12. TRAFFIC POLLUTION CONTRIBUTION TO GLOBAL WARMING & A LOGICAL APPROACH TO CONTROL URBAN TRAFFIC POLLUTION

自動車排気ガスによる大気汚染の制御方策に関する考察

Md. Masud Karim*, Hiroshi Matsui**
モハマド　マスド　カリム*・松井　寛**

ABSTRACT; Environment is a vital concern for the current world. Meso and microscale pollution have direct and or indirect impact on global environmental problems. This paper is going to introduce a general overview of global problems due to various alternative sources, special care be taken of traffic pollution. Present some atmospheric chemistry and a logical approach to control microscale urban pollution, conveying intelligent traffic management. Congestion occur on an urban road due to the convergence of traffic flows from different streets. In such a congested or polluted road, if pollution exceed ambient standard level or critical level, a computer algorithm compiled within some logical statements and a number of control measurements *in situ*, *in vitro*, in the abstract, in real time, suggested to the city administration and or road commuters to alleviate traffic pollution on site by traffic planning and management; delivering congestion or pollution news via radio waves, ITS (Intelligent Transport Systems) technologies, electronic display and Internet superhighway etc.
KEY WORDS; Global Atmosphere, Global Warming, Traffic Pollution, Traffic Management.

アブストラクト; 環境問題は今や局所的問題から地球規模の環境問題となりつつある。とくに地球温暖化の原因とされる大気汚染は深刻化を増している。先進国を中心に固定発生源である工場からの大気汚染量は改善されつつあるが、移動発生源である自動車からの排気ガスは排出規制の強化にもかかわらず、自動車の増加に伴ってNO_xを中心に依然として悪化の傾向にある。加えて開発途上国は経済発展に伴いこれからまさにモータリゼーションの時代を迎えようとしており、排出規制の遅れもあって局所的にも地球環境にもますます深刻化することが予測されているのが現状である。

本論文は自動車排気ガスによる大気汚染が局所的、地球的、及び地球規模的にどのような関連性をもつかを概観するとともに、先進国と開発途上国との問題点の差異に注目しつつ、自動車排気ガスによる大気汚染の制御のための各種交通政策の在り方について論じる。
キーワード; 地球温暖化　交通公害　交通制御

1. INTRODUCTION

Environment is a major concern to all developed nations. Governments have fought for clean air by regulating all major and many minor sources of air pollution. Industrial emissions have been significantly reduced. As a result of new motor vehicle emission standards introduced in 1988, new vehicles are 90% cleaner than those manufactured in the 1970s. However, despite those substantial

* Graduate Research Assistant, ** Professor, Department of Civil Engineering, Nagoya Institute of Technology, Gokiso-cho, Showa-ku, Nagoya 466, Japan. *名古屋工業大学大学院社会開発工学専攻博士後期課程; **名古屋工業大学社会開発工学科教授, 〒466, 名古屋市昭和区御器所町

efforts, we continue to be plagued with air pollution problems. A major issue is our continued and growing reliance on the private car. Growth in both the number of operating vehicles and in the usage of these vehicles, is a detriment to the technical progress being made as cleaner new cars replace older, high polluting vehicles.

For developing nations, however, pollution severity occur due to the high content of lead in gasoline, big number of high polluting vehicles, impure fuel, inefficient landuse and overall poor traffic management. Even the pollutants regulated by developed and developing nations should differ, one wants to make gross generalizations. The pollutants of concern for developed countries would be volatile organic compounds, nitrogen oxides and Carbon monoxide; whereas leaded fuel, particulate matter, dust and sulfur dioxide would be targeted by developing nations.

Presently, most important aspects for environmental expert are greenhouse effect and global warming. The growth in greenhouse gases could lead to an increase in temperature of 2^0C over preindustrial levels by 2005. Resulting in inundation of coastal lowlands (seriously affecting countries such as Bangladesh, China and Egypt), changes in rainfall patterns (more intense tropical storms and more severe droughts in midcontinental regions), dislocations, loss of many unmanaged ecosystems, reducing global diversity, altered patterns of vector borne and viral disease (Asif Faiz, 1993).

In arranging the paper, we will explain first current problems in global scale, there physical structure and severity on human society and the total impacts on the global atmosphere. Motor vehicle contribution for greenhouse effects as a whole. And a local solution based on a logical algorithm how to minimize pollution employing better traffic management for an example highway. Finally some basic conclusions are made for general air pollution problem and recommendations are presented for severe traffic pollution areas.

2. CURRENT PROBLEMS OF URBAN TRAFFIC POLLUTION

Augmenting rate of mechanical movable maneuvered by the people of developed countries, iterate number of problems on urban environment. Recently in Japan, NO_2 concentration in some large cities and their surrounding areas has gradually increased without decreasing SO_2 concentration. In one recent study with 187 locations in Japan, NO_2 concentration monitoring and atmospheric temperature observation were conducted in the period 1982 -1988. It was found that 72% of the locations have the increasing rate of NO_2 and 23% of the areas have the temperature with larger rate (Gotoh, 1993). "CO_2 emissions total 318 millions in 1990", it was the headline of "The Japan Times" on Saturday, May 23, 1992. Inside the headline "Japan emitted 318 million tons of carbon dioxide in 1990. The environment agency reported Friday, calling for further efforts to reduce emission of the gas. Announcement of the 1990 emission total now gives a specific numerical target to the government's previously outlined goal of stabilizing total carbon dioxide emissions at the 1990 level by 2000". In another report "Diesels seen car air pollution high" written in "The Japan Times" on Saturday, November 30, 1991. The contents were "Air pollution caused by automobiles remains for above recommended levels, with high concentration of nitrogen dioxide due to increase of diesel-powered vehicles. High fuel consumption and an increase in traffic, boosted by a robust economy, were cited as reasons for the pollution." These are few of the reports on environmental pollution. Scientists have started to talk about global warming due to the increase of carbon dioxide and resulting abnormal climatic changes and the rise of the sea level.

In the former USSR, the relatively higher share of CO emissions from the transport sector is attributable to the large proportion of gasoline-powered trucks and buses with very high emission rates (Makela, 1991). The higher share of SO_x emissions from automobiles, in developing countries is due to the poor fuel quality and the extensive use of diesel-powered in some cases with impure diesel vehicles .

Automotive lead emissions have declined sharply in most OECD countries whereas in developing countries they are rising. The contribution of developing countries to lead emission already exceeds that of OECD countries and measures are urgently needed to reduce or eliminate lead in the gasoline marketed in developing countries. The share of motor vehicles in domestic emissions of fossil-fuel CO_2 would be higher in Nigeria but lower in Bangladesh as a function of the percentage of petroleum fuel used in transport - 59% in the United States, versus 74% in Nigeria and 28% in Bangladesh (Taylor, 1991).

3. EFFECTS OF AUTOMOTIVE EMISSIONS

Exhaust from the tailpipe of motor vehicles is a complex mixture that contains hundreds of chemicals in the form of gases as well as solid and liquid aerosols. The composition of the mixture depends on the fuel, the type and operating conditions of engine and the effects of any emission control devices. Pollutants and their derivatives cause harm by interacting with and impairing molecules, crucial to the biochemical and or physiological processes of the human body. The risk of toxic injury from a substance depends on three factors: the chemical and physical properties of the substance, the dose of the material that reaches critical tissue site and the responsiveness of these sites to the substance.

After releasing the pollutant, emitted substances are transformed by complex atmospheric chemical reactions. Airborne pollutants, therefore, consist of primary tailpipe emissions (for example carbon monoxide, nitric oxide), and new chemical species formed as a result of atmospheric reactions (for example, nitrogen dioxide, ozone); the opportunity for chemical diversity is immense. Oxide of Nitrogen emitted from automobiles constitute:

$NO_x \approx (NO, NO_2, N_2O, HNO_2$ and possibly $HNO_3)$

Oxides of Nitrogen is a net destroyer of Ozone at the atmosphere. Depending upon the VOC and NO_x ratio, an incremental change in NO_x emissions results in a net increase or decrease in O_3. The NO_x reactions which lead to the formation of O_3 are:

$$NO_2 + \text{✸} \xrightarrow{M} NO + O \qquad \text{-----(1)}$$

$$O_2 + O \Rightarrow O_3 \qquad \text{-----(2)}$$

In the above equations, ✸ is sunlight and M is any third-body molecule. The chemical reactions which lead to the destruction of O_3 are:

$$NO + O_3 \Rightarrow NO_2 + O_2 \qquad \text{-----(3)}$$

$$NO_2 + .OH \Rightarrow HNO_3 \qquad \text{-----(4)}$$

where .OH is the hydroxyl free radical. The third reaction temporarily removes O_3, because it can reform again by reactions 1 and 2. However it delays, the formation of O_3 and tends to lower peak O_3 concentrations because the plume will disperse as it moves downwind. Reaction 4 is the most important, because it removes NO_2 from participating further in the O_3 formation chemistry, because HNO_3 is a stable compound. In addition, the chemical composition is dynamic; the air we breathe today is different than the air we breathed 10 years ago. Therefore, a changing constituency must be recognized in any evaluation of chronic health effects.

4. CONNOTATIONS FOR GLOBAL WARMING

Motor vehicles contribute to nearly all the major greenhouse gases: carbon dioxide (CO_2), chlorofluorocarbons (CFCs), tropospheric ozone (from HC and NOx emissions), nitrous oxide (N_2O) methane and carbon monoxide (CO) (which indirectly aggravates the buildup of methane and tropospheric ozone). CFCs and N_2O also contribute to the destruction of the stratospheric ozone layer. Carbon dioxide accounts for about 50% of the annual increase in global warming, CFCs about

20%, methane 16%, tropospheric ozone 8% and nitrous oxide 16% (Mackenzie and Walsh, 1990). Carbon dioxide emissions are almost directly proportional to the amount of fuel consumed. The motor vehicle share of carbon dioxide emissions is thus closely related to consumption of fossil fuel energy - typically 30% to 40% of total energy demand and 60% to 80% of transport energy demand in industrialized countries.

Figure 4-1 shows the contribution to global meteorological change due to different sources. Motor vehicles account for 20% of total greenhouse gas emissions. Considering total world emissions of greenhouse gases and conventional pollutants from anthropogenic sources, motor vehicles account for about 14% of fossil fuel CO_2, 50% to 60% of CO, HC and lead and about 30% of NOx and consume about 25% of CFCs. The role of motor vehicles in global SO_x emissions is small - about 4% (Asif Faiz, 1993).

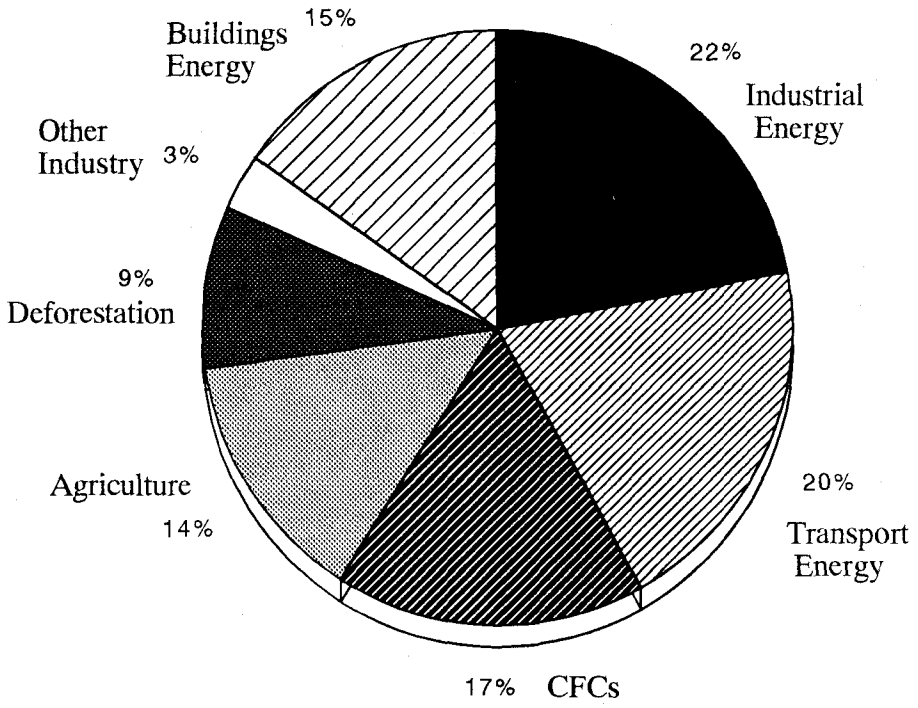

Figure 4 -1 Greenhouse gas emissions contribution to global warming.

5. TRAFFIC POLLUTION CONTROL

Increasing number of automobile usage in developed and near soon developing nations beyond the scope of transport planner, only except implementing smart traffic management; unless problems are being eradicate; restricting owning more cars, technological improvements of engines, alternative fuels or zero emission vehicles. Previous study recommended that 1 to 4% of fuel savings and 5 to 10% pollution could be reduced by traffic management.

Earlier study (Karim & Matsui, 1995) conducted by the authors, outlined the key idea; urban traffic pollution problems are solely dependent on the meteorological conditions. Wind speed especially playing a vital role for the transport of primary level pollution from microenvironments. A critical level of wind speed (3 m/sec) beyond which background concentration in microenvironment approaches to negligible. Figure 5-1 represents a flow chart how we work for a smart traffic planning system. Traffic planners have some social constraints at policy making, they do care only the local problems, how to make pollution free urban atmosphere and to implement those ideas traffic planners contribute to transport and arrange the pollution that are emitting from tailpipes.

Congestion or traffic pollution in urban roads occur due to the convergence of traffic flows from different streets. In such a congested or polluted road, if pollution exceed some standard limit (ambient air quality standard), we may appreciate a logical algorithm shown in Figure 5-1. For a logical true situation, control measurements constitute as: in-situ and long term. In-situ measures are delivering

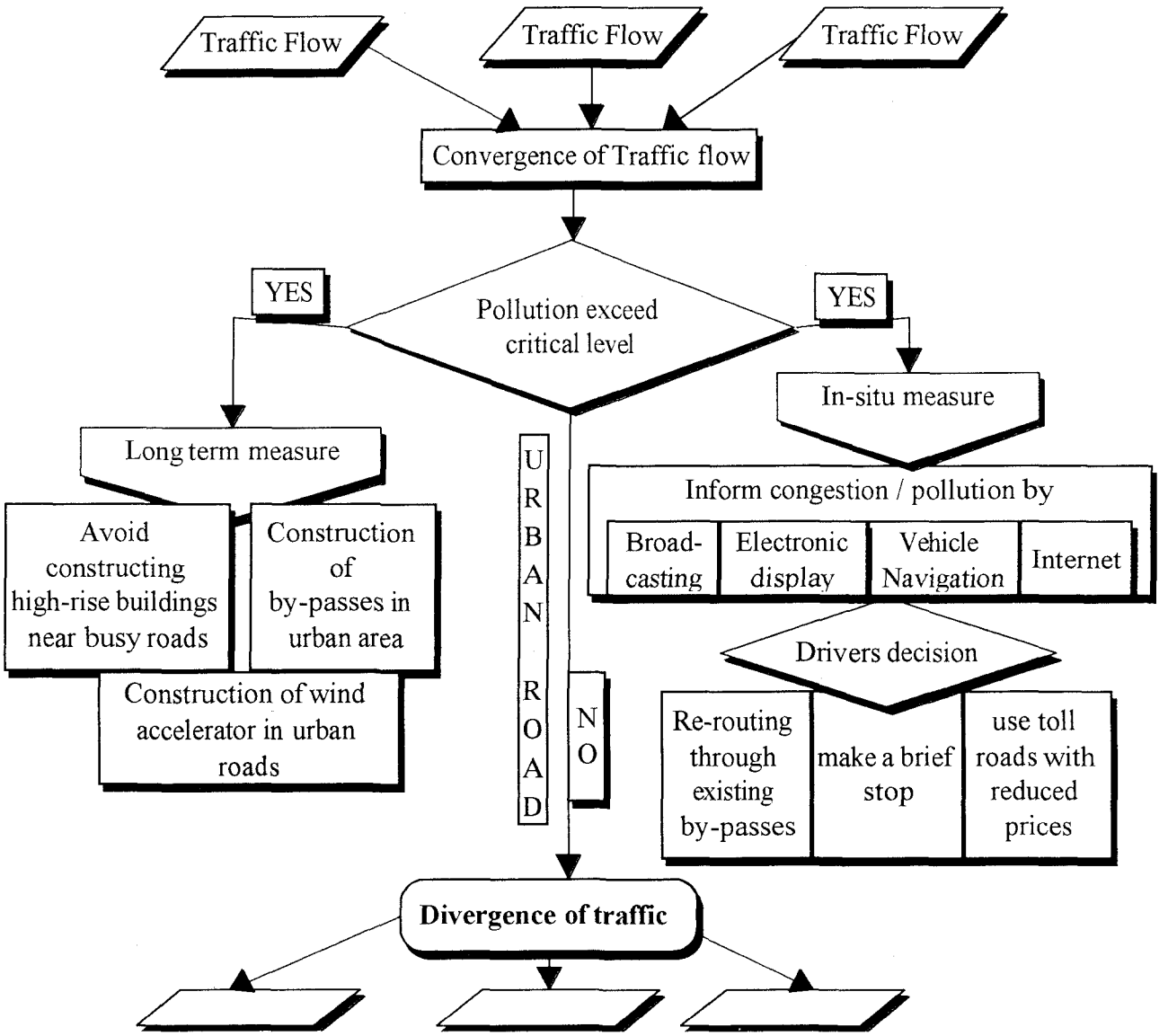

Figure 5 - 1 Flow algorithm for the logical approach controlling traffic pollution.

congestion or pollution news by broadcasting and overhead electronic display to drivers. Cars equipped with navigation systems, Facsimile services and Internet facilities linked to Intelligent Transportation Network could easily be attention drivers the location of heavily polluted roads. In most of the developing countries, some services are already stationed. Japanese highways are networked through highway radio and overhead electronic display, some metropolitan expressways are providing traffic information by facsimile. In USA, California Department of Transport (CALTRANS) providing real time traffic data in every 5 minutes through Internet. Some World Wide Web pages are providing on-line various pollution data on their sites. Our Internet site (http://doboku2.ace.nitech.ac.jp/htph2/htph2.htm) provides various traffic pollution information and Nagoya city traffic pollution data for public to generate public consciousness on environmental

problems. According to the information drivers access, should take their individual decisions as: re-routing through existing by-passes,use toll roads with reduced prices and those who are not in a hurry make a brief stop some where on their ways. During peak traffic hours, city administration could reduce tolls for travelers in highways. Some percentage of traffic flows could be transformed from ground level roads. Emission from the tailpipes of vehicles solely dependent on the speed of vehicles and operating modes of engines. It would not be out of subject to introduce the common criteria that for uniform traffic velocities on roads traffic pollution would be small enough and have substantial contribution for controlling urban traffic emissions. Long term measures are; construction of wind accelerator in urban road, avoid constructing high-rise buildings near busy roads and construction of more by-passes in urban areas.

Wind speed is playing a vital role on dispersion process. During very low wind speed, particular areas in urban roads, located near high-rise buildings, where pollution entrapped in and impact a severe buildup of pollution. In those areas, we can arrange some artificial wind accelerator to transport the pollutants to the upper stratosphere of air. In Nagoya city, most of the subways are beneath the main roads. Efforts could be made to utilize existing subway exhaust with little modification in those heavily polluted areas. There are some nations (especially German) taking substantial considerations while planning new developments of their big cities. For new urban developmental planning, efforts should be made to avoid high-rise buildings near busy roads and if it is necessary to do so, they could be designed in staggered way to create more spaces for not entrapping pollutants in street canyons.

CONCLUSIONS

The current research is a theory based work to present the physical problems and proposed a future study to work and alleviate traffic pollution from urban roads. The study identify few traffic pollutants those have greater impacts on global environmental problems. Special care be taken of on the possibilities to carry out research works based on the current problems for existing traffic pollution in urban areas. The latest improvements of information technologies integrated on traffic management systems.

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