Using a heated pipe to improve air-quality measurements

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Particulate matter (PM) sensors are very helpful in determining the quality of the air we breathe in. They measure the amount of small and often harmful particles suspended in the air. Cheaper particulate sensors have recently been introduced to the market. These sensors, however, have shown to be susceptible to measurement errors when the relative humidity of the air is high, which is often the case in the Swedish climate. By attaching a heated pipe to the inlet of a low-cost particulate sensor, the relative humidity of the air measured by the sensor was lowered. Our tests showed that this led to a reduced humidity-induced error in the sensor resulting in more accurate PM readings. This study strengthens the knowledge towards the possibility of deploying multiple low-cost PM sensors in order to collect more accurate and high resolution air quality data in a cost-efficient way.

One can survive 3 weeks without food, 3 days without water and 3 minutes without air. Despite the importance of air to human lives, air quality is not something we typically reflect over in our everyday life. 4.2 million deaths are annually attributed to outdoor air pollution and 3.8 million deaths are claimed to be the result of exposure to household air polluted by e.g. smoke from cooking stoves. Deaths related to air pollution are mainly caused by lung cancer, chronic obstructive pulmonary disease (COPD), stroke, lower respiratory tract infection (LRTI) and heart disease. It is clear that air quality is something important to measure.

Recent sensor technology development has made cheap and compact low-cost PM sensors readily available. Such low-cost sensors can be purchased for as little as 300 SEK, thus allowing the deployment of multiple sensors at different locations. This could mean increased coverage and better data resolution as compared to the limited resolution from existing measurement stations. Today, the measurement values from these low-cost sensors are, however, often sensitive to variables such as temperature and humidity. High-end sensors do not generally suffer from these same sensitivities in the same way because of built-in measures to reduce this.

Figure 1: A field test being performed in central parts of Malmö

This study looked at how low-cost PM sensors were influenced by humidity and how the humidity-induced error could be reduced. A protype was built using a heated pipe to warm up the air before it reached the sensor. Heating the incoming air serves to reduce its relative humidity. This prototype was later set up in a central location in Malmö, Sweden to compare the readings against a reference instrument placed at the same location. The results from these measurements showed that a heated inlet was effective in reducing the humidity-induced error.

Further work is planned to see how this solution can be developed and deployed as a new product.