The Environmental Pollution In Vietnam: Source, Impact And Remedies

Tuan Anh Hoang, Nam Xuan Chu, Trung Van Tran

Abstract: Currently, the environmental problems is one of the urgent problems for all countries in the world. Vietnam is among of 10 countries with the most polluted air in the world, the health of people is affected by the non-guaranteed air quality in Vietnam. According to the EPI in 2015, Vietnam ranked 79 in the total of 132 countries in the overall environmental assessment. However, the air pollution index, Vietnam ranked 123. On the burden of disease due to environment, Vietnam ranked 77. Therefore, the solutions for reducing the environmental pollution in Vietnam are ultra necessary. This paper presents the effects of environmental pollution, the impact of air pollution on the ecology and the life of people. The results of the paper contribute to improving people's awareness of environmental protection and also offer some solutions to reduce environmental pollution in Vietnam.

Keywords: air pollution, toxic emissions, transportation, environmental urban, Vietnamese environment

1 Introduction

Urban environment protection is an ultra important task in the national sustainable development, because the urban population is ever-growing and gets the ever-increasing proportion in the total population. Therefore, in the urban areas, the serious air pollution problem usually occurs especially in large urban areas. From this situation, all the organizations in the world including the Environmental Protection Agency has issued and amended many laws, regulations, specific decrees to limit the release of pollution materials to the environment and the atmosphere such as SO_x, NO_x, CO_x, HC emissions. These emissions must be reduced to the lowest level in developing countries and limit the rise in developing countries. The disposal of greenhouse gases should be very limited in the high-income countries and prevented in the low-income and the developing countries. Transport activities are a major source of air pollution in big cities in Vietnam, the air pollution in urban areas caused by traffic is accounted for approximately rate of 70%. The type of transport in Vietnam is mainly motorcycles and cars, hence the issues related to the degree of pollution arising from the engine exhaust of this vehicle are necessary to solve thoroughly in the near future. This means that: either the use of this engine in the world will be prohibited or using the solutions to lessen the toxic emission generated from the engine. In terms of waste sources causing the air and environmental pollution on a national scale (including urban areas and other areas), estimation showed the transportation activities contribute to nearly 85% of carbon monoxide (CO), 95% of VOCs. Meanwhile, the industrial activity is the source of approximately 70% for contribution SO_x emission. For NO_x emission, the transportation activities and industrial production contributed approximately the same rates and shown in Table 1.

- *Tuan Anh Hoang. Mechanical Engineering Faculty , Ho Chi Minh University of Transport , Vietnam. E-mail: anhtuanhoang1980@gmail.com*
- *Nam Xuan Chu. Ho Chi Minh College of Transport III, Vietnam. E-mail: chuxuannam@gmail.com*
- *Trung Van Tran. Mechanical Engineering Faculty, Ho Chi Minh University of Transport, Vietnam. E-mail: tvtrungck@yahoo.com.vn*

***TABLE 1** Estimated Emissions Of Pollutants From Major Sources Of Vietnam In 2015 (Tons / Year)*

Production Field	CO	NO_x	SO_x	VOCs
Thermoelectric	6.562	65.263	131.665	2.489
Industrial production, Services, Living	74.004	182.061	315.588	1.598
Transportation	495.952	112.856	38.122	67.863

Figure 1 shows the rate of pollutant emissions for different vehicles. Motorcycles are major contributors for CO, VOCs, and C_nH_m emissions. Meanwhile, trucks dispose much SO_x and NO_x.

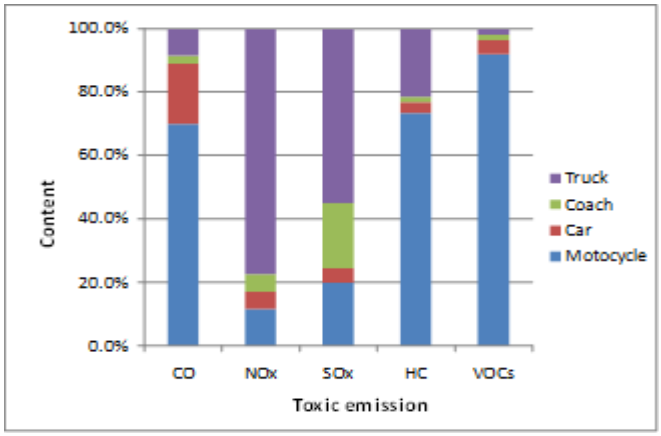

***Figure 1.** Emission rate of pollutants by vehicles in Vietnam*

Therefore, finding the solution applied to reduce the concentration of harmful emissions is essential. The paper has done the research on the causes of environmental pollution, analyzed of impacts and the level of polluting the environment. The solutions are proposed to carry out in Vietnamese conditions in order to reduce the exhaust gas pollutants and help manufacturers, operators, user applying in practice, the implementation of environmental protection laws.

2 The Effects Of Environmental Pollution

Environmental pollution is the impact, which changes the component of the environment and causes an imbalance in the environmental status, causes an adverse effect on lives of

things and the natural environment. Environmental pollution directly affected to the human by way of food, water, changes in physical conditions, chemical and degradation of natural environment. According to statistics, every day, the people in Hanoi and Ho Chi Minh City are breathing the dust 10 times higher than that of the WHO regulations. Table 2 shows the ominous rise in concentration of some pollutants in the atmosphere.

TABLE 2 *Rise In Pollutants In The Atmosphere*

Pollutants	Pre- industrial (ppm)	Now (ppm)	Rising rate (%/year)
CO_2	270	390	1.2
NO_x	0.28	0.40	0.52
CO	0.05	0.18	4.1
SO_x	0.001	0.005	3.2

Polluted air will have a major change in the component of the atmosphere or the appearance of strange gas, which makes the air is not clean, smell, reduce in visibility, causing climate change, pathogenic for humans and creatures. These pollutants come from many different sources and many substances react with each other to create new toxic material. Pollutant emissions are toxic compounds that directly affect the human health and the environment in the long term. They include: carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), aldehydes, unburt hydrocarbons (HC) and the component of dust (Particulate matter-PM). The presence of pollutants, especially the greenhouse gases, effects primarily on the heat balance of the atmosphere. Among the greenhouse gases, it is concerned about carbon dioxide (CO2) as it is the main ingredient in the combustion products of carbon components- containing-fuel. With the speed of increasing the carbon dioxide concentrations in the atmosphere as present, it is anticipated that, in the mid 22 century, the carbon dioxide concentrations can be doubled. Meanwhile, according to the estimation of scientists, it will occur a significant change to the heat balance on earth such as: Temperature of the atmosphere will increase 2 ÷ 3°C; A part of the ice in the Arctic, the Antarctic will melt and raise the height of seawater level; Change of the rain and the desertification of Earth's surface will also appear. The increase in NO_x, especially nitrogen protoxide N_2O causes the risk of distruction the ozone layer on the upper atmosphere that is essential for preventing the ultraviolet from the sun. On the other hand, the gases such as SO_2, NO_2, which are oxidized into sulfuric acid, nitric acid dissolved in rain, in snow, in fog, will destroy the vegetation on the ground and corrode the metal structures. In this paper, the air quality was assessed based on the monitoring data of environmental parameters and concentrated in the period from 2010 to 2015 and compared with the national technical regulations Vietnamese Standard QCVN 05:2013/BTNMT - national technical regulations on ambient air quality and shown in Table 3. Air pollution is defined when the concentration of the parameters exceed the allowed limit of QCVN 05:2013/BTNMT with different thresholds average of 1 hour, 8 hours, 24 hours (day) and year. This is the basis for assessing the changes in air pollution.

TABLE 3 *Limit Values For Basic Parameters Of The Ambient Air Environment Following Vietnamese Standard - Qcvn 05:2013/Btnmt*

Parameters	Average of 1 hour	Average of 8 hours	Average of a day	Average of year
SO_x	350	-	125	50
CO	30.000	10.000	-	-
NO_x	200	-	100	40
Total suspended particular (TSP)	300	-	200	100
PM_{10}	-	-	150	50
$PM_{2.5}$	-	-	50	25

The quality and level of influence on human health due to air pollution are assessed not only by the methods of Vietnamese standard QCVN but also air quality index (AQI). This is a composite index representing the concentration of a group of basic pollutants in the ambient air. AQI values are based on the results of monitoring parameters SO_2, CO, NO_x, O_3, PM_{10}. Overall, for the composition of dust in Vietnam, the percentage of fine dust ($PM_{2.5}$ and PM_{10}) is relatively high. In Hanoi, from the measured data at monitoring stations Nguyen Van Cu from 2010-2015, the ratio of $PM_{2.5}$ and PM_{10} may fluctuate in accordance with the laws and the pollution is concentrated in the months with low temperature or dry air that will prevent the dispersion of pollutants in the surface layer. Unlike the Northern region, the Southern Middle region is located in the tropical monsoon climate with stable temperature, less volatile all the year round so the difference between the measured concentrations of particulates PM is not clear. Monitoring data from 2010 -2015 period showed significant differences in the levels of dust and TSP in ambient air environment in the urban. Pollution is often concentrated in urban areas with large traffic density (such as Hanoi, Ho. Ho Chi Minh City, Bien Hoa) or with the industrial activities (such as Quang Ninh Coal) and there were times when pollution levels exceeded the permitted threshold from 2-6 times in comparison with Vietnamese standard QCVN 05: 2013/BTNMT. NO_x is the most dangerous toxin. NO_x is formed by the reaction between N_2 and O_2 in high temperature conditions, NO_x includes NO, NO_2 and NO. Monoxyde nitrogen (NO) is not dangerous, but it is the basis for creating nitrogen dioxide (NO_2). NO_2 is a difficult dissolve, so it can go into the lungs causing inflammation and destroying the cells of the respiratory organs. Victims suffer from insomnia, cough, shortness of breath. Protoxyde nitrogen N_2O is the basis of creating ozone in the lower atmosphere. CO, HC are the product of incomplete combustion of fuel. In urban areas with large traffic density, the amount of CO in the air is usually very high. When CO enters the body will combine to hemoglobin and hinders O_2 reception so lead to suffocation. That is why this is very harmful gases for pregnant women and people with heart disease. In atmosphere, there is about 15% of CO_2 due to the transport vehicle emissions. It not only pollutes the environment but also has a huge impact on human health. CO_2 causes suffocation, if exposed to 15% of CO2 concentrations, people will not be able to work, and with 30 to 60% of CO_2, it would be dangerous to life.

3 ENVIRONMENTAL POLLUTION BY TRANSPORTATION MEANS IN VIETNAM

One of the main pollution sources are the exhaust gas from the internal combustion engines, which provide up to 80% of the total consumed energy in the world. This is a major pollution source to the air and environment, especially in urban areas and densely populated areas. The process of fuel combustion is creating the polluting gas such as CO, CO_2, SO_2, NO_x, Pb, CH_4, HC. Along with economic – social development, quantity and density of vehicles increased rapidly. Every year, the number of motorcycles increases by 20%, cars increases by 15%. The increase in the number of vehicles is the cause leads to increase the exhaust gas emissions into the air and cause the pollution of traffic emissions more severe. The increasing rate of motors and cars quantity is given in Figure 2.

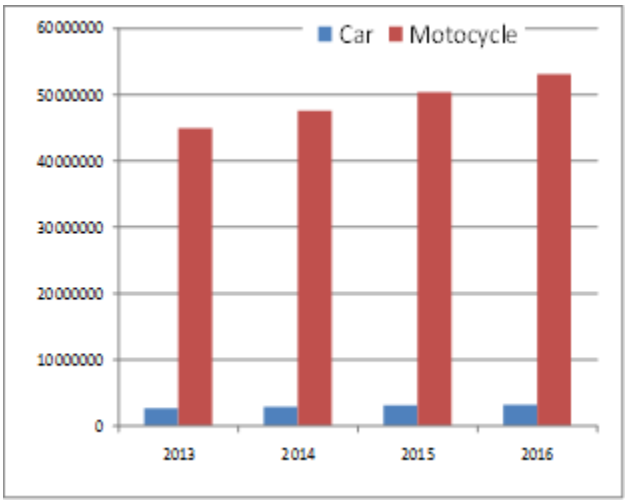

Figure 2. *The number of cars and motorcycles in Vietnam from 2013 to 7/2016*

Figure 2 shows that, the number of private vehicles has increased rapidly and caused the increase in air pollution levels in big cities in Vietnam. Many private vehicles are not taken seriously warranty periodic maintenance therefore it causes the increase in emissions into the environment with ever-growing toxic levels. In particular, dilapidated and out of using date facilities are still in traffic, they are not only threatening the safety of lives for people in traffic but also seriously affecting the quality of urban air, threatening the health and lives of people. Vietnam is ranked No.4 in the world in the number of motorcycles used as the transportation means. As statistics from Figure 2, there are currently all over the country of 52 million motorcycles and 2 million cars. However, those are the registered vehicles, while the unregistered vehicles are not mentioned. That means the toxic emissions from vehicles considered as key factors in Vietnam are very horrible and much different from the developing countries in the world. A different calculation in two biggest cities such as Hanoi and Ho Chi Minh City showed that, motorcycles are about 95% of total vehicles, they use 56% of gasoline consumption but discharge 94% of unburt hydrogen carbon emissions (HC); 87% of carbon monoxide (CO); 57% of nitrogen oxides (NO_x)… in total emissions of vehicles.

Figure 3. *Air pollution by motorcycles in Vietnam*

Due to the large amount of vehicles, gasoline consumption in the country will be ever-increasing in next 25 years and shown in Figure 3. The level of fuel consumption in Vietnam in next 5 and 10 years is shown in Figure 4.

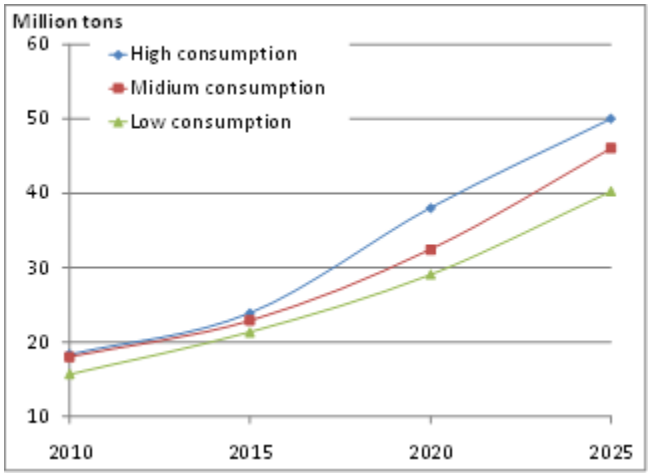

Figure 4. *Demand for gasoline in Vietnam, the forecast for 2025*

Figure 4 shows that, the increasing level of fossil fuel is respectively 50% of total volume in 2020 and 25% of total volume in 2025. Therefore, if the quality standards for fossil fuel and gasoline are not tightened, we will face the serious problem of air and environment pollution in the urban because of the harmful emissions such as CO, HC, VOCs, SO_2, lead, BTX from gasoline.

4 REMEDIES

4.1. Using bio-fuels

Before the urgent demands aiming at reducing the pollution caused by the engine exhaust gas, it has been working to find the ways to reduce the amount of toxins in the engine exhaust gas. Almost all of the methods are aimed at improving the quality of combustion in the engine to reduce the amount of toxins produced in the bad combustion. However, the solutions of using alternative fuels and additives are interested in Vietnam. According to the project on development of bio-fuels from 2015 to 2025 by the Prime Minister, many plants for producing bio-fuels have been formed to provide ethanol for

blending E5 (5% of ethanol and 95% of gasoline) in order to serve the needs of the market. The Petro Viet Nam (PVN) has developed a roadmap for bio-fuel- development targets to 2015. This roadmap is to develop bio-fuels to ensure energy security, improve the environment and increase income for farmers. To accomplish this target, PVN and Vietnamese Oil & Gas Corporation have launched 3 projects for producing bio-ethanol with a capacity of 300.000 m3/year in operation, including Phu Tho Bio-ethanol Plant (Tam Nong District, Phu Tho Province), Quang Ngai Bio-ethanol Plant (Dung Quat Economic Zone, Quang Ngai and Binh Phuoc Ethanol Plant (Bu Dang district, Binh Phuoc). The production capacity of the whole country for producing bio-ethanol reached 535 million liters/year, quality of produced ethanol is enough to mix 8.35 million tons of E5 or 4.17 million tons of E10, and ensure to supply fully for the domestic market. Bio-fuel development is an important part of the energy security strategy of the country, contributing to the environmental protection and preservation, able to help farmers to develop product, especially cassava growers get stable output. However, op to now, to boost the bio-fuel consumption, the propaganda for raising community awareness about the benefits of using E5, B5 and bio-fuel should be integrated into the national program of using energy saving and efficiently. To bring the best effects on society, simultaneously, save the costs for businesses in bio-fuel production in financial difficulties, Vietnamese Government has carried out the policy in order to promote the production and use the bio-fuel of Vietnamese people. These policies are environmental tax exemption for part of the background for mixing E5, B5; reduce in excise duty on E5, B5 (including the background for mixing E5, B5); support VAT on output of the plant for bio-ethanol and biodiesel; rationally use the Price Stabilization Fund for bio-fuels. Beside, modified lecithin from soy oil used as an additive for reducing emissions exhaust of diesel fuel has researched successfully. Tests confirmed this additive compatible with diesel fuel and effectively reduce exhaust smoke emissions when used at a concentration of 0.05%, reduction in 15.7% of CO emission, reduction in fuel consumption up to 2.7%; reduction in smoke up to 26.86%. On that basis, Ho Chi Minh City is developing urban bus fleet used CNG fuel. According to the analysis, the use of CNG fuel will be reduced about 30% of harmful emissions. Also, in the near future, the Metro in Hanoi and Ho Chi Minh City in operation will bring more benefits to traffic and emissions. Besides, a number of city bus routes also start using electrical engines to replace diesel engines.

4.2. Technical methods

This system can be used for gasoline engines and diesel engines. The function of the system is to reduce NOX emissions in the engine. To reduce the combustion chamber temperature down, we can do by using a system to bring certain waste gas back combustion chamber, this system is called exhaust gas recirculation system (EGR). These emissions amount have the following functions: The specific heat capacity of emissions is higher than that of air, so it will reduce the temperature of the combustion chamber if the same amount of heat is still high. Make a mixture with low oxygen levels. Make the mix more dirtily. However, these emissions must be controlled, adjusted, because if a large emission is taken into combustion chamber, the engine will operate unstable and affect the engine power. Type without catalysts SNCR but only using NH3 or Urea is low cost. The reaction occurs in a certain temperature and high temperature range to operate SNCR is very narrow, the optimal temperature for effective SNCR is about 900 ÷ 1100^0C therefore it should apply to the exhaust flow with high temperature, stable performance and SNCR equipment appropriate adjustments. The reaction takes place the same as with SCR, NO_x reduction efficiency is lower but much cheaper than SCR. SNCR systems reduce 30-60% of NO_x emission, affect less to operate the engines, are easy to install. This method has the advantages that can be applied to older engine types without any impact on the structure of the engine, the engine is only supplied the simply equipment in the exhaust pipe. However, the process has not been finalized because either NO_x or NH_3 were redundant, hence leading to difficulties in adjusting the flow. Some NH_3 is out of the catalyst at high temperature and oxidized into pollutants and created toxic emissions.

4.3. Policy

Based on the researches and technological solutions aiming at reducing harmful emissions, Vietnam Government has carried out some solutions:

First, continue to improve the legal system for environmental protection, including the sanctions (administrative enforcement and criminal process) must actually physically strong enough to deter violators. Besides, it is necessary to develop of comprehensive system for environmental treatment in factories, industrial parks under the international standards, monitoring organization towards a nice and friendly environment with humans.

Second, strengthen the inspection, testing, environmental oversight (regular and irregular); close collaboration between specialized agencies, especially between environmental inspection force with the environmental police force at all levels in order to detect, prevent and treat promptly, thoroughly the polluting behavior. At the same time, improve their professional staff for specialized work in environment field; equipped with modern technical facilities to serve effectively the activities of these forces.

Third, pay attention to the plan for development the industrial zones, locations, villages, cities but ensure high scientific, based on calculating thoroughly and comprehensively the development trends and carrying out appropriate policies; avoid planning rampantly, inconsistently, overlapped to make difficulty in general management, environmental management. For industrial zones, provision should be made mandatory for companies to invest in infrastructure for wastewater treatment, environmental analysis, and regular periodic reports on the operation of waste treatment.

Fourth, focus seriously on implementing and evaluating the impact of environmental assessment for projects, on that basis, specialized agencies will advise exactly the competent authorities for review to carry out the decision whether or not to grant investment licenses. The decision on the investment project should be considered carefully between bringing immediate benefits to its impact on the environment in the long term. The transparency of the planning, investment projects are announced and created the conditions for all organizations and citizens who can participate in social debate about the

environmental impact of the plans and projects.

Fifth, promote the environmental dissemination and education in the whole society in order to create changes and raise awareness, consciously abide by environmental laws, social responsibility of citizens, businesses in preserving and protecting the environment; building ecological awareness, make people aware of a self-conscious of the position and role, intimate relationship between nature - man - society.

5 CONCLUSIONS

Air pollution is also a major factor leading to global warming, acid rain, ozone layer depletion, ecological imbalance ... As reported by the Environmental Program UN, Hanoi and Ho Chi Minh city are the head of pollution level in Asian. Therefore, the use of urgent solutions to reduce pollution in Vietnam is very necessary. However, in addition to above solutions, Vietnamese people also need to raise their awareness about the consequences of environmental pollution so that jointly contribute to reduce and remedy the environmental pollution and improve the quality of life.

ACKNOWLEDGMENT

The authors acknowledge Ho Chi Minh University of Transport, Ho Chi Minh College of Transport III for supporting this research.

REFERENCES

[1] http://www.services.ait.ac.th/admissions/

[2] http://www.nationalgeographic.com/environment/global-warming/pollution/

[3] http://aqicn.org/city/vietnam/ho-chi-minh-city/us-consulate/

[4] https://www.epa.gov/clean-air-act-overview/air-pollution-current-and-future-challenges

[5] http://www.ucsusa.org/clean-vehicles/vehicles-air-pollution-and-human-health#.WI1iPdd97IU

[6] http://tuoitrenews.vn/features/482/vietnam-air-pollution-among-the-worst-in-the-world

[7] http://e.vnexpress.net/news/news/air-pollution-in-vietnam-cities-hit-unhealthy-levels-government-study-3476529.html

[8] https://www.numbeo.com/pollution/in/Ho-Chi-Minh-City

[9] https://en.wikipedia.org/wiki/Environmental_issues_in_Vietnam

[10] http://www.ngocentre.org.vn/news/vietnam-biggest-city-warned-rising-air-pollution

[11] http://www.thanhniennews.com/society/hanois-persistent-air-pollution-reaches-hazardous-level-59888.html

[12] http://www.nytimes.com/2007/07/06/world/asia/06iht-pollute.1.6529573.html

[13] https://www.megaessays.com/viewpaper/204357.html

[14] http://saigoneer.com/saigon-development/6528-urban-vietnam-reckons-with-its-air-quality-dilemma

[15] https://www.researchgate.net/publication/237207391_AIR_POLLUTION_IN_HOCHIMINH_CITY_VIETNAM

[16] http://tcmt.monre.gov.vn/pages/article.aspx?item=Is-air-pollution-in-Vi%E1%BB%87t-Nam-really-concerned?-41369

[17] https://www.ncbi.nlm.nih.gov/pubmed/27016680

[18] Bang Quoc Ho, Alain Clappier, Golay François: Air pollution forecast for Ho Chi Minh City, Vietnam in 2015 and 2020. 2011, Volume 4, Issue 2, pp 145–158, DOI 10.1007/s11869-010-0087-2.

[19] http://www.urbanemissions.info/cities/hanoi-vietnam/

[20] https://www.geospatialworld.net/news-posts/scientists-in-vietnam-invents-air-pollution-warning-system/.