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# A Study on Particulate Matter ($Pm_{10}$& $Pm_{2.5}$) and Formaldehyde (Hcho) In the Industrial Areas of Faridabad, Haryana, India

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**ABSTRACT**
Air pollution is the main issue in today's world. There are many pollutants present in the air, particulate matter is one among them. Formaldehyde also if present in atmosphere in high concentration will pollute the air. It arises from different sources like burning of wood, heavy traffic, factories etc. Industrial activities are one of the sources to produce particulate matter. Faridabad is a smart city and has tremendous industries in it. The objectives of the research are to monitor ambient concentration of$PM_{10}$, $PM_{2.5}$, formaldehyde (HCOC) at various industrial areas of Faridabad and the Comparative assessment of monitored $PM_{2.5}$, $PM_{10}$ and HCHO at Industrial areas.Handy sampler (pollution meter) was used to take the data/samples at the selected locations. The samples has been taken in morning shift and evening shift. In the selected time, the samples has been taken after every 15 minutes i.e, there will be 15 minutes gap between every sample taken. The analysis of data has been done by using the Excel sheet. It was seen that the concentration of $PM_{10}$ was more than $PM_{2.5}$ and the concentration level of HCHO was well below the permissible limits of WHO. On comparison between the industrial area locations, both the PM concentration level and HCHO concentration levels were higher at industrial area 2. The industrial areas are unsatisfied and unsafe in case of particulate matter, as it crosses the permissible limits of WHO and CPCB for particle pollution but are safe in terms of HCHO.As the previous researches have shown that the particulate matter has very serious health issues to the human so the safety should be provided to the workers at industries.
**KEYWORDS:** Particulate Matter, Industrial Area, Analysis, Monitoring, Concentration

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## I. INTRODUCTION

Air pollution due to anthropogenic sources, is a matter of concern in whole world. Moreover, worldwide epidemiological study on the impact of air pollution has revealed that gaseous pollutants and particulate matter has enough potential to cause severe health effect like respiratory, cardiovascular diseases and cardio pulmonary mortality(Gupta et al., 2008). Modernization and industrialization of developing countries has led to the increased use of fossil fuels and their derivatives. As such, developing countries are confronted with the great challenge of controlling the atmospheric pollution especially in the rapidly growing big cities. Hence a systematic monitoring programme all over the world especially in urban cities is urgently needed. In every city, the levels are getting worse because of rapid industrialization, growing number of vehicles, energy consumption, and burning of wastes. Several cities face severe air pollution problems, with annual average levels of total suspended particulates (TSP) at least three times as high as the WHO standards(CPCB, 2003).

India is a developing country and of the first ten industrial countries of the world (Sharma, 2007). Due to enhanced anthropogenic activities (Goyal and Sidhartha, 2003) in India air pollution problem have become a saviour debatable topic for all the platforms. As per study of world economic forum in Davos, India has the worst air pollution in the world parameters (effects on human health).A recent study in middle-income 12 homes of Delhi found PM10 levels to be as high as 170–810 µg/cu-m even in homes where there was no cooking or smoking activity (Kumar, 2001).A report showed that SPM concentrations in Shanghai, New Delhi, Mumbai, Guangzhou, Chongquin, Calcutta, Beijing and Bangkok exceeded WHO limits (90 µg/cu-m) by three, five, three, three, four, four, four and two times respectively . It also showed that PM10 exceeded the USEPA limit (50µg/cu-m) by several times in a number of cities, most notably by over four times in New Delhi and Calcutta(http://envirocenter.yale.edu/news/237/56/I

ndia-s-Air-the-World-s-Unhealthiest-Studysays/d,newsDetail). In a study conducted in the city Kanpur it was found out that average pollution level in the city expressed in PM10 was 225.68 µg/cu-m during the year 2004(Gupta Usha. Valuation of Urban Air Pollution).One of the monitoring stations i.e., Vikas Nagar registers wild fluctuations in the level of PM10. It varies from 295 to 463µg/cu-m during summer and from 42.5 to122 µg/cu-m during the monsoon and winter seasons respectively (Gupta U., 2007). (Cheng et al., 2004) briefly elaborates a more effective way of determining a suitable concentration level of pollutants in Taiwan. (Longhurst, 2005) presented a case study of the creation and criticism of an air pollution quality in Pittsburgh, Pennsylvania, long known for its industrial production and the resulting pollution for that location.

The main objectives of the research paper are to monitoring of $PM_{2.5}$ and $PM_{10}$ at various industrial areas of Faridabad, Monitoring of HCHO at various industrial areas of Faridabad and Comparative assessment of monitored $PM_{2.5}$, $PM_{10}$ and HCHO at Industrial areas.

## II. METHODOLOGY

Methodology gives the framework of processes by which the whole work has been completed. The main part of the methodology is the selection of the study area due to which the study becomes limited and is only carried out for the selected area. The other main parts of the methodology are monitoring instrumentation, monitoring procedure and data analysis procedure. The details of these selected industrial sites are:

**Industrial site 1** (Address: Sector 32, 19-A, Faridabad, Haryana, 121003, India)

**Industrial site 2**(Address: 6, Main Mujesar Road, Sector 24, Faridabad Haryana, 121005, India)

**Industrial site 3** (Address: Sector 6, Opp. Petrol Pump, Sector 6, Faridabad, Haryana 121006, India)

### 2.1 Selection Of The Study Area

Faridabad District connected to Delhi on its south-eastern side having total area of 742.90 sq. km. and municipality Area of 208 sq. km. It is situated at 28° 25' 16" North Latitude and 77° 18' 28" East Longitude. It is surrounded by the National Capital Territory of Delhi on its North. Delhi-Mathura National Highway No. 2 passes through the center of the district. The city is famous for Henna Production on agriculture sector while Tractors, Motorcycles, Textile Dyeing & Printing, Switch Gears, Refrigerators, Shoes and Tyres are other famous industrial products of the District. Badkhal Lake tourist complexes, SurajKund Tourist Complex,Aravalli Golf Club & Raja Nahar Singh Palace are the famous tourist places. Faridabad is the oldest as well as Industrial City of the State & rapidly grown during the last few years, due to a large number of industries have come up in the town. All these developments are associated with intense pressure and affected on the receiving Environment. The rapid growth of the city also brought immigrants from other parts of the country. People from UP, Rajasthan, Bihar and Bengal increased the population size of Faridabad District.

The study is conducted on the industrial zone of the Faridabad district. Faridabad Industrial agglomeration is a geographical space, consisting of the Haryana urban development authority (HUDA) of Faridabad. This area has been identified as the industrial capital of Haryana and hence occupies a large number of factories both in the private and public domain. The Central Pollution Control Board in collaboration with the State Pollution Control Board marked Faridabad as one of the polluted areas in the country (National Ambient Air Quality Monitoring: CPCB 2006). It ranks first in both number of vehicles and number of registered factories. It is also reported that potential air pollutants like suspended solids, dissolved fluorides and phosphates, free ammonia, ammoniac nitrogen, carbon powder, hexavalent chromium, acidic chemicals like S02, C02 C\2, HCL, etc. emitted by these factories in to the environment are one of the highest compared to other districts of the State and are even beyond the level of tolerance. It is further marked that most of these pollutants recorded in this area are found to be harmful in many ways to the living particles and property of human population (Pollution Control Board -PCB: 2000) National Environmental Engineering and Research Institute (NEERI, 2000).

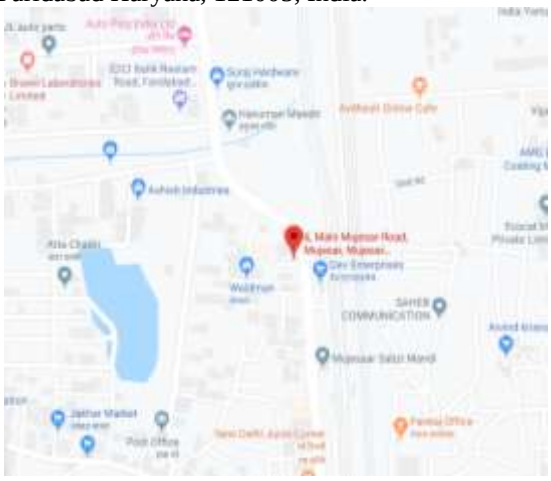
#### 2.1.1 location of the selected industrial areas

**1) Industrial Area 1**

**Address:** Sector 32, Faridabad, Haryana,19-A, 121003,India

| Latitude | Longitude |
|---|---|
| 28.4625 | 77.3108889 |

**2) Industrial Area 2**
**Address:** 6, Main Mujesar Road, Sector 24, Faridabad Haryana, 121005, India.



| Latitude | Longitude |
|---|---|
| 28.3690125 | 77.3070199 |

**3) Industrial area 3**
**Address:** Sector 6, Opp. Petrol Pump, Sector 6, Faridabad, Haryana 121006

| Latitude | Longitude |
|---|---|
| 28.3605472 | 77.318952 |

## 2.2 Monitoring Instrumentation

The most important measurements of particles are particle concentration and particle size. There are several instruments for measuring different characteristics of particulate matter. So, Portable pollution meter (SMILEDRIVE Portable air Quality Monitor) has been selected for taking the readings of particulate matter ($PM_{10}$& $PM_{2.5}$) and HCHO. It is extremely easy to use and it does not require any technical knowledge. Anyone can use the portable pollution meter to know the pollution level in ones surroundings in a matter of few seconds. It features a large LED display screen that shows the concentration of particulate matter, TVOCs and Formaldehyde. It is based on the laser scattering detection technology. It detects $PM_1$,$PM_{2.5}$, $PM_{10}$, formaldehyde and TVOCs. It uses a multi-layer micro-filtration mechanism to prevent ethanol and carbon monoxide from interfering with the gadgets functions.

The air pollution monitor is equipped with a high performance three core 32-bit ARM processor. It is a premium quality chip that does complex high speed calculation. Test range for formaldehyde is 0-1.999 $mg/m^3$, for $PM_1$, $PM_{2.5}$ and $PM_{10}$ it is 0-999 $\mu g/m^3$ and for TVOCs it is 0-9.999 $mg/m^3$


**Figure 2.1**: Portable Pollution Meter

## 2.3 Data Monitoring Procedure

The device pollution meter is calibrated in the clean air atmosphere for the purpose of minimization of errors in the data collection. The samples has been taken in morning shift and evening shift. At construction sites, the samples are

taken during the construction process. In the selected time, the sample has been taken after every 15 minutes i.e., there will be 15 minute gap between every sample taken. The monitoring procedure has been summarised below:

| Sr. No. | Location | Monitoring Dates | Monitoring Time | No. of Samples |
|---|---|---|---|---|
| **1.** | Industrial area 1 | 17-03-2019 | 10:30am-12:00pm 5:00pm-6:30pm | 14 |
| **2.** | Industrial area 2 | 24-03-2019 | 9:00am-10:45am 5:30pm-7:15pm | 16 |
| **3.** | Industrial area 3 | 10-03-2019 | 2:00pm-5:30pm | 16 |

**Table 2.1:** Data monitoring procedure

### 2.4 Data Analysis Procedure

After the collection of data, the analysis of data collected has been done by using the Excel Sheet. Many samples are taken at every selected location and the bar graph is plotted between the maximum observation, minimum observation and mean observation by using Excel sheet. Furthermore, the comparative analysis has been done between the particulate matter ($PM_{10}$& $PM_{2.5}$)& HCHO averages of every selected location, WHO standards and CPCB standards. The results after analyzing the data are shown on bar graph by using Excel Sheet. The mean (average) of the samples is obtained by the formula given as under:

$$\text{Mean/Average} = \frac{\text{Sum of samples/observations}}{\text{Total number of samples/observations}}$$

## III. RESULTS AND DISCUSSIONS

At industrial area 1, the minimum concentration of $PM_{10}$ is 67µg/m$^3$, maximum concentration is 101µg/m$^3$, and the average $PM_{10}$ is 83.21µg/m$^3$, while the WHO and CPCB standards (24-hourly) for $PM_{10}$ are 50µg/m$^3$ and 100µg/m$^3$ respectively. So, the concentration of $PM_{10}$ at Industrial area 1 is much higher than the standards of WHO and it does not cross the limits of CPCB. For $PM_{2.5}$, the minimum concentration is 48µg/m$^3$, maximum concentration is 89µg/m$^3$ and Mean concentration is 63.14µg/m$^3$, while the WHO (24-hourly) and CPCB (24-hourly) standards are 25µg/m$^3$ and 60µg/m$^3$ respectively. So, it shows that the $PM_{2.5}$ concentration is also much higher than standards. The minimum concentration of HCHO is 0.014 mg/m$^3$, maximum concentration is 0.026 mg/m$^3$ and the mean concentration is 0.021 mg/m$^3$, while the WHO permissible limit for HCHO is 0.1 mg/m$^3$. SO, it is clear that the HCHO concentration levels are well below the WHO permissible limits. By analyzing figure 4.2 and figure 4.3, the air quality at industrial area is dangerous as it has high concentration of particulate matter.

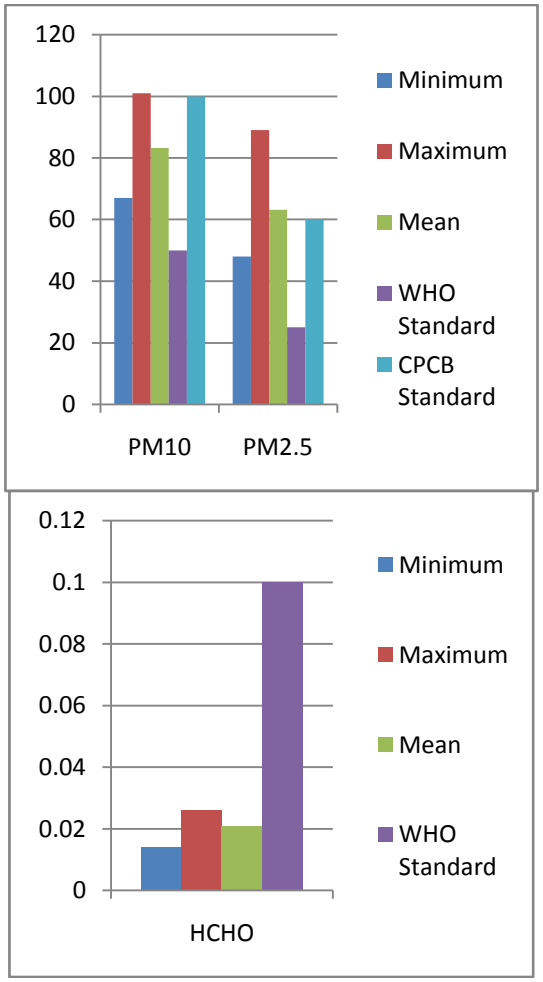



**Figure 3.1:** $PM_{10}$, $PM_{2.5}$& HCHO Concentration results at Industrial area 1

At industrial area 2, the minimum concentration of $PM_{10}$ is 66µg/$m^3$, maximum concentration is 105µg/$m^3$ and the average $PM_{10}$ is 90µg/$m^3$, while the WHO and CPCB standards (24-hourly) for $PM_{10}$ are 50µg/$m^3$ and 100µg/$m^3$ respectively. So, the concentration of $PM_{10}$ is much higher than the standards of WHO and falls under CPCB permissible limits. For $PM_{2.5}$, the minimum concentration is 52µg/$m^3$, maximum concentration is 91µg/$m^3$ and Mean concentration is 76.25µg/$m^3$, while the WHO (24-hourly) and CPCB (24-hourly) standards are 25µg/$m^3$ and 60µg/$m^3$ respectively. So, it shows that the $PM_{2.5}$ concentration is also much higher than standards. But in case of $PM_{2.5}$, it crosses both the standard limits of WHO and CPCB. The minimum concentration of HCHO is 0.017 mg/$m^3$, maximum concentration is 0.035mg/$m^3$ and the mean concentration is 0.0269mg/$m^3$, while the WHO permissible limit for HCHO is 0.1 mg/$m^3$. SO, it is clear that the HCHO concentration levels are well below the WHO permissible limits. By analyzing figure 4.5 and figure 4.6, the air quality at Industrial area is dangerous as it has high concentration of particulate matter.

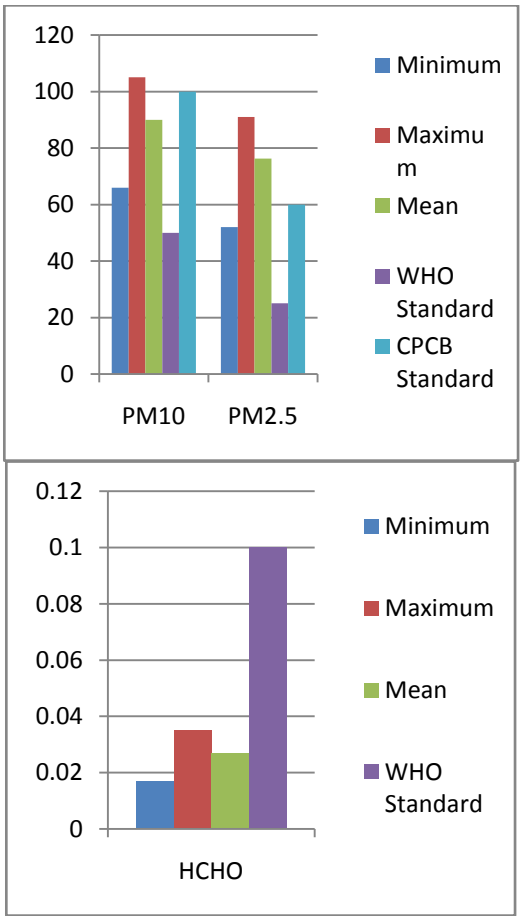



**Figure 3.2:**$PM_{10}$, $PM_{2.5}$& HCHO Concentration results at Industrial area 2

At industrial area 3, the minimum concentration of $PM_{10}$ is 66µg/$m^3$, maximum concentration is 98µg/$m^3$ and the average $PM_{10}$ is 83.625µg/$m^3$, while the WHO and CPCB standards (24-hourly) for $PM_{10}$ are 50µg/$m^3$ and 100µg/$m^3$ respectively. So, the concentration of $PM_{10}$ is much higher than the standards of WHO and falls under CPCB permissible limits. For $PM_{2.5}$, the minimum concentration is 51µg/$m^3$, maximum concentration is 83µg/$m^3$ and Mean concentration is 68.56µg/$m^3$, while the WHO (24-hourly) and CPCB (24-hourly) standards are 25µg/$m^3$ and 60µg/$m^3$ respectively. So, it shows that the $PM_{2.5}$ concentration is also much higher than standards. But in case of $PM_{2.5}$, it crosses both the standard limits of WHO and CPCB. The minimum concentration of HCHO is 0.019mg/$m^3$, maximum concentration is 0.029mg/$m^3$ and the mean concentration is 0.0223mg/$m^3$, while the WHO permissible limit for HCHO is 0.1 mg/$m^3$. SO, it is clear that the HCHO concentration levels are well below the WHO permissible limits. By analysing figure 4.5 and figure 4.6, the air quality at Industrial area is dangerous as it has high concentration of particulate matter.

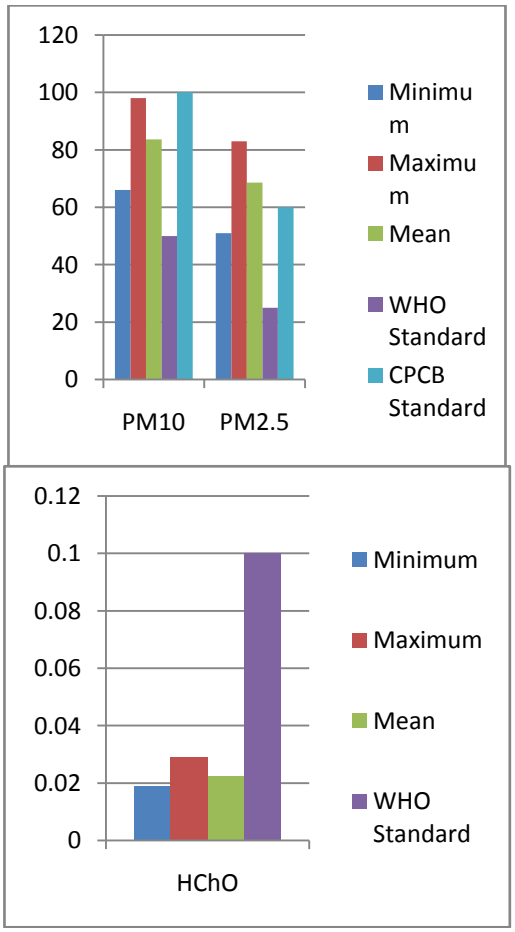



**Figure 3.3:** $PM_{10}$, $PM_{2.5}$& HCHO Concentration results at Industrial area 3

By analysing the above tables and figures, it is possible to notice that the $PM_{10}$ showed the highest concentrations than $PM_{2.5}$ at all the monitored industrial areas.

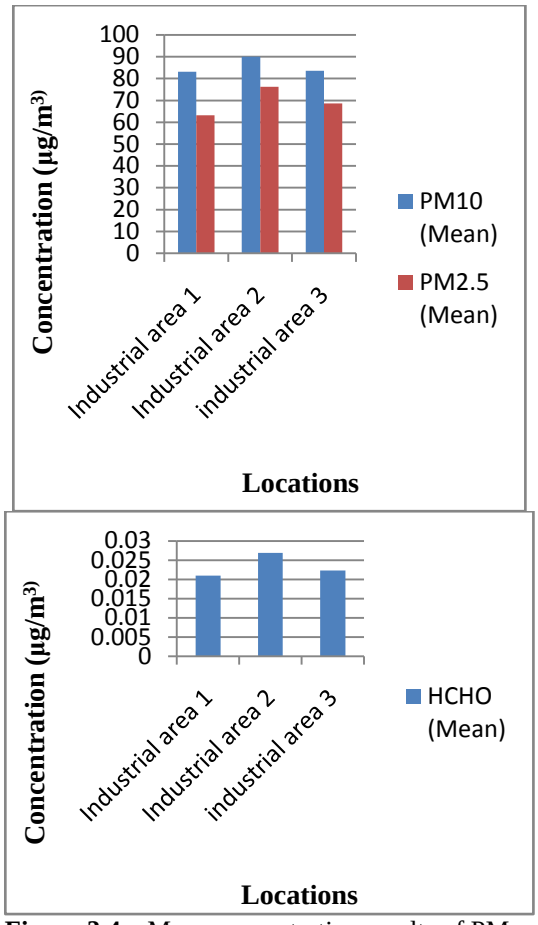



**Figure 3.4** Mean concentration results of $PM_{10}$, $PM_{2.5}$ and HCHO at all locations

By analysing figure 3.4, it is clear that the $PM_{10}$ concentration is higher than $PM_{2.5}$ concentration. The formaldehyde (HCHO) has been seen more at industrial area 2 and all the industrial area locations neither fall under CPCB standards nor under WHO standards in case of both $PM_{10}$ as well $PM_{2.5}$. But the HCHO falls well under the WHO standard limits at all the monitored locations.

However, there were three locations to monitor, it was not possible to carry the high volume sampler to all the locations for monitoring purpose in such a short time period, so the suggestion was the installation of SMILEDRIVE Pollution Meter in order to better control the measurement process.

On the basis of analysis of collected data it is seen that among all the industrial area locations, there was much higher concentration of PM at the industrial area 2 as compared to other two sites. This is because there were different types of industries at the locations i.e., steel industries, forging industries etc.

In case of HCHO, as per the data analysis, it does not cross the permissible limits of WHO. Hence, the air is safe in case of Formaldehyde (HCHO).

## IV. CONCLUSIONS

Based on the observations, it can be said that the pollutants at industrial area does not arise from single industry. As there are many industries at the same locations. Due to the activities in the industries, the high concentration of pollutant is produced at industries and gets released into the atmosphere. So along with the industrial area, the atmosphere of nearby residential and other areas also gets polluted.

On comparison between industrial areas and WHO & CPCB permissible standards, the industrial areas have higher concentration of particulate matter which cross the limits. Hence, the industrial areas are unsatisfied and unsafe in terms of PM, as it crosses the permissible limits of WHO and CPCB for particle pollution.

This research indicates that, HCHO does not cross the WHO standard limits. Therefore, industrial areas are satisfied and safe in case of HCHO.

To tackle the problems of particulate matter production at industrial areas and to reduce the health risks generated due to particle pollution, some recommendations are given as under:

1. Instead of using furnace oil, coal, pet coke etc., PNG (pipe natural gas) should be used in industries.
2. Machineries should be improved to reduce emissions from industries
3. Boost the performance of machineries and equipment.

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