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Modeling of Intelligent Mechanical System for Detection and Mitigation of Air Pollution Using IIOT Sensor

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Abstract:
Recently, Industrial air pollution affected by air quality, dangerous to health of millions of peoples. Condensation of cryogenic principle provided for inside purification of air changed at humidifiers, air conditioners,fitness benefits of weight energy consumption. Air pollution emits in industrial such as combustion of fuels, gasoil, fuel oil, and natural gas. The industrial and outdoor air purification technologies of air are not satisfied, some disadvantages as poor efficiency, pollutants limits target are needed to replace adsorbents, filters, the harmful products by generation. In this research to reduce the air pollutions or control the air pollution at intelligent mechanical system (IMS) and then to sense pollution by using IIOT advanced sensor. Further to optimize the proposed IMS machine techniques has been integrated. Then to reduce energy consumption, network life time precision or accuracy, and mean square error. Application of this machine used to industrial pollution, outdoor pollution and indoor air pollutions.

Keywords: *industrial pollution, IMS, IIOT sensor, purification of air*

1. Introduction

Pollution is the mainly affected by plant and animals. They are many pollution are produced in India such as soil pollution, water pollution, noise pollution, air pollution, these pollution produced by sulphuric acid and also produced by acid rain. Major causes are dieses and affect the living organisms. Air pollution is mainly affected by ozone layer and also produces acid rain and greenhouse gases. Air pollution comes to reliable industries and naturally produced. Pollution defects at environmental affects, protection of environment, global warming, safety of occupational, thermal pollution, waste water treatment and biological sources in pollution. [1] Public transport is mainly created by pollution, this pollution are reduced by fuel consumption, pollution emission, reduce vehicle's movement, finally to reduce the pollutants are normally.[2] in this research are mainly pollution are created by private transport, to measure the air pollution , process of production, emission measurements. They are, improve the tapioca stockpile area, improve the drying process, improve the hot air generator, it can reduce the dust so2 levels receptors up to 44 % and 30 %. [3] Decreasing the pollution level is now the main aim for many. Pollution is in many forms; almost every natural thing is now affected by the term pollution. Not only land, water, air, but each and every thing belongs to the planet is now in danger levels of pollution. [4] the haze pollution contributes by weight gain , respiration problem, breathing problem, and metabolic function , mentally disturbed problems are studied.[5] they are eight gases are mainly produced by air pollution such as sulphuric oxides, Non-Methane Determined Organic Pollutants, Black Carbon, these pollution are measured by the PM10,PM2.5.[6,9] Now a days air pollution increasing by metropolitan area.pm2.5 and pm10 are mainly used for this devices at gather pollution, several traffic and service of air quality.[7] in this research are mainly implemented for electrochemical sensors, to transmit the data at IOT sensors. Air quality level is very poor finally efficiency, accuracy, material strength, weight of material, reduced by this research [8].

2. Design Parameters

2.1 Honeycomb filter: The honeycomb structure is minimum material and minimum cost, minimum weight. It has succeeded with the drawing requirements and design of an IMS as shown in fig 1.

After designing of IMS the material should be selected and do several analysis such as tensile test, stress strain analysis, air flow analysis, by using ANSYS software. Advantages of honey comb structure is recyclability[10], isolation, fatigue résistance. Finally honey comb filter is more efficiency that types of honeycomb filter are selected. Inlet suction part is x. outlet delivery part is y. For rectangular duct is Eq (1)

$$P_e = \frac{1.30(cg)^{0.625}}{(c+g)^{0.250}} \tag{1}$$

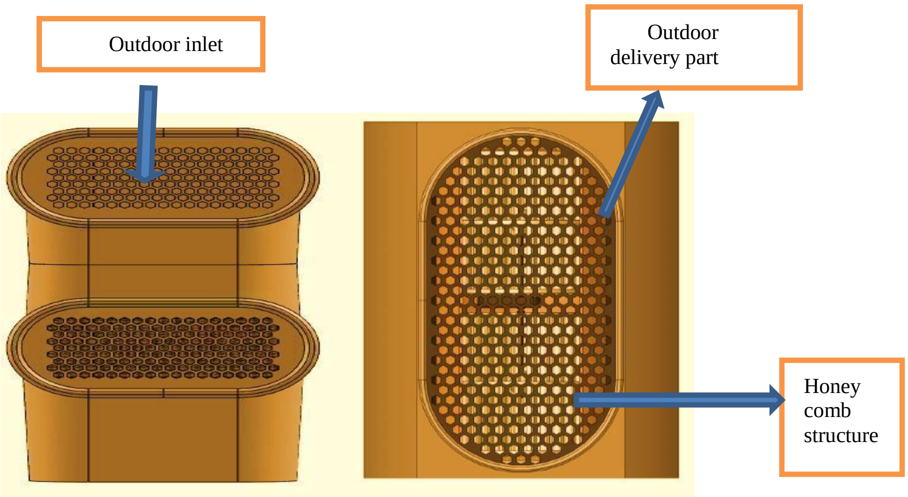

Figure1. Honey comb filter structure

For flat oval duct also used for these devices so that equation (2), (3),(4) becomes

$$P_e = \frac{1.30U(C/2)^{0.625}}{(H)^{0.250}} \tag{2}$$

$$U\frac{P}{2} = \left(\frac{\pi u^2}{4}\right) + c(C-c) \tag{3}$$

$$H = \pi c + 2(C-c) \tag{4}$$

P_e- diameter of duct in mm; c- length of duct in mm; g-Adjacent side duct Length in mm, U-Duct Area in mm^2 ; H-Perimeter of oval duct in mm, C-Major axis of oval duct,

c- Minor axis of duct in mm.

2. 2 DUCT DESIGN: The duct design modeled by using solid works software and has been analyzed for pressure drop through the application of duct model[11,12] Fig 2. 20% reduction in energy consumption from blowers to maintain the mass flow rate, reduce the time required to execute test. Normally duct design has low suction created but delivery has been high air flow pressure. Then three types of filter are used namely, primary filter, secondary filter, and fine filter. Primary filter size is 10µm, secondary filter size 5µm, fine filter size 3µm this filter activated on carbon coated material.

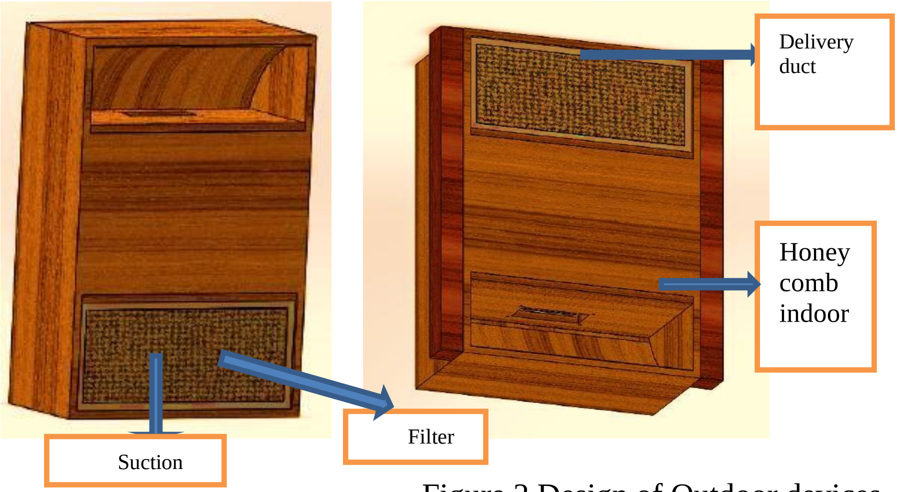

Figure 2.Design of Outdoor devices

This design has been created by upper duct and lower duct, upper duct mounted on bottom side its suction part and lower duct mounted on upper side[13] its delivery part and commonly three filters used due to primary, secondary and fine filters. Duct design consider by space air diffuser, noise level, space availability, duct leakage, duct heat gains, balancing, initial investment cost, operating cost. The term $n/\gamma b$ is static head, n is static pressure. Then the term $s^2/2b$ refers to velocity head and $\gamma s^2/2$ refers to velocity pressure velocity head is independent of air density, velocity pressure, calculate the Eq (1) to eq(5) n_v is velocity pressure in pa, air velocity m/s.

$$n_v = \gamma s^2/2 \tag{5}$$

For air standard condition ($1.204 kg/m^3$), equation (1) becomes and as in eq(6)

$$n_v = 0.602 s^2 \tag{6}$$

Velocity is calculated by (3) or (4) where L is discharge and U is area of cross section in m^2

$$S = 1000L/U \tag{7}$$

Total pressure is the sum of static pressure and velocity pressureby adding (7) and (6)

$$n_t = n_s + n_v \tag{8}$$

3. Design Analysis and Experimental Analysis

Air flow test this test conducted by CFD software the stream parting consumes artificial the volume of flow rate finished by diffusers through the reduction cross section area. Inlet pressure $101.325 KN/M^2$, inlet velocity 2m/s, Air flow analysis the outlet pressure is increased by this type of design and also outlet velocity has been increased. Pollution test conducted on experimental setup of air pollution and recommend the reduction of eight air pollutants:

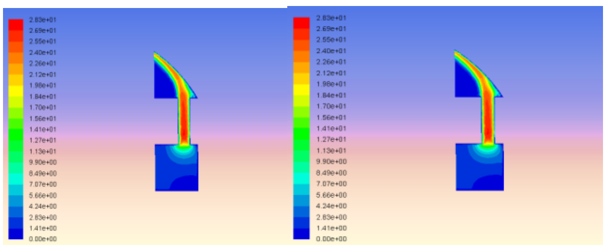

Figure 3. Velocity and discharge analysis outdoor

The outdoor (1) area weighted average total pressure outlet is 237.3934 Pascal. Area- weighted average velocity magnitude outlet is 3.7478707m/s Fig 3. The upper duct design analysis is the out let velocity is approximately 4 m/s. carbon filters are used due to remove the air fine dust particles. Mass flow rate outlet is -0.34989502 kg/s. The principle of Eq (10) used for to calculate the outlet pressure and outlet velocity, discharge is calculated by theoretical calculation. Finally compare that result theoretical and analyzing results as in (9)

$$(\gamma bz)^1 + n + \frac{\gamma s^2}{2} = constant \quad (9)$$

γ-density of air kg/m^3; b-gravitational force m/s^2; n-pressure in KN/M^2; s-velocity of air in m/s Bernoulli equation; as in eq (10)

$$(\gamma bz)^1 + n + \frac{\gamma s^2}{2} = (\gamma bz)^1 + n + \frac{\gamma s^2}{2} \quad (10)$$

potential energy, kinetic energy per unit volume, pressure energy per unit volume, the pressure head has been consider when a pumping system either begins into a IMS that under some pressure other than atmospheric. The pressure is such an IMS device must be converted to feet of air .A vacuum in the suction part or a positive pressure in the discharge part will added to the system head a positive pressure in the suction part or vacuum in the discharge part would be considered by Eq (11). The discharge is calculated normally inlet pressure is assumed by atmospheric pressure like 101.325KN/M$^{2.}$ Inlet pressure denotes (n_1) and velocity is(s_1) 2m/s suction area of duct(u_1) is 300mm x 600mm , delivery area of duct(u_2) is 320mm x 600mm finally discharge (L) is calculated by using this Eq (12).

Discharge (L)

$$u_1 s_1 = u_2 s_2 = L \quad (11)$$

u_1- area of inlet in m^2; s_1- suction velocity of Inlet m/s; u_2- area of Outlet in m^2 ;

s_2- delivery velocity of Outlet in m/s ,Mass flow rate = mass/time

Fan total pressure (TPF)

$$\gamma b H_1 + \gamma b(z_2 - z_1)^1 + (n_2 - n_1) + \frac{\gamma (s_2 - s_1)^2}{2b} = TP \quad (12)$$

Frictional pressure losses in duct section are result from air velocity from air viscosity. Evaluation of frictional pressure drops (FPD) as in (13)

$$\text{FPD} = y \frac{m}{p} \left(\frac{\gamma s^2}{2}\right) \quad (13)$$

m -length of duct; p-diameter of duct; y-friction factor

The friction factor of Reynolds number and the relative surface roughness of the duct surface in contact with the working medium at air. Can be expressed as in eq (14)

$$\text{RN} = \frac{ms\gamma}{€} \quad (14)$$

RN-Reynolds number; €-Coefficient of friction; Normally the experimental and analysis is the air flow is turbulent because the Reynolds number is high so the air flow is high that turbulent flow will be calculated by theoretical formula at the Eq(17). For turbulent flow, the friction factor is given by eq (15)

$$\frac{1}{(y)^2} = -2log_{10}\left[\frac{i}{3.7m} + \frac{2.51}{(RN)(y)^2}\right] \quad (15)$$

y- Friction factor; i- material absolute roughness factor in mm; As simplified the eq (16) and (17) formula for calculating friction factor, developed by the Eq (18)

$$y' = 0.11\left(\frac{i}{p} + \frac{68}{RN}\right)0.25 \quad (16)$$

$$if\ y' \geq 0.018:\ y = y' \quad (17)$$

$$if\ y' < 0.018: y = 0.85y' + 0.0028 \quad (18)$$

Measurements of air quality (@ 8.00 pm – 8.20 pm) without duct delivery

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Measurement of Air quality time (7.00pm to 7.15pm) Table 5 without delivery ducts without 3µm filter is $PM_{2.5}$ and PM_{10} sensor is used for distance from devices in 10cm, 150cm, 300cm, 450cm ambient measurement for $PM_{2.5}$ is 167,165,163,165, respectively. Also, with filter measurement is 81,71,84,90 respectively. Then efficiency will be calculated in 51%, 57%, 48%, and 45%. Then PM_{10} sensor is used for distance same and ambient measurement is 191, 189, 178, 180 and with filter measurement is 92, 82, 82, 85 respectively hence the efficiency of this sensor reading is 50%, 58%,45%,41%. Index sensors efficiency is 20%, 24%,22%,18%

Air Quality	Measurements of Ambient (Distance from Device)				Measurements of With Filter (Distance from Device)				Percentage of Efficiency (Distance from Device)			
	15 cm	200 cm	350 cm	500 cm	15 cm	200 cm	350 cm	500 cm	15 cm	200 cm	350 cm	500 cm
$PM_{2.5}$	177	175	173	175	92	85	82	88	53	60	51	50
PM_{10}	188	195	189	190	106	78	100	120	52	62	52	51
Index	210	211	217	210	175	162	158	182	30	30	32	20

Figure 4 indicates x axis is air quality and y axis is distance from device at 10cm, 150, 300cm, 450cm. black color indicates pm 2.5 without filter, red indicates pm10 without filter, sky blue indicates index in without filter, pink indicates pm2.5 with filter, green indicates pm10 with filter, dark blue indicates index in with filter , blue indicates efficiency in pm 2.5, violet indicates efficiency in pm10,brown indicates efficiency in index graph is fully analysis the pollution for bus stand . here lot of pollutants gases are there that gases mainly affected in human health and to produce the acid rain , all living things are affected ,so that mains problem to full fill that device.

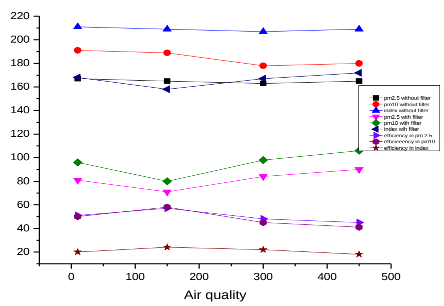

Figure 4 Measurement of air quality without duct delivery

Measurement of Air Quality Measurements (@ 8.20 pm – 8.40 pm) with duct delivery

Measurement of Air quality time (8.20pm to 8.40 pm) with delivery ducts (fangs) without 3µm filter is $PM_{2.5}$ and PM_{10} sensor is used for distance from devices in 10cm,150cm,300cm,450cm ambient measurement for $PM_{2.5}$ is 185,187,185,193, respectively as shown in figure 4.. Also, with filter measurement is 53,77,70,80 respectively. Then efficiency will be calculated in 71%,59%,62%,and 59%. Then PM_{10} sensor is used for distance same and ambient measurement is 207,210,207,225 and with filter measurement is 69,90,81,106 respectively hence the efficiency of this sensor reading is 67%,57%,61%,53%. Index sensors efficiency is 43%, 30%, 31%, 29%. .the device to control the pollution and remove the dust particles to go fresh air into the atmosphere related to fig 5

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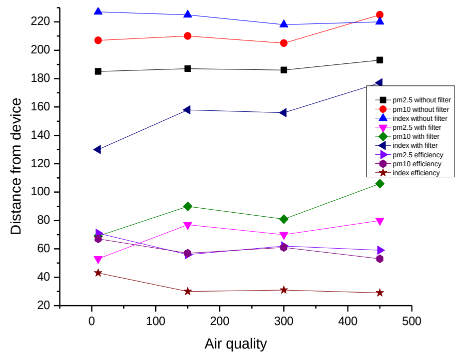

Figure 4 Measurement of air quality with duct delivery

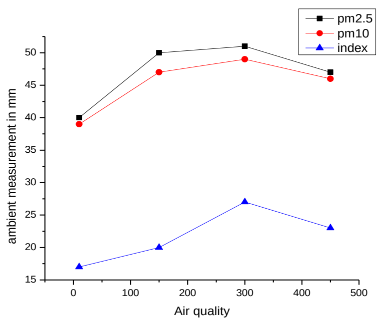

Figure 4 Measurement of air quality with pm2.5, pm10, index

Figure 4 and 5 indicates x axis is air quality and y axis is distance from device at 10cm, 150, 300cm, 450cm. black color indicates pm 2.5 without filter, red indicates pm10 without filter, sky blue indicates index in without filter, pink indicates pm2.5 with filter, green indicates pm10 with filter, dark blue indicates index in with filter , blue indicates efficiency in pm 2.5, violet indicates efficiency in pm10,brown indicates efficiency in index.

Conclusion

This work seems to challenge our good assessment of the improvement of air quality in parks through the removal of environmental pollution. The adequacy of internal and current air circulation was shown for both particulate and vapor emission evacuation. Nevertheless, the use of vitality, humidity control and other technical problems should also be studied in practical application. So, this efficiency is very high , Hence result has been considered for the accuracy, performance, strength of material, weight of the machine etc. finally in this research machine result is best for pervious machine. Sox, No, NMVOC, HMs, POPs, O3, this gas are removed in thus machine

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