**A TERM PAPER ON**

**DEVELOPMENT OF ENVIRONMENTAL HEALTH ENGINEERING FACILITIES, EQUIPMENT, SENSORS AND PUBLIC HEALTH SYSTEMS FOR TACKLING COVID-19 PANDEMIC**

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**ABSTRACT**

Coronavirus disease known as COVID-19 is an infectious disease caused by a new virus. The disease causes respiratory illness (like the flu) with symptoms such as a cough, fever, and in more severe cases, difficulty breathing. The spread of the virus has become a pandemic, having 961,749 active cases and 48,165 death cases all over the world. To tackle the spread of the virus firstly the development of environmental health engineering facilities, equipment, sensors and public health systems would be considered and this will be discussed in this term paper.

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**CHAPTER ONE**

1. **INTRODUCTION**

The Coronavirus disease (COVID-19) pandemic (caused by the virus SARS-CoV-2) has increased demand for medicines, vaccines, diagnostics and reagents, all related to COVID-19, creating an opportunity for the chemical engineers and all other fields in engineering to create avenue for the development of environmental health engineering facilities, sensors and public health system to aid in providing this.

 **FIGURE 1**

During this worldwide crisis, the chemical process industries (CPI) continue to operate to provide products and services that are part of our critical infrastructure. Goggles, face shield, and gowns, as well as items for specific procedures-filtering face piece respirators (i.eN95 or FFP2 or FFP3 standard or equivalent)-hereafter referred to as “respirators"-and aprons. Public health has always been, and remains, an interdisciplinary field, and engineering was closely aligned with public health for many years. Indeed, the branch of engineering that has been known at various times as sanitary engineering, public health engineering, or environmental engineering was integral to the emergence of public health as a distinct discipline.

The provision of safe water, sanitation and hygienic conditions is essential to protecting human health during all infectious disease outbreaks, including the COVID-19 outbreak. Ensuring good and consistently applied WASH and waste management practices in communities, homes, schools, marketplaces and health care facilities will further help to prevent human-to-human transmission of the COVID-19 virus.

Public health and engineering were closely aligned as professional fields for many years; indeed, engineering was integral in the emergence of public health as a distinct discipline from clinical medicine . However, the practice and profession of environmental engineering have become partially separated from public health in the latter half of the 20th century in the United States (U.S.). Several factors contributed to this separation, including an evolution in leadership roles within public health; increasing specialization within public health, including the formation of the sanitarian/environmental health field, to which some tasks migrated that were formerly within public health engineering; and the emerging environmental movement, which led to the creation of the U.S. Environmental Protection Agency, with its emphasis on human health and the natural environment. In this paper, we consider these factors in turn, and also highlight an example of public health engineering in current practice in the U.S. We also consider how to educate public health engineers in the modern world, and the global implications of public health engineering.

Engineering is obviously found in other content areas and occupations within public health beyond environmental applications. For example, biomedical engineering is prominent within the Food and Drug Administration (FDA), as is safety engineering and industrial hygiene in the National Institute of Occupational Safety and Health (NIOSH) [[3](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6388373/#B3-ijerph-16-00387)]. In this paper, however, we specifically focus on the aspects of engineering that were most closely aligned with the emergence of public health, and that have been known at various times as sanitary engineering, public health engineering, and environmental engineering. We believe that there is a current need to strengthen the connection between this type of engineering and the practice of public health, and an appropriate moniker for this profession is “public health engineering”.

 **CHAPTER TWO**

**LITERATURE REVIEW**

1. **CORONA VIRUS (COVID-19)**

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus.

Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment.  Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.



 **FIGURE 2: IMAGE OF COVID-19 (MICROSCOPICALLY)**

The best way to prevent and slow down transmission is to be well informed about the COVID-19 virus, the disease it causes and how it spreads. Protect yourself and others from infection by washing your hands or using an alcohol based rub frequently and not touching your face.

The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it’s important that you also practice respiratory etiquette (for example, by coughing into a flexed elbow).

At this time, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments. WHO will continue to provide updated information as soon as clinical findings become available.

**SYMTOPMS OF CORONA VIRUS**

The COVID-19 virus affects different people in different ways.  COVID-19 is a respiratory disease and most infected people will develop mild to moderate symptoms and recover without requiring special treatment.  People who have underlying medical conditions and those over 60 years old have a higher risk of developing severe disease and death.



**FIGURE 3: IMAGE OF A LADY GETTING TESTED**

Common symptoms include:

* fever
* tiredness
* dry cough.

Other symptoms include:

* shortness of breath
* aches and pains
* sore throat
* and very few people will report diarrhoea, nausea or a runny nose.

People with mild symptoms who are otherwise healthy should self-isolate and contact their medical provider or a COVID-19 information line for advice on testing and referral.

People with fever, cough or difficulty breathing should call their doctor and seek medical attention.

**PREVENTION OF CORONA VIRUS**

To prevent infection and to slow transmission of COVID-19, do the following:

* Wash your hands regularly with soap and water, or clean them with alcohol-based hand rub.
* Maintain at least 1 metre distance between you and people coughing or sneezing.
* Avoid touching your face.
* Cover your mouth and nose when coughing or sneezing.
* Stay home if you feel unwell.
* Refrain from smoking and other activities that weaken the lungs.
* Practice physical distancing by avoiding unnecessary travel and staying away from large groups of people.
	1. **ENVIRONMENTAL HEALTH**

Environmental health is the branch of [public health](https://en.wikipedia.org/wiki/Public_health) concerned with all aspects of the [natural](https://en.wikipedia.org/wiki/Natural_environment) and [built environment](https://en.wikipedia.org/wiki/Built_environment) affecting human health. Environmental health is focused on the natural and built environments for the benefit of human health. The major subdisciplines of environmental health are: [environmental science](https://en.wikipedia.org/wiki/Environmental_science); environmental and occupational medicine, [toxicology](https://en.wikipedia.org/wiki/Toxicology) and [epidemiology](https://en.wikipedia.org/wiki/Epidemiology).

As of 2016 the WHO website on environmental health states "Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments. This definition excludes behaviour not related to environment, as well as behaviour related to the social and cultural environment, as well as genetics.

The WHO has also defined environmental health services as "those services which implement environmental health policies through monitoring and control activities. They also carry out that role by promoting the improvement of environmental parameters and by encouraging the use of environmentally friendly and healthy technologies and behaviors. They also have a leading role in developing and suggesting new policy areas.

The term [environmental medicine](https://en.wikipedia.org/wiki/Environmental_medicine) may be seen as a medical specialty, or branch of the broader field of environmental health Terminology is not fully established, and in many European countries they are used interchangeably.

**Five basic disciplines** generally contribute to the field of environmental health: **environmental epidemiology, toxicology, exposure science, environmental engineering, and environmental law**. Each of these disciplines contributes different information to describe problems and solutions in environmental health, but there is some overlap among them.

* [**Environmental epidemiology**](https://en.wikipedia.org/wiki/Environmental_epidemiology) studies the relationship between environmental exposures (including exposure to chemicals, radiation, microbiological agents, etc.) and human health. Observational studies, which simply observe exposures that people have already experienced, are common in environmental epidemiology because humans cannot ethically be exposed to agents that are known or suspected to cause disease. While the inability to use experimental study designs is a limitation of environmental epidemiology, this discipline directly observes effects on human health rather than estimating effects from animal studies.
* [**Toxicology**](https://en.wikipedia.org/wiki/Toxicology) studies how environmental exposures lead to specific health outcomes, generally in animals, as a means to understand possible health outcomes in humans. Toxicology has the advantage of being able to conduct randomized controlled trials and other experimental studies because they can use animal subjects. However there are many differences in animal and human biology, and there can be a lot of uncertainty when interpreting the results of [animal studies](https://en.wikipedia.org/wiki/Animal_studies) for their implications for human health.
* [**Exposure science**](https://en.wikipedia.org/wiki/Exposure_science) studies human exposure to environmental contaminants by both identifying and quantifying exposures. Exposure science can be used to support environmental epidemiology by better describing environmental exposures that may lead to a particular health outcome, identify common exposures whose health outcomes may be better understood through a toxicology study, or can be used in a risk assessment to determine whether current levels of exposure might exceed recommended levels. Exposure science has the advantage of being able to very accurately quantify exposures to specific chemicals, but it does not generate any information about health outcomes like environmental epidemiology or toxicology.
* [**Environmental engineering**](https://en.wikipedia.org/wiki/Environmental_engineering) applies scientific and engineering principles for protection of human populations from the effects of adverse environmental factors; protection of environments from potentially deleterious effects of natural and human activities; and general improvement of environmental quality.
* [**Environmental law**](https://en.wikipedia.org/wiki/Environmental_law) includes the network of treaties, statutes, regulations, common and customary laws addressing the effects of human activity on the natural environment.

Information from epidemiology, toxicology, and exposure science can be combined to conduct a [risk assessment](https://en.wikipedia.org/wiki/Risk_assessment) for specific chemicals, mixtures of chemicals or other risk factors to determine whether an exposure poses significant risk to human health (exposure would likely result in the development of [pollution-related diseases](https://en.wikipedia.org/wiki/List_of_pollution-related_diseases)). This can in turn be used to develop and implement environmental health policy that, for example, regulates chemical emissions, or imposes standards for proper [sanitation](https://en.wikipedia.org/wiki/Sanitation). Actions of engineering and law can be combined to provide [risk management](https://en.wikipedia.org/wiki/Risk_management) to minimize, monitor, and otherwise manage the impact of exposure to protect human health to achieve the objectives of environmental health policy.

 **FIGURE 4**

* 1. **PUBLIC HEALTH**

Public health is the science of protecting and improving the health of people and their communities. This work is achieved by promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases.

Overall, public health is concerned with protecting the health of entire populations. These populations can be as small as a local neighborhood, or as big as an entire country or region of the world.

Public health professionals try to prevent problems from happening or recurring through implementing educational programs, recommending policies, administering services and conducting research—in contrast to clinical professionals like doctors and nurses, who focus primarily on treating individuals after they become sick or injured. Public health also works to limit health disparities. A large part of public health is promoting healthcare equity, quality and accessibility.



**FIGURE 5: REALTIONSHIP BETWEEN ENVIRONMENTAL HEALTH AND PUBLIC HEALTH**

**CHAPTER THREE**

**METHODOLOGY**

1. **CHALLENGES FACED BY PUBLIC AND ENVIRONMETAL HEALTH DURING COVID-19 PANDEMIC**
* Poor water safety
* Lack of adequate equipment for treatment and test
* Air purification challenges
* Proper sanitization of infected areas.
	1. **SOLUTIONS TO SCHALLENGES OFFERED BY CHEMICAL ENGINEERING**

**POOR WATER SAFETY**: A water-treatment plant consist of various kinds of unit operations (e.g., separation, transport phenomena, filtration) that only a chemical engineer have studied during a bachelor of chemical engineering program. That is the reason why a chemical engineer is needed to design, operate, control, and maintain a water-treatment facility. Part of the job might be performed by a civil engineer, but under supervision of chemical engineer.

Wastewater treatment plant operations should ensure workers follow routine practices to prevent exposure to wastewater. These include using engineering and administrative controls, safe work practices, and[PPE](https://www.cdc.gov/healthywater/global/sanitation/workers_handlingwaste.html) normally required for work tasks when handling untreated wastewater. No additional COVID-19–specific protections are recommended for employees involved in wastewater management operations, including those at wastewater treatment facilities.

**LACK OF EQUIPMENT FOR TREATMENT AND TEST:** The first step in tackling an outbreak like this is the protection of frontline staff. Without them, we couldn’t respond to the pandemic. Thousands of them are falling ill across affected countries, so keeping them safe and free from infection is key.

The next step is realising that, although hospitals are vital to the response, home care and outreach are also really important. In an outbreak, you cannot focus only on hospital care; general practitioners and family doctors have a vital role to play as well. You have to take the wider community into account. As well as the these practioners are needed the facilities for treatment are also needed.

Chemical engineering would come alongside other fields of engineering to play a role in ensuring that public health facilities, sensors required at this period of pandemic are provided.

**AIR PURIFICATION:** Air-filtration and dust-collection systems are the go-to gear for protecting employees and equipment from dust exposure and for complying with air-quality, safety and combustible-dust regulations enforced by local, state and federal authorities. Despite the necessity of the equipment, many processors use legacy systems that no longer function at the highest levels of filtration or energy efficiency or, worse, do not meet National Fire Protection Agency (NFPA; Quincy, Mass.; [www.nfpa.org](http://www.nfpa.org)) guidelines for combustible dusts. Clearly, these are very big concerns in chemical process industries (CPI). For this reason, updating to more modern equipment may be in order. However, because every dust, every facility and every process is different, there’s a lot to consider when evaluating a new dust collection system.

 “Asset protection — protecting process equipment from dust that may cause corrosion or get inside bearings or moving parts of the machinery and cause abnormal wear or premature failure — is another factor in employing a dust collection system. And, certainly, a lot of the material chemical processors work with presents a risk of explosion or combustibility, so collecting and controlling combustible dust helps protect from these hazards,” Haynam says.

While air-filtration and dust-collection systems are nothing new for chemical processors, problems arise when existing equipment can no longer keep up with current standards or processes. “There are two issues we often see. First, a lot of facilities have legacy systems that aren’t properly protected according to current NFPA standards, which is a problem in the chemical industry because they often handle more exotic dusts with higher explosivity ratings,” says Steve McConnell, global director of filtration with Schenck Process .

“The second issue is that a lot of legacy systems have gone out of balance due to changes in the process or the addition of new ductwork and pick-up points. The system was likely designed and working correctly initially, but alterations may cause the collection system to become problematic in that it is no longer collecting the dust in an efficient manner.”

Upgrading the system may seem like an obvious step, but experts say selecting air-filtration equipment is anything but simple. For this reason, many equipment providers, including Schenck, have engineering groups that will assist processors in determining what they need to protect employees and facilities from dust. “Our dust-collection engineering group includes industrial ventilation design specialists with experience in ductwork design and dust collection systems,” says McConnell. “They analyze the health of existing systems, look at maintenance schedules, provide a complete ductwork and airflow design analysis and offer recommendations for existing systems that aren’t working properly and aren’t NFPA compliant, as well as for upfront design of new systems.”

Experts agree that having this type of engineering study is necessary to find the system that will work most efficiently and meet the specific dust collection needs of each facility. And, the two most-asked questions during these studies are how to handle combustible dusts and how to lower the overall cost of the system while providing the most efficient filtration.

**PROPER SANITIZATION OF INFECTED AREA:** The provision of safe water, sanitation and hygienic conditions is essential to protecting human health during all infectious disease outbreaks, including the COVID-19 outbreak. Ensuring good and consistently applied WASH and waste management practices in communities, homes, schools, marketplaces and health care facilities will further help to prevent human-to-human transmission of the COVID-19 virus.

 **FIGURE 6: SANITIZATION**

With the knowledge about chemical compounds and their characteristics chemical engineers can produce sanitizers which would be able to stop the spread of the covid-19 in the environment taking the following compounds below from the knowledge about chemical compounds how sanitizers are produced is described.

Two families of acceptable viral disinfectants are quaternary alkyl ammonium compounds (“quats”), and halogen-based disinfectants (namely chlorine bleach and iodofors). The quats are the same compounds found in commercial wet-wipes and various surface disinfection sprays. Quats are effective bacterial and viral disinfectants, and have a strong detergent characteristic. This means they not only neutralize viral or bacterial potency, but also help wash the surfaces clean. Some quat products are combined with water, alcohol, or hydrogen peroxide, but the basic sanitizing aspects are due to the quats. Check the manufacturer’s safety data sheet (SDS) for advice on proper dilution and use.

The second group of compounds are oxidizing halogens. These are generally chlorine-based (sodium or calcium hypochlorite) or iodine-based, commonly called iodophors (iodine in a silicone aqueous solution, sometimes with nitric acid added). These halogen sanitizers can stain clothing and surfaces and cause noticeable flavor changes. The CDC has posted [recommendations](https://www.cdc.gov/disasters/bleach.html) for how to use bleach as a sanitizer.

An extra benefit of quats and halogen-type sanitizers is that they have a long-lasting activity on the surfaces they have been used on. In other words, where acid oxidizers like PAA have a short activity time on the surface, quats, bleach, and iodophors last longer on the surface, giving more time to affect disinfection.

Going forward through the COVID-19 crisis, the Brewers Association recommends the use of quats and halogen sanitizers in front-of-house activities. Frequent spraying and cleaning with expendable paper towels is recommended. Disposable gloves should be used.

Within the beer manufacturing and canning/bottling areas, existing SOPs should be followed, and traditional cleaning/sanitizing cycles should be used, employing PAA or other appropriate brewery sanitizers.

**CHAPTER FOUR**

**ANALYSIS OF RESULTS**

1. **RESULTS**

This difficult time presents challenges on many levels, both in our personal and professional lives. During this worldwide crisis, the chemical process industries (CPI) continue to operate to provide products and services that are part of our critical infrastructure.

The chemicals industry is likely to feel the impact of the coronavirus (COVID-19) pandemic from every direction. Just as supply chains are being disrupted by outbreaks in key regions, demand may fall due to uncertainty in the global economy and capital markets. Workforces are facing the risk of infection, and governments are beginning to enact restrictions on movement — and both add an unpredictable dimension to the crisis. But with strong workforce and zeal the chemical engineering fields hopes to develop the environmental health engineering facilities and public health. With the above suggestions to tackle the covid-19 we also have to be managerial and economic as engineers to have something for the future.

**CHAPTER FIVE**

**CONCLUSION AND RECOMMENDATION**

1. **CONCLUSION**

Coronavirus disease known as COVID-19 is an infectious disease caused by a new virus. The disease causes respiratory illness (like the flu) with symptoms such as a cough, fever, and in more severe cases, difficulty breathing. The provision of safe water, sanitation and hygienic conditions is essential to protecting human health during all infectious disease outbreaks, including the COVID-19 outbreak. Ensuring good and consistently applied WASH and waste management practices in communities, homes, schools, marketplaces and health care facilities will further help to prevent human-to-human transmission of the COVID-19 virus.

The role which a chemical engineer is to play during this times cannot be overemphasizes but together with the various fields of engineering the effect Covid-19 on public and environmental health can be tackled.

* 1. **RECOMMENDATION**

I would recommend as student that proper educational curriculum be provided for students aspiring to become chemical engineers in order to tackle the worlds problem when need arises.

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