The Effect of Ejectors on Reduction Indoor Air Pollution in the Welding Room

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ABSTRACT

In this study, the ejector installation has been designed and processed according to the plan and it further investigated the effect of the ejector's performance on reducing air pollutants in the welding chamber. This is done after gas and dust particles appear during the welding process. The measurement of air pollutants is carried out in two conditions. The first condition is during the welding process without using the ejector and the second condition is when the welding process continues and the ejector runs simultaneously. The measurements made for carbon monoxide (CO) gas, Natrium Monoxide (NO) gas and Total Suspended Particle. The Ambien Gas Sampler is used in measuring CO and NO gases, while the Staflex Air Sampler measures dust particles. The results show that when the ejector is run or in the second condition, carbon monoxide and sodium monoxide and total dust particles are lower in concentration compared to the situation when the ejector is not running.

Key Words: *Ejector, Air pollution, Carbon monoxide, Natrium monoxide, Total suspended particle*

INTRODUCTION

The rapid industrialization over the past two decades has caused many problems in the environment, including air pollution whose influence has started to be felt and has even become a pivotal problem today and certainly requires special attention in the development of a country (Lima et al., 2009), including in the City of Makassar, South Sulawesi Province. It is one of the cities in Indonesia which has the air pollution trends increasing from year to year (Sattar et al., 2012; Sattar et al., 2019). The increasing number of population is not only happening in developed countries but also in developing countries that have caused widespread air pollution (WHO, 2005). Urban air pollution affects the health, well-being and lives of hundreds of millions of people, women and children every day in Asia. It was reported that outdoor air pollution causes around 537,000 deaths annually, indoor air pollution causes more than double the number of deaths (WHO, 2002), this means that indoor pollution causes a greater impact than outdoor pollution especially in indoor activities that directly produce gases and particles (dust) which are quite dangerous for those exposed as well as in welding activities.

Based on the discoveries of historical objects, it can be seen that the technique of connecting metal known today with welding has been known since prehistoric times, for example the contrasting of copper gold alloy metal and lead-tin disordering. According to the information, it has been known and practiced in the span of years 4000 to 3000 BC and alleged sources of heat come from burning wood and charcoal. In the 19^{th} century, welding technology developed rapidly due to the use of electrical energy sources (Suharno, 2008). According to Deutsche Industrie Normen (DIN), welding is a metallurgical bond on alloy metal joints that is carried out in hot and liquid conditions, further explained that welding is a process where the same material and type are combined together so that a connection is formed through the chemical bonds produced from the use of heat and pressure (Suharno, 2008). Since there is a heat source, it will produce gases and particles where the gases that arise are dust (particles) in large welding fumes ranging from 0.2 µm to 3 µm. The chemical composition of welding smoke dust depends on the type of welding and electrodes used. When the hydrogen type electrode is low, there will be fluorine (F) and potassium oxide (K_2O) in smoke dust. In electric arc welding without gas, the smoke will contain a lot of magnesium oxide (MgO). The gases that occur during welding are carbon monoxide (CO), carbon dioxide (CO2), ozone (CO3) and Natrium Monoxide gas (Wiryosumarto & Okumura, 2004). In line with that when the welding process takes place there are dangerous gases which need to be considered such as Carbon Monoxide Gas (CO). This gas has a high affinity for hemoglobin (Hb) which will reduce the absorption of oxygen, and the condition of the Total Suspended Particle (TSP) also needs attention in the welding room (Harsono, 1996).

In the effort to minimize the gases and harmful particles that arise in the room when welding takes place, a system or tool is required that can reduce gases or particles that occur. One method that can be done is by using the ejector method. The projector has succeeded used for polluted gas cleaning applications over the past few decades because of their ability to handle gases containing pollutants such as vapor, gas, and solid / liquid aerosols up to 0.1 μm (Dutton et al., 1982; Subramarian et al., 2006). In line with this, it was stated that the ejector is one of the most important devices used in industry. This device has two main tasks. One is to make a vacuum and remove gas and the other is to mix it in liquid. One of the tasks above or both can be considered in designing and using an ejector (Stefan & Hamjak, 2008; Gamisansa, 2002). In general, the main function of the ejector is to achieve maximum secondary flow in each of the main operating conditions given and to compress entangled masses in the ejector to the necessary release conditions (Chou, 1996).

Based on this description, in this study we will investigate whether there is a reduction in the concentration of gases and particles in the air that arise specifically Carbon monoxide (CO), Natrium monoxide (NO) and Total Suspended Particle (TSP) with tools that have been designed with the ejector method.

MATERIALS AND METHODS

Ejector Installation

The design of the ejector installation consisting of several core components such as cylindrical joints, reservoirs and other components has been done and completed, installation as shown in the following Fig 1:

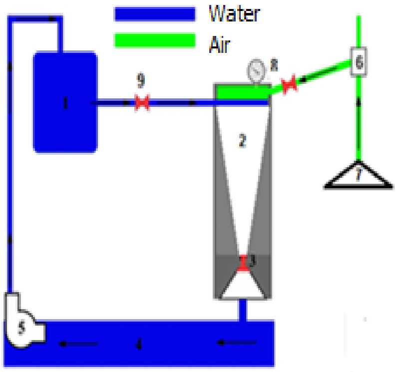

Fig. 1: Ejector Installation design results

Tools and Procedure Sampling

The implementation of the study is to examine the extent of the influence of the ejector tool that has been designed and made will require direct testing to the actual environment, namely the industrial environment. As a testing phase, this tool is carried out in the student's welding practice room at the Makassar Industrial Engineering Polytechnic (ATI) Makassar, with the consideration that in the welding room when welding takes place there will be a range of air conditions with bad air condition which certainly has an impact on welders or students who temporarily practice welding.

The entire air sampling process uses tools from the Environmental Engineering Center and Makassar Class I Disease Control whose equipment is available and sufficient for sampling and also for analysis of air samples that have been taken. The tool used for sampling air for gas is used Ambient Gas Sampler (Impinger Model: MD-51MP), while TSP samples are used by the Staflex Air Sampler tool.

Sampling is carried out in two air test conditions, namely:

1. Condition I (Ejector OFF): Retrieval and analysis of air samples when welding practices are taking place but the ejector has not operated. The data generated is as a control to see how much influence the ejector has.

2. Condition II (Ejector ON): Retrieval and analysis of air samples while ongoing welding practices and temporarily operated ejectors. Data generated will be compared with the data generated in condition I.

Sampling Implementation Procedures: Supply installation equipment systems with electric power, throat length used is 30 cm (Saini et al., 2018). Operate the pump engine (5) to fill the reservoir (4). Open the valve (9) and valve (10) and close the valve (3) until the cylinder (2) can be fully charged. Close the valve 9 and valve 10 after the cylinder 2 is fully filled. Measure the initial height of the reservoir water level (4). Run the ejector by opening valve (3) and valve (10), so that the water is circulated continuously. Records the vacuum value measured in the vacuum gauge (8) after opening the valve (10). Take notes and maintain the level of water in the reservoir (4). Set throat ejector (3), which is 30 cm long, which is used based on the results of previous tests. Operate ambient gas sampler tools and staflex air samplers. Record the time to start operating the tool in this step. Sampling tools are operated for 60 minutes, with three sampling times at 9-10; 10-11; 13-14 (in the case of students while doing welding, such as conditions when taking samples without running an ejector). After enough time for each time, then the ejector is stopped and also the sampler. Air samples were taken to the BTKL-PP Laboratory for analysis.

RESULTS AND DISCUSSION

Based on the results of air measurements in the welding room for the parameters Carbon monoxide as shown in Figure 3.1 with the Ejector condition not yet executed (OFF) at sampling at 9-10 am CO concentrations of 2,384 ppm, 11-12 at 2.43 ppm, while at 13 -14 the concentration is 2,425 ppm, while for the measurement conditions when the ejector is 09-10 a.m. COs concentration is 2,378 ppm, 11-12 is 2.41 ppm, while at 13-14 the concentration is 2.39 ppm. Concentration when the ejector is carried out at all hours, the nine samples show a decrease in concentration, which more noticeably decreased in the 13-14 is sampling. This means that the longer the ejector is executed, the more carbon monoxide in the indoor air will be.

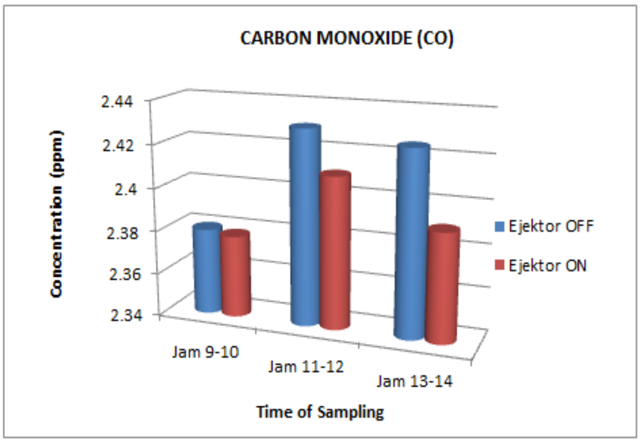

Fig.1: Graph CO concentration in the air when the ejector is OFF and ON

Based on the results of the air test for the parameters of Nitrogen monoxide as shown in Fig 2 with OFF Ejector conditions at sampling at 09-10 am, NO concentration was 0.003 ppm. At 11 - 12 it is 0.004 ppm, while at 13-14 the concentration is 0.0045 ppm. Meanwhile on the ejector ON condition at 09-10 a.m., NO2 concentration was 0.0025 ppm. At 11 - 12 it is 0.0039 ppm, while at 13-14 the concentration is 0.0044 ppm. There appears to be a decrease in NO concentration when the ejector is run, but it is different from Carbon monoxide which decreases a bit.

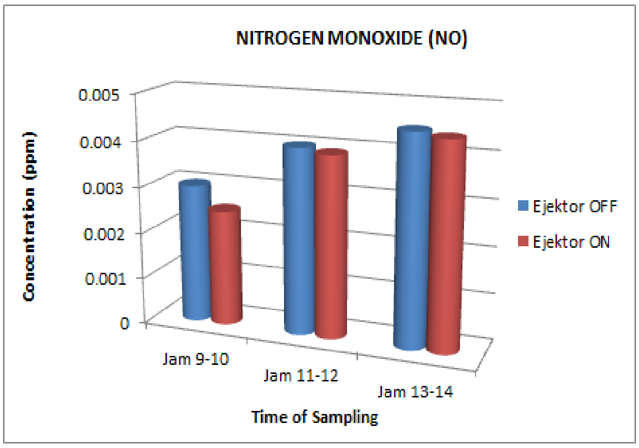

Fig.2: Graph the NO concentration in the air when the ejector is OFF and ON

Based on the air measurement results in the welding room for the Total Suspended Particle parameters as shown in Fig 3, with the ejector not running, at 09-10 am sampling TSP concentrations of 0.155 mg / m3 were obtained, 11-12 at 0.156 mg / m3, while at 13-14 the concentration is 0.158mg / m3. While the results of TSP measurements on the condition of the ejector are carried out, at 09-10 a.m., the TSP concentration of 0.152mg / m3 is obtained, 11-12 at 0.149mg / m3, while at 13-14 the concentration is 0.147 mg / m3. There appeared to be a decrease in TSP concentration when the ejector was run, also a reduction was seen in the 13-14 sampling, as in Carbon monoxide.

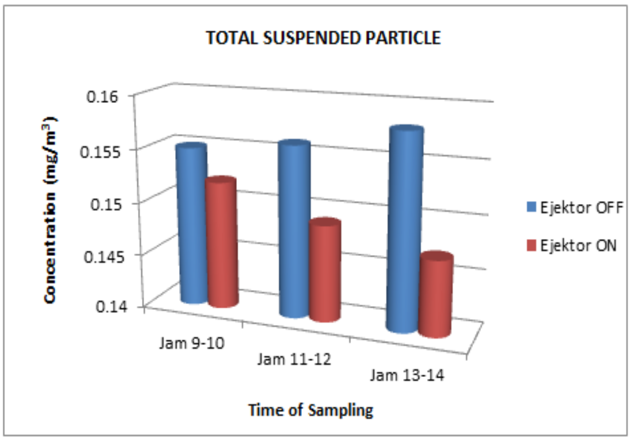

Fig.3: Graph TSP concentration in the air when the ejector is OFF and ON

Based on the graph of the data shown in Fig 1 and Fig 3, it seems that there are differences that can be observed, namely that in the measurement of Carbon monoxide, the highest concentration in the sampling hours is 11-12 both when the ejector is not executed and when the ejector is executed. Whereas in TSP measurements it appears that when the ejector has not been executed the trend of TSP concentration appears to increase, whereas when the ejector is carried out the total dust concentration (TSP) trend is decreasing. From both air and CO and TSP measurements, it appears that the total dust concentration decreases more Suspended Particle) as the effect of the ejector around 4.47 percent, compared to Carbon monoxide (CO) around 0.78 percent. One reason is because particles have heavier mass than CO in addition to larger sizes, the particles themselves can be categorized by diameter. If the diameter is smaller or equal to 2.5 microns, it is categorized as fine particles, if the diameter between 2.5-10 microns is called coarse particles, whereas those with a diameter greater than 10 microns is called

Total Dust or also known as Total Suspended Particles (Sattar et al., 2014). The finer the particles the higher the impact on respiratory health (Rashid et al., 2014).

CONCLUSIONS

In this paper, the reduction and recovery of pollutant gas and total dust is sucked from the air with vacuum conditions into the tube and then pollutant gases and particles will be sent into the water fluid that continues to circulate, the conclusions in this study are: There is a reduction in the concentration of Carbon monoxide gas and Total Suspended Particles by the operation of the ejector. The longer the ejector is operated, the bigger the carbon monoxide and Total Suspended Particles gas will appear. Compared to Carbon monoxide gas, the concentration of Total Suspended Particles appears to have a greater degree of reduction in all hours of sampling. The greater the vacuum value, the higher the ability to reduce the concentration of carbon monoxide gas and Total Suspended Particles.

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