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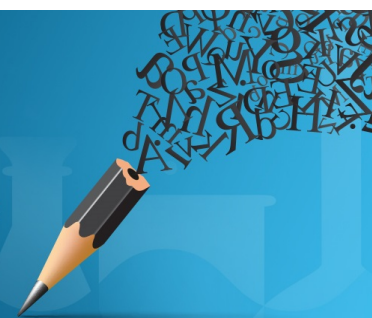


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The Influence of Throat Length and Vacuum Pressure on Air Pollutant Filtration Using Ejector

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Abstract. Environmental pollution can be caused by natural events or human treatment through uncontrolled industrial and technological activities. In fact, such pollution can threaten living creatures including on humans. It is caused by the inclusion of particles or other chemical compounds that are not present in the natural component so that it exceeds the required amount. In this paper, a construction design with pressure pollution control system was done to find appropriate pressure to eliminate the exhaust gas using sawdust and pipes as a funnel simulation in the industry. This research used the ejector system to filter air contaminated with sawdust. The results showed that the highest vacuum pressure value was 87.5kPa with the mass of the adsorbed sawdust up to 32.2 grams while for the lowest vacuum pressure of 90.5 kPa, the adsorbed sawdust was equal to 15.6 grams.

INTRODUCTION

The impacts of the uncontrolled industrial activity on the environment can lead to unhealthy ecosystems, which affect the human well-being, the availability of natural resources and the sustainable economic viability. Hazardous industrial waste potentially cause pollution that damages human health, lead to the extinct of some species, and contribute to global warming and the depletion of the ozone layer. Air pollution is defined as the entry into the gas composition of air, so the air does not correspond to its natural composition. This phenomenon is caused by the entry of particles or chemical composition into the air, where natural air should not contain chemical composition in the atmosphere [1]. The cause of air pollution is generally derived from two factors, namely the internal and external factors. The internal factors are naturally occurring factors such as dust from soil wind, dust released by volcanic eruptions and dust from the process of decomposing organic waste. Meanwhile, external factors can be interpreted as a result of human activities such as burning fossil fuels, dust (powder) from the results of industrial activities, and the use of chemicals sprayed in the air [2]. Air pollution is defined as the inclusion of living things, substances, energies or other components into the environment, and or the changing of the environmental order by human activities or by natural processes, so that the quality of the environment decreases to a certain extent, causing the environment to malfunction in accordance with its designation [3]. In this context, pollution is also defined as the emergence of one or more physical, chemical, or biological substances in the atmosphere. Some of them may be harmful to humans or may damage the health and lives of others, interfere with the aesthetics and comfort, and destroy property or the environment, or generally cause health problems in humans [4]. According to the Tenth Report of the Commission on Environmental Pollution, pollution is generally defined as the introduction by humans into the environment of substances or energy resulting in such deleterious effects as harm to human health, hazards to living resources and ecological systems, structural damage or improper use of the environment [5].

The process of reducing air pollution can be done by using the mechanism of the pressure differences between two fluid streams in opposite directions in different spaces. Such a mechanism will change the direction and

velocity characteristics significantly. By applying such mechanism into a construction design, it is expected that the compressible fluid flow rate (particle vapor, dust, and particles) will reverse in such a way as a result of larger incompressible fluid momentum force mechanism. In order to obtain a sufficient incompressible (water) momentum fluid momentum mechanism, a geometric construction of the ejector was varied in order to obtain optimum results [6].

The type of parameters based on the quality of ambient air standards and regulated in the Government Regulation No. 41 of 1992, namely particulates with diameters less than $10\text{ }\mu\text{m}$ (PM10), particulate matter with diameter less than $2.5\text{ }\mu\text{m}$ (PM2.5), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), hydrocarbon (HC) [7, 8]. Air is also the atmosphere that is around the earth and its function is very important for life in this world. In the air, the oxygen (O_2) is used for breathing, carbon dioxide (CO_2) for photosynthesis by leaf chlorophyll and ozone (O_3) to withstand ultraviolet rays. The environment according to the Law No. 23 of 1997 is defined as the unity of space and all materials, power and living creatures including humans and perpetrators that affect the viability of life and welfare of humans and other living creatures. The environment is a source of raw materials, energy, food, water, clean air and land that is useful for human life. The mechanism of the entry of foreign elements into the air can occur with various forms and processes such as:

- Photochemical fog shaped like orange-brown smoke but has a fairly heavy mass like fog, which usually occurs over industrial areas and busy highways.
- The photochemical haze that occurs as a result of the reaction of nitrite compounds and some of the volatile organic compounds present in the air.
- Vehicle exhaust gases and industries containing NO, CO and unburned hydrocarbons (primary pollutants), and also NO_2 and SO_4 in the form of smog (secondary pollutants).

This paper aimed at determining the effect of the throat length and the vacuum pressure on the sawdust filtration process using ejector equipment.

EXPERIMENTAL METHOD

Materials and Equipment

The testing material was sawdust as pollutant materials. The equipment included compressor, water pump, reservoir, the ejector system, and the manometer of fluid pressure as instrumentation tool.

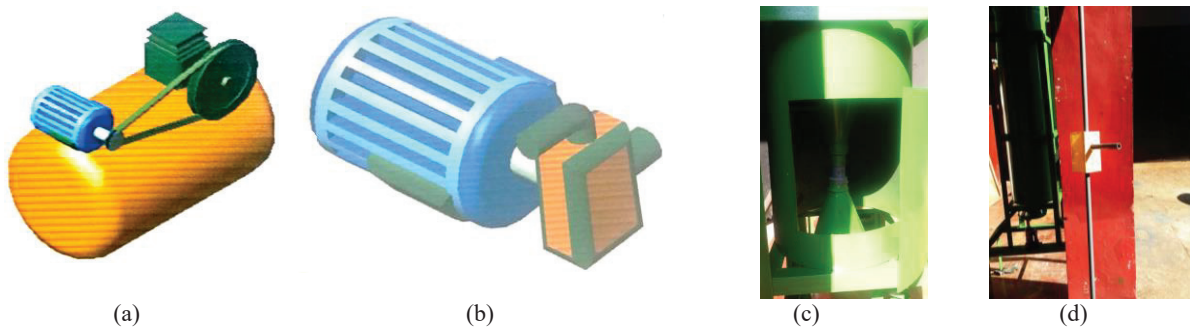


FIGURE 1. The equipment of: (a) compressor, (b) water pump, (c) ejector system, and (d) PVC Pipe.

Experimental Method

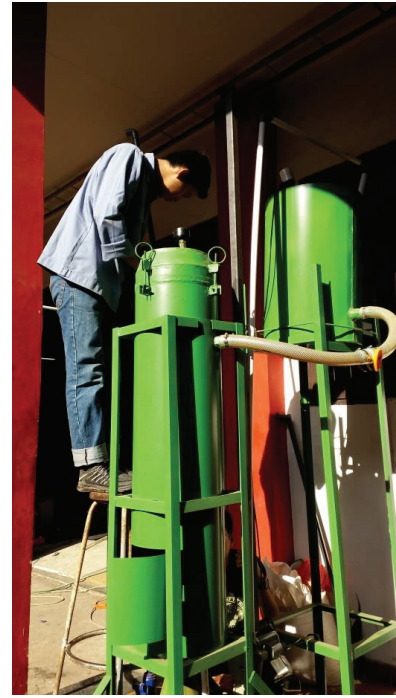
The experimental method was performed as follows:

1. Install all devices with a drive mechanism to drain the fluid in all areas to be operated.
2. Supply the installation equipment system with electric power and operate the pumping machine to fill the tubs, energy cylinders, and ejector in full while conducting a descriptive survey.
3. Activate all instruments (measuring instruments) and record the value of the reading.

The experimental setup was controlling the air pollution using ejector system as shown in Fig. 2.



(a)



(b)

FIGURE 2. The equipment of air pollutant: (a) without running and (b) with running.

RESULTS AND DISCUSSION

This research investigated vacuum cylinder of 30cm in diameter and throat of 2 cm in diameter. This study was also conducted on a variety of throat lengths, i.e. 10cm, 20cm and 30cm. The result of the experiment was obtained as follows:

TABLE 1. The results of the usage of the 1st Ejector with throat of 10cm in length

Ejector Pressure (bar)	Inserted sawdust (gram)	Non-adsorped sawdust (gram)	Adsorped sawdust (gram)	Ejector Diameter		Initial height (mm)	Final height (mm)	Time (s)
				A ₁ (cm)	A ₂ (cm)			
0.860	70.8	49.9	20.9	10	2	90	169	43.59
0.870	67.8	33.0	34.8	10	2	54	134	46.66
0.890	63.0	31.3	31.7	10	2	52	133	43.59

TABLE 2. The results of the usage of the 2nd Ejector with throat of 20cm in length

Ejector Pressure (bar)	Inserted sawdust (gram)	Non-adsorped sawdust (gram)	Adsorped sawdust (gram)	Ejector Diameter		Initial height (mm)	Final height (mm)	Time (s)
				A ₁ (cm)	A ₂ (cm)			
0.863	68.8	46.7	21.4	20	2	90	169	43.59
0.885	67.0	34.1	32.9	20	2	54	134	46.66
0.900	64.2	33.3	30.7	20	2	52	133	43.59

From the results as shown in Table 1, 2, and 3, it can be described the relationship between the variable the length of throat and the vacuum pressure as shown in Fig. 3. In addition, the relationship between the vacuum pressures and the adsorped sawdust is also described in Fig. 4. Investigation of ejector was studied on hydraulic transport [9].

TABLE 3. The results of the usage of the 3rd Ejector with throat of 30cm in length

Ejector Pressure (bar)	Inserted sawdust (gram)	Non-adsorbed sawdust (gram)	Adsorped sawdust (gram)	Ejector Diameter		Initial height (mm)	Final height (mm)	Time (s)
				A ₁ (cm)	A ₂ (cm)			
0.880	65.5	31.7	33.8	30	2	51	132	41.5
0.890	65.7	30.3	35.4	30	2	51	129	42
0.905	62.0	29.7	32.3	30	2	51	132	43

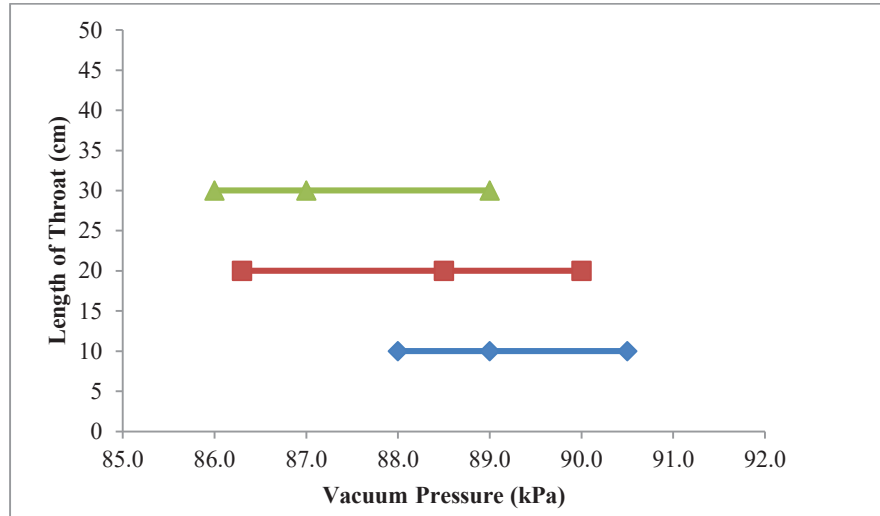
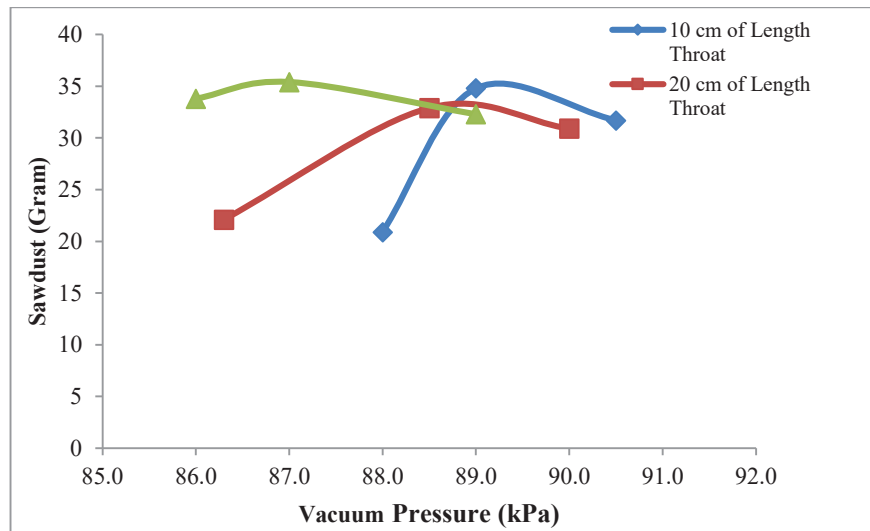
**FIGURE 3.** Graph of throat length and vacuum pressure.

Figure 3 shows the highest vacuum pressure of 87.5kPa was obtained by using a throat with length of 30cm, while the lowest vacuum pressure of 90.5 kPa was obtained by using a throat with length of 10cm. The diameter of throat was 2cm. The testing with the longer size of the throat indicated the compressive strength of the top of the ejector would be increasingly converted into the flow velocity, resulting in the greater vacuum pressure. Another investigation has studied the effect of nozzle throat length on the resolution of a low-pressure impact [10].

**FIGURE 4.** Graph of vacuum pressure and sawdust.

Based on Fig. 4, the highest vacuum pressure value of 87.0 kPa had a capacity to absorb sawdust up to 35.4 grams. Meanwhile, the lowest vacuum pressure of 90.5 kPa could adsorb 31.7 grams of sawdust. The generated

vacuum pressure will make the sawdust adsorbed by the ejector. The researcher has investigated the influence of vacuum pressure and activation condition on pore development through filtering the Chinese fir sawdust [11]. For other responses, the power demand can be determined. The power demand was investigated through operating the compressor unit and the pump water unit for filtering the air pollutant. Determining the power demand was performed on turning process of aluminum alloy [12, 13, 14].

CONCLUSION

Based on this study, it can be concluded:

- Constructively, the pressure pollution control systems can determine the sufficient pressure to eliminate the exhaust gas by using sawdust and PVC pipe as a chimney simulation in the industry.
- The highest vacuum pressure value was obtained by the usage of a throat of 30 cm in length and a vacuum pressure of 87.5kPa. Meanwhile, the lowest vacuum pressure was obtained by a throat of 10 cm in length and a vacuum pressure of 90.5 kPa. It shows that the longer the throat, the greater the produced vacuum pressure. The use of compressor pressure which is less than the vacuum ejector pressure will make the sawdust on the PVC pipe able to be absorbed by the ejector.
- The highest vacuum pressure of 87.5kPa and the lowest vacuum pressure of 90.5 kPa can adsorb sawdust of 32.2 grams and 15.6 grams, respectively.

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