Proposal for solving the haze problem

– an integrated application of plant barrier and precipitators

Problem:

Haze is traditionally an atmospheric phenomenon where dust, smoke and other dry particles obscure the clarity of the sky. Singapore has been affected by haze periodically due to deforestation with fire in Indonesian. Prevailing winds carry large smoke particles consisting of various pollutants such as sulfur and nitrogen oxides and carbon monoxide[1]. It obscures the clear sky and leads to multitudes of diseases.

Literary review:

Other than managerial strategies in coordinating with Indonesia, existing measures in Singapore to tackle the haze problem include the monitoring of air quality and prediction of haze, online updates on haze situations, health advisories and the use of air-cleaning devices[1]. Among various air-cleaning devices, the most common types utilize electrostatic precipitation of dust particles or filtration of air using dense fibrous materials[1].

However, electrostatic precipitators can be expensive for use in large scale and would be inefficient if greater coverage of air-cleaning is required. Their use is also limited to indoor air-cleaning and they require constant maintenance and discharge to keep them function smoothly. They are inflexible to changes in operating coditions once installed or purchased. Moreover, they cannot control gaseous emissions. Similarly, media filters have their limitation of influencing airflow and thus have to be matched with fans for use indoors.

Proposed solution:

Vegetation Barrier Integrated with Self-sustaining Electrostatic Precipitators

Rationale:

Plants that trap dust particles or absorb pollutants can be arranged to most efficiently reduce the impacts of haze; serve as heat barrier and create shades in architecture; create moisture that precipitates and clears away dust in the air. Moreover, they do not obstruct the airflow too much. They can be genetically engineered to absorb specific dust particles and toxic gaseous pollutants. They could also serve to beautify the city landscape and advocate green living.

Literary review

1) There have been various scientific efforts in investigating the effect of plants on environmental wellness, which have shown promising results. For instance, a study from the

University of Lancaster published in the journal Environmental Science & Technology has shown that silver birch trees can absorb as much as 50% of the particulate matter generated by automobiles.[2] Aside from their use outdoors, in 2009, scientists identified some plants that show high rates of contaminant removal inside a house. These include purple waffle plant, English ivy, asparagus fern, the purple heart plant and variegated wax plant.[3] A portable product was created by Dr. Wolverton, dubbed the "Plant Air Purifier", which uses an electric fan and activated carbon in a ceramic growing medium to filter and trap pollutants around the roots of the plants[3]. Such portable air purifiers can be further developed to assist air-purifying in larger scale.

2) Electrostatic precipitator being sustained by piezoelectric or electromagnetic generators installed in the windows or floors where the dust collected can be removed with ease and the energy can be saved. They could be made portable and rechargeable for daily use in all circumstances. These electrostatic precipitators function by electrostatically charging the dust particles in the gas stream. The charged particles are then attracted to and deposited on plates or other collection devices. When enough dust has accumulated, the collectors are shaken to dislodge the dust, causing it to fall with the force of gravity to hoppers below. The dust is then removed by a conveyor system for disposal or recycling[4]. The energy requirement can be high and should be sustained and controlled at a fixed voltage to maximize the efficiency of the precipitation of the particulate matter[4].

Conceptual framework:

There is potential for a combination of the vegetation barrier and electrostatic precipitators to be explored. Plants on themselves are limited in air-purifying efficiency whereas precipitators alone cannot take care of the toxic gaseous pollutants involved in a haze situation. The morphology of the plants' leaves can be altered to best trap dust from the haze via experiments and simulations[5]. Moreover, winds on the plant leaves create ambient vibrational energy that may be harvested via piezoelectric generators[6]. Moreover, electricity can be obtained directly by using electrolyte inside a plant by creating electrodes on the body of a plant, thus to generate energy that is stored and controlled for sustaining the micro-scale dust precipitator.

Potential limitations:

Plants that are naturally good at purifying air may not adapt to the tropical climates and more research is first required to determine their compatibility to local environment and maybe modify them genetically to suit the needs to remove specific pollutants from the haze. Moreover, maintenance is needed to prevent overgrowth and manage the plants to maximize their effect. Energy harvested from ambient environment might result in compromise on the efficiency of the electrostatic precipitators so a best combination of the portions of air-purification contributed by precipitators and by plants should be explored. A variety of alternative energy sources can be explored, such as solar energy and piezoelectricity from raindrops under trees, but may amount to significant cost-inefficiency.

Summary:

A flexible combination of air-purifying plants and self-sustaining electrostatic dust precipitators is proposed. The precipitators are small in scale, portable and chargeable, ready to be relocated to suit other locations. They can be attached to branches of plants so as to be in the air. Such combination can be employed in the streets, in architectural structures, buildings or as indoor ornaments which help purify in-house air during periods of haze. Large-scale application may require integrating the plants and precipitators with subtlety so as to be aligned with urban landscape to best mitigate the impact of haze[7]. Thus, strategic locations should be carefully planned for the installation of such devices. They can be simplified for domestic use with a variety of combinations targeting different pollutants in the haze situations to choose from.

References:

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