# Physical Characteristics of Fine Particles Emitted from an Oil-Fired Heating Plant

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**Abstract**

Heavy fuel oil (HFO) is used widely in industrial scale energy production (heat and power), and in large marine vessels. HFO includes many impurities which affect the particle emissions and, further, the air quality and human exposure on particles. Depending on characteristics of particles, the particle emissions from combustion of HFO may affect also the climate. The primary particulate matter emitted in HFO combustion has been known to contain metallic and sulphur compounds. The combustion of HFO is known to produce also considerable amounts of sulphur oxides which can contribute to the particulate formation in the atmosphere. In order to decrease the high PM and sulphur emissions of HFO combustion, the knowledge related to particle characteristics and formation as well as to the effects of fuel composition and flue gas cleaning on the particles is needed.

In this study we focused on the detailed characterization of particles emitted from an HFO-fired boiler having nominal power of 47 MW. The measurements were performed at 30 MW power and with three different fuels. The studied fuels were HFO, water emulsion of HFO and water emulsion of HFO mixed with light fuel oil (LFO). The flue gas was sampled continuously by using a Fine Particle Sampler (FPS, Dekati Inc.). After that, the number size distribution, volatility and hygroscopicity of particles were studied. Particle number size distributions were studied using two scanning mobility particle sizers (SMPS, TSI Inc.) and an electrical low pressure impactor (ELPI, Dekati Inc.). In the hygroscopicity studies we used a hygroscopic tandem differential mobility analyzer (HTDMA). The particle volatility was studied by treating the diluted flue gas sample with a thermodenuder and, after that, by measuring the effects of the treatment on the particle size distribution and hygroscopicity. In addition, these studies were supported by comprehensive analyses for particle chemical composition. For more detailed description of the measurements, see Happonen et al. (2013).

With all the studied fuels, the particle number size distribution was dominated by particles smaller than 100 nm in diameter. These small particles were observed to consist mainly of nonvolatile compounds. The particles were observed to be quite hygroscopic even as fresh. In addition, especially when the fuel was water emulsion of the mixture of HFO and LFO, the hygroscopicity of the particles was strongly dependent on particle size; the hygroscopicity of larger particles was observed to be significantly lower than the hygroscopicity of smaller particles. In general, the results indicate that even the fine particles emitted from HFO based combustion can have a significant effect on cloud formation, visibility and air quality.

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References: Happonen, M., et al. 2013. Size distribution, chemical composition, and hygroscopicity of fine particles emitted from an oil-fired heating plant. Environmental Science & Technology, DOI: 10.1021/es4028056.

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