Filtering Air Pollution using Roosegaarde Towers: A Proposition for Lucknow

Jamal Ahmed[1] A. K. Gautam[2]
[1]Research Scholar [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]Maharishi University of Information Technology, Lucknow, India

Abstract— Increasing expectations from direct filtering of the pollutants in the air has been reviewed. It appears that many countries in the world are experimenting with it. Chinese have constructed actual filtering towers for real life control and studies. Since PM 2.5 has turned out to be the main culprit, Roosegaarde type towers hold great promise as they use new positive ion technology which does not produce the ill effects of ozone creation which happens in older technologies. From the information available in the literature a suitable type (50 meters height) of tower has been identified for Lucknow and its layout details have been worked out. Efforts have been made to estimate the no. of towers that may be needed and their possible locations.

Keywords: Roosegaarde Towers

I. INTRODUCTION

Literature review shows that air pollution in cities is a complex problem, and thus different kind of solutions have been found or being implemented in different cities. It may possibly be due to the differences in the nature of the pollution, degree of pollution and the availability of control infrastructure of an intelligent city etc.

The atmospheric pollution situation has become alarming after wide publicity has been made of nearly 5 million people dying in the world every year due to air pollution related causes in the cities. A quarter of these may be in India.

Indian cities are repeatedly coming out on the top of the most polluted cities in the world. This includes Delhi as well as Lucknow.

It is proposed to examine active filtering through Roosegaarde type of towers for the city of Lucknow as it is being experimented with in several cities in the world.

Active filtering out of the pollutants is a kind of last ditch effort. It is not surprising that large no. of cities across the geographies are experimenting with it. It may partly be due to the fact that new technologies are becoming available. Such a measure has to be over and above the standard techniques followed in the cities to mitigate the effects of the pollution.

Generally large scale modification of city environment looks impractical but for the low profile near natural method being proposed, through filtering towers, has some plausibility.

In course of time it has become clearer that vehicular pollution has become the main source of pollution as many other sources has been brought under control. Therefore, focus has been on bringing it under control everywhere through the use of better fuels, better engines, better vehicles, better scheduling, and better exhaust control devices etc.

Among the new technologies being talked about are huge panels of mosses in the city , as it has been shown to be capable of absorbing various types of air pollution, making a fast switch to electrical drive technologies and developing better batteries besides Roosegaarde and other types of filtering technologies through towers etc.

II. THE OUTLINE OF THE SUGGESTION

The literature[1] shows that PM 2.5 remains the main cause of air pollution at Lucknow throughout the year, while industrial pollution content is modest at Lucknow and so is the power plant related pollution. Crop residue burning and wood burning remain important constituents of PM 2.5 sources. While crop residue burning is seasonal wood burning is round the year phenomenon. Some of these can be influenced by better agricultural and fuel policies. For example [2] it has been reported that wrong type of incentives given to farmers result into cultivation of crops which require huge water consumption and also require crop residue burning.

However, this proposition focuses on exploring:

1) The suitability of positive ion Roosegaarde filtering towers
2) Determining the design and deployment features for the proposition

III. THE ROOSEGAARDE TYPE FILTERING TOWERS

A brief Outline: Once the decision is made that relatively large scale control of nature has to be attempted, a variety of options emerge like making artificial rains, providing artificial covers and partitions, altering airflow etc. However, just filtering the unwanted constituents may be attractive as there may not lead to other repercussions. The demonstration of the working of a smog filtering 7 meters tall tower, shown in Fig 1, [3]t has caught the attention of many countries, who wish to scale it up in a big way.

The main feature of this type of tower is that it is based on a patented positive ion technology. These positive ions collide with PM (of 2,5, 10 microns etc.) particles and get themselves attached to it. Being positively charged they are attracted by a negatively charged plate provided and get adhered to it. From there they are removed subsequently. The idea is exploited in a tower design where polluted air is sucked from the top and made to pass PM 2.5 and 10 filtering and other filtering processes as well and then discharged at some height above the ground level. In the Roosegaard design, energy for moving the air comes from the solar greenhouse constructed near the tower which heats the air and makes it go upwards.

Fig. 1: Roosegaarde's 7 meters smog removing tower

Due to very rapid industrial development Chinese cities became much polluted, exceeding all acceptable norms. This made the State to take a strong decision [4] to reduce pollution by 25% in next few years. They have been largely successful. Air pollution in their cities is not only from transportation but also heavily due to old fashioned power plants and from industries. Some of them had to be shut down.

However, the Roosegaarde type filters looked attractive as a solution and several large size towers [5], typically of 100 meters height have been constructed and their performance and possibility of further scaling them is being studied. In fact simulation has been done for one Km height tower as well [6]. Results so far look practical and interesting. Several other counties like Columbia, Mexico, Poland, Netherlands and France are also showing interest, besides India for towers and tower grids [7].

IV. PROPOSITION FOR LUCKNOW CITY:

It is proposed to study the possibility of managing air pollution through a series of filtering towers located at strategic places in the city of Lucknow.

A design concept of the tower used for simulations[6,7] has been adopted here and is shown in Fig 2.The first parameter to be decided is the height of the tower. Meanwhile, Fig.3 shows, from several published sources, the variety and the sizes of towers that are being explored. Roosegaarde who started the idea of filtration towers made a 7 meters high tower that could improve quality in about 30 meters diameter space.

It appears that apart from the city of Xi'an in China there is a proposal of a grid of 100 meters tall towers from Zenera [7] for the city of Delhi to combat pollution.

The most studied towers are of 100 meters height and they could possibly manage cleaning the air of around the tower of 2 or 3 Km diameter (around 5 sq km) . However, these kind of towers will require huge ground space for construction, specially for the heating of the air through sunlight which does not look practical for the densely populated city of Lucknow. It is thus proposed to have towers of around 50 meters height only and deploy fans for pushing the air up. By comparing it with other towers it may be seen that it may be capable of cleaning air in around 1 to 1.5 Km in diameter(roughly 1 to 2.0 sq Km).

The location of towers have to be fixed keeping the pollution map of the city in mind rather than through uniform grids covering all the area. The round the year pollution records for Lucknow are available mainly from UP Pollution Control Board for four or five locations in the city only.

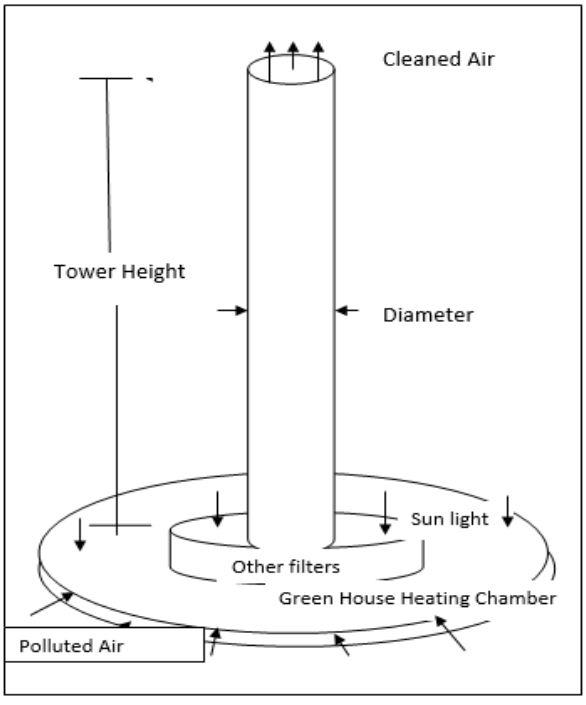

Fig. 2: The proposed Roosergaarde type tower and some functional details

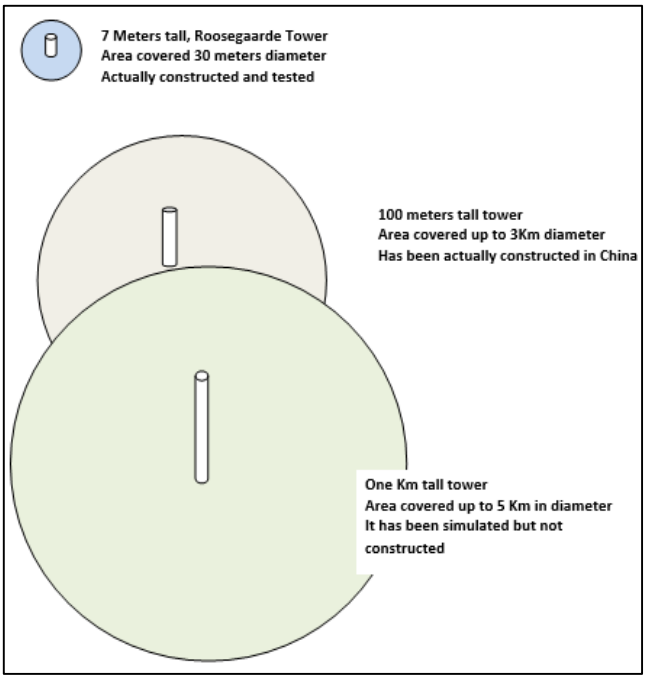

Fig. 3: The range in which Roosegaarde towers design is being explored

A better picture can be arrived at if mobile measuring devices are used to improve the coverage of the area, by monitoring the pollution at several places at short intervals at time. This may then provide a dynamic information on pollution and traffic jams etc.

Data available about the city (at limited places) is updated every 2 hours intervals and data of temperature, wind velocity, humidity and pressure are also available for better understanding of the situation.

Based on the scanty information, it can be assumed that Lucknow from Aliganj downwards in the map is more polluted and possibly more towers should be located in this area. Since each of the proposed towers can take care of roughly one sq. Km area only, a possibility of installation of up to 30 towers can be considered. Some obvious locations of the towers in areas of high pollution are shown in Fig. 4. The north south orientation of the city, major population areas along the main roads and metro lines also point to this

The full execution of such a project may be based on the experience generated in the initial phases of the activities and the construction of the initial towers.

Implication of the height of the towers: The towers of higher heights may have the advantage that fewer construction spaces may be needed and a large dome of purified air becomes available in the areas of tall buildings. The literature does not provide any information but the location, but it can be seen that some resilience against blowing wind and other disturbing phenomenon has to keep in mid in deciding the location.

Observations about desirability of the height of the clean air bubble or the dome are not available. A larger body of air may serve as temporary sink of the pollution and might help in maintaining the pollution level with traffic jams etc... At the same time if the cleaned air is not utilised it becomes a burden.

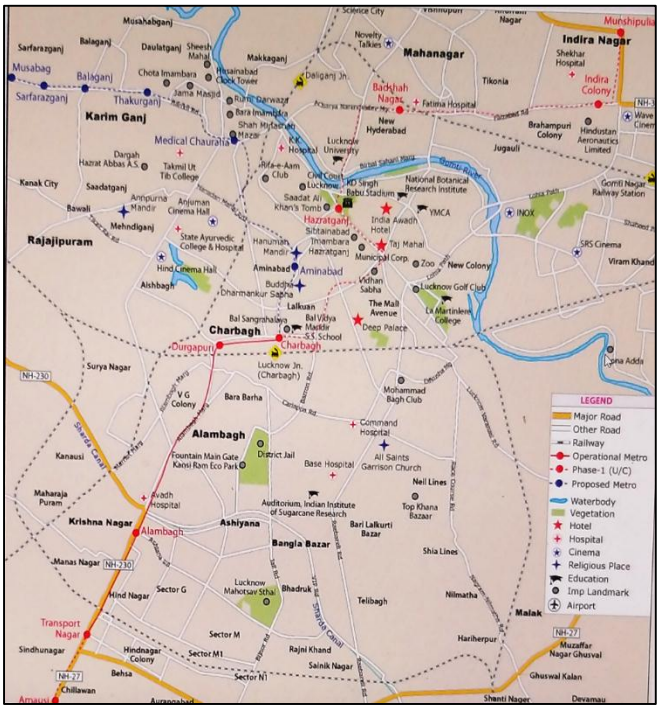

Fig. 4: The proposed location of Roosegaarde type towers superposed on Luknow map. Some proposed locations for the towers ○ (50 meters height) are shown in the map based on known pollution and congestion areas along the roads

V. CONCLUSIONS

From the study of literature and published information it can be seen that some experimentation in air heating methods, tower location close to other buildings and desirable size of the towers may be called for before a successful scheme may be implemented. Further,

1) Locating the towers in a grid may make location decisions easier but may not be an efficient method as air pollution in Lucknow city varies widely.
2) Reliance only on one of the methods to manage air pollution may not be enough. Control through better engines in vehicles and better fuels should remain the top priority.
3) However, the appeal of towers in cleaning the whole air irrespective of the origins(vehicular or otherwise) and the level of pollution remains high.

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