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Comment on “Performance evaluation of 3 optical particle counters with an efficient multimodal calibration method” (Heim et al., 2008) - performance of improved counter.

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Abstract

This comment adds performance data for a modified version of one of the optical particle counters investigated in Heim et al. (2008), namely the WELAS 2100. The new version was found to have a counting efficiency much closer to unity for larger particle sizes as well as some improvement in the lower 50% detection limit.

Keywords: Optical Particle Counter; Particle Sizing; Counting Efficiency; Particle Measurement

1 Introduction

We previously presented the results of extensive calibration and characterization of three Optical Particle Counters (OPC)s, using both polystyrene latex (PSL) and di-ethyl-hexy-sebacate (DEHS). This work found several critical issues with both sizing accuracy and counting efficiency of the instruments examined.

Ensuring that aerosol measurements obtained using OPCs are accurate, has been found to be non-trivial. Burkart et al. (2010) have presented calibration and characterization measurements of ambient aerosols using 2 different OPCs (Grimm GmbH, Ainring, Germany). Flores et al. (2009) have presented an elegant means of calibrating white-light optical particle counters - such as the WELAS 2100 OPC (Pallas GmbH, Karlsruhe, Germany) tested previously (Heim et al., 2008). The authors (Flores et al., 2009) however neglected to mention the effect of the counting efficiency of the device (which increases to significantly over unity) on any particle size distribution calculation.

Due to the findings of our previous work (Heim et al., 2008), the manufacturers of the WELAS 2100 (Pallas GmbH, Karlsruhe, Germany) have revised their device in order to improve the counting efficiency. It was therefore considered prudent to test the counting efficiency and sizing accuracy of the revised WELAS Digital OPC (Weiss and Moelter, 2009).

The following work presents a characterization study of the WELAS 2100 Digital OPC. Functionally, the device is largely identical to the WELAS 2100 (analogue) OPC which was examined previously, therefore we refer readers to (Heim et al., 2008) for details. The changes between the 2100 and the Promo are reported to be (Weiss and Moelter, 2009) as follows:
(1) New optics, designed to produce a sharper boundary between illuminated and non-illuminated zones (i.e. - between the measurement volume and the remainder of the aerosol chamber)
(2) A laminarization tube which attaches to the inlet of the measurement chamber, to ensure the flow field is uniform and therefore the particles evenly distributed - an important consideration as the device in question is not an absolute counter.
(3) Logarithmic analogue to digital conversion, which reportedly improves performance of

the device for small particle sizes
(4) Digital signal processing

2 Methods and Materials

The methods shown were identical to those presented in our previous work (Heim et al., 2008), and utilized the apparatus shown in Figure 1. The PSL sizes used were the sizes used in (Heim et al., 2008): 236, 305, 358, 427, 516, 783, 972 nm. In this study, the additional PSL sizes: 98, 202 and 1430 nm were also used. (PSL was manufactured by Postnova Analytics, Landsberg/Lech, Germany and Polysciences Inc., Warrinton, USA.)

3 Results and Discussion

Figure 2 shows the measured counting efficiency of the new WELAS 2100 Digital for PSL, compared to the WELAS 2100 (analogue) (Heim et al., 2008). It can clearly be seen that the counting efficiency has been significantly improved. The smallest detectable particle size has been decreased by 200 nm, 100% counting efficiency is attained shortly after 300 nm, and the counting efficiency only increases to a maximum of 113%, compared to 190% for the superceeded device. The counting efficiency curve is now similar to the typical counting efficiency curve measured for other OPCs (Heim et al., 2008).

Figure 3 shows the sizing accuracy for the WELAS 2100 Digital only, also for PSL. It can be seen that in the smallest sizes ranges (200 nm and below), the counter is no longer able to accurately size the particles, as they are on the very edge of the detection limit. However this corresponds with the detection limit specified by the manufacturer (200 nm) (Weiss and Moelter, 2009). However it should be noted that the detection of such particles < 200 nm may mean that the count of particles in the 200 nm size class is increased artificially. Furthermore, the largest particle size (1430 nm) was sized slightly smaller (1350 nm) than the actual particle size. It is possible that the (new) logarithmic AD conversion may improve the resolution of small particle measurements, while decreasing the resolution for the larger particles, however this cannot be confirmed.

4 Conclusion

It can be seen that the counting efficiency issued experienced by the superseded WELAS 2100 (analogue) haver largely been corrected during the development of the WELAS 2100 Digital.

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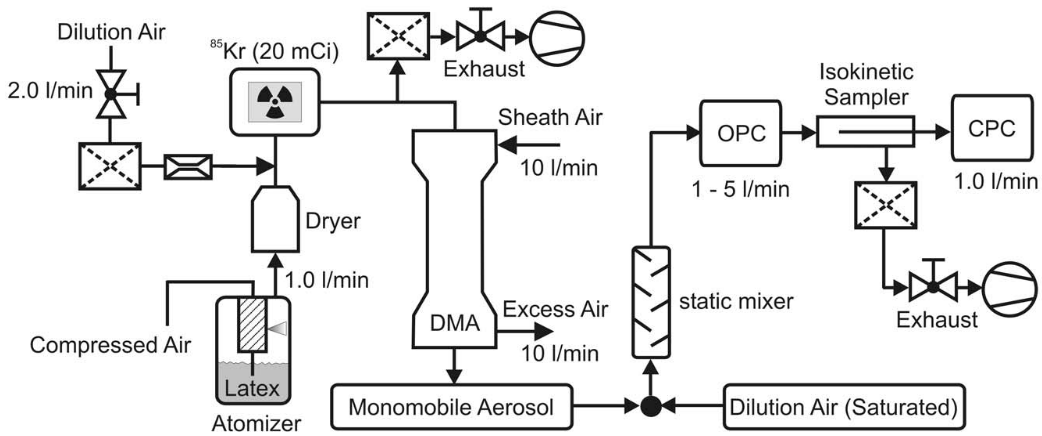

Figure 1: Experimental apparatus used for calibration experiments

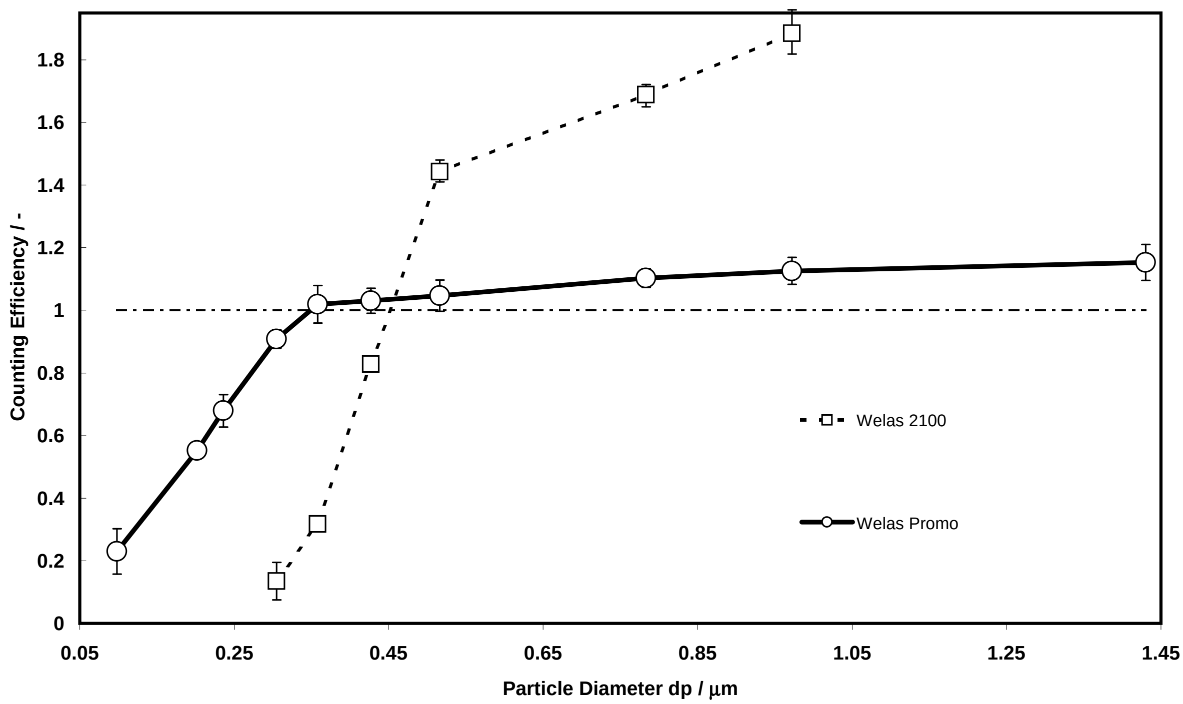

Figure 2: Comparison of the counting efficiency of the WELAS 2100 (analogue) (dashed line) and the WELAS 2100 Digital (solid line). (measured using PSL)

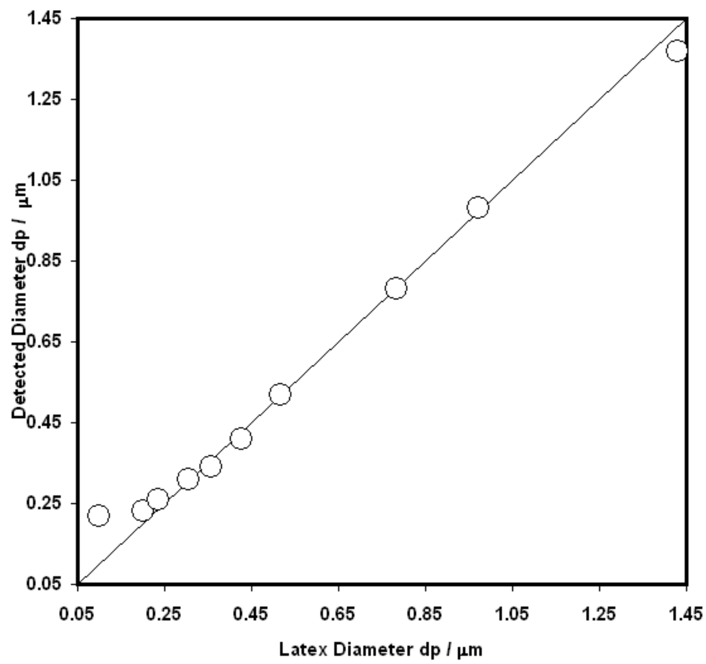

Figure 3: Sizing Accuracy of the WELAS 2100 Digital for PSL.