

The Effect of Covid 19 on the Performance of Industrial Wastewater Treatment Plant

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Research

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Abstract

Samsun is Black Sea Region's one of the biggest industrial and trade cities with its proximity to transportation, energy, infrastructure and major markets. It contributes to the national economy in all sectors with six Organized Industrial Zones, transportation and the quality of the labour force opportunities and industrial investments. This study aims to examine the impact of COVID-19 on the industrial wastewater treatment in Samsun Central Organized Industrial Zone. It is a roadmap for post-epidemic science at the same time.

1 Introduction

Intermittent outbreaks of pandemics have had profound and lasting effects on societies throughout history [1]. The different pandemics that humanity has experienced, such as Severe Acute Respiratory Syndrome (SARS) (China, 2003), The avian flu or H5N1 (2003), Swine Flu or H1N1 (Mexico, 2009), Middle East respiratory syndrome (MERS) (Saudi Arabia, 2012), EBOLA (out broke in West Africa in 2014), ZIKA (2016) and Ebola (Democratic Republic of Congo in 2019) in the current century [2–3].

In December 2019, in Wuhan, the capital of Hubei province in China, the world has witnessed a novel infectious disease causing severe acute respiratory syndrome [4–7]. This disease, named as coronavirus (Covid-19) by WHO, has rapidly turned from a local outbreak in Wuhan into the biggest pandemic of the last century (in Europe especially in Italy, in Africa and America (especially in the United States and India) [8–10].

This pandemic has induced more concern and fear globally than before and most of its impacts on the health, socio-economic development and environment such as agriculture, commerce, education, health, industry, livestock, tourism, transport are still uncertain [3, 11, 12]. Global pandemics are the unexpected result of interaction between wild fauna and humans.

The Covid-19 pandemic is the biggest health crisis of the 21st century due to a lack of proven treatment and the complexity of its transmission [13]. Therefore, the mortality rates were high, and the spreading areas were wide.

The COVID-19 poses a major threat to human health as well as the economy, the environment and the social. To reduce the spread of Covid 19 or to prevent infection, government authorities have taken very strict restrictions such as quarantine, social distancing, travel restriction, good hand hygiene (washing of hands), use of mask and most importantly, lockdown [14–17]. These measures have greatly changed the importance of peoples' daily life and have caused disruption of economic, industrial, and social activity [18–20].

The COVID-19 epidemic has contributed to renewal of the environment [21–22]. The use of both private and public transportation vehicles has decreased largely with the closure of people's homes and fossil fuel consumption has decreased significantly, with the closure of many workplaces and the decrease in

the production speed of factories [23]. All this led to a dramatic improvement in the quality of air (nitrogen dioxide, greenhouse gas emissions), water, noise and soil pollution, undisturbed and calm wildlife [18, 23, 24–28].

Since the first case of COVID-19 has confirmed on March 11 in Turkey the virus has reached every corner of the country, all 81 provinces. Authorities have implemented and adopted strict restrictions such as distance learning, working from home, quarantine, travel restriction, social distancing, hand-washing, mask-wearing, hand hygiene and most importantly, lockdown. This study aims to examine the impact of COVID-19 on the industrial wastewater treatment in Samsun province in Turkey. It is a roadmap for post-epidemic science at the same time.

2 The Environmental And Economic Impacts Of Covid-19

2.1. The economic impacts of COVID-19

As COVID-19 pandemic continues to spread, it seriously threatens the world economy, the environment and public health [29, 30]. Economic institutes (World Bank and IMF) are underlined that the COVID-19 caused to loss in international trade and slowdown of the most countries economy in 2020. The global economy would decrease by 5.2% and the economic growth rate would drop to - 3% [8]. Many resources point out that this will be worse than The 2008 Global Financial Crisis [28, 30]. The environmental impact of economic growth is analyzed by increasing consumption of non-renewable resources, an increase in pollutant emissions and global warming [31–33]. There are many research that showing the change of the environmental pollution due to economic growth and economic decline [34].

2.2. The environmental impacts of COVID-19

The human health and life, water and environmental systems have positive impacts due to the reduction of pollutant loading from industries, vehicle emission, and other sources. Air pollution is the presence of pollutants ($PM_{2.5}$, PM_{10} , O_3 , NO_2 , SO_2 and CO) released into the environment in high concentrations that are harmful to the health of humans and other living beings, or cause damage to the climate or to materials [35]. Air pollution is one of the biggest threats to human health. 90% of the world's population breathes unsafe air [36]. It causes about 8.8 million premature deaths in the worldwide every year, according to the 2019 World Health Organization (WHO) report.

The measures which are taken to prevent the spread of the COVID 19 by governments around the world have led to improvements in air quality in the short-term because of a significant declining in the pollutants [37]. There are reported indicating that air pollution levels are falling in various cities in Asia, Europe and America, specifically concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 2.5 μm in diameter (PM) [18, 23, 25, 28, 38–41].

With the COVID-19, the health effect of air pollution has started to be discussed over viral infections. There are researches also showing that air pollution increases pre-existing health problems such as

diabetes, lung diseases, asthma, heart diseases and cancer, which cause COVID-19 to be more serious and fatal (Brazil [42], Chile [43], China [44, 45], Germany [46], Iran [47], Iraq [48], Indonesia [49], India [50], Italy [51–53], Japan [54], Malaysia [55], Mexico [56], Norway [57], Spain [58], China, Italy and USA [59–61], Singapore [62], Turkey [63]).

Water pollution is the contamination of water resources (lake, river, ocean, aquifer and groundwater) because of human, commercial, industrial, and agricultural activities. The water-related diseases cause 3.4 million people, mostly children, deaths a year. The water quality has improved worldwide during the lockdown due to decreasing sources of industrial pollution [8]. The COVID 19 is detected in the feces of infected patients and sewage while it has not been detected in drinking-water supplies. The risk in water supplies is low according to the current evidence [64]. Laboratory studies show that the COVID 19 could remain infectious in water contaminated with faeces for days to weeks [65]. Conventional water treatment methods (filtration and disinfection) should inactivate the virus.

The noise pollution is the hazardous type of pollutant after air and water pollution [64]. Health impacts due to an increase in environmental noise are a concern worldwide. People exposed to prolonged or excessive noise has been shown to cause Remarkable health issues ranging from stress, poor concentration, productivity losses in the workplace, elevated blood pressure, cardiovascular disease, fatigue from lack of sleep, and some other physiological disorders such as heart rate, anxiety and depression [10, 66]. The reduction of anthropogenic activities (for instance, industrial or commercial activities) during the lockdown have shown the considerably decrease of the noise level in most countries [23].

The amount of waste has reduce significantly due to the closure of all the restaurants, markets, malls etc. during the lockdown period. Another reason for the decrease in the amount of waste is that waste collection cannot be done effectively [67]. In addition, the cessation of the construction sector caused the amount of waste to decrease [68].

The COVID 19 has the positive effects as well as the negative effects on the environment. In the USA and the European nations, waste and recycling facilities has been restricted with the risk of spreading the virus [23].

Biomedical wastes are solid and liquid wastes that pose an infection threat to humans. The body parts, body fluids, blood, blood products, and laboratory and veterinary wastes are biomedical wastes produced during the diagnosis, treatment of humans and other primates, or in research activities pertaining thereto, or in the production or testing of biologicals [69]. The harmful chemicals released from biomedical waste can pollute water, air, and soil and cause health problems.

Medical waste is contamination sources of the water and soil resources if realeased directly or indirectly to the receiving environment. The growth of the sector, an increase in the use of disposable medical products has contributed to the increase in the amount of medical waste [70]. The amount of biomedical waste continues to increase since the outbreak of COVID-19. From the beginning of the pandemic

outbreak, the COVID-19 wastes (personal protective equipment (PPE) kits, testing kits surgical mask, gloves) in Wuhan increase from 40 tons/day to 240 tons/day, in the US increase from 5 million tons/year to 2.5 million tons/month, in the South Korea has generated about 2000 tons [25, 67]. The wastes in accordance with local waste disposal regulations must be disposed of and rendered harmless [71].

Samsun Metropolitan Municipality undertakes the medical wastes of the COVID hospitals, quarantine centres. Samsun has generated about 150 tons of bio-medical waste since March 2020. The contaminated wastes such as plastic coverall, face shields, goggles, used masks, head cover, shoe cover etc. are collected in appropriate containers and transported to Samsun Medical Waste Sterilization Facility. They sterilized at the biomedical waste sterilization facility and then disposed in the solid waste landfill according the national biomedical waste regulation [72].

3 Study Area

Samsun is Black Sea Region's one of the biggest industrial and trade cities with its proximity to transportation, energy, infrastructure and major markets (Fig. 1).

Organized Industrial Zones, which provide an environment where small and medium-sized enterprises can make production by using common infrastructure services are extremely important organizations in terms of both added value and their relations with urbanization and industrialization. Organized Industrial Zones, which provide optimum utilization of available scarce resources towards the industrialization and important contributions to Turkey's economic development are a center of attraction for investments with opportunities with its logistic facilities, industrial infrastructure and human resources (Fig. 2).

In Samsun, there are six Organized Industrial Zones: Central Organized Industrial Zone, Kavak Organized Industrial Zone, Food Specialization Organized Industrial Zone, Bafra Joint&Medical Specialization Organized Industrial Zone, Havza Agrofood Processing and Agricultural Machinery Specialization Organized Industrial Zone Çarşamba Organized Industrial Zone.

Samsun Central Organized Industrial Zone was established on an area of 1.606.522 m² and 103 hectare area. 6.583 people are being employed in Zone. The enterprises operating in the zone produce in the manufacture of textile products, metal products, electrical and non-electrical machinery and equipment, chemical and chemical extinguishing, food products, other non-metallic minerals, basic products manufacturing (Fig. 3).

4 Data And Methods

The wastewater treatment plant in Samsun Central Organized Industrial Zone was inaugurated in November 2012. The wastewaters from the companies in the different sectors have been come in one channel and treated together. This wastewater's character is determined. The treatment strategy is specified according to the characterization of wastewater.

The plant contains mechanical treatment units (coarse and fine screens, equalisation tank and sand traps), chemical treatment units (mixing and flocculation tank), biological treatment units, sludge consolidation and drying process, chemical preparation and blower units.

The screens and sand traps ensure the removal of large objects and solid particles that accumulate in the treatment plant and protect mechanical equipment such as pumps. The equalisation tank is used to control of pH as well as flow rate oscillations in wastewater treatment plants.

In the mixing tank, a homogeneous wastewater which contains particles that are too small or light to be able to settle and be eliminated by using chemical is prepared. In process, a chemical substance, such as polyelectrolyte, aluminium sulphate ($\text{Al}_2(\text{SO}_4)_3$), ferric chloride (FeCl_3), PAC (poly aluminium chloride $\text{Al}_2\text{Cl}(\text{OH})_5$) substances are used. The aim is to removal of suspended solids (SS) and prevent excessive load on biological treatment.

5 Results And Discussion

On 24 January, thermal imaging cameras were installed to check passengers at the airports. Anyone who showed the symptoms of the Covid 19 infection was quarantined. On 1 February, all the flights from China were stopped by government officials. On 23 February the border with Iran was closed. On 29 February, all flights to and from Italy, South Korea and Iraq were stopped. On 11 March 2020, Covid 19 cases also began to be seen in Turkey, after a man who had returned to Turkey from Europe, tested positive. In the country the first death occurred on 15 March 2020. After 21 March, authorities announced its decision to apply strict restrictions such as distance learning, working from home, quarantine, travel restriction, social distancing, hand-washing, mask-wearing, hand hygiene and most importantly, lockdown. The restrictions continued until 1 June 2020 (Fig. 5).

After lockdown measures, there had been large declines in industrial production and trade in March and April. Therefore, to measure the real-time effects of the COVID-19 in industrial production in Samsun, the electricity and water consumption had been analyzed. Data on electricity and water consumption in Samsun Central Organized Industrial Zone obtained from The Organized Industrial Zone Directorate.

The economic activity is reliant on the consumption of electricity and water. There was a sharp decrease in the electricity and water consumption in April (Fig. 6). This also shows the negative impact of Covid 19 on industrial production and trade. Industrial production started to recover rapidly, with the easing of lockdown measures. It is the employer's responsibility to protect the health, safety and welfare of their workforces.

Samples are analyzed with the Standard Methods for Examination of Water and Wastewater [73, 74]. These methods are the best current application of wastewater analysis.

The Urban Wastewater Pollution Control Regulation (91/271/EEC) is applied as The Turkish Water Pollution Control Regulation (2004/ 25687) in Turkey. This regulation contains the procedures on

protection of water resources, prohibitions, the procedures of wastewater discharge, the principles for design, construction, and operation of wastewater treatment facilities and the monitoring and controlling principles to prevention of water pollution.

The analysis results are evaluated according to “The Water Pollution Control Regulation” published by The Ministry of Environment and Urbanization of Turkey (Tablo 1).

5.1. Inflow – Outflow Trends

Flow measurement can be defined as quantification of the movement of water. The measurement of wastewater flow in wastewater treatment plants is a critical element for water resources monitoring for various applications (an efficient process control and a healthy operation control). Flow can be measured either by determining the displacement and/or Velocity of the water. ISO 7145 method has applied to analyse of the measurement of wastewater flow.

Sampling has been performed twice each month since November 2012. The input and output flow rates have been observed in average values in a month during that period. Samples are transported to the laboratory, stored in a refrigerator at around + 4°C until they are analysed.

The change of inflow and outflow rates over 3 year period from 2018 to 2020 is shown Fig. 7. The wastewater inflow and outflow rates for the wastewater treatment plant fluctuate.

The decrease levels reflect the impact of the COVID 19 and the restrictions on decline in industrial activity.

5.2. Water Quality Trends

In the study, with the aim of determine the quality of water, total suspended solids (TSS, mg L^{-1}), chemical oxygen demand (COD, mg L^{-1}), pH and oil and grease (mg L^{-1}) parameters have been characterized. Measurement and analysis of TSS, COD, pH and oil and grease were made by applying Standard Methods which are valid for waters. The available data contain measurements of water quality parameters like TSS, COD, pH and oil-grease.

TSS are an important parameter in control of biological and physical wastewater treatment processes. “Total solids” is called all of the remaining material after evaporation of a sample and its subsequent drying at 103-105°C according to SM 2540 D [75]. Total solids includes “total suspended solids,” and “total dissolved solids,” found in water or wastewater. Wastewaters high in suspended solids adversely affect effluent quality and receiving environments. Therefore, the amount of solids at wastewater, drinking water and potable water is not allowed to exceed a certain limit. Discharge limit for TSS will be less than 200 mg L^{-1} or equal according to Water Pollution Control Regulation.

The TSS for the wastewater treatment are summarized in Fig. 6. Figure indicates that The Wastewater Treatment Plant TSS parameter is below limit. TSS values in this study showed an increase and decrease (Fig. 8), due to water flow rate. Between January and June for the fact that the TSS values in 2020 is

lower compared to other years is that the input of wastewater are low. This shows the real-time effects of the COVID-19 on industrial production in Samsun, Turkey.

The COD is the most important to determine the degree of pollution of industrial wastewaters. The parametre is used to monitor water treatment plant efficiency. The COD is a measure of the oxygen in the process by which the organic substances in a water sample are converted to carbon dioxide. The SM 5220 B method is based on measurement of the amount of strong chemical oxidant as potassium dichromate, potassium iodate, potassium permanganate in an acid solution [77]. This method can be used to easily quantify the amount of oxidizable pollutants found in wastewater.

The TSS and COD parameters in wastewater seem to decrease during lockdown (Fig. 9). There are no direct impact on the efficiency of wastewater treatment plant from an economic and environmental perspective.

pH is the most important parameters of the wastewater treatment process. Hydrogen ion activity or pH is the intensity of the acidic or basic character of a solution at a certain temperature. pH influences the performance of the process and the treatment efficiency chemical, physical or biological treatment method. It is an critically important to treatment. In order to continuously monitor the quality of the wastewater, the customer needed to measure the pH at the outlet of the wastewater treatment plant. pH has measured according to SM 4500 H⁺ [78].

“Oil and grease” is defined a substance soluble (fats, oils, waxes, and other related constituents) in water, and wastewater. They are the major risk to human, animal, environmental health. Oil and grease cause ecology damages for plant, animal, toxic, mutagenic and carcinogenic for human being. Oil and grease on the water surface reduces dissolved oxygen and prevent the air-water surface contact. The oil grease layer that adheres to water and suspended solids reduces biological activity. Thus, the dissolved oxygen levels in the water decreases. Oxidation of hydrocarbon molecules slows down as the oxygen level decreases. Oil grease in the water may accumulate on the pipe walls over time and cause the line to clog and also reduces the wastewater treatment efficiency. The measurement of amount of oil and grease in water is important for design and operation of wastewater treatment systems. The measurement of amount of oil and grease can be determined with Method 5520.

In the parameters i.e., pH and oil and Grease, a reduction are observed during the restrictions taken to prevent the spread of COVID 19 (Fig. 10–11). An increase in TSS, COD, pH and oil-grease values of the wastewater has been observed from 1 June when all restrictions are lifted. However, in compare to the other years (2018, 2019) during the said time period the increase of pollution parameters are stil low. This is an indication that the COVID 19 outbreak has had a drastic impact similar to the 2008–2009 global financial crisis on the global economy.

6 Conclusion

The COVID-19 pandemic is first a health crisis. The COVID-19 pandemic has the devastating effect for industries worldwide, especially for smaller enterprises. This can be listed as the effect of business closures, supply shortages, the decreasing consumer demand. As has been the case after other major upheavals, such as the 2008–2009 financial crisis, a return to pre-crisis levels will likely take several years, if not more.

There are at two reasons for the decrease in industrial production. First, the restrictions such as quarantine, travel restriction, and most importantly, lockdown have taken by government authorities. Second, producers have a hard time procuring their raw materials. In this study, the effect of the restrictions on the spread of COVID 19 virus in industrial wastewater and industrial activity is analyzed. Results show that the application of the restrictions by governments has had *negative impact reflection* on the *manufacturing sector in Samsun Central Organized Industrial Zone*. The spread of COVID-19 are hitting the economy hard, with manufacturing sectors being especially affected by the economic fallout of the pandemic. This can be explained with sharp decrease in the electricity and water consumption. The decrease in the pollution parameters of the wastewater treatment plant indicates the negative impact of the Covid 19 pandemic on industrial activities.

Declarations

Availability of data and materials

All data generated or analyzed during this study are available from the Samsun Central Organized Industrial Zone.

Competing interests

The author declares I have no competing interests.

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Authors' contributions

I read and approved the final manuscript.

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Authors' information (optional)

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Tables

Table 1 The Wastewater Quality Parametres limits according to The Water Pollution Control Regulation.

The analysis parametre	Method	Unit	Turkish Water Pollution Control Regulation - Table 19
Flow	ISO 7145		
Total Suspended Solids (TSS)	SM 2540 D	mg L ⁻¹	≤ 200
Chemical Oxygen Demand (COD)	SM 5220 B	mg L ⁻¹	≤ 400
pH	SM 4500 H ⁺		6 - 9
Oil And Grease	SM 5520 B	mg L ⁻¹	≤ 20