PM$_{2.5}$ and Condensible Particulate Matter Regulatory Developments

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Particulate Regulatory History

- Particulate matter, also known as particle pollution or PM, is a complex mixture of small particles and liquid droplets. PM is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, soil, or dust particles
- Particulate matter from stationary point sources was the first pollutant to be Federally regulated and is now the most widely regulated air pollutant emitted from industrial sources
- Particulate matter was originally defined as ANY airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 100 microns (um)
- In 1971, the U.S. Environmental Protection Agency (USEPA) established the National Ambient Air Quality Standard (NAAQS) for total filterable particulate matter – There was some debate, but condensible particulate matter fraction was not included at the time

Particulate Matter Regulatory History, con't

- Subsequent particulate control regulations developed by State and local agencies in response to the NAAQS have been instrumental in reducing particulate matter emissions since 1971
- Over time, the regulatory emphasis for particulate control has shifted to fine particles
- Health effect studies conducted in the 1980s and 1990s on smaller particle size fraction health effect studies resulted in new NAAQS ambient standards for PM_{10} and $PM_{2.5}$

Filterable Particulate Matter Composition

- Filterable particulate matter is made up of three fractions – PM, PM_{10}, and $PM_{2.5}$
  - Filterable PM is currently defined as a particle emitted by a point source as a solid or liquid at stack temperature and captured on a filter (maintained at filter temperatures of 250 – 325 Deg. F) of an isokinetic type sample train.
  - Filterable $PM_{2.5}$ is particulate matter with an aerodynamic diameter equal to or less than 2.5 microns (um)
  - Filterable PM_{10} is particulate matter with an aerodynamic diameter equal to or less than 10 um
  - All fractions are stable in atmosphere and collected with ambient samplers

Condensible Particulate Composition

- Condensable particulate matter (CPM) also known as "back-half condensibles" fraction
  - Vapor or gas at stack conditions but which condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid particulate matter
  - The formation of most condensable particulate matter occurs within a few seconds after discharge from the stack, but some can form significantly downstream
  - CPM is stable in the atmosphere and collected with ambient samplers
  - CPM is small, typically in the $PM_{2.5}$ size range, and therefore it is considered a component of both $PM_{2.5}$ and PM_{10} sample fractions

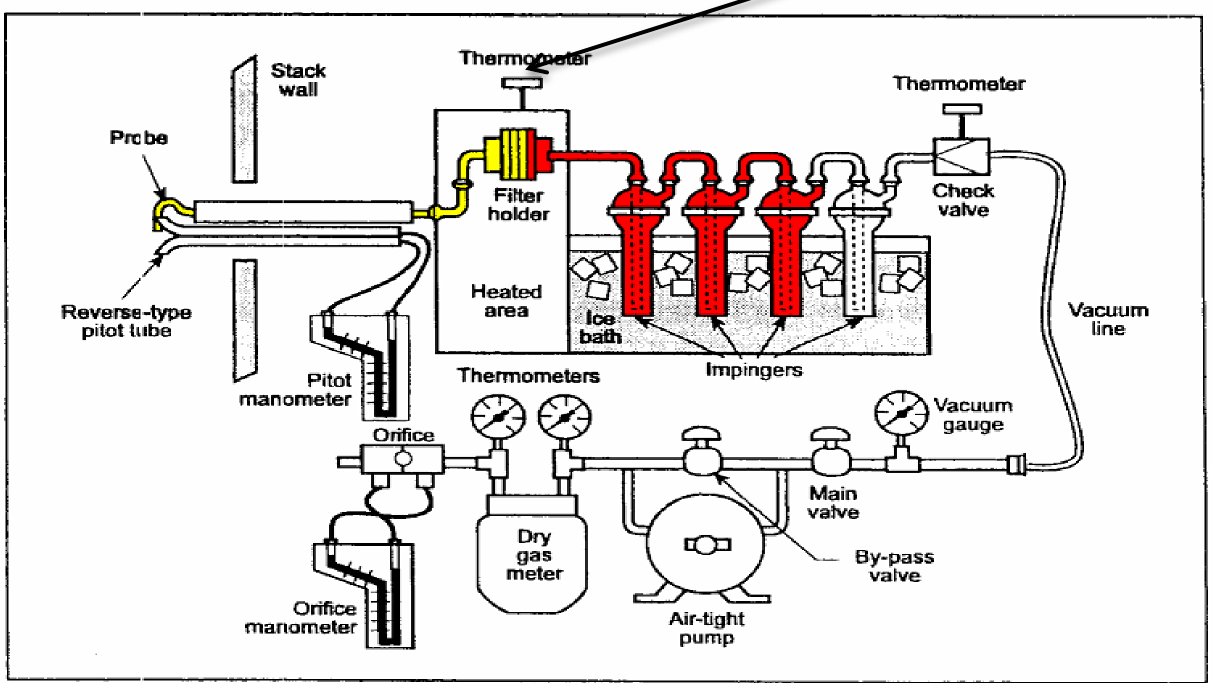
Particle Size Summary

USEPA Particle Size Terminology	
USEPA Description	**Particle Size**
Supercourse	Dia > 10 um
Course	2.5 um < Dia ≤ 10 um
Fine	0.1 um < Dia ≤ 2.5 um
Superfine	Dia ≤ 0.1 um

Filterable PM Test Methods

- USEPA Reference Method 5 sample train for total filterable particulate matter measurement – Measures total PM (filterable PM + PM_{10} + $PM_{2.5}$)

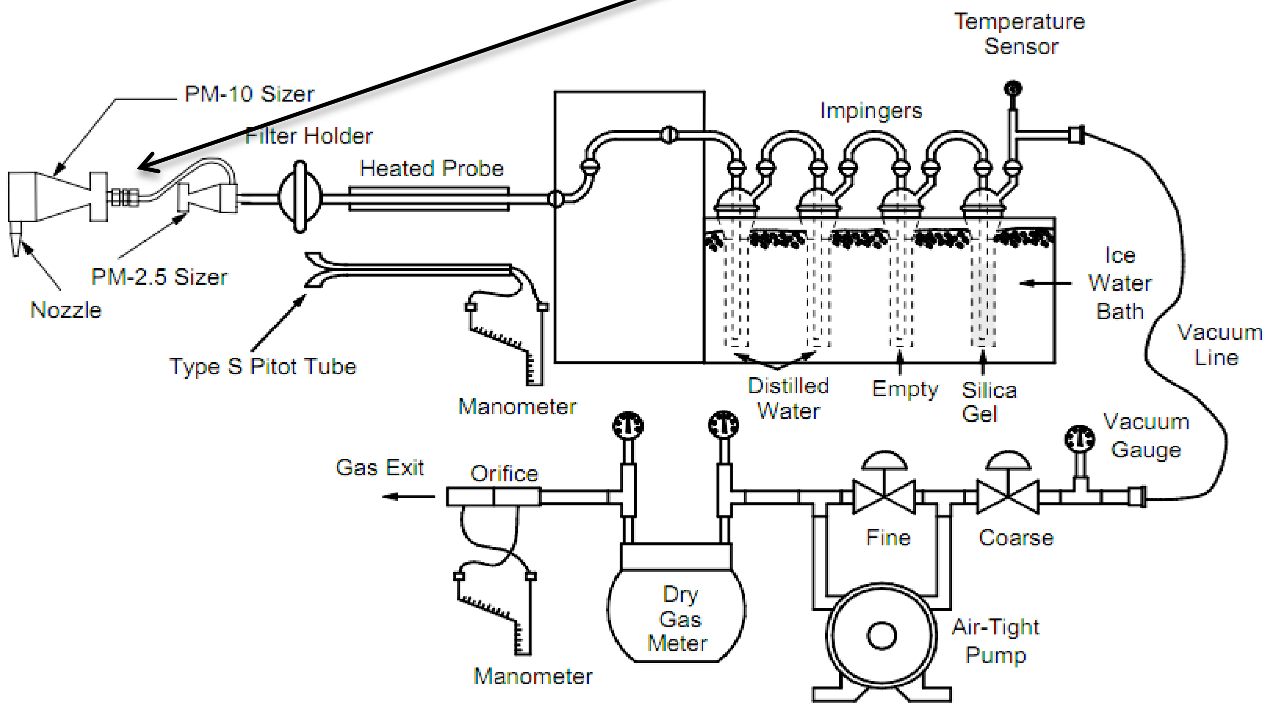
Filterable sample fraction collected here



Filterable PM Test Methods , con't

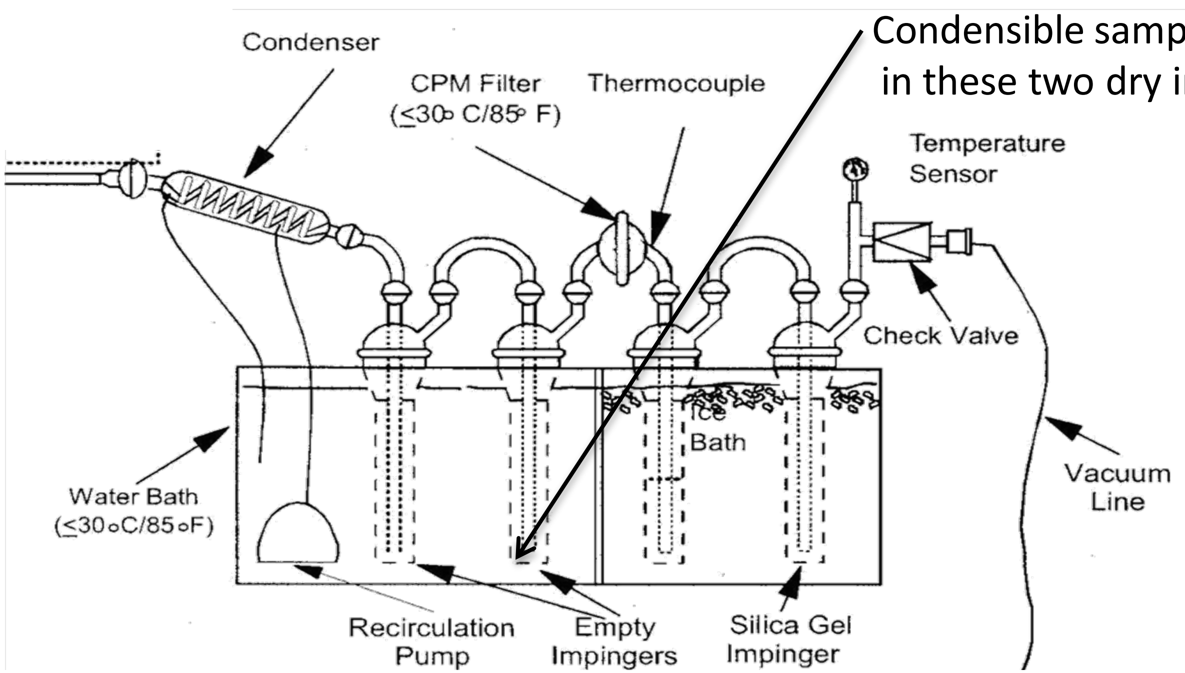
- USEPA Reference Method 201A Type Sample Train for measurement of filterable PM_{10} and $PM_{2.5}$

PM_{10} and $PM_{2.5}$ filterable sample fraction collected in these cyclones



Condensible Particulate Matter Test Methods

- USEPA Reference Method 202 sample train for measurement of condensible fraction of PM_{10} and $PM_{2.5}$
- RM 202 was revised in December 2010 to collect condensate in dry impingers to reduce potential high bias caused by sulfate artifact formation



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CPM Emissions – The Issues

- Prior to the development of the first CPM sample method in 1991, CPM emissions were not on anyone's radar
- Thre was some debate at the time, however CPM was not included in early NSPS PM emission limit determinations or emission factor calculations
- Existing source testing methods did not quantify CPM emissions
- Upon USEPA promulgation of Method 202 in 1991, CPM became a quantifiable part of particulate matter. CPM could now no longer be ignored
- However, USEPA, individual States, and local agencies have been inconsistent in how they classify CPM emissions
- The differing approaches were in part due to the inaccuracy of the initial Method 202 that was highly variable due to the potential high bias caused by sulfate interferences

CPM Emissions – The Issues con't

- Condensable emissions in many cases are a significant fraction of total particulate matter
- CPM emission factors are not available for many source categories

Filterable and Condensible AP-42 Emission Factors		
Source Type	**Filterable PM Factor**	**Condensible PM factor**
Fuel oil fired boiler	2.0 lb/10^3 gal	1.3 lb/10^3 gal
Natural gas fired boiler	1.9 lb/mmscf	5.7 lb/mmscf
MDF press exhaust	0.18 lb/MSF ¾"	0.20 lb/MSF ¾"
Hot mix asphalt	0.25 lb/ton product	0.17 lb/ton product
Natural gas-fired turbine	1.9E-03 lb/MMBtu	4.7E-03 lb/MMBtu

$PM_{2.5}$ Implementation Rule

- Promulgated in 2007 and stated that filterable PM, $PM_{2.5}$, and PM_{10} emissions shall include gaseous emissions from a source or activity which condense to form particulate matter at ambient temperatures
- On or after January 1, 2011 (end of the "transition" period of the Rule), CPM emissions must be accounted for in applicability determinations and in establishing emission limitations for PM, $PM_{2.5}$ and PM_{10}
- Compliance with PM, $PM_{2.5}$ and PM_{10} emission limits and applicability determinations made <u>prior</u> to January 1, 2011 were not required to include CPM unless required by the individual source permit or State implementation plan
- Compliance evaluations conducted <u>prior</u> to this date without accounting for CPM emissions shall <u>not</u> be considered in violation of this section unless the applicable State implementation plan required CPM to be included.

$PM_{2.5}$ Implementation Rule Implications

- Sources need to confirm that CPM is included in any new (post January 1, 2011) $PM_{2.5}$ and PM_{10} emission limits
- It is not necessary to revisit **old** limits, however must incorporate condensable PM in **new** limits – Generally safe to assume that pre 1/1/2011 limits are filterable PM only but need to confirm!
- Double check all emission factors used to ensure that CPM is included where appropriate (many adjusted in 1998, but not all)
- Check emission inventories to see whether CPM is identified or addressed – confirm whether you have a reporting issue
- Need to review any recent applicability determinations to be sure they correctly include CPM
- Be sure that the revised Method 202 (12/2010 method) procedures are used for any CPM emission testing – very important! Due to higher analytical costs, this approach will add approximately $500 to $800 to a typical single source $PM_{2.5-10}$/CPM test program

$PM_{2.5}$ Implementation Rule Implications, con't

- No later than January 1, 2011, CPM must be included in PM emission rates used in dispersion models
- But what assumptions are we to make in this modeling?
  - Assume 100% of the material condenses in the stack or immediately upon exiting the stack exhaust?
    - Limited studies conducted or data to validate this assumption for individual source categories
    - May underestimate regional contributions
  - Assume some arbitrary CPM percentage at stack exhaust?
    - Again limited data exists to obtain these ratios, especially given the variety of source types
- Current USEPA guidance is to assume all CPM is formed at the stack exhaust. However, check SIP and stay tuned as this approach could change

$PM_{2.5}$ Implementation Rule Implications, con't

- Be sure to include CPM in any new control device evaluation and selection
- In some cases (i.e., water droplets present, small stack sizes, high stack temps) Method 201A for PM_{10} and $PM_{2.5}$ cannot be used. Method 5/202 can be used to obtain a total PM/CPM value
- Remember though that this is a conservative approach as Method 5 only measures total PM– not PM_{10} or $PM_{2.5}$

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