INDOOR AIR QUALITY MEASUREMENT IN SERVER AND BATTERY ROOMS IN ICT COMPANIES IN MACEDONIA

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ABSTRACT

In this paper we will analyze the results from the Indoor Air Quality measurements in the server and battery rooms in ICT companies. The measurements were done on request of the ICT companies after installation of air-quality filters, after having problems with failure of hard disks. The monitoring equipment is the compact multi gas air quality system (airpointer® by recordum). It is able to measure PM10, CO, O3, SO2, NO/NO2/NOX, RH and temperature with its standard reference method sensors over a wide range of concentration. The measurements were performed every day, 24 hours a day in Data-center and Battery rooms. These gases alone or in combination with humidity and/or with temperature reacts with copper and silver in electronic circuit boards, server cards, cooling equipment, datacom connections resulting in micro - electronic corrosion/malfunction resulting in downtime losses. Downtime which translates into data loss, revenue loss and ultimately customer dissatisfaction.

Keywords: indoor air quality, airpointer, monitoring system

I. INTRODUCTION

The "Indoor Air Quality" (IAQ) is today's most worrying problem being faced by the city planners, environmentalists, health professionals and ICT industry. The "Outdoor Air Pollution" is one of the contributors to the "Indoor Air Pollution" but not the only one.

Indoor Air Quality refers to the nature of conditioned air that circulates throughout the closed space/area. The air we breathe during most of our lives, and/or is circulated through the electronic equipment intended for cooling purposes. IAQ, refers not only to comfort, which is affected by temperature, humidity and odors, but, also to harmful biological contaminants and chemicals present in the conditioned space. [1].

The world focus has shifted from the 'environment' to the 'invironment'. In the 1970s, the concerns were "Energy Conservation", in the 1980s was "Global warming and Ozone Depletion", in the 1990s and in this millennium the focus will remain mainly on *"Indoor Air Quality*".

Over the last 15 years, our knowledge of environmental and invironmental risk due to poor air quality has increased drastically. Poor Indoor air quality leads to an increased incidence of health related symptoms and malfunction (due to corrosion or short-circuit) for the electronic devices.

Indoor air quality has increasingly been attracting attention worldwide. In most dwellings in developed countries, the level of indoor air pollution is very low because there are controls on the design, ventilation and construction of buildings and rooms. If ventilation of rooms (where people live and/or the electronic devices are operating/stored) is poor, or the ventilation system is faulty, pollution can build up to levels which may be detrimental to human health or working electronic equipment. The indoor air will certainly have all of the pollutants of the outdoor or surrounding air and those, that are generated within the building by people and their activities like smoking, hair sprays, cleaning products, paints and pesticides spray residues, carpeting, or the devices and their operation like copy machines, air-conditioning coolants, universal power supplies, computer server machines. As a result, indoor air may contain concentration of some components which are greater than the outdoors ambient air. [2]

Indoor air pollution may have many sources in a dwelling, and indoor air quality can vary widely. A significant source of "indoor air pollution" is the "outdoor air pollution" derived from the burning of fuels. During this process, incomplete combustion with the release of carbon monoxide (CO) may result. [1]

Particulates are seen by many as one of the most critical air pollutants. The extent to which particulates are considered harmful depends largely on their composition. [2]

Very fine particulates can penetrate deep into the electronic parts and can lead to malfunction of the electronic equipment (overheating due to reducing of the cooling characteristic).

The three basic methods that EPA (United State Environmental Protection Agency) suggests for maintaining and improving indoor air quality are:

- controlling the source,
- improving ventilation,
- using an air purifier.

The first step you take should always be an attempt to control the source. If the pollutant stems from something like mold or chemical off-gassing, it may be possible to remove it from the room. This is the best and most permanent method for improving indoor air quality. This method is not applicable when the devices are the sources of the pollution that harms them (as is the case with some electronic equipment example the UPS batteries and server machines). In this case the dust (PM10) as an indoor air pollutant is too pervasive, so preventing it from entering inside is impossible in some cases.

Improving ventilation can help improve the indoor air quality if the offending pollutant is a chemical or gas. In this case, bringing fresh air into the rooms can be very helpful. Ventilation required by the EPA for battery rooms will be adequate to keep the hydrogen content in air below its explosive limit 4% by volume. [7]

However, some problems with indoor air pollution come from outside, because the outdoor air can be polluted due to many reasons.

The third step is to use an air purifier. There are many types of air purifiers that are well-suited to our particular situation. Quality air purifiers can work wonders on IAQ. But also many air cleaners can cause some of the very problems they are meant to prevent.

II. Our Case Study

But nowadays IAQ is not only dangerous for the people's health but also for the ICT industry because of the big impact on the malfunctioning of the electronic parts that run the world of telecommunications and Internet. There are many physical threats that are threatening to the proper operation and the performance of these ICT systems. The most important from the section of the air-quality are:

A. Humidity Level

Maintaining proper humidity levels in the computer room is essential for reliable equipment performance. Humidity levels outside the recommended range of 25 to 45 percent, especially if these levels are sustained, lead to equipment damage and result in equipment malfunction through several mechanisms. High humidity levels enable galvanic activity to occur between dissimilar metals.

Galvanic activity can cause high resistance to develop between connections and lead to equipment malfunctions and failures. Extended periods of humidity levels greater than 60% have also been shown to adversely affect modern printed circuit board reliability. High humidity can also adversely affect some magnetic tapes and paper media.

High humidity levels are often the result of malfunctioning facility air conditioning systems. High humidity can also be the result of facility expansion in excess of air conditioning system capacity. Humidity levels below the minimum recommended value can also have undesirable effects. Low humidity contributes to high ESD voltage potentials.

ESD events can cause component damage during service operations and equipment malfunction or damage during normal operation. Low humidity levels can reduce the effectiveness of static dissipating materials and have also been shown to cause high speed printer paper feed problems. Low humidity levels are often the result of the facility heating system and occur during the cold season.

Most heating systems cause air to have a low humidity level, unless the system has a built-in humidifier. ASHRAE and representatives of ICT equipment manufacturers recommend a range of 18°C dry bulb with a5.5°C dew point temperature to 27°C dry bulb with a 5.5°C dew point temperature. Over this range of dry bulb temperature with a 5.5°C dew point, the relative humidity varies from approximately 25% to 45%. For more information on humidity levels, see the ASHRAE website. [3]

B. Dust (PM10) and pollution

Dust and microscopic particles in the site environment adversely affect computer equipment. Airborne abrasive particles can cause bearing failures in disk drives, tape drives, and other mechanical devices. Dust may also blanket electronic components and printed circuit boards, causing premature failure because of excess heat, humidity buildup, or both. Conductive metallic particles can cause power supply and other electronic component failures. A build-up of these metallic particles over time can cause short circuits on the densely packed circuit boards common in modern electronics. Use every effort to ensure that the environment is as dust and particulate-free as possible[3].

C. NO

Nitric oxide is a major air pollutant. Nitric oxide is rapidly oxidized in air to nitrogen dioxide. Nitric oxide concentration can be determined using a simple chemiluminescent reaction which involves ozone. One sample of nitric oxide has a large quantity of ozone. Some methods of testing include electro analysis, where nitric oxide reacts with an electrode to induce a current or voltage change. Nitric oxide should be stored separate from combustible materials. Oxidizer storage should be separated from flammable substances by a minimum distance of 20 ft. Also should be away from non-combustible materials at least 5 ft. high, having a fire-resistance rating of at least a half hour

D. NO2

Nitrogen dioxide is a gas with red-brown colour witch is produced when fuel burns. It is occurs in vehicle exhaust and the fumes from burning fuel oil, kerosene, propane, natural gas or wood. This gas can be produced by appliances such as gas stoves, portable heaters, fireplaces etc. When NO2 react with water, it forms nitric acid, which is a chemical that contributes to acid rain. Nitrogen dioxide is also a major cause for the existence of smog. Nitrogen dioxide is a large scale pollutant, with huge concentrations in some areas around 30 µg/m3. The term for this process is "atmospheric fixation of nitrogen".

E. O3

Ozone is a high toxic and corrosive substance and a common pollutant. Ozone is formed in the atmosphere by reaction of nitrogen oxides, hydrocarbons, and sunlight. Ozone can occur by some kinds of electrical equipment, e.g. television sets, photocopiers and electric motors. Many of the chemicals commonly found in indoor environments. Ozone does not react with all chemicals. Ozone may also increase indoor concentrations of formic acid, both of which can irritate the lungs if produced in sufficient amounts.

F. SO2

Sulphur dioxide is a toxic gas. Sulphur dioxide is a colourless and pungent smelling gas. Sulphur dioxide is a reason for causing acid rain and with that the corrosion of buildings and monuments accelerate. Ferrous metals such as steel exposed to sulphur dioxide combustion fumes are rapidly oxidized and sulphated. Sulphur dioxide has explosive properties when it comes in contact with sodium hydride. It reacts with water or steam to produce toxic and corrosive fumes.

G. CO

Carbon monoxide is a very dangerous gas. Carbon monoxide is also known as “silent killer” gas. Power supply must operate with all carbon monoxide appliances for at least 12 hours. Detectors must be on the ceiling in the room as permanently installed fuel burning appliances. Detectors must be located on every habitable level and in every zone of the building.

III. MONITORING SYSTEM

For the purposes of this paper we will rely on the data collected during the measurement conducted in one ICT Company in our country. The measurement were done using the world’s first “out of the box plug and play” compact multi gas air quality monitoring system (airpointer® by recordum).[4]

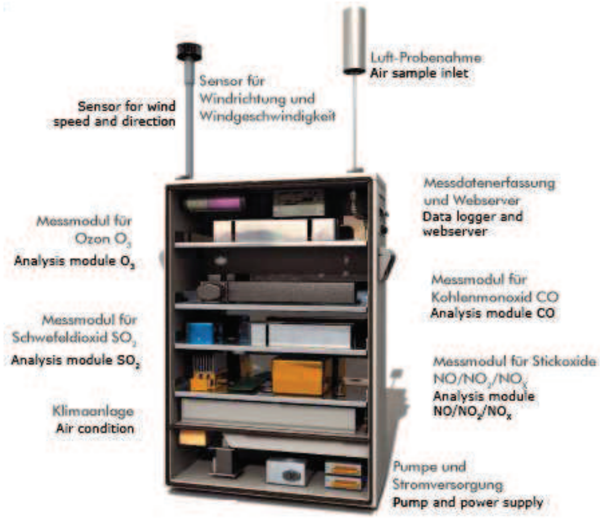

Figure 1: airpointer.

The airpointer® is the ideal tool for fence line-type monitoring of combustion gas und volatile emissions. It is able to measure CO, O_3, SO_2 and $NO/NO_2/NO_X$ with its standard reference method sensors over a wide range of concentration. Due to its open platform design other sensors can easily be added. To be able to react quickly and prudently in case of accidents, the airpointer® continuously provides real time information.[4]

IV. AIR QUALITY STANDARDS

The European Union has developed an extensive body of legislation which establishes health based standards and objectives for a number of pollutants in air. These standards and objectives are summarized in the table below. These apply over differing periods of time because the observed health impacts associated with the various pollutants occur over different exposure times.

Pollutant	Concentration
Fine articles (PM2.5)	25 µg/m3***
Sulphur dioxide (SO2)	350 µg/m3
	125 µg/m3
Nitrogen dioxide (NO2)	200 µg/m3
	40 µg/m3
PM10	50 µg/m3
Carbon monoxide (CO)	10 mg/m3
Ozone	120 µg/m3

Figure 2: Table of pollutants. [6]

V. OUR RESULTS

In a period of 27.10.2011 to 14.11.2011 it was performed a measurement in one ICT company in Republic of Macedonia. The measurement were performed every day, 24 hours a day in Data center,Battery room, UPS and in the others remained rooms.

In a Data center room, it was measured SO_2 [ppb] parameter in a period of 28 October to 31 October and it was received the following graph

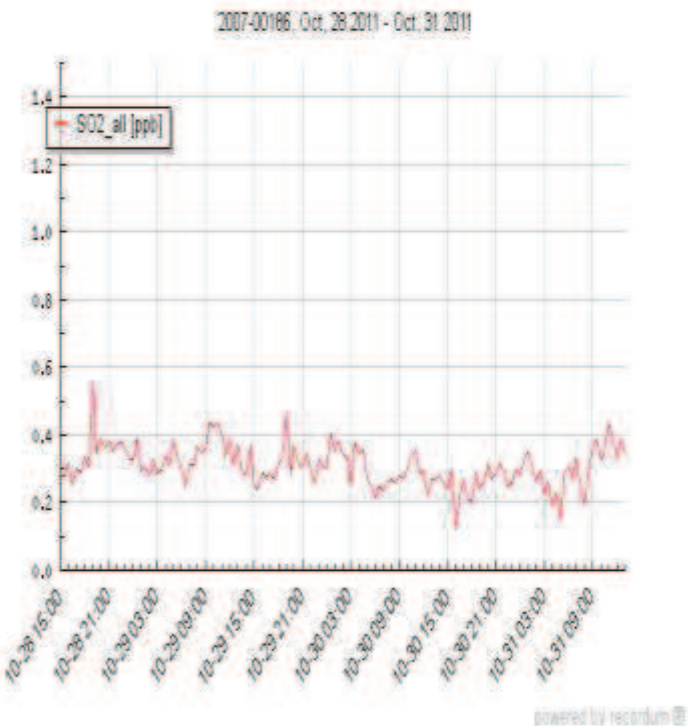

Figure 3: Data center room SO2 [ppb] graph.

The values were measured every half hour in the same room. The average ppb in a Data center room is 0,33.

In a Battery room, it was measured SO_2 [ppb] parameter in a period of 31 October to 3 November and it was received the following graph

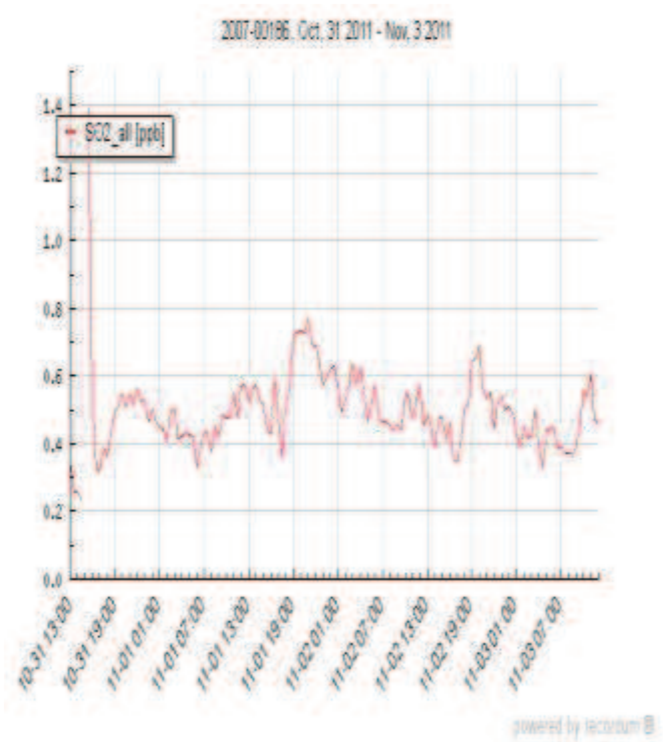

Figure 4: Battery room SO_2 [ppb] graph.

The values were measured every half hour in the same room. From this graph we can see that the major peaks on indicate interruption. The average ppb in a Battery room is 0,501.

In a UPS room, it was measured SO_2 [ppb] parameter in a period of 3 November to 10 November and it was received the graph shown in Figure 5.

The values were measured every half hour in the same room. The average ppb in a Battery room is 0.612.

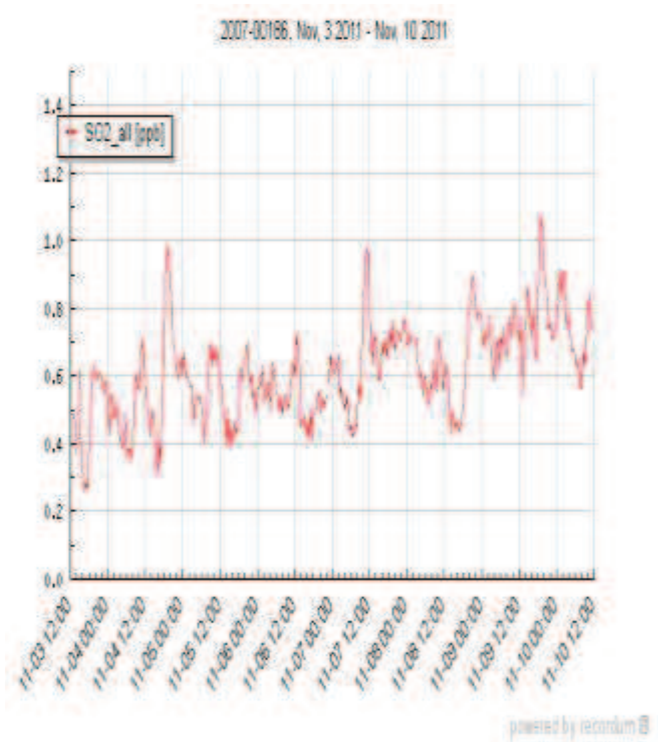

Figure 5: UPS room SO_2 [ppb] graph.

In the other rooms it was measured CO[ppm], NO[ppb], NO2[ppb], O3[ppb] and SO2[ppb] parameter in a period of 28 October to 10 November and it was received the following graph:

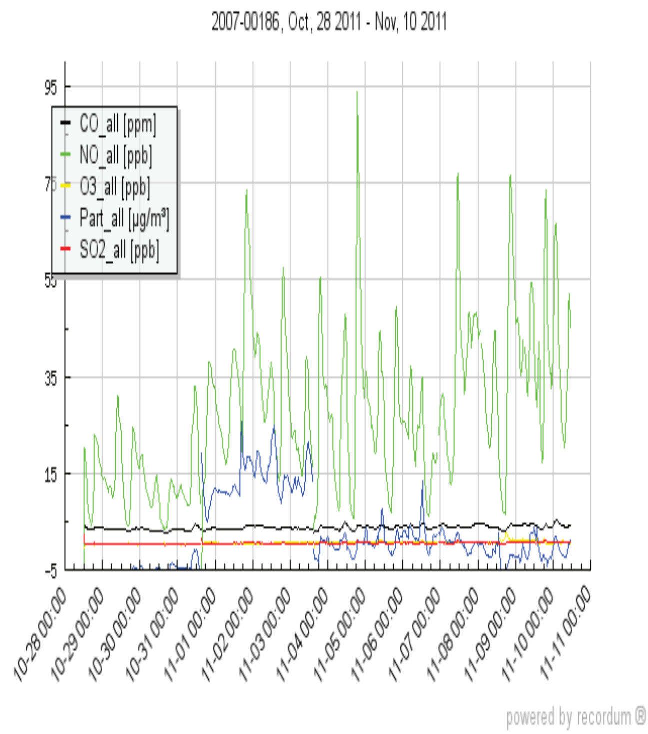

Figure 6: CO[ppm], NO[ppb], NO2[ppb], O3[ppb] and SO2[ppb] graph.

The values were measured every half hour in the same room. From this graph we can see that the value of NO parameter in rather high.

In the both, the server and the battery room we have also measured the humidity and the dew point. The results from these measurements are provided below:

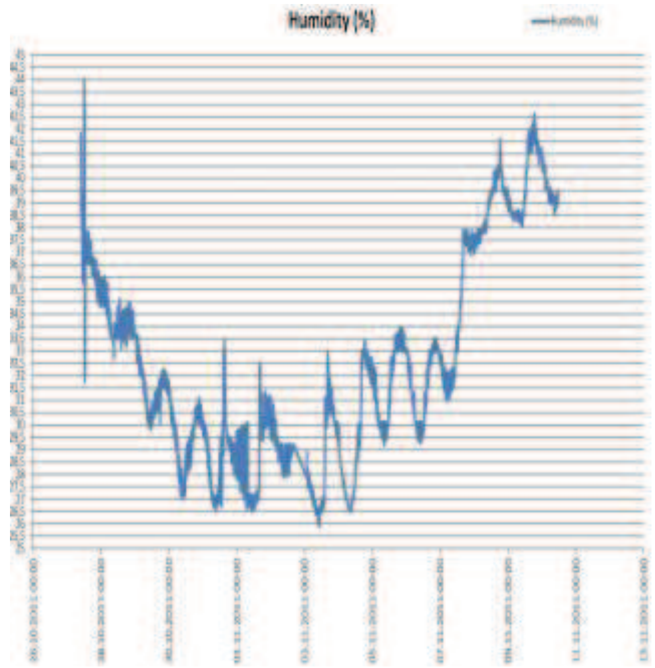

Figure 7: Relative Humidity (%) graph.

The average value of the Humidity values (in %) is 32.44. The max value is 44 and the min value is 25.9.

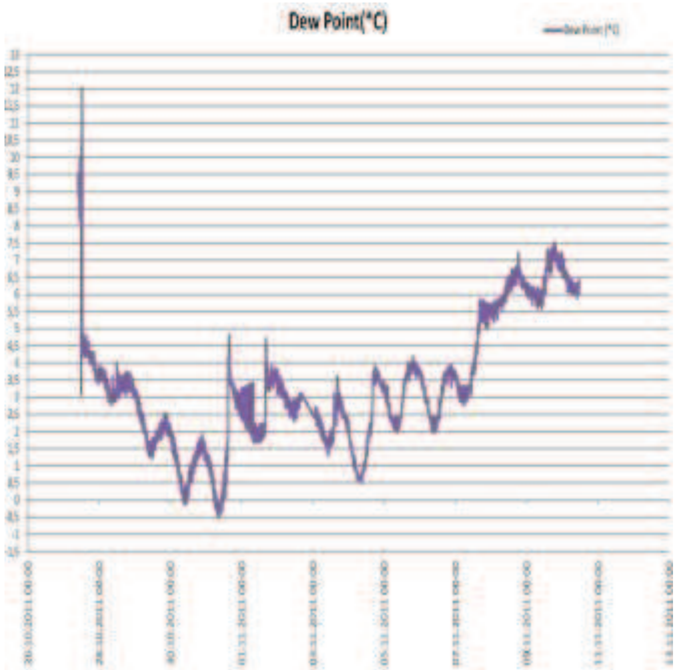

Figure 8: Dew Point (*C) graph.

The average of the values of Dew point in (*C) is 3.34. The max value is 12 (*C) and the min value is -0.5 (*C).

VI. CONCLUSION

Analyzing the results from the Indoor Air Quality monitoring system in the server and battery rooms in IT companies, we conclude that these gases react with electronic circuit boards, server cards etc. The measurements were done using the compact multi gas air quality monitoring system. It is able to measure PM10, CO, O3, SO2 and NO/NO2/NOX with its standard reference method sensors over a wide range of concentration. The measurements were performed every day, 24 hours a day in Datacenter and Battery rooms. According to our results we conclude during this short term measurements that the values are within the limits allowed for proper functioning of the running systems. This is mainly because of the proper functioning of the ventilation system and the filter installed, but we propose a long term monitoring just to assure that the measurements reflects the real situation.

These gases alone or in combination with humidity and/or with temperature reacts with copper and silver in electronic circuit boards, server cards, cooling equipment, datacom connections resulting in micro - electronic corrosion/malfunction resulting in downtime losses. Protecting the datacom equipment and servers from any potential contaminants threat is a vital step in ensuring IT datacom equipment and servers' good health and continued viability. The ultimate solution to corrosion lies in gaseous filtration, which involves passing the contaminant laden air stream through a bed of dry media placed in a properly designed housing. The composite effect of multiple pollutants can have short-term-minor impact, but long-term-major on the IT-industry via malfunctioning not working at all of some of the electronic parts and devices.

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