Atmos. Chem. Phys. Discuss., 8, S788–S796, 2008
www.atmos-chem-phys-discuss.net/8/S788/2008/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "CCN activation experiments with adipic acid: effect of particle phase and adipic acid coatings on soluble and insoluble particles" *by* S. S. Hings et al.

Anonymous Referee #2

Received and published: 17 March 2008

1 General Comments

The paper addresses issues that have been sources of conflict in cloud condensation nuclei (CCN) activation studies. The paper describes experiments related to the CCN activity of adipic acid, as both a pure particle and as a coating on particles with cores of ammonium sulfate and soot. Adipic acid is a particle chemistry, for which past studies have exhibited a wide range of results. The study seems well designed and executed and is relevant to the ACP audience.

The paper itself is not very well written and was found to be confusing and vague at points. I suggest a major re-write, paying attention to organization, grammar, and proper punctuation. The impact of the paper would be stronger, and the ideas expressed in the paper would be better conveyed, if more attention were given to organization and punctuation. Be more specific, especially in the results and discussion section. Also, moving some information from the appendices into the main body of the paper could enhance the paper.

2 Specific Comments

2.1 Abstract

Page 4440
Lines 11 through 14
Clarify whether lines 11 through 14 in the abstract are results related to the ”pure” adipic acid studies or the adipic acid ”coating” studies. It is a bit confusing, since these statements immediately follow a statement about the coatings experiments.

2.2 Experimental

Page 4446
Lines 9 through 16
The generation of the ”wet” adipic acid particles is unclear. Is the CCNC used as part of the particle generation system? How do you differentiate the particle generation process from the activation process and measurement? Why was this method chosen

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over a humidifying system?

When the dry adipic acid particles take up water to become ”wet” adipic acid particles, are there changes in diameters? If so, how did you take that into account?

2.3 Results and Discussion

Page 4448
Line 6
Define d_{va} and d_m.

Page 4450
For all Results and Discussion sections
In the text, it might help to include a quick summary of your results, i.e. by giving a range of measured experimental values for the reader.

Line 15
Could you make the following sentence more specific?

> ”The data are the results for each point of at least 3 independent measurements performed over a period of 3 days.”

What does ”results” mean? Is it an average of the data from three different experiments? Also, what does ”each point” mean? Does ”each point” refer to each diameter

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or each supersaturation?

Page 4451
Lines 2 through 11
Could you comment on the relevance of these particle sizes in the atmosphere? Are they realistic sizes for particles found in the atmosphere? If so, under what conditions? Under what conditions would other sizes be more prevalent?

Can you make the following sentence more specific and/or explain this limitation in the experimental discussion?

> ”(This size was the smallest for which we were able to obtain accurate results.)”

What is meant by ”accurate results”? Do you mean your results were inconsistent at smaller sizes? Why? Could the particles be less spherical at smaller sizes than at larger sizes or could the particle morphology be less consistent at small sizes, as a result of the particle generation method?

You may be omitting very important information by ignoring or throwing out the experiments that gave less ”accurate results”. Those experiments might give some insight into the activation process of adipic acid, if you dig deeper and find out why those experiments were ”inaccurate” or ”inconsistent”. It seems that what you have observed at these smaller sizes is what has been observed in past experiments.

Lines 12 through 17 (last paragraph)

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What mechanisms or chemical characteristics would result in non-spherical particle generation by homogeneous nucleation?

Why is the uncertainty in d_{va} measurements as high as $\pm$15%? How was this uncertainty determined? Is the instrument calibrated (is d_{va} measured by the AMS or DMA)? I would suggest adding some instrument calibration discussion in the experimental discussion rather than the appendix, so that these issues are discussed up front and not as side bars.

You use the bulk density for the calculation of the dynamic shape factors. Could you comment on whether this is a good assumption for particles formed by homogeneous nucleation? How would your calculations change if you used a particle density instead of a bulk density?

Page 4453
Section 3.2.3
Would you expect the wet adipic acid particles to be spherical (because they have taken up water)?

In some studies, it has been found that even a small amount of ammonium sulfate can enhance CCN activation of organic compounds. Here, you state that activation is not affected by the presence of ammonium sulfate if it is present in a mass percentage less than 15%, based on calculations in Appendix A1. Is this consistent with past experimental studies? If not, could you discuss why?

Could the presence of water have an effect on the CCN activation of these particles?

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I suggest adding a paragraph that compares the wet and dry adipic acid studies and discusses the basis of the different results.

Page 4454
Section 3.3
Could you discuss in a bit more detail the difference in the ”wet” adipic acid studies and the coating studies? Is it simply the amount of ammonium sulfate present and/or adipic acid coating thickness?

It might be helpful to discuss how dT_c and S_c are related, as well as instrument calibrations, in the experimental section instead of in an appendix.

2.4 Appendix A3

Be specific and differentiate between calculated S_c and experimentally determined S_c. For example, the point of this section may be misunderstood when the statement ”S_{del}<S_c” is made. Earlier in the paper, S_c is defined as the experimentally determined critical supersaturation.

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3 Technical Corrections

3.1 Introduction

Page 4440
Line 26
I suggest adding the word ”is” between the words ”but” and ”much”.

Page 4441
Line 3
I suggest adding the word ”atmospheric” between the words ”of” and ”aerosol”.

Line 13
I suggest adding some reference to the fact that these compounds influence CCN activity when they are presence in atmospheric aerosol particles (not just gas phase).

Page 4442
Line 22
The Rissman et al. (2007) citation should be moved to be immediately after the word ”preparation”.

Page 4443
Line 1
The word ”then” should be replaced with the word ”than”.

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3.2 Experimental

Page 4444
Line 17
I suggest placing parentheses (or commas) around ”S” and ”dT”.

3.3 Results and Discussion

Page 4449
Lines 5 through 19
I suggest moving item (c) up in the paragraph, so that it is included right after item (b). Then, go into the discussion of standard Köhler theory, etc. It’s confusing to have item (c) pop up in the middle of the paragraph.

In previous lists, similar to this one, numbers were used instead of letters for the listings. I suggest using consistent formatting throughout. Also, check punctuation on all such lists.

Page 4452
Line 1
Should this section be numbered?

Line 21
The word ”atomizing-generated” should be ”atomization-generated”.

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Page 4456
Line 1
I suggest adding the word ”an” between the words ”with” and ”effective”.

3.4 Figures

Use ACP guidelines for reference format in the figure annotations (Figures 1 and 5). Also, italicize symbols in the figure annotations and axes labels (Figures 1, 3-8, A1-4, and B1-2).

Figure 7
”Wettable” is misspelled in the annotation (”wettalble”).

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