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# INVESTIGATION OF THE DESIGN OF VERTICAL CIRCULATION ELEMENTS IN BUILDINGS WITHIN THE CONTEXT OF COVID-19 CONTAMINATION AND DETERMINATION OF NEW DESIGN PRINCIPLES

## Abstract

It is necessary to emphasize the preventive feature of the elevator design and manufacturing concept on the spread of infectious diseases. Because the size and volume of the elevator cabin must also have limits. It is obvious that the rate of people residing in high-rise buildings will use elevators. We have limited our work to certain buildings in order to find out to what extent people who have to use elevators during pandemic periods are under threat in terms of health.

For this reason, it is important that materials and equipment are placed in accordance with all safety rules in order to minimize the risk of contagion in the elevator cabin and to provide a healthy and safe environment. Here, the "AODS" project, which can minimize the risk of people catching the virus in elevator cabins during a pandemic, is a new design that can be applied to elevators in hospitals or residences. In the drawings prepared, the main elements that should be placed in certain areas in the elevator car are shown.

***Key words:*** *levators cabin, weather analysis, Covid-19, building, installation, project*

**Nəzrin Namiq qızı Tağıyeva**

# COVİD-19 çirkləməsi şərtində binalarda qurğu elmentlərinin layihəsinin tədqiqi və yeni layihə prinsiplərinin məyyənləşdirilməsi

## Xülasə

Yoluxucu xəstəliklərin yayılmasında liftin dizaynı və istehsal konsepsiyasının profilaktik xüsusiyyətini vurğulamaq lazımdır. Çünki lift kabinəsinin ölçüsü və həcminin də həddi olmalıdır. Aydındır ki, çoxmərtəbəli binalarda yaşayanların nisbəti liftlərdən istifadə edəcək. Pandemiya dövründə liftdən istifadə etməli olan insanların sağlamlıq baxımından nə dərəcədə təhlükə altında olduğunu öyrənmək üçün işimizi müəyyən binalarla məhdudlaşdırdıq.

Bu səbəbdən lift kabinəsində yoluxma riskini minimuma endirmək, sağlam və təhlükəsiz mühiti təmin etmək üçün material və avadanlıqların bütün təhlükəsizlik qaydalarına uyğun yerləşdirilməsi vacibdir. Burada pandemiya zamanı insanların lift kabinələrində virusa yoluxma riskini minimuma endirə bilən "AODS" layihəsi xəstəxana və ya yaşayış yerlərində liftlərə tətbiq oluna bilən yeni dizayndır. Hazırlanmış çertyojlarda lift vaqonunda müəyyən sahələrdə yerləşdirilməli olan əsas elementlər göstərilir.

***Açar sözlər:*** *lift kabinəsi, hava analizi, COVİD-19 bina, qurğu, layihə*

## Introduction

As time passes, technology develops and we know that more than 50% of the world's population, which is increasing with it, has started to live in cities (since 1980). Since the housing needs of the population concentrated in cities cannot be met in flats spread out horizontally, it is possible to meet in high-rise buildings and will continue in this way. In order to maintain the normal rhythm of life in high-rise buildings, it is inevitable that the vertical circulation problem of high-rise buildings will only be solved by the elevator system. Due to the structure of the elevators, it will require more people to be together in a narrow volume, even for a short time. The main problem with elevators in the age of coronaviruses is that they are almost all small enclosed spaces. These are ideal conditions for the spread of coronavirus, as it is transmitted through droplets produced when an infected person coughs, sneezes

or speaks. In addition, the ventilation in the elevators is insufficient. The lack of strong airflow means that COVID-19 carriers can leave some viral particles behind in the cabin (Arat,Ercan, və b. 2021:56). It is most likely to become infected after touching a surface or object with bacteria on it and then touching the mouth, nose or eyes. The lifetime of the virus on different surfaces depends on ambient temperature, humidity, surface type and other factors.

How can an elderly person go to higher floors in a 9-storey or higher-floor building with elevators used by the society, including public buildings? This should not be expected to have an impact. The necessity of a disinfection system without permanent contact for elevators is considered.

Bacteria are a large group of microorganisms. Bacteria are primitive on the one hand and advanced organisms on the other. Bacteria live in all environments of life, both in air, in water and in soil, degraded products, outside and inside living things (9).

Air is an environment that contains a large number of bacteria. Unlike soil and water where bacteria live, they settle only with the help of air.

Bacteriological analyzes of the air revealed the presence of bacteria in the atmospheric air and in the air of enclosed spaces, namely elevator cabins.

Especially when there is a crowd of people, indoor air has more bacteria. In indoor air, the number of microorganisms is higher in winter than in summer.

Bacteria can worsen the sanitary conditions of people's lives and harm health. The problem, therefore, is that the presence of a large number of bacteria in the air environment in elevators increases the risk of airborne diseases in humans.

**Indoor microflora**

Indoor air microflora is more homogeneous and relatively stable compared to outdoor air. Among the microorganisms, the inhabitants of the human nasopharynx predominate, including pathogenic species that enter the air when coughing, sneezing or talking.

**Air analysis method**

The sanitary condition of the air is assessed by the total microbial number (the number of all microorganisms present in 1 m3 of air) and the presence of sanitary indicator microorganisms (hemolytic streptococci and Staphylococcus aureus). Cultivation by the Koch method (sedimentation method), one of the main methods of determining the bacterial state of air, is based on the ability of microorganisms to settle on the surface of the nutrient medium together with dust particles and water droplets due to gravity and under the influence of air movement.

Sedimentation method for studying air (Koch's method). It is often used to determine the composition of the microflora in indoor areas. Petri dishes with media are placed in various places and opened for a certain period of time; It is then incubated and identifies the microorganism species. Most often, TMC is determined in air (plates with MPA are used; exposure time is 10-30 minutes), staphylococcal content [plates with yolk-salt agar (JSA) are used); exposure time 15 minutes), the streptococcal content is determined according to the symptoms of the epidemic (containers with CA are used; exposure time is 10-15 minutes) (Demirbaş, 2020:58).

$$X = \frac{n \times 10^4}{75\ cm\ 2 \times t}$$

In addition: 1. The microflora of the indoor air is homogeneous and stable. Self-cleaning of indoor air does not occur. 2. Bacteria are a group of unicellular microorganisms that are grouped according to the shape of the cells.

The main forms of bacterial cells are cocci. Among the bacteria are pathogenic species. 3. There are two methods of determining bacterial air pollution: sedimentation and aspiration method. In this study, results were obtained by using the sedimentation method.

Sedimentation method calculation:

X – is the total microbial number of the indoor air studied (SME – colony forming unit)

n - the number of colonies in a Petri dish (COB)

t – Petri dish exposure time (min)

Pr2 – Petri dish area (cm2) = 75 cm2

104 – 1 m2 area (in cm2) (Demirbaş, 2020:109).

For inoculation, the Petri dish is opened indoors for 5 - 30 minutes. The Petri dishes are then sealed, signed and placed in a thermostat for 48 hours for sowing.

First of all, the places to be researched were determined. Samples were taken from vertical circulation elements such as elevator cabin and entrance floor stairs.

The sedimentation method was used on the recommendation of laboratory doctors to determine the total bacterial contamination of the air.

Petri dishes were used for sampling. One day, in the morning, when people do not go out and on the contrary, at the time of going to school, air sampling was carried out before any cleaning process is carried out inside the building (Sarven, 2010:107).

Air sampling from elevator car and stairs:

EPA – Must be held at hand breathing altitude for 15 minutes (various bacteria)

MS – Should be held at hand breathing height for 30 minutes (agar, staphylococcus)

SABURO – Should be held at hand breathing height for 30 minutes (mildew)

cocci are pathogenic dormant bacteria. Staphylococci - Their cells are spread in a similar way to a bunch of grapes. Staphylococci are a genus of anaerobic spherical bacteria that cause pneumonia, endocarditis, a number of skin infections, osteomyelitis, meningitis, septic arthritis, toxic shock syndrome and other diseases. Bacteria constantly live on the skin of a healthy person, in the nasopharynx and oropharynx.

***Petri Kabı No:1***

The Petri dish containing the food medium was kept open in the hands for 15 minutes in the elevator cabin in the building, where the cleaning work was done meticulously during the day from the elevator and stairs in the newly built building. With the Petri dish open, microorganisms in the air of the ladder settled on it

| Petri dishes | Opened | Closed |
|---|---|---|
| 1 EPA | 05:00 | 05:15 |
| 2 MS | 05:00 | 05:30 |
| 3 SABURO (Sab) | 05:00 | 05:30 |
| Stairs: (new building) | Location: Azerbaijan, Baku, Zabrat, new building. | |

***Petri Dishes No:2***

The Petri dish containing the food medium was kept open in the hands for 30 minutes in the elevator cabin in the building, where the cleaning work was done meticulously during the day from the elevator and stairs in the newly built building. With the Petri dish open, microorganisms in the air of the room settled on it.

| Petri dishes | Opened | Closed |
|---|---|---|
| 1 EPA | 07:10 | 07:25 |
| 2 MS | 07:10 | 07:40 |
| 3 SABURO | 07:10 | 07:40 |
| Stairs: (new building) | Location: Azerbaijan, Baku, Zabrat, new building | |

***Petri dishes No:3***

In the basement of the old building, where the humidity level is high and the old elevators and stairs in the building were not cleaned during the day, the Petri dish containing the nutrient medium was kept open in the hands for 15, 30, 30 minutes in the elevator cabin of the building. With the Petri dish open, microorganisms in the air of the stairs settled on it (Onat, & Kabul, 2007:76). This building is one of the old buildings and just before reaching the entrance of the building, it was felt that there was an intolerable bad smell on the ground floor because of the high humidity level in the basement. Air samples were taken from this building at the time of going to school.

| Petri dishes | Opened | Closed |
|---|---|---|
| 1 EPA | 11:51 | 12:06 |
| 2 MS | 11:51 | 12:21 |
| 3 SABURO | 11:51 | 12:21 |
| | | |
| Stairs: (new building) | Location: Azerbaijan, Baku, Ahmedli, Babek prospect 93, 9-storey old house. | |

In the basement of the old building, where the humidity level is high and the old elevators and stairs in the building were not cleaned during the day, the Petri dish containing the nutrient medium was kept open in the hands for 15, 30, 30 minutes in the elevator cabin of the building. When the Petri dish was open, microorganisms in the air in the elevator cabin settled on it (Küçükçalık, 2014: 83). This building is one of the old buildings and just before reaching the entrance of the building, it was felt that there was an intolerable bad smell in the ground floor and elevators, so the inside of the elevator cabin was full of mosquitoes, because the humidity level was high in the basement. Air samples were taken from this building at the time of going to school (Atasoy, 2009:87).

| Petri dishes | Opened | Closed |
|---|---|---|
| 1 EPA | 11:53 | 12:08 |
| 2 MS | 11:53 | 12:23 |
| 3 SABURO | 11:53 | 12:23 |
| Stairs: (new building) | Location: Azerbaijan, Baku, Ahmedli, Babek prospect 93, 9-storey old house. | |

***Petri No:5***

The old elevator and stairs in the old 20-year-old building are not cleaned during the day, but only on their own floors are cleaned on demand by the residents. When the Petri dish was open, microorganisms in the air inside the elevator cabin settled on it. Air samples were taken from this building at the time of going to school and work.

| Petri dishes | Opened | Closed |
|---|---|---|
| 1 EPA | 11:14 | 11:29 |
| 2 MS | 11:14 | 11:45 |
| 3 SABURO | 11:14 | 11:45 |
| Stairs: (new building) | Location: Azerbaijan, Baku, Inqilab, Hasan Aliyev 33, 9-storey old building. | |

Elevator interior elements:

I. The lighting system works in two different regimes. After motion sensors detect that there is no passenger in the cabin, it works with the UV light system. The UV light system exposes the air to radiation and neutralizes all airborne microbes, including the Covid-19 virus.

II. As soon as the motion sensors detect that there are people in the cabin, no exposure to radiation, the disinfection system is blocked instantly and the elevator continues to operate normally. As soon as the elevator operates normally, the lighting normally illuminates the cabin interior without the UV light system.

A. When the UV radiation disinfection system, which is one of the two air purification regimes in the cabin, is deactivated, the filtering system is only sterilized by the air cleaning filter and the air in the cabin is partially sterilized. These air cleaning filters can work comfortably when there are passengers in the cabin because they do not pose a danger to human health like the ultraviolet system (Araz,Güngör, və b. 2014: 56).

B. The task of the motion sensor, located on the edge of the lighting system inside the area where the cabin doors meet, is to detect whether there is a passenger in the cabin when the air purification regime with ultraviolet is started. If there are passengers in the cabin, the disinfection process is immediately canceled and the elevator continues to operate normally thanks to filtering. If there are no passengers in the cabin, then the ultraviolet air cleaning system is activated.

C. It is the indicator inside the elevator cabin. Thanks to the display, it is possible to see the floor on which the person is during the cabin journey. Thanks to the indicator, you can see where the elevator is and which floor it is moving to, thanks to this system. Unlike the ones inside the normal elevator cabin, the indicator shows not only the floor number but also how clean the air inside the cabin is, with interest. In this way, the passenger gets fresh air in the cabin and feels safe and comfortable (Gungor, 2020:98).

E. The second is the motion sensor, which determines the number of kilos on the floor of the elevator car. If it detects that there is additional weight outside the weight standard specified in the system, it sends a signal to the other sensor that there is a passenger in the cabin. It is a motion sensor that can detect auxiliary weight as a backup if there is a possibility that there may be a problem with the sensor located on the lighting edge.

## Conclusıon

The study experimentally proved that:

1. The air in the elevator cabins and stairs in their buildings does not meet the recommended standards for hygienic air assessment; The air is cleaner before the morning hours go to school.

According to the results of the air pollution analysis, the air in the elevator cabin contains different types of bacteria. Determination of total bacterial air pollution; Based on the results of the study, it is impossible to unequivocally assess the presence of pathogenic bacteria in the air of the elevator cabin. However, due to the lack of air and the high humidity on the ground floor in the buildings, the presence of various types of bacteria and mold that can be harmful to human health is high in the air inside an elevator cabin (9).

As a result of the air samples taken, Staphylococcus was detected from the air sample taken into the No: 2 MS and No: 5 MS Petri dishes. The interesting thing about the results obtained is that Staphylococcus (completely present, but not exceeding the norm for human health) was detected in the new building, but the molds were very few. In the old buildings, on the contrary, it was determined that there was a large number of mold, not Staphylococcus. The result we have come up with from all this is that even if the building is new, no matter how meticulously cleaned, bacteria that are harmful to human health maintain their position and this is not good at all. Therefore, the necessity of applying the new "AODS" system that I have made in the elevator design is taken into consideration.

1)-UV light system, 2)-Circulation of the air cleaned with the ultraviolet method, 3)-Normal air filtration system, 4)-periodical cleaning of the cabin with chemical disinfectant, 5)-Activating the operation of the filters by means of the motion sensor (ultraviolet disinfection systems It has been concluded that the new design system working with these different methods should be applied in future elevator designs.

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