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Impact of COVID-19 Induced Lockdown on Air Pollution and Remediation Measures

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Authors' contributions

This work was carried out in collaboration between both authors. Author IAK designed the study, managed the literature searches and wrote the first draft of the manuscript. Author MIM managed the progress of the work, redesigned the work and drafted the final manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Air pollution is reported to have reduced to a level that has not been recorded since the end of World War (II), and this is largely due to the global lockdown imposed to curb the spread of the novel Coronavirus disease (COVID-19) across the globe, hence the need for a review, interpretation and harmonisation of the available literature in this regard. Attempt is made from the available literature in elaborating the generality of the concepts of air pollution from the perspective of the global lockdown due to the COVID-19 pandemic. The synergy between the lockdown and decreased air pollution in relation to climate change, is explored. Various health and environmental consequences of air pollution and climate change are outlined. Major ailments and mortalities associated to air pollution are bound to decrease due to reduction in air pollution, and this is affirmed. We highlight some achievable control measures and techniques for tackling air pollutants in line with the principles of green chemistry for re-consideration under reviewed policies and guidelines by governments, stakeholders and policy-makers. Additionally, we propose some new remediation measures and policies that could be harnessed and deliberated upon by stakeholders and policy-makers to checkmate greenhouse gases emissions, improve air quality and minimise air pollution and climate change. We recommend how these measures could be adopted and

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implemented for improved health care. Data need to be collated post COVID-19 to ascertain the level of mortalities due to the consequence of air pollution and compare same with the mortality rate for COVID-19.

Keywords: COVID-19; air pollution; climate change; global lockdown; and mortality.

1. INTRODUCTION

Human's life is considerably altered world-over to curb the spread of COVID-19. People remain restricted to their homes continually washing their hands (though some eased lockdowns are being experienced in some parts of the world now), while streets are deserted, with uncommon cases of some very few people walking around in distance wearing protective masks [1]. In December, 2019, a new infectious respiratory disease appeared in Wuhan of the Hubei province, China, and was termed by the World Health Organisation (WHO) as COVID-19 (coronavirus disease 2019) [2]. A novel class of corona virus, known as SARS-CoV-2 (severe acute respiratory syndrome coronavirus-2) has been found to be responsible for the manifestation of this disease [2]. The negative effects of the disease indulged the WHO to proclaim the COVID-19 as a pandemic [3]. As per the 162nd situation report released by WHO on June 30th, 2020, the COVID-19 had spread in more than 200 countries. About 516,570 people had died from the disease, out of 10,708,589 confirmed cases, but almost 5,860,386 people have recovered from the disease [4].

Actions such as lockdown taken by countries to contain the spread of COVID-19 have, according to Shrestha et al*.,* [5], noticeably influenced the dynamics of air pollution, thereby bringing a significant air pollution reduction. There is a cognizant reduction in the monthly concentrations of $PM_{2.5}$, PM_{10}, O_3, SO_X, CO_X, and NO_X in about forty (40) most industrialised; as-well-as most populated and polluted cities world over, between the months of February and March 2020, in association to same time in the year 2019 [5]. The lockdown enforced restrictions on vehicular movements, commercial flights and bans commercial activities, except for essential services, resulting in a provisional shutdown of air pollution sources from these activities which expressively reduced the emissions of most greenhouse gases (GHGs) that alter the climate [1,5]. In China, for example, the deferral of industrial activities due to the lockdown leads to about 30% and 25% drip in the levels of NOx and SOx respectively [3].

The emissions of CO_2 waned in April 2020 by about 17%, the biggest change in CO_2 emission since world war II, and this has been attributed to the global lockdown [6]. The COVID-19 outbreak has caused a drop in the emission of GHGs by about a quarter in Asia, leading to improvements in air quality that could finally save more lives [5,6,7]. Urban air pollution has a substantial impact on the chemistry of the atmosphere and therefore potentially on global climate [8]. Already, air pollution is a foremost issue in a number of megacities around the globe, and the release of gases and microscopic particles that are dynamic in air pollution and climate are often greatly interrelated due to shared generating process involving fossil fuels combustion which produces carbon (iv) oxide (CO_2), carbon (ii) oxide (CO), nitrogen oxides (NO_X), volatile organic compound (VOCs), black carbon (BC), aerosols (microscopic particles), and sulphur oxides (SOx) [8,9]. The six pecuniary sectors that are accountable for the total fossil fuels industry consumption and GHGs emission world over, especially CO_2, are power (44.30%), industries (22.40%), surface transportation (20.60%), public buildings and commerce (4.20%), residential buildings (5.60%), while the aviation sector accounts for (2.80%) [6]. Surface transportation according to Le Quere et al*.,* [6], is responsible for nearly half of the reduction in emissions during the lockdown period [6].

Many pre-existing health conditions such as cardiovascular and respiratory problems that increase the risk of death for COVID-19 are the same ailments that are affected by long term exposure to air pollution [5]. In fact, Wu et al*.,* [10] reported that air pollution exacerbates the COVID-19 death rate. What then could have been the mortality rate due to COVID-19 if lockdown have not been enforced? In the year 2016 alone, the WHO reported that almost 4.2 million people died from ambient air pollution worldwide, 29% of which were from lung cancer, 24% due to stroke, and 25% were as a result of heart ailments, while other lung related diseases covered 43%, as reported by Geladari et al*.,* [1]. However, air pollutants are projected to increase after COVID-19, and the real challenges must subsequently be confronted [1]. There is therefore the need to highlight the emerging synergies between air pollution and climate change, in relation to the global lockdown due to COVID-19.

2. LITERATURE REVIEW

Attempt is made from the available literature, in elaborating the generality of the concepts of air pollution and climate change in relation to the global lockdown due to the COVID-19 pandemic.

3. THE CORONAVIRUS 2019 (COVID-19) PANDEMIC

The plague of the novel coronavirus infection (COVID-19) originated from a seafood market in Hunan, within the city of Wuhan of China, in the month of December of 2019. It turned out, within few months, to be a global health emergency. Live animals like bat, frog, snake, and rabbit are commonly sold at the Hunan seafood market [11]. Although the intermediary source of origin and transmission to humans is not clearly known, the rapid human to human spreading capability of this virus has been documented [11]. As per the 162nd situation report released by WHO on June 30th, 2020, the COVID-19 had spread in more than 200 countries, and has so far resulted to the death of about 516,570 people, out of the total of 10,708,589 confirmed cases, while almost 5,860,386 people have recovered from the disease [4].

4. COVID-19 AND THE GLOBAL ENVIRONMENT UNDER LOCKDOWN

Due to the strange plague of COVID-19, almost all big and small cities and towns in the affected countries are under partial or total lockdown for a definite period of time. All local and central administrations worldwide have factually put a ban on free movement of their citizens outside their home in order to avoid community transmission [2]. The various religious, cultural, social, scientific, sporting, and political mass gatherings and events are cancelled. Vehicles are scarcely found on the roads resulting virtually to zero emission of gases and toxic suspended tiny particles to the environment [2].

Various types of industries are not functioning, all types of travels are cancelled. Meanwhile, efforts to restrict transmission of the COVID-19 by restricting the movements have had an exceptional environmental effect. Due to non-functioning of industries, industrial waste emission has reduced to a large extent [2]. Due to a very low demand of power in industries, use of fossil fuels have been greatly lowered. In many big cities, the inhabitants are experiencing a flawless sky for the first time in their lives. The pollution level in tourist spots such as forests, sea beaches and hill areas is also largely dwindling. Ozone layer has been found to have revitalised to some magnitude. The pandemic has presented its contrasting consequence on human civilization, in the sense that, on one hand it has accomplished worldwide destruction, but, on the other hand, produced a very positive bearing on the atmospheric air quality and the generality of the environment [2] (Fig. 1).

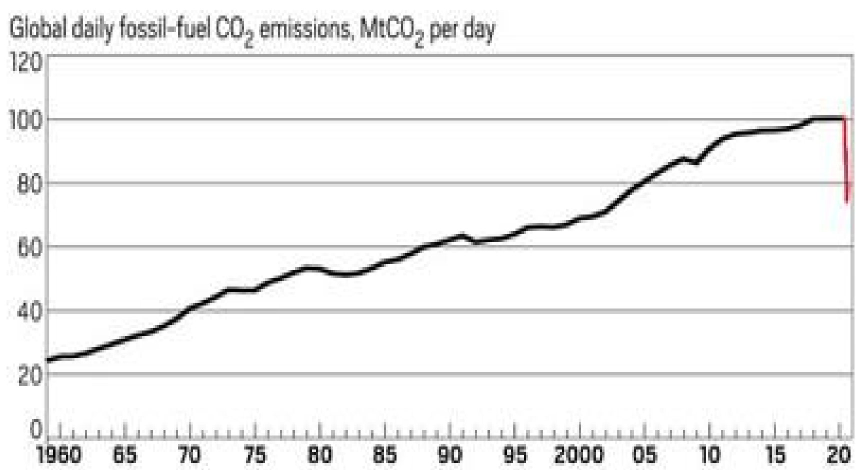

Fig. 1. Global daily fossil-fuel CO_2 emissions

Note: $MtCO_2$ is million metric tons of carbon dioxide (Source: Le Quere et al.,*[6]).*

5. EFFECTS OF AIR POLLUTION

The undesirable health impacts of air pollution have spawned considerable interest in the preceding decades where several studies have established that exposure to air pollution has increases health risks associated to respiratory, cardiovascular, pulmonary, and other health-related consequences [3]. The economic and social bearings of air pollution arising from its negative effects on public health have been extensively described in many countries around the world [3]. The situation in some developed and developing countries has gained attention due to the extraordinary growth and development that led to a considerable cost on the environment and posed a threat to public health and human welfare [12]. Air pollution was in 2013, responsible for about 32% of the reported deaths, with a mortality rate of 1.9% that were associated with $PM_{2.5}$ in some 74 leading cities, according to Fang et al*.,* [13]. The reported deaths were linked to cardiovascular, respiratory and lung-cancer diseases [13]. Globally, the WHO estimates that 92% of the world's population breathes in places where air quality is below guideline levels, and that outdoor air pollution causes about 3 million untimely deaths every year [3].

5.1 Major Air Pollutants: Their Health and Environmental Consequences

5.1.1 Carbon dioxide (CO_2)

An estimated 900 kg of CO_2 for every 1000 kg of cement produced is emitted into the atmosphere. This makes the industry as one of the highest in terms of CO_2 emissions, constituting about 5-7% of the global anthropogenic CO_2 emissions. About 40% is from burning of fossil fuels, 10% from electricity generation, as well transportation of raw materials. The remaining 50% is mainly released during major industrial operations [14]. According to Mishra and Siddiqui [15], the climate change effect of CO_2 is anticipated to increase the global temperature to +5.8°C by the year 2100, resulting to life-threatening weather conditions, loss of ecosystems and potentially hazardous health effects for humans and livestock, leading to surge in deaths, surface ozone, carcinogens and particulate matter, hence more cases of asthma, death and cancer. Crops are likely to get destroyed through acid rain, reduced transpiration, shrunk chlorophyll content, and declined seed yield [15].

5.1.2 Nitrogen Oxides (NOx)

These are formed via combustion of fuels and enters the atmosphere to undergo many reactions. Majorly, NOx are formed by thermal oxidation at temperatures between 1,200 – 1,600°C, resulting to the generation of amounts of nitrogen (ii) oxide (NO). Combustion of other nitrogen bearing fuels such as coal also produces N_2, or NO [15].

$$N_2 + O \rightarrow NO + N$$
$$N + O_2 \rightarrow NO + O$$

The formation of NO also increases with increase in temperature with about 90% of the nitrogen oxides produced in form of nitrogen (II) oxide (NO) and the remaining 10% are in the form of nitrogen (IV) oxide (NO_2) [16]. The NO produced converts to NO_2 at the exit of the stack at atmospheric conditions and appears in brown – yellow colour [16].

$$NO + {}^1/_2\, O_2 \rightarrow NO_2$$

NOx, according to Najjar [16], Mishra and Siddiqui [15], cause a wide range of environmental and health impacts due to the fact that they react with water and other compounds to form various acidic compounds that got deposited on the earth's surface and impair water quality of water bodies, as well as acidify lakes and streams; thereby making it difficult for aquatic species to survive, grow and reproduce. Acid rain can also harm forest ecosystems by directly damaging plant tissues. NO_2 accumulates in the atmosphere and as a GHG, changes the climate and warm the globe [15,16]. NOx and Volatile organic compounds react in the atmosphere in the presence of sunlight to form ground – level ozone, which causes smog in cities and rural areas. This ozone causes respiratory disease when breathed. NO_2 affects body functions such as difficulty in breathing, chronic lung diseases, heart failures and cancer [15,16].

5.1.3 Sulphur oxides – SOx

SOx emissions result from the combustion of sulphur bearing compounds in coal, oil, coke, and from pyrite and sulphur containing raw materials via many industrial processes [17]. Sulphur is oxidized to form SO_2 and SO_3 at temperatures between 370°C and 420°C, and from thermal decomposition of $CaSO_4$. The anhydrite SO_3 can easily be decomposed to SO_2 and O_2, according to Mishra and Siddiqui [15].

The sulphur oxides react with water vapour and other chemicals high in the atmosphere in the presence of sunlight to form sulphuric acids. The acids formed usually dissolve in the suspended water droplets, which can be washed from the air on to the soil by rain or snow. This is known as acid rain. It is responsible for so much damage to life and health. Respiratory illnesses such as bronchitis increase with SOx levels. Increased level of SOx in the atmosphere can also degrade agricultural productivity and death of some plants [15]. Cases of lung diseases, cancer and livestock deaths have been reported due to accumulation of SOx by Mehraj and Bhat [17].

5.1.4 Volatile Organic Compounds (VOCs)

Manufacturing and industrial processes release variable amounts of volatile organic compounds like dioxins and furans, which have attracted significant scrutiny [18]. Dioxins and furans are general names applied to a large, complex group of polychlorinated organic compounds, many of which are highly toxic even in trace amounts, the most toxic and well-studied member being 2,3,7,8–tetrachloro-dibenzo-p-dioxin (TCDD) [18]. VOCs have been reported by Mishra and Siddiqui [15] to be precursors to ozone formation which can also contaminate soil and ground water, and also affect the environment and human health through retardation of plant growth, irritations in the respiratory tract and the eyes, headache, nausea, damage to liver, and kidney. VOCs are also carcinogenic [15,18].

5.1.5 Particulate Matters (PM_{10} and $PM_{2.5}$)

Particulate matters are fine particles that can persist in the air and include dust and soot [17]. The main environmental problem occasioning from dust emission is reduced visibility and worsened ambient air quality. Particulate emissions contain harmful toxic metals such as lead chromium, nickel, barium – which can pose serious health impact on human health. They carry carcinogens, mutagens, immunotoxins, respiratory toxins, and neurological toxins [15]. Coarse particulate (>PM_{10}) are considered to cause local nuisance than creating health hazard by sticking to vehicles, clothes hanged at laundry, building surfaces and damaging ornamental metals [15].

5.2 Urban Air Pollution and Climate Change: The Tropospheric Chemistry

Urban air pollution has a substantial impact on the chemistry of the atmosphere and therefore perhaps on global climate [8]. Already, air pollution is a major issue in an increasing number of megacities around the world, and the emission of gases and microscopic particles (aerosols) that are vital in air pollution and climate are often highly correlated due to shared generating process involving fossil fuels combustion and biomass which produces carbon (iv) oxide (CO_2), carbon (ii) oxide (CO), nitrogen oxides (NO_X), volatile organic compound (VOCs), black carbon (BC), aerosols and sulphur oxides (SOx) [8,9] (Fig. 3).

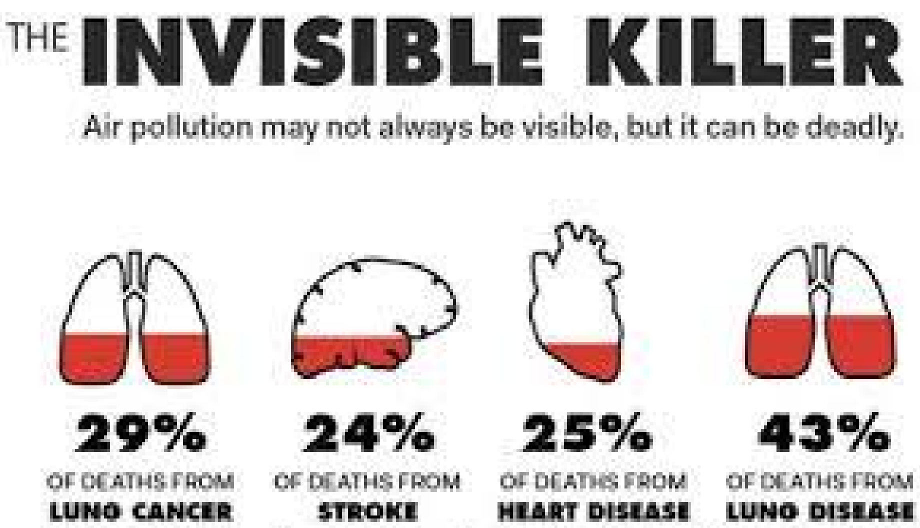

Fig. 2. Ambient air pollution death related diseases
(Source: Isaifan, [3])

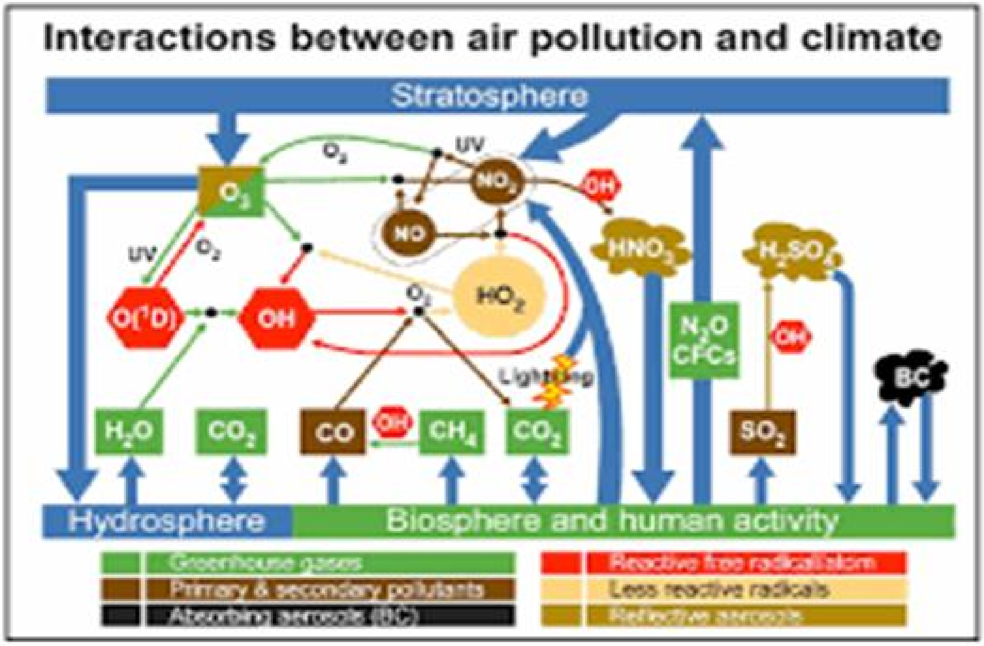

Fig. 3. Summary of the chemistry in the stratosphere important in the linkage between urban air pollution and climate
(Source: prinn, [8])

Explaining the Fig. 3 above, when hydroxyl radical (OH) reacts with methane (CH_4), the methane is typically transformed to carbon (ii) oxide (CO) in steps that consume the hydroxyl radical and also produce hydroperoxy (HO_2). The OH in turn converts CO to CO_2, nitrogen (iv) oxide (NO_2) to trioxonitrate (v) acid (HNO_3), while sulphur (iv) SO_2 is transformed into tetraoxosulphate (vi) acid H_2SO_4. The primary OH production pathway occurs when water vapor (H_2O) reacts with the excited oxygen $O(^1D)$ atoms that come from dissociation of ozone (O_3) by ultraviolet (UV) light. In about a second of its formation, typically, the OH reacts with other gases, either by donating its O atom (e.g., to CO to form CO_2 and H) or by removing H (e.g., from CH_4 to form CH_3 and H_2O). The H and CH_3 formed in these ways attach rapidly to O_2 to form hydroperoxy (HO_2) or methylperoxy (CH_3O_2) free radicals which are somewhat unreactive. If there is no way to rapidly recycle HO_2 back to OH, the levels of OH are kept fairly low. The accumulation of NOx emissions into the mix significantly changes the chemistry [8].

Specially, a second pathway is created in which NO reacts with HO_2 to form NO_2 and subsequently OH. Ultraviolet light then decomposes NO_2 to produce Oxygen (O) atoms which immediately attach to O_2 to form O_3 and reform the NO. Hence the sum of NO and NO_2 (NOx) is a catalyst which is not consumed in these reactions. The production rate of OH by this secondary path in polluted air is about five times faster than the above primary pathway involving $O(^1D)$ and H_2O. The reaction of NO with HO_2 does not act as a sink for HOx (the sum of OH and HO_2) but instead determines the ratio of OH to HO_2. Calculations for polluted air suggest that HO_2 concentrations are about 40 times greater than OH. This is due mainly to the much greater reactivity of OH compared to HO_2. If emissions of air pollutants that react with OH, such as CO, VOCs, CH_4, and SO_2, are increasing, then keeping all else constant, OH levels should decrease. This would increase the lifetime and hence concentrations of CH_4. However, increasing NOx emissions should increase tropospheric O_3 (and hence the primary source of OH), as well as increase the recycling rate of HO_2 to OH (the second source of OH). This OH increase should lower CH_4 concentrations. Changing the level of OH causes greenhouse gas, and hence climate change. Climate change will also influence OH. Higher ocean temperatures should increase H_2O in the lower troposphere and therefore increase OH production through its primary pathway. Higher atmospheric temperatures also increase the rate of reaction of OH with CH_4, decreasing the concentrations of both. Greater cloud cover will reflect more solar ultraviolet light, thereby decreasing OH, and vice versa. Added to these interactions involving gases, are those involving aerosols. For example, increasing SO_2 emissions and/or OH concentrations should lead to greater concentrations of sulfate aerosols which are a cooling influence. Accounting for all of these interactions, and other related ones requires that a detailed interactive atmospheric chemistry and climate model be used to assess the effects of air pollution reductions on climate [8].

5.3 Some Control Measures and Techniques for Major Air Pollutants

The following control measures and techniques could be adopted as reported by many scientists and compiled by Sharma et al. [19].

5.3.1 Carbon dioxide (CO_2)

- Economical fuel consumption in manufacturing process. This could be achieved through replacement of old machines with new ones or reduction in the production of the components or sequencing of the machines for optimization of resources.
- Use of electricity, water or renewable energy powered vehicles. Improved technologies and scientific breakthroughs should be harnessed for environmental friendly vehicles in terms of energy usage. By this, large amount of fossil fuel would greatly be reduced in usage, and this will in turn greatly reduce the amount of greenhouse gases been emitted.
- Promotion of public transportation system across the world. Governments and other stakeholders should promote mass transportation system. Through this, the large number of vehicles in motion on daily basis will significantly be reduced and this will no doubt contribute greatly in reducing the amount of GHGs in the atmosphere, hence air quality is promoted.
- Energy efficient process selection and operation. Efficient usage of energy should be researched into, tested and promoted for both domestic and industrial applications. This should be promoted through the selection of efficient processes for optimal burning and maximum output.
- Low ratio carbon content to calorific value fuel selection like natural gas. This would ensure the minimization of carbon based oxide pollutants, and reduce the amount of soot and aerosols, which in-turn shall improve air quality and improved health of the populace

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5.3.2 Nitrogen oxides (O_x)

- Maintaining secondary air flow as low as possible (e.g. oxygen reduction). This is to reduce the amount of harmful carbon dioxide emitted from exhaust valves. It is achieved by injecting high amount of ambient air containing oxygen into the exhaust gas manifold which creates less harmful oxide via post combustion.
- Using low NO_x burners to avoid localized emission hot spots. These are heat conduction oil furnace that use the indirect heating of heat-transfer oil by burning the burner, forcing the heat-transfer oil after the liquid phase circulating heating through the circulation pump, thereby achieving low NOx combustion at temperatures of about 200̊ C to 250̊ C. This would ensure reduced amount of NOx and improved air quality.
- Developing a staged combustion process as applicable in pre-heater (PH) kilns. This would go a long way in reducing the NOx emission. Models should be developed on the implementation and application of this concept for improved efficiency.
- Employing flame cooling by adding water to the fuel or directly to the flame (e.g. temperature decrease and hydroxyl radical concentration increase).

5.3.3 Sulphur oxides (SO_x)

- Use of packed dry and wet scrubbers. These are used to treat or clean certain harmful chemicals such as ammonia, chlorine, hydrochloric acid, chlorinatwd silanes, amines, SOx and metallic compound; from a process exhaust air stream. This would ensure less air pollutants and improved air quality.
- Selection of fuel and materials with lower sulphur content. This would ensure the reduction of emission of SOx and other related particulates for improved air quality and reduced GHGs emission.
- Injection of absorbents such as hydrated lime [$Ca(OH)_2$], calcium oxide [CaO], or fly ashes with high CaO content into the exhaust gas before filters. This would ensure the removal of harmful gases such as CO_2 from the exhaust gases, hence it

would not be emitted into the atmosphere to cause air pollution.

- Use of a vertical mill and gases passing through the mill to recover energy and to reduce the sulphur content in the gas, hence less soot and SOx are to be released into the atmosphere.
- Mixing the gases containing sulphur oxide mixes the calcium carbonate [$CaCO_3$] of the calcium sulphate (Gypsum)

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5.3.4 Particulate matter and heavy matals

- Minimizing the number of transfer points by using a simple linear lay-out for materials handling operations including enclosed belt conveyors and emissions controls at transfer points.
- Better storage of raw materials and fuel, which include: storing crushed and pre-blended raw materials in covered or closed bays and storing pulverized coal and petroleum coke in silos.
- Waste-derived fuels should be stored in areas which are protected from wind and other weather elements
- Control of fugitive emission by automatic bay filling using a rotary bag filling machines
- Capturing of soot and dust using filters and the subsequent recycling of such
- Use of electrostatic precipitators (ESPs) to collect and control fine particulate emissions in kiln gases.
- Use of cyclones to remove large particulate of cooler gases, followed by fabric filters and recycling within the mill
- Use of activated carbon for absorption of heavy metals and efficient dust abatement to capture bound metals.

6. REMEDIATION MEASURES AND POLICY RECOMMENDATIONS

The impacts of air pollution will still be there even when the global lockdown is completely uplifted. There is the likelihood that more pollutants will be discharged into the atmosphere and, to ensure less impact on global air quality and health of the populace, we propose some new measures and policies that could be harnessed and deliberated upon by stakeholders and policy-makers post COVID-19; to checkmate air pollution and improve air quality, thereby minimising air pollutant related ailments. We recommend how these policies could best be adopted and implemented for reduction in air pollution and improved healthcare.

7. COMPULSORY WEARING OF FACE MASKS

Wearing of facemask by all inhabitants of densely populated and industrialised cities should be made compulsory and penalties outlined for defaulters. This would no doubt help in checkmating the many health threats associated with air pollution and promotes longevity in not only the aged populace, but also the young and infants who could be vulnerable to air bone diseases and challenges. This should be backed by all the necessary legislations and policies by governments and policy makers to ensure compliance. Medical and professional organisations should also be incorporated in sensitization, awareness and enforcement of the legislation for improved health delivery and socio-economic stability.

8. ROBUST ICT FOR IMPROVED TECHNOLOGICALLY BASED SERVICES

Rendering some vital services from home during the global lockdown has, for the first time globally, promotes the very vital role of Information and Communication Technology (ICT) for most organisations, companies, banks, institutions, public service providers and even government parastatals. Virtual meetings have been conducted via various forms and applications, with many service providers reporting financial boom. Many public and private institutions of learning resorted to online lecture deliveries and virtual interactions with students. Seminars and conferences have been organized and are still been conducted virtually, which greatly reduces GHGs emission as a result of non-vehicular movements of people, and reduced fossil fuels combustion for electricity generating sets. All these measures and initiatives should be sustained, promoted and supported. Online schools, conferences and seminars should be greatly encouraged and adopted.

9. HOME ORIENTED SERVICE DELIVERY FOR MOST NON-ESSENTIAL STAFF OF ORGANIZATIONS, COMPANIES AND AGENCIES OF GOVERNMENTS

Government parastatals, public and private organisations should consider and adopt moving some of their staff back home, from where they will be rendering their service via a robust ICT based platform. This will go a long way in not only reducing GHGs emission and preventing climate change, but would also help in abating various forms of accidents, traffic jams and prevent large number of people from getting exposed to air pollutants.

10. LEGISLATIONS ON MOTOR CAR OWNERSHIP, PUBLIC TRANSPORTATION AND CLEAN ENERGY POLICIES

Legislations deterring multiple car ownership should be enacted to reduce excess emission of pollutant gases. Massive public transportation of different sorts should be provided and greatly encouraged especially across cities, towns and states. This would go a long way in reducing the level of pollutant gases emitted from vehicular transportation. Various professionals and energy scientists should be engaged in designing, provision and implementation of cleaner renewable energy sources. This should also be promoted to be adopted by companies, organisations and other sectors that use energy on a large scale.

11. CONCLUSIONS

One significance of the COVID-19 induced lockdowns around the world has been lesser air pollution levels in virtually all major industrialised and highly populated cities around the globe. As the world starts to arise out of the lockdown effects and businesses take up again, it is imperative to take steps to guarantee that the air we breathe remains clean.

Collective efforts and responsibilities are needed to better our past efforts through concrete, united and conveniently agreed international decisions and policies for the betterment of the lives of all. These efforts are crucial for reducing future impacts; however, because over-all global emissions are expected to continue to raise post COVID-19, adaptation to the impacts of future climate variability will also be required. Data need to be collated to ascertain the level of mortalities due to the consequence of air pollution and compare same with the mortality rate for COVID-19.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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