Proceedings of the World Congress on New Technologies (NewTech 2015)
Barcelona, Spain – July 15 - 17, 2015
Paper No. 174

The Natural Mechanism for Cleaning Technology of City Atmosphere

Dina Burkitbaeva, Serik Burkitbaev
Harvard business school. Harvard University./Kazakhstan Research and Engineering Institute of Energy and Communications
Boston, USA/Almaty, Kazakhstan
dburkitbayeva@mba2015.hbs.edu; sburkit@gmail.com

Serik Ismailov, Karine Kotoyants
Kazakhstan Research and Engineering Institute of Energy and Communications
348 Rayimbek ave., Almaty, Kazakhstan 050061
smail99@inbox.ru; karine.kotoyants@gmail.com

Abstract -The utilizing of natural aspects of the city's landscape and atmosphere for the purposes of filtration and air flow circulation is proposed. The necessary system requires natural air flow, preferably where the citizens' active lives take place, through a "filter", which is located perpendicular to the direction of airflow. Our studies based on example of Almaty, which is the largest city in Kazakhstan. Air flow circulation: Almaty possesses both natural wind and mountain-valley air circulation thanks to its location at the steps of Alatau Mountains. Mountain-valley air circulation system: at dawn, polluted air is heated by the sun and as a result, expands and spreads up the mountain canyons. After the sun sets, the polluted air is chilled at the glaciers and moves down the canyons to the north towards downtown. This guarantees "pumping" of polluted air twice a day from north-to-south. Filter: We propose using the small water droplet fall in the vertical cross-section of existing irrigation channels or rivers for the purposes of cleaning the city atmosphere. It allows to build the necessary «filter». As a result, the goal of creating a natural «rain» will be solved in the cross-sections of the city. Taking into account the above, the polluted atmosphere will be naturally "pumped" through the filter, which will be equivalent to a city-wide regular rain that takes place twice a day.

Keywords*:* air, pollution, mountain-valley, circulation, filter

1. Introduction

Efforts to decrease the effects of pollution allow to only cut certain types of pollution. Unfortunately, due to the growing dynamics of industrial pollutants and other ecological problems, the pollution levels cannot be radically cut within the needed time frame. As a result, the city atmosphere is degrading. Various solutions on ventilation and filtration of the city atmosphere have been proposed, however, the large scale of city's atmosphere makes man-made methods economically and technologically unfeasible.

As a result, we propose utilizing natural aspects of the city’s landscape and atmosphere for the purposes of filtration and air flow circulation. The necessary system requires natural air flow, preferably where the citizens’ active lives take place, through a “filter”, which is located perpendicular to the direction of airflow.

2. Air Flow Circulation

Almaty possesses both natural wind and mountain-valley air circulation thanks to its location at the steps of Alatau Mountains (Gelmgolz N., 1963). Mountain-valley air circulation system: at dawn, polluted air is heated by the sun and as a result, expands and spreads up the mountain canyons, reaching Medeo and Chimbulak Mountains around lunch time. After the sun sets, the polluted air is chilled at the glaciers and moves down the canyons to the north towards downtown (as shown Mirkarimova B., 2004). The main layer of polluted air contracts to ~ 5-30 m above ground and is then additionally chilled by the banks of Mountain Rivers and canyons and moves north, occasionally

reaching the Kapchagay water reserve. The cycle repeats each morning. Fig. 1 and Fig.2 present the scheme of Mountain-valley air circulation.

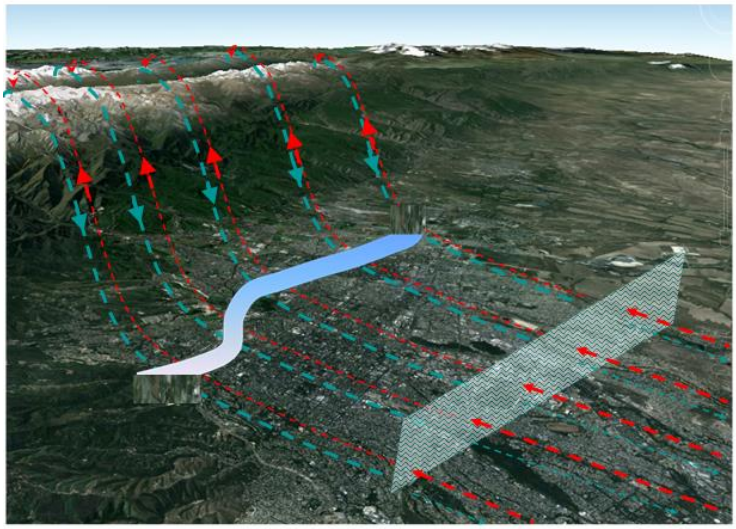

Fig. 1. Mountain-valley air circulation

The given mountain-valley air circulation guarantees "pumping" of polluted air twice a day from north-to-south. The effective measurements of the "filter", through which the major volume of polluted air passes, should be 10 km wide (east-to-west), 10-30 m high and 30-50 km long (north-to-south). Taking into account the meridian direction of mount-valley air circulation and the effect of air contraction due to chilling process in the mountains and river canyons, the effective measurements of the "filter" (east-to-west) should be 10 km by 30 m. The trail of airflow passing through the "filter" is about 70-100 km and volume of passing air will be no less than 20-40 cubic meters per day.

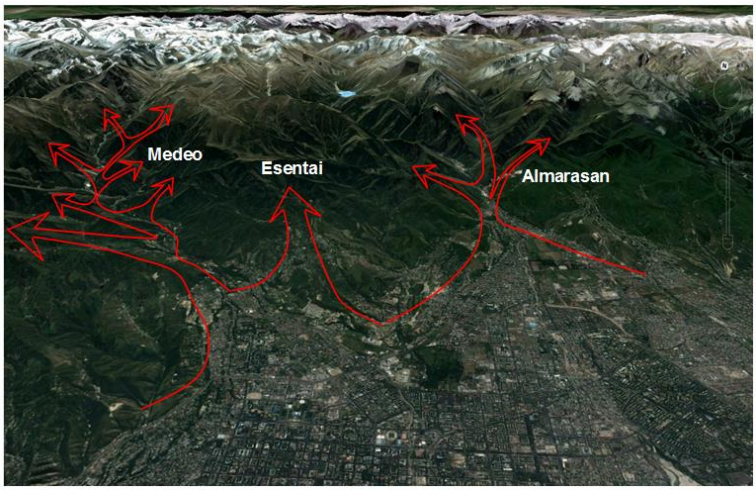

Fig. 2. Valley wind: Direction of upstream warm air along main valleys
(Phase III, 09:00 – 18:00)

3. Filter

It is a well-known fact that even a short rain or snowfalls are the most effective methods of cleaning the atmosphere of the city. Also, having a large number of water fountains creates an especially clean microclimate, even if only in the immediate proximity of the fountains. However, the high energy and operating costs make it unrealistic to cover the entire city with a system of fountains. Generating rains on a regular basis is also an unrealistic option.

There are numerous natural and man-made hydrotechnical structures in the city, including the following:

- three main rivers (large and small Almatinka and Esentai), flowing in the natural valleys which, unfortunately, lie in the meridian direction;
- man-made channels, such as the main irrigation canal along Abay street as well as the Large Almaty Canal (LAC) – close to Ryskulov street. The latter is the most suitable one for our purposes. It has a natural flow in the latitudinal direction, i.e. perpendicular to mountain-valley air circulation, has the appropriate dimensions (length of over 10 km, isolation space of 100 m and location in the lower part of the city).

As can be seen from the above, the LAC can be used as basic infrastructure to build the necessary «filter» as it has the ideal geographical location, orientation, isolation space and necessary water reserves.

In the history of mankind, aqueducts of ancient Greece and Rome were cutting edge technology for creating waterways and fountains. In addition to their technical purposes, they also served an aesthetic purpose. In the modern world, small water shroud or small water droplet fall is the most effective and economically feasible method of cleaning the atmosphere of mines, coal, iron and steel plants. Based on the wide range of existing technical solutions and experience in these areas, we propose using the small water droplet fall in the vertical cross-section of LAC for the purposes of cleaning the atmosphere of the city.

Based on the concept of ancient aqueducts, we propose assembly of a water channel above the LAC that will be a light structure with dimensions of 0.5 m x 1 m x 10 km at the height of 20-30 m (Fig.3).

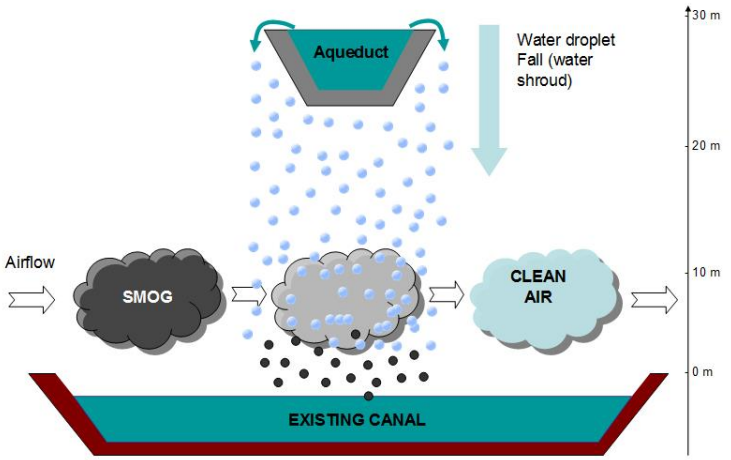

Fig. 3. Scheme of atmosphere filtration by means of small water droplet fall (water shroud)

The required small water shroud will be created based on the natural overflow of the horizontal sections of the Canal and spillover of excess water of the «reverse fountain» in the form of small-dispersion water shroud falling into the main LAC. Water usage will not exceed 1 liter per 1 running meter per minute (~ 10 $м^3$/min).

As a result, the goal of creating a natural «rain» will be solved in an economically feasible and technologically simple manner in one of the cross-sections of the city, namely, along LAC or Esentai river. Taking into account the above, the polluted atmosphere will be naturally «pumped» through the filter, which will be equivalent to a city-wide regular rain that takes place twice a day. During the next phases, a system of medium aqueducts (in the main canyons) and small aqueducts (along the rivers valleys) will complete the formation of the «Almasagyn» system.

Besides of ecological functions a reverse fountains can bare social and recreational features (like promenades, fountains terraces) and commercial functions also (trade lanes).

4. Conclusion

Active cleaning of the city atmosphere based on natural mechanisms of pumping and filtering of the polluted air is achieved via an economically feasible and technologically simple and elegant method. Such method does not require spending additional energy or creating a large infrastructure.

Servicing the system is simple and doesn't require significant operating expenses. Kazakhstan will get clean, fresh, ionized air in the largest city of the country.

The original architectural design and the idea itself can be compared to other ecological concepts that exist in the world, such as the Fountain Bridge gallery of man-made fountains along the river in Seoul, the Skyline walkway in Manhattan and Sky Park – a pedestrian deck-park built on top of several skyscrapers in Singapore.

This innovative technology will not only drastically clean the atmosphere of the city but will also become a symbol of Almaty and Kazakhstan as a whole as we approach Expo 2017, which will take place in capital city of Kazakhstan.

This effective and low-cost method of air cleaning can be easy popularized for other world cities having the similar relief, mountain-valley air circulation or natural breeze.

References

Gelmgolz, N. (1963). Gorno-Dolinnaya Circulaciya Severnyh Sklonov Tyan'-Shanya. *Gidrometeoizdat.*

Mirkarimova, B. (2004). Geoinformation Modeling Of Air Pollution State Of City Of Almaty At Different Scenarios Of City Transport Development. *Journal of Comp. Technologies,* 9(2 special issue), 124-135.