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Recent Researches in Earth and Environmental Sciences

2nd International Conference on Advanced Science and Engineering 2019 (ICOASE2019) Zakho-Duhok, Kurdistan Region—Iraq, April 2–4, 2019

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Preface

This book includes the papers presented during the 2nd International Conference on Advanced Science and Engineering 2019 (ICOASE2019) which was held in Duhok, Kurdistan Region, Iraq, in April 2019. This conference was jointly organized by two universities: University of Zakho and Duhok Polytechnic University. The theme of the book mainly focuses on the Natural and Environmental Sciences, and Earth Science and Geoscience as they are part of the ICOASE2019 tracks. It aimed to give a more concrete expression to the science and engineering applications with a new multilateral scientific forum that emphasizes the vulnerability and proactive remediation from an earth and environmental point of view.

The presented topics in both tracks of the ICOASE2019 were organized as:

- **Natural and Environmental Sciences**
  - Plant and Animal Ecology
  - Ecology and Pollution
  - Biodiversity
  - Soil Science and Geochemistry
  - Environmental Health and Waste Management
  - Environmental Biotechnology
  - Molecular Biology
  - Microbiology
  - Histology and Embryology
  - Biochemistry
  - Animal Physiology
  - Genetics
  - Entomology; Mycology and Parasitology
  - Pathogenic Bacteria and Immunology
  - Organic and Inorganic Chemistry
  - Analytical Chemistry

- Physical Chemistry
- Industrial Chemistry
- Quantum Chemistry

- **Earth Science and Geoscience**

- Geology; Hydrology; and Geomorphology
- Atmospheric Science
- Human Geography
- Photogrammetry
- GIS and Remote Sensing Application
- Forestry
- Geodesy
- Land Administration
- Airborne and Terrestrial Laser Scanning
- Hydrography
- Cadastral Surveys
- Spatial Data Infrastructure
- Cartography
- GNSS Application

More materials and information of the conference are available in https://icoase2019.uoz.edu.krd.

All submitted papers went through a rigorous (double-blind) peer review process commensurate with their tracks. In all, 39 research papers were submitted; each was reviewed by at least three reviewers, and only 12 were accepted (with 30.76% as acceptance rate). The process included full paper submission through a conference management system, the so-called EDAS. This system includes built-in software for similarity checking (iThenticate). The accepted similarity ratio is 25%. Next, the papers were assigned to reviewers through EDAS as they sent their review, comments, and recommendations through the system as well. The final decision was made by track chairs and editors after receiving revisions. Hence, a set of high-quality contributions to the recent researches in earth and environmental sciences were accepted.

We would like to thank everyone who contributed to this effort including paper authors, session presenters, reviewers, track chairs, program committee members, volunteers, and sponsors. Without their support, the event would not have been successful.

Zakho, Iraq — Yaseen T. Mustafa
Babil, Iraq — Sattar Sadkhan
Duhok, Iraq — Subhi Zebari
Zakho, Iraq — Karwan Jacksi
April 2019

Contents

Application of Computational Fluid Dynamics in the Simulation of Carbon Monoxide Distribution, a Case Study: Sayad Underground Tunnel in Tehran

Hazhir Karimi, Borhan Riazi and Mokhtar Mohhammadi

Abstract Vehicular emissions can easily contaminate the air quality of the traffic tunnel especially during traffic congestion or low vehicle speeds, which would pose serious health hazards to passengers and drivers. In this study, Carbon Monoxide (CO) concentration was simulated using a computational fluid dynamic inside the Sayad Tunnel in Tehran. Three-dimensional simulation using CFX is carried out to investigate the effect of tunnel geometry, vehicles' speed, the ventilation systems, and the fuel type on the CO concentration. For the making accurate simulation, the geometry of the tunnel was divided into grids and transmitted to the Ansys CFX. The result showed that the maximum concentration of CO for the top and bottom floors were 47.13 and 42.47 ppm respectively. Compared with the standards, these levels are not higher than the 8-h standard limit (109 ppm) for human health. In conclusion, using a three-dimensional CFD model for CO simulation is a suitable method to show and analyze the concentration in particular in the closed spaces.

Keywords CO · Numerical Simulation · CFD · Tehran

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1 Introduction

The simulation of the pollutant concentrations inside the closed spaces is an efficient way to explore the pollutant distributions through these spaces and assess the effects of vehicle speed, the locations of the fans, and the flow rate of the fresh air from fans. Simulating the concentration of the pollutants gives the better perspective to the place of the ventilation systems which could help the replacing contaminated indoor air with fresh air from outside, and it plays an essential role in the drivers' health and the efficiency of the operational expenses of construction costs [1].

Computational Fluid Dynamics (CFD) is one of the most proficient numerical methods that provide a qualitative and quantitative prediction of fluid flows using mathematical and numerical methods [2]. CFD gives an insight into flow patterns that are difficult, expensive or impossible to study using experimental techniques [3]. The advantages of the high resolution visualization, simulation for all desired quantities at a time, and application for actual flow domain have led to widespread use of CFD to study and predict various environmental phenomenon such as smokes, plumes, and [2, 4–7].

However, previous studies have focused on the smoke and heat distribution during the fire in which vehicles are stopped, and the effects of induced turbulence caused by vehicle motions has not been considered. Few studies have been caring out by recognizing vehicles movement at a slow speed, which may have a significant effect on pollutant distribution. For instance, Ashrafi et al. [3] used a computational fluid dynamics to the numerical simulation of airflow and carbon monoxide concentration inside the Resalat Tunnel in Tehran. Likewise, Dong et al. [8] investigated the CO_2 level in three traffic conditions (severe traffic congestion, traffic flow, and low vehicle speeds) in which fan conditions were considered to model the influence of mechanical winds on pollutant dispersion, and comparison with vehicular piston effect was also performed.

This study aims at the 3-D simulation of CO distribution in Sayad Tunnel of Tehran. The simulation of CO concentration was carried out using CFD based on the geometry of the tunnel, the consumed fuel, the type of the vehicle, and ventilation systems. The interaction between vehicular piston effect, ventilation and the volume of the input and output rates were also considered.

2 Methods

2.1 Tunnel Geometry

Sayad tunnel is the largest roadway tunnel in Iran with 10-km length. The geometry and overall layout of the tunnel is shown in Fig. 1. The tunnel is on two floors, one to go and the other to return the vehicles. Each floor has three lines of movement and a path for the emergency situations. The maximum depth of the tunnel is 32 m and

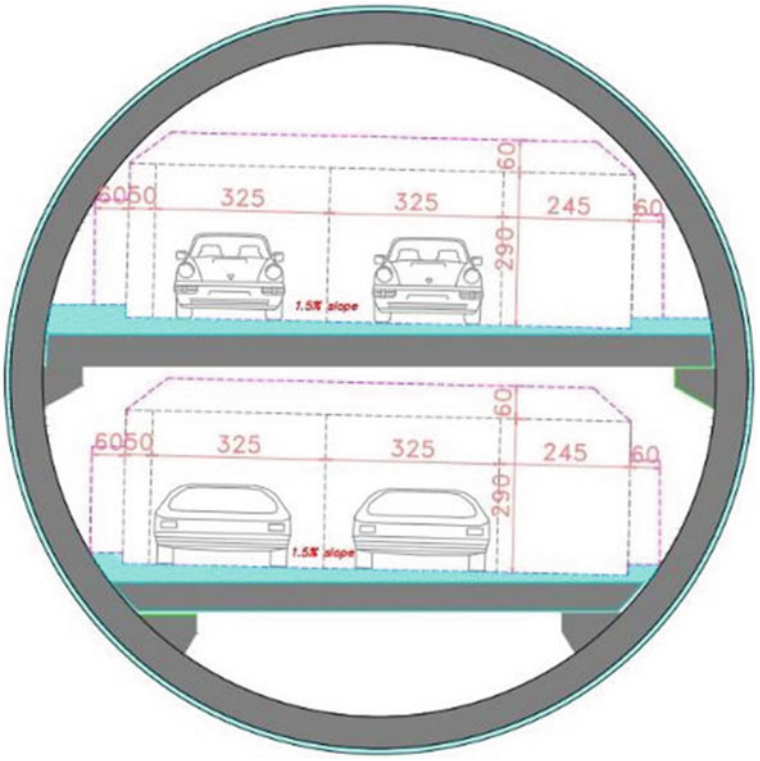

Fig. 1 The geometry of the tunnel

it has a 3.5 m height and a maximum slope of 5%. Each floor of the tunnel has 40 fans that are placed in 10 sections.

2.2 Vehicle Simulation

A vehicle with an average length and the medium volume of pollutants emission was considered for this study. Figure 2 shows the defined sample vehicle with a 4.8-m length. This vehicle is averaged in dimensions, velocity, and emissions. Two movement lines and one emergency line was considered with 10-m distances.

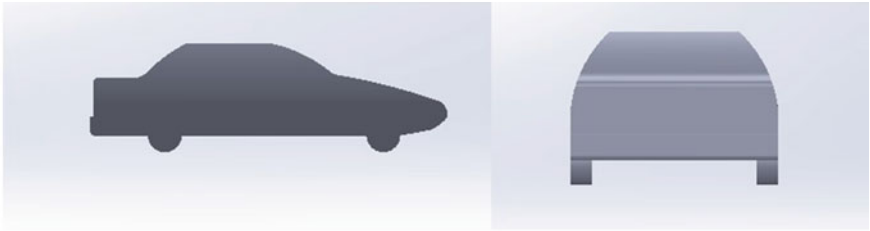

Fig. 2 Schematic presentation of a sample vehicle

Table 1 Characteristics of fans in different sections of the tunnel

Type	Location	Flow rate (m^3/s)	P (Pa)	Number
Blower	Upper floor	220.3	30.98	9
Suction	Lower floor	123.2	43.34	9

2.3 Ventilation System

The ventilation system of the tunnel consists of the blower and suction fans and jet fans. The volume of required air for the tunnel ventilation is estimated at 1983.04 m^3/s. Characteristics of jet fans are determined also based on the volume of the air and the pressure to transferring air between two jet-fan stations. The general system characteristic is shown in Table 1. According to the proposed model, nine fans with equal distance of 1000 m from each other are placed along the tunnel.

The momentum generated by the jet fan is also defined as Eq. 1:

$$V_m = V_d - V_o \;\&\; Thrust = Q \cdot V_m \cdot \rho \tag{1}$$

where Q is the passing volumetric flow rate through the jet fan, V_m is the pivot speed of the passing fluid that the jet fan can generate, ρ is the density of the fluid; V_o is the free flow speed around the jet fan and V_o is the velocity of the passing fluid through the fan. It is clear that if $V_d = V_o$, then the fan thrust it will be zero and practically the jet fan cannot create more speed.

2.4 Software Settings

For ease of grinding, the tunnel geometry is divided into several parts, and then network grids were imported into CFX. The input air from the entrance portal of the tunnel (in the presence of a piston effect in the movement of the cars) and the air supplied from the fans is the same as that of the urban environment air. To increase

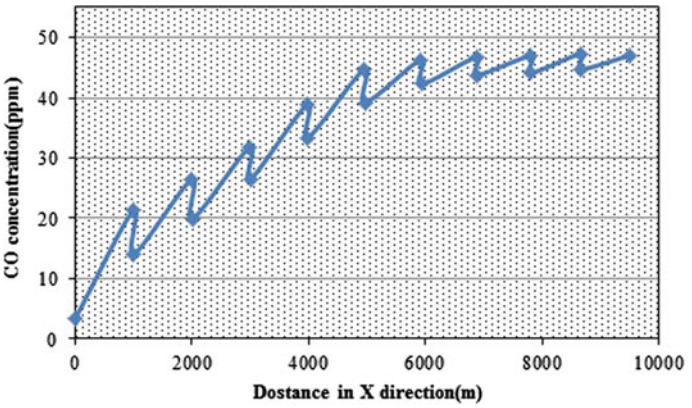

Fig. 3 Profiles of CO concentration in different sections inside the tunnel

the accuracy of simulating carbon monoxide concentration values over one year, a monthly average for air quality in these inputs is considered.

3 Results and Discussion

Simulation of CO pollutant was performed using CFD method and in CFX software. In the mode of cars motion, the tunnel is investigated according to its design conditions for two rows of cars at an average speed of 60 km/h. Figures 3 and 4 illustrate the average distribution of carbon monoxide inside the tunnel and the concentration contour of tunnel output respectively. In this case, the ventilation systems and piston effect were also considered. According to the graphs, the concentration of CO rose gradually during the tunnel and the CO_2 concentration reached about 47 ppm at the output, which was also under a hazardous level for the environment.

Figure 5 illustrates the standard level of CO in different exposure time. According to the figure the concentration of 50 ppm for 3 h is not at the hazardous level, and given that the speed of the vehicles is considered 60 km/h and the tunnel length of 10 km, the total duration of the time that the vehicles run through the tunnel will be 10 min. Thus there will be no concern for the health of people, and the ventilation system will respond to the dilution of the air. It is necessary to note that the best concentration condition of 35 ppm for 8 h of inhalation is considered and breathing carbon monoxide 9 ppm for a long time is mentioned permissible.

Use of the CFD model as a 3D model in the contaminants emission simulation showed that this model could be able to simulate the pollutant contamination inside the tunnels. In similar studies by Ashrafi et al. [3] and Dong et al. [8], they investigated the CO_2 level in traffic tunnel using CFD. They resulted that CFD is a powerful tool for simulating CO concentration in the tunnel. They also found that the vehicular

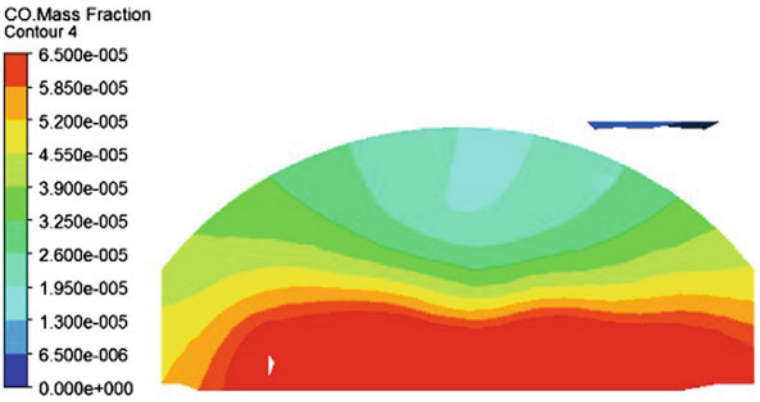

Fig. 4 Concentration of the contour in the tunnel

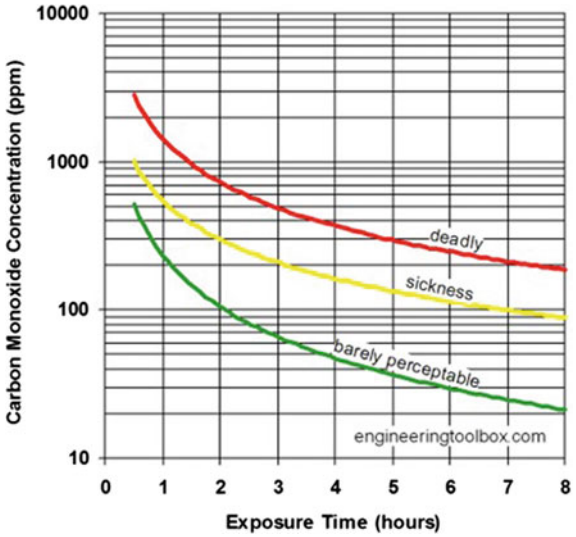

Fig. 5 Standard level of CO

piston effect could efficiently remove vehicular emissions when vehicles travel is at higher speed. The result of this study agrees with those conducting by Ashrafi et al. [3] and Dong et al. [8].

4 Conclusion

In this study, CO concentration in Sayad Tunnel was simulated using CFD that is a 3D numerical method. Simulation of CO contaminant showed that this model is a power model to simulate CO distribution. The result indicated that piston effect and ventilation system helped the elimination of emissions adequately under a vehicle speed. Distribution of CO concentrations depends on several factors, including tunnel geometry, vehicle movement, fan locations, and fresh air flow of the fans. In the lots of studies, the movement of vehicles has not been considered and the actual concentration of CO has not been achieved. However, we simulated the turbulent boundary conditions and the actual CO concentration considering the speed and movement of vehicles.

One of the important points in simulation and modelling is validation and accuracy assessment. This study was conducted at the time of designing. Therefore, it is not possible to getting air contamination samples during the use of the tunnel to compare the level of the CO with the simulated results of this study. It is strongly suggested that in the future studies, researches will compare the results with the level of the pollutants by sampling in different sections and profiles of the tunnel.

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Dendroclimatological Analysis of *Pinus brutia* Ten. Grown in Swaratoka, Kurdistan Region—Iraq

Tariq K. Salih, Muzahim Saeed Younis and Salih T. Wali

Abstract It is well known that there is a strong relationship between the amount of precipitation and radial growth of the trees, but it is not known up to which extent they depends on each other. On the other hand, the data about the amount of precipitation is available from 1976 in Duhok governorate in general. One of the problems studied here is to estimate the quantity of the precipitation using the width of annual ring for the periods prior to 1976, in order to see the trend of rain and snow fall in the region. The data used in this study came from 387 sample pairs of precipitation and diameter growth. These data were undergone data processing for the purpose of developing of regression equations between the width of diameter growth as dependent variable and the amount of yearly precipitation as independent variables in regression equations. Accordingly, thirteen regression equations were developed; two of them were simple regression equations, one polynomial, and the rest of equations were nonlinear. These equations were undergone several measures of precision for the purpose of selecting the most appropriate one which fits our data set. Ultimately the non-linear regression equation: $D_g = 0.293781 + 0.0000371 \times p^{1.40698}$ was selected, with an adjusted R^2 of 76.22, standard error of estimate of 0.1283 and DW of 1.88 The selected equation can be used to estimate the amount of radial growth of a tree in the region by substituting the amount of precipitation in the equation.

Keywords Annual ring · Dendrochronology · Precipitation · Increment borer · Diameter growth

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1 Introduction

Pinus brutia Ten is the native coniferous tree species grown in Kurdistan of Iraq. It covers up to 50,000 ha [1], which is considered as a 10% of the overall forest area in the region. The rest of the area is covered by broadleaves, particularly the oak trees species [2–4].

The annual rings are more conspicuous in the cross sectional area and, also on the extracted core from brutia pine as compared with the other naturally grown trees in the region [5]. Furthermore, the process of cores extraction from pine trees via increment borer is much easier than extraction from oak trees. For such reasons this species was used for such dendro-climatological study.

The relationship between climate and tree-ring width is a part of so-called Dendrochronology.

The main reason behind using the diameter growth in this chronological study is the variation of growth rate in different seasons within one year. Growth is the increase of the size of tree under a period of time [6–8]. The growth takes place in different parts of a tree at the same time. It can be expressed in different parameters, and therefore there is diameter growth, height growth, and volume growth [8]. Growth is the product of an interaction of several abiotic and biotic factors, over a tree and forest, through the time. Diameter growth is the difference between the diameters of a tree under two successive years [9].

In measuring the width of annual rings, one may face some problems, the difficulties in distinguishing the true boundaries of annual rings and mistakes which may arise in counting the annual rings [10].

Leonardo da Vinci [11] realized the relation between climate and width of tree rings. He is considered, as the father of dendrochronology [12]. However, the beginning of broad scientific knowledge of wood formation, tree rings and climate, can be dated to the middle of the nineteenth century, when Theodor Hartig and others postulated their theory of tree-ring formation as a consequence of low temperature in winter [13]. The nature can be considered as a book of many pages and each page tells us a fascinating story [14].

The climatic variation in a location can be read on the annual rings of a tree from the same location, because the width of these rings has a high relationship with the climatic conditions [15]. This characteristic can be used to study the previous climate variation, in order to see the trend of some aspects of climate in the past [16, 17].

This study is partially dealing with the possibility of anticipating the past precipitation of the region using the annual growth of the trees. The relationship between the width of annual rings and the precipitation has been studied intensively by many researchers such as [18–20].

Although the chronological investigations have been conducted throughout the world since the beginning of the last century, in our country this attempt can be considered as the pioneer one at least for the mountainous region of Kurdistan. The tree rings can be used as a record containing year by year something of the climate history in the annual rings.