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Research Paper

Engineering Interventions to Reduce the Environmental Stress of Air Pollution

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ABSTRACT
Environmental engineer is concerned with the protection and prevention of the environment and develops the solution to environmental problem. Environmental engineer ensures work place hazards and environmental health and safety related policies and procedure are communicated to employer and employees, ensures the availability of medical surveillance programme in assisting employer and employees in the course of potentially hazards, that can pose immediate danger to health and safety, encouraging conducive environment for stress free conditions in the environment. Consequently, restriction of stress to condition where an environmental demand exceeds the national regulatory capacity of an organism, in particular situations that include unpredictability and uncontrollability also ensuring employees are properly trained for their jobs and environmental health and safety obligation are carried out by everyone involved.
Air quality engineers have helped reduce its presence by contributing to designs for cleaner engines and power plants and also advocating for standards such as the Cross-State Air Pollution Rule limiting emissions that exacerbate pollution in neighboring states.
KEY WORDS: *Environment, stress, engineer, intervention and health.*

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I. INTRODUCTION

The Engineer's Joint Council on Air Pollution and Its Control defines air pollution as "the presence in the outdoor atmosphere of one or more contaminants, such as dust, fumes, gas, mist, outdoor, smoke or vapor in quantities, of characteristics, and of duration, such as to be injurious to human, plant, or property, or which unreasonably interferes with the comfortable enjoyment of life and property." Air pollution, as defined above, is not a recent phenomenon. Natural events always have been the direct cause of enormous amounts of air pollution. Volcanoes, for instance, spew lava onto land and emit particulates and poisonous gases containing ash, hydrogen sulphide (H_2S), and Sulphur dioxide (SO_2) into the atmosphere. It has been estimated that all air pollution resulting from human activity does not equal the quantities released during three volcanic eruptions: Krakatoa in Indonesia in 1883, Katmai in Alaska in 1912, and Hekla in Iceland in 1947. Lightning, another large contributor to atmospheric pollution, activates atmospheric oxygen (O_2) to produce ozone (O_3), a poisonous gas [ozone in the upper atmosphere, however, acts as a shield against excessive amounts of ultraviolet (UV) radiation, which can cause human skin cancer. In addition to the production of ozone, lightning is the indirect cause of large amounts of combustion-related air pollution as a result of forest fires. The Forest Service of the United States Department of Agriculture reported that lightning causes more than half of the over 10,000 forest fires that occur each year. For centuries, human beings have been exposed to an atmosphere permeated by other natural pollutants such as dust, methane from decomposing matter in bogs and swamps, and various noxious compounds emitted by forests. Some scientists claim that such natural processes release twice the amount of sulfur-containing compounds and 10 times the quantity of carbon monoxide (CO) compared to all human activity. Why, then, is society so perturbed by air pollution? The concern stems from a combination of several factors:

1. Urbanization and industrialization have brought together large numbers of people in small areas.
2. The pollution generated by people is most often released at locations close to where they live and work, which results in their continuous exposure to relatively high levels of the pollutants.
3. The human population is still increasing at an exponential rate. Thus, with rapidly expanding industry, ever more urbanized lifestyles, and an increasing population, concern over the control of man-made air pollutants is

now clearly a necessity. Effective ways must be found both to reduce pollution and to cope with existing levels of pollution. As noted earlier, natural air pollution predates us all. With the advent of Homo sapiens, the first human-generated air pollution must have been smoke from wood burning, followed later by coal. From the beginning of the 14th century, air pollution from coal smoke and gases had been noted and was of great concern in England, Germany, and elsewhere. By the beginning of the 19th century, the smoke nuisance in English cities prompted the appointment of a Select Committee of the British Parliament in 1819 to study and report on smoke abatement. Many cities in the United States, including Chicago, St. Louis, and Pittsburgh, have been plagued with smoke pollution. The period from 1880 to 1930 has often been called the "Smoke Abatement Era." During this time, much of the basic atmospheric cleanup work started. The Smoke Prevention Association was formed in the United States near the turn of the 20th century, and by 1906, it was holding annual conventions to discuss the smoke pollution problem and possible solutions. The name of the association was later changed to the Air Pollution Control Association (APCA). The period from 1930 to the present has been dubbed the "Disaster Era" or "Air Pollution Control Era." In the most infamous pollution "disaster" in the United States, 20 were killed and several hundred made ill in the industrial town of Donora, Pennsylvania in 1948. Comparable events occurred in the Meuse Valley, Belgium in 1930 and in London in 1952. In the 1960s, smog became a serious problem in California, especially in Los Angeles. During a 14-day period from November 27 to December 10, 1962, air pollution concentrations were extremely high worldwide, resulting in "episodes" of high respiratory incidents in London, Rotterdam, Hamburg, Osaka, and New York. During this period, people in many other cities in the United States experienced serious pollution related illnesses, and as a result, efforts to clean up the air were started in the cities of Chicago, New York, Washington, DC, and Pittsburgh. The substitution of less smoky fuels, such as natural gas and oil, for coal, for power production and for space heating accounted for much of the subsequent improvement in air quality. Air quality in the United States depends on the nature and amount of pollutants emitted as well as the prevalent meteorological conditions. Air pollution problems in the highly populated, industrialized cities of the eastern United States result mainly from the release of Sulphur oxides and particulates. In the western United States, air pollution is related more to photochemical pollution (smog). The latter form of pollution is an end product of the reaction of nitrogen oxides and hydrocarbons from automobiles and other combustion sources with oxygen and each other, in the presence of sunlight, to form secondary pollutants such as ozone and PAN (proxy acetyl or acyl nitrates). Temperature inversions effectively "put a lid over" the atmosphere so that emissions are trapped in relatively small volumes and in correspondingly high concentrations. Los Angeles, for example, often suffers a very stable temperature inversion and strong solar input, both ideal conditions for the formation of highly localized smog. Rain and snow wash out the air and deposit the pollutants on the soil and in water. "Acid rain" is the result of gaseous sulfur oxides combining with rain water to form dilute sulfuric acid and it occurs in many cities of eastern United States.

II. REASONS FOR ENGINEERING INTERVENTIONS:

- More than 5 million people die each year from air pollution related causes. According to research presented at 2016 American association for the advancement of the science conference.
- Air pollution in India caused over 1.6 lakh infant deaths in 2019.
- Industrial activities.
- Use of charcoal and wooden heaters in homes and offices.
- Excessive use of motor vehicles.

An air quality engineer typically performs a variety of tasks, which nevertheless fall into a few broad categories:

1. Modeling and understanding pollution and its sources.
2. Monitoring emissions and compliance with applicable regulations.
3. Designing and implementing quality improvement solutions

Modeling And Understanding Pollution and Its sources: Say a new chemical factory is slated for construction. Early on its life cycle, environmental engineers including ones specializing in air quality will play important roles in identifying the types of compounds that will be used in its production processes, as well as the air pollutants materials will generate.Such analysis is essential to any potential containment of pollution, whether from a factory, a car or another source. It may be supported by statistical models and representations that link pollution levels to specific fuels, contaminants and air patterns, which can in turn be addressed with appropriate technologies and regulations.For example, air quality modelling was pivotal in the reduction of nitrogen dioxide, which can impair the respiratory system and affect ozone concentrations, in major U.S. metro areas between 2005 and 2011, as charted by NASA. Nitrogen dioxide is produced mostly by automobiles and coal-fired power plants. Air quality engineers have helped reduce its presence by contributing to designs for cleaner engines and power plants and also advocating for standards such as the Cross-State Air Pollution Rule limiting emissions that exacerbate pollution in neighbouring states.

Monitoring Emissions And Compliance With Applicable Regulations: Air quality engineers who work in the public sector may be responsible for ensuring compliance with rules and regulations like the Cross-State Air Pollution Rule, at the federal and/or state levels. The comprehensive guidelines provided by the state of Michigan exemplify the common activities that air quality engineers may oversee, such as:

- Reviewing applications for installation permits.
- Assessing compliance of these atmospheric emissions.
- Assisting with additional specific compliance standards.

In the private sector, air quality engineers may perform similar tasks. Engineers may also participate in negotiations with regulatory agencies on such issues.

Designing and Implementing Quality Improvement solutions: Meeting mandated standards for air quality is only possible with the right infrastructure. Ventilation systems, baghouses (for removing particulates at steel mills, fossil fuel-burning power plants, pharmaceutical factories, etc.), regenerative incinerators (for controlling pollution streams from volatile organic compounds) and many other control mechanisms are designed and maintained by air quality engineers.

Plus, environmental engineers often visit industrial and municipal sites to measure the success of these air pollution controls and advise on any necessary changes. Their recommendations are rooted in evaluations of scientific evidence, along with applications of engineering methodology and consultation of regulatory guidance. These skills are developed both on the job and in degree-granting engineering programs.

ENGINEERING INTERVENTIONS TO REDUCE AIR POLLUTION

- Solar ferry
- Chakr Innovation
- Photosynthesis bike
- Smog-free towers
- Air-purifying billboard
- Clean air bubble

Solar Ferry:

Aditya is a solar-powered ferry operating between Vaikkom and Thavanakkadavuin the Indian state of Kerala. The boat was inaugurated by Kerala Chief Minister Sri. PinarayiVijayan and Central Cabinet Minister for Power, Renewable Energy, Sri. PiyushGoyal on 12 January 2017.

It is India's first solar-powered ferry and the largest solar-powered boat in India. The vessel was designed and built by NavAlt Solar and Electric Boats in Kochi, India. NavAlt is a joint venture firm between Navgathi Marine Design and Constructions, Alternative Energies (France) and EVE Systems (France).

The normal operating speed is 5.5 knots (10 km/h) to achieve a 15-minute travel time between Vaikom and Thavanakkadavu, a distance of 2.5 km on water. For achieving this speed, the power needed is about 16 kW. During maneuvering, when leaving the jetty or approaching it, about 22 kW of power is needed. Hence, on average about 20 kW power is needed. The total running time, neglecting the time in jetty for embarkation and disembarkation of passengers is 5.5 hours on a sunny day (depending on client needs).

Although the maximum power needed is a total of 22 kW during maneuvering and 16 kW under cruise, more than double the power, a total of 40 kW, is provided in two motors of 20 kW each. The two systems on either side of the boat (in each demi-Hull) are electrically independent to ensure redundancy in case of system failure in one. Even if one system fails the power is available to safely cruise to shore with others. Also, unlike diesel engines, since efficiency does not drop with load, the electric motors can normally operate at 50% load and in emergencies at 100%.

For higher safety standards and reliability, the vessel is built under IndianRegister of Shipping rules for inland vessels and operating conditions of the Vaikom – Thavanakkadavu route. The boat construction is complete and was tested by Technical committee, Indian Register of Shipping surveyor and Kerala Port surveyor on 16 November 2016, near in backwaters at Aroor. The boat is registered in Kodungallur Port under Kerala Ports.

The boat is remotely monitored and troubleshooting can also be done remotely. All the operating parameters of the boat are recorded and transmitted to the NavAlt Solar and Electric Boatsserver from where the technical experts can monitor the boat. The upgrades and settings in the software can also be performed remotely as if a computer is plugged into the boat. This makes the boat even safer.The project cost was US$370,000.

Chakr Innovation:

Chakr Innovation is a company founded by engineering graduates from IIT Delhi that aims to develop sustainable and environment-friendly solutions for power generation. The Company was incorporated in June 2016 and

has been recognised as a Start-up under the "Start-Up India Stand up India" scheme launched by Department of Industrial Promotion and Policy (DIPP). It is one of the 10 start-ups selected for special mentoring and benefits. They have established a workshop with large production facility as well as a trained operations team for on-field work. They have also collaborated with BOSCH India and IOCL for technology commercialisation and product development. Chakr Innovation has been recognised and awarded by various organisations, as an organisation, mission is to develop and implement technologies, which can effectively control pollution - saving the natural environment and people's health. Currently, they have identified air pollution as a focus area due to its tremendous health and environmental impact. Diesel generators being a significant contributor to ambient particulate matter, they have developed a novel device, which can capture up to 90% of particulate matter being emitted from diesel generators. Along with controlling emission at source, their technology also ensures that the collected particulate matter is not disposed-off or burnt but is used as a raw material for inks and paints.

Photosynthesis bike:

Bicycle transportation is already one of the cleanest forms of transportation there is for the environment.The Air-Purifying Bike is a concept, developed by designers at the Bangkok-based Light fog Creative & Design Company, that uses an air filter to clean the air around a cyclist. The filter sits between the bike's handlebars and uses a "photosynthesis system" to generate oxygen with a water tank and battery-powered electric motor. But the bike doesn't just clean the air while you ride, it can also work while it's parked.

To be clear, this concept is just that, an idea. The design is sleek and the idea is an innovative one, but it currently only exists in two-dimensions. The messy details are yet to be worked out. How will the battery be charged? How long will it last? Will the amount of clean air justify the added cost of the attached "photosynthesis system"? The hardest part is yet to come if this bike is ever to reach the streets. But according to Fast Company, Light fog does plan to build a prototype.

Still, the design has already won an award and looks infinitely more pleasant to ride (and more safe) than another clean-air producing bike we saw earlier this year.

Smog Free Tower:

Combating air pollution in recent years, through astutely innovative sustainable methods, is Dutch artist and architect DaanRoosegaarde. With his Smog Free Project - a series of urban innovations such as the Smog Free Tower, the Smog Free Ring, the Smog Free Bicycle and the Smog Eating Billboard – he is providing local design solutions to clean air in public spaces, and aiming for a healthier, cleaner future for cities and their inhabitants.

The seven-meter tall aluminum towers are Roosegaarde's fresh approach to tackle detrimental smog in cities. The world's first smog vacuum cleaner is equipped with technology that purifies 30 cubic meters of air per hour, and employs patented positive ionization techniques to supply smog-free air. Giving access to (free) cleaner air in public parks in particular, the Smog Free Tower sucks in smog at its top, and purified air is released through vents on its six-sided body, using a small amount of green electricity to function.Recent Smog Free Towers have been launched in cities such as Tianjin, Dalian and Beijing in China, Rotterdam in the Netherlands, Poland, and is now providing clean air to the public of Pyeong-chon Central Park, Anyang, South Korea.The competency of the Smog Free Tower has been confirmed through test-results obtained by the Eindhoven University of Technology, the Netherlands.

Air Purifying Billboards:

The University of Engineering and Technology of Peru (UTEC), are back with an encore idea that sounds just as clever. This one involves a slightly different sort of billboardalso located in Limathat sucks pollution from the sky and returns purified air to the surrounding areas. Not just trace amounts of air, like those claimed by conventional room-based HEPA air purifiers, either, but 100,000 cubic meters of urban air per day. That's over 3.5 million cubic feet, which UTEC says is equivalent to the work of 1,200 mature trees. That's a lot of air. Furthermore, UTEC claims the billboard is "totally effective in removing [the] dust, metal and stone particles" that contaminate air spaces around construction zones, and which can lead to life-threatening health problems, from respiratory issues to cancer.

Working: It's employing basic thermodynamic principles that are, principles related to shifts in temperature, pressure and vacuum to combine incoming air with water in a mechanism that balances their internal heat. That transaction results in the pollutants (dust, small particles of metal, germs and bacteria) hanging back in the water, effectively scrubbed from the air. It keeps metrics on the actual amounts, and measures them daily: it told me that between March 24-30, 49,800 people benefitted from 489,000 cubic meters of purified air, and that its billboard managed to eliminate 99 percent of the airborne bacteria from that total.

This is a highly efficient continuous process, with very low energy consumption just 2.5 kilowatts (2,500 watts) of electricity per hour, or roughly what an emergency generator might consume powering your bare essentials in a small home. The billboard's benefits extend to a radius of five city blocks, benefitting both

residents and construction workers, and that the water used by the billboard is fully recyclable. The university adds that it's using the extracted materials as an opportunity to analyse the residual pollutants, presumably to get a better read on pollutant specifics with an eye toward building even more thorough billboards down the road.

III. CONCLUSION:

In conclusion, (AEO, 2013) noted that the existence ofstress caused by unhealthy and unsafely environmentcaninduce a rise in certain hormones secreted by theadrenal gland which triggers and increase the heart rate and bloodpressure on the employees of the establishment. PNNL (2015) is of the opinion that unconducive and unsafe environment are the factors thatmostly cause environmental stress, which can cause ill-health to the employees.Therefore, unhealthy employees are always unproductive and thus a socio-economicproblem that could lead tomoribund of any establishment(company)Consequently, an environmental engineer is more qualified to curb the problems of stress. Moreover, hisresponsibilities as an environmentalist are complying,implementing, communicating and ensuring, adherence to environmental, health and safety, regulations, principles and practice which will be beneficial to the employer, employees and entire establishment (Renald,2010).

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