 ultrafine, butanol-based counter.