SOA Partitioning with Pre-existing Particles: Size-independent?

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It has been more than ten years since Odum (Odum et al., 1996) and his colleagues proposed the mass based Secondary Organic Aerosol (SOA) yield theory and verified it with controlled chamber experiments of several SOA precursors. The method was widely accepted and was followed by numbers of studies both in chamber experiments as well as modeling works (Cocker et al., 2001,Griffin et al., 1999, Kroll et al., 2006, Odum et al., 1997a, Odum et al., 1997b, etc.) Despite of the improving of our knowledge of partitioning and yields of SOA, the principal processes that governs the partitioning theory remains unrevealed, even some basic physical processes.

Among those unknown questions, one is particularly interesting because it appears to be simple enough. The question is: why this partitioning process of aerosol is not size-dependent? Condensation/ evaporation can affect the formation of SOA as important gas/particle process. The theory of condensation process of aerosol process was established decades ago and the rate of it depends on the surface area of aerosols (Seinfeld and Pandis 2006). Thus it also depends on the size of aerosols. In this study, we calculated certain ambient size distribution change with mass based yields of SOA. We then compared it to the result of simulation of the assumption that the formation is condensation based.

We made several assumptions to simplify our calculation. M-xylene is chosen as the exclusive Reactive Organic Gas (ROG), which is a common compound in vehicle exhausts. Preexisting aerosols are considered to have on effects on the process. No other process, such as nucleation and coagulation, is included in the study.

We start with an averaged size distribution from 5 near highway aerosol distributions. The reacted amount of ROG is set to be 2000 micog/m^3. The yield is calculated to be 4.01% followed the approach from Odum (Odum et al., 1996). Figure 1 is the major result of this study.

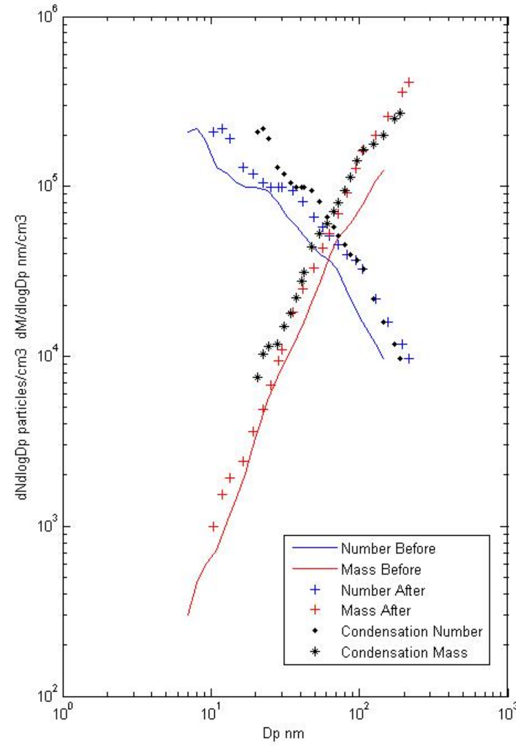

Figure 1. Size Dependence of Formation of SOA

The blue line is the original distribution and the red line is the identical distribution in mass. Red pluses were calculated from the yield above and blue pluses were the size distribution. Both of the distributions after the formation are in the shapes just as what we expected. The growth of mass is proportional to preexisting mass and number distribution is shifted towards larger size with no size dependence.

The black dots are the results from condensation. It also goes with our anticipation that the formation on small size ends up much more larger than that of large size.

The significant discrepancy between the two simulations is the lack of understanding of the chemical and physical dynamic processes instead of the final yield of partitioning equilibrium. In order to achieve that, we could launch more studies aimed at getting both time-resolved and size-resolved SOA profiles when the formation is going on.

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