Portable fume hood-acid-1

by Choirul Amri

Submission date: 09-Sep-2021 11:11AM (UTC+0700)
Submission ID: 1644249926
File name: Amri_2020_J._Phys.__Conf._Ser._1625_012039.pdf (720.03K)
Word count: 3082
Character count: 15085

Journal of Physics: Conference Series

PAPER · **OPEN ACCESS**

Portable Fume Hood as an Environmentally Friendly Laboratory Tool to Neutralize Acid Contamination

To cite this article: C Amri 2020 *J. Phys.: Conf. Ser.* **1625** 012039

View the article online for updates and enhancements.

IOP ebooks™

Bringing together innovative digital publishing with leading authors from the global scientific community.

Start exploring the collection–download the first chapter of every title for free.

This content was downloaded from IP address 103.108.87.2 on 05/02/2021 at 02:43

Portable Fume Hood as an Environmentally Friendly Laboratory Tool to Neutralize Acid Contamination

C Amri

Department of Environmental Health, Poltekkes Kemenkes, Yogyakarta - Indonesia
Corresponding Author: chamri@hotmail.com

Abstract. A portable fume hood design with an acid pollution absorber filter was prepared. This study aims to: (1) make a portable fume hood equipped with an acid contaminant absorbent filter housing, and (2) determine the length of time the ability of the lime granule can function as an acid contaminant absorbent filter. This study is a quasi-experimental study using posttest only with control group design to assess the feasibility of using lime granules as acid absorbent filters on portable fume hoods. Data analysis was performed by regression using the Excel program. The results of the study are as follows: (1) portable fume hood that use acid-absorbent filters have been made, (2) The average length of time the ability of lime granules can function as an acid contaminant absorbent filter on the use of a portable fume hood at a lime granule weight of 0.5; 1,0; 1,5; and 2.0, respectively 222, 589, 880, and 1219 minutes. This relationship can be estimated with a regression equation Y = 0.619X - 36.71. Which Y is the ability of lime granule as absorbent of acid contamination, and X is the weight of lime granule.
Keywords: Acid, contamination, filter, lime, portable fume hood

1. Introduction

Fume Hood is a fume hood in a laboratory that is used for research activities that use chemicals, especially strong acids and radioactive materials. The working principle of the Fume Hood is to direct the air pressure from inside the Fume Hood towards the exhaust air through the ducting exhaust fan [1]. Many laboratories rely on fume hoods to provide laboratory workers with safe working conditions [2].

Some of the problems that often occur in the use of Fume Hoods, namely: (1) When carrying out activities using the Fume Hood, the Fume Hood blower does not operate first so that the gas generated by these chemicals will not be sucked and wasted through the proper drain, but can be turned around directions to the laboratory room are even sucked up or on the body of the user / researcher, (2) Fume hood is not equipped with a filter to absorb chemical contaminants, so that the chemical contaminants pollute the environment and endanger the health of researchers in the laboratory, (3) Fume hood is generally installed a patent on a certain place in the laboratory, so it does not allow to be moved.

Based on the reasons above, the researcher intends to design portable fume hoods that are equipped with suitable chemical pollution capture filters. Common chemical contaminants in the use of fume hoods are acidic contamination in the form of gases or aerosols. Therefore, researchers used a filter in the form of lime in the form of granules which allows air circulation to occur. The expected reaction system is as follows the equation (1) [3]:

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

$$H^+ + Ca(OH)_2 \rightarrow H_2O + Ca^{2+} \quad (1)$$

Based on the reaction equation system, it is expected that the acid chemical contamination when using fume hood will be caught in the filter and not pollute the environment. In this research, the fume hood is designed portable to enable the fume hood to be moved around as needed.

Lime granule as filter absorbing acid contamination will one day be saturated, so it is no longer possible to absorb acid contamination, so in this study researchers used bromine thymol blue (BTB) as a sign that the lime granule lime granule is no longer able to absorb acidic contamination anymore. BTB will give a green-blue color if the quicklime is still functioning, and BTB will give a yellow color when the quicklime granule is no longer functioning in absorbing acid contamination in the use of portable fume hoods.

2. Experimental Section

This research is a quasi-experimental study to assess the feasibility of using lime granules as acid absorbent filters on portable fume hoods. The design uses posttest only with control group design to determine the length of time the ability of the lime granule to function as an acid absorbent filter and determine whether or not bromine thymol blue (BTB) is used as a sign that the lime granule granules on portable fume hoods are not able to absorb acid contamination again.

2.1. Instruments and Materials

The tools used in this study include: portable fume hoods, granule molding devices, and equipment for determining air acid numbers.

Materials used in this study include: lime tohor, concentrated hydrochloric acid (HCl) p.a. 37%, brom thymol blue / BTB), ethanol 96%, sodium hydroxide (NaOH) p.a., oxalic acid dihydrate ($H_2C_2O_4.2H_2O$) pa, methyl orange indicator, and distilled water.

2.2. Manufacturing Portable Fume Hoods

Portable fume hoods are made in the form of wheeled fume hoods. Important parts of this portable fume hood are: (1) Fume hood frame, (2) Fume hood table, (3) Electrical installation, (4) Water installation, (5) Blower, and (6) Filter.

2.3. Test the Use of Portable Fume Hoods

Test of the use of portable fume hoods were carried out in the experimental and control groups, each with 5 replications. The experimental group was carried out in 4 groups, namely the experimental group 1 (portable hood fume hood using 0.5 kg lime granule filter), the experimental group 2 (portable hood fume using 1 kg lime granule filter), the experimental group 3 (portable hood fume using 1.5 kg lime granule filter), and experimental group 4 (Portable Fume hood uses 2.0 kg lime granule filter). The control group uses a portable fume hood without lime filter.

The fume hood test is carried out as follows: (1) 400 ml of distilled water is filled into housing filter 2 (last filter housing), then 1 ml of BTB indicator solution is added, (2) Lime granule filled with housing filter 1, (3) The fume hood blower is turned on, (4) A 500 ml beaker containing 500 ml of concentrated HCl solution is placed on an 80 °C temperature heater located right in the middle of the portable fume hood workbench, and the start time is recorded, (5) Observe for color changes indicator solution on the filter housing 2, (6) Note the length of time needed for the indicator solution to turn yellow.

3. Result and Discussion

As the purpose of this study, the results and discussion in this chapter are presented: (1) Manufacture of portable fume hoods, (2) Lime granules as acid contaminant absorbent filters, and (3) BTB as long markers of use of Lime granules.

3.1. Portable Fume Hood

Fume hood in this study was designed to answer the problems as in the background of this study. For this reason, some of the basic designs of this portable fume hood are at least: (1) the fume hood can be moved / equipped with wheels, (2) equipped with electrical installations, (3) equipped with lighting / lamps, (4) equipped with vacuum smoke / gas, (5) equipped with a network of water / washing equipment, (6) the presence of an acid pollution absorbent filter, and (7) a marker / indicator that the acid contaminant absorbent filter needs to be replaced. The portable fume hood image that has been created is presented in Figure 1. This portable fume hood is equipped with four wheels. This allows portable fume hoods to be moved from one place to another, or from one room to another. Portable fume hood wheels can be locked, so they can stand firm without sliding somewhere when in use. When it is moved somewhere else, the wheel lock is opened, and the portable fume hood can be shifted by pushing or pulling on the handle.

Figure 1. Front-right view of the portable fume hood that has been made in this study.

Electrical installations installed on portable fume hoods use 220 voltage as the electrical voltage that is often used in Indonesia. With the installation of this electricity installation, in addition to providing power sources for suction equipment for smoke / gas, also for other purposes, namely for lamps, heating stoves, magnetic stirrers, and other equipment that uses power sources that are often used in connection with the use of this fume hood.

The lighting device installed on the portable fume hood is a 15 watt LED lamp mounted on the fume hood workbench. With this lighting, portable fume hoods can be used in a room with minimal lighting or at night.

The smoke or gas suction unit is installed inside the fume hood. There are two suction machines installed, namely: (1) Suction machine which is located directly above the fume hood workbench, and (2) Suction machine installed under the fume hood workbench. The two machines are connected to each other through a piping network. Suction machine which is right above the fume hood workbench functions to inhale smoke or gas produced during the use of fume hood, then pushes the smoke / gas into the filter to absorb acid contaminants. The suction machine under the fume hood workbench serves to suck the acid free air that comes out of the acid absorbent filter after passing through the

filter housing containing the indicator solution. This suction machine has a suction power of 10 KPa with an air flow rate of 30 liters/second.

For the purposes of washing tools or work tables, this portable fume hood is equipped with a water faucet that can be connected to the nearest water network through a hose. As for the former washing dirty water or rinse water will enter and be accommodated in a dirty water reservoir in the form of derigen. Derigen pool of dirty water under the work table. This 20 liter capacity can be retrieved and reassembled in connection with the need for dirty water disposal. The main advantage of this portable fume hood is that it is equipped with a filter housing located behind the fume hood, making it easy to use. In the filter housing is where the acid contaminant absorbent filter is inserted. This filter is used to absorb polluted fumes / gases produced during the use of fume hoods. This acid contaminant absorbent filter in the form of lime granules which will be discussed more specifically in this study.

To find out when the lime granule as an acid-absorbent filter needs to be replaced, this fume hood is equipped with an indicator solution. When the indicator solution turns yellow, this is a sign that the lime granule needs to be replaced. This matter will also be discussed more specifically in the BTB discussion as a long-time marker of the use of lime granules.

Table 1. Duration of the ability of lime granules as absorbers of acid contamination.

Weight of Lime granule (gram)	Replication	Duration of the ability (minute)	Average (minute)
0 (Controle)	1	1.25	1.32
	2	0.85	≈1
	3	2.25	
	4	1.50	
	5	0.75	
500	1	185.25	221.68
	2	278.77	≈222
	3	209.50	
	4	192.08	
	5	242.82	
1,000	1	522.50	588.52
	2	588.90	≈589
	3	604.85	
	4	628.77	
	5	597,58	
1,500	1	835.80	880.41
	2	848.62	≈880
	3	896.45	
	4	938.63	
	5	882.55	
2,000	1	1,128.48	1,219.41
	2	1,343.68	≈1,219
	3	1,132.87	
	4	1,293.68	
	5	1,198.35	

3.2. Lime Granules as Acid Absorbent Filter

To absorb acid contamination from smoke or gas produced during the use of fume hoods, portable fume hoods are equipped with a lime granule filter (Figure 2). The active compound in lime granule which acts as an acid absorbent filter is calcium oxide (CaO), which when absorbing water will turn into calcium hydroxide ($Ca(OH)_2$) [4]. The mechanism of action of this lime granule in absorbing acid contamination as stated in the reactions. Based on the reaction, the air / smoke / gas is contaminated with acid, after passing through this lime granule filter the air will be free of acid contamination, so it does not pollute the air space or environment.

Figure 2. The filter housing contains lime granules on a portable fume hood.

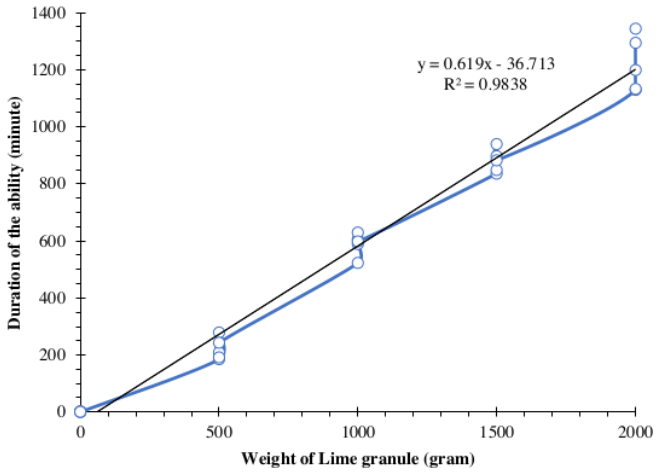

Figure 3. Relationship between lime granule weight and its ability to absorb acid pollution.

The ability of this lime granule to absorb acid contamination will one day be reduced. For this reason, this research is focused more on this matter, especially related to the length of lime granule's ability to absorb acid contamination. The results of this test are presented in Table 1.

Based on the old test results, the ability of lime granules to absorb acid contamination in Table 1 shows a trend that the heavier lime granules used as filters absorbing acid contamination, the longer the ability of the lime granules to absorb acid contamination. This trend is more clearly seen in Figure 3.

The relationship between the weight of lime granule and its ability to absorb acid contaminants follows the equation Y = 0.619X - 36.71. Which Y is the ability of lime granule to absorb acid contamination, and X is the weight of lime granule. Based on these equations, it can be seen how long the ability of lime granules as absorbent acid contamination for every gram or kg of lime granule weight, so it can be estimated when the lime granule should be replaced.

Housing filter of lime granule with a maximum capacity of 2.5 kg. With this capacity, the portable fume hood can be estimated to be used for up to 1,500 minutes or about 24 hours. However, if a larger lime granule is needed, a portable fume hood that is made is still possible to add a lime granule filter housing.

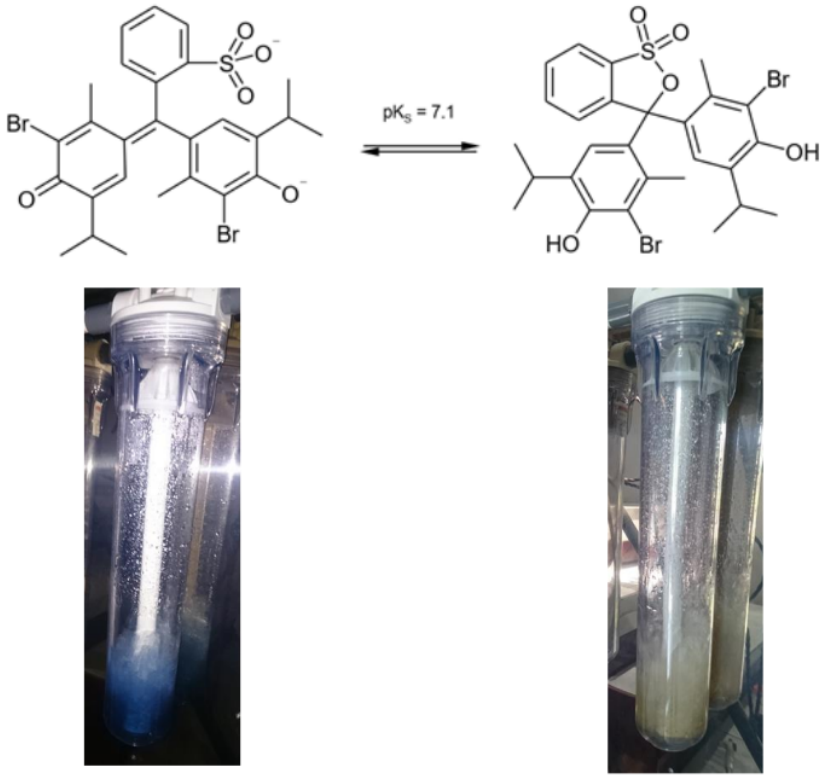

Figure 4. BTB structure and color in alkaline (a) and acidic (b) environments.

3.3. BTB as a marker of the duration of the use of Lime Granules

Estimated, the length of use of lime granules as absorbents of acid contamination can be estimated, but to ensure the real balance that the lime granules must be replaced immediately, the portable fume hood is also equipped with a marker in the form of an indicator solution, the BTB indicator. This BTB indicator has a color gradation from blue to yellow in the pH range of 7.6 - 6.0.

In alkaline conditions (see Figure 4), BTB is not protected. In this situation BTB has a peak absorption at a wavelength of 602 nm [5], thus transmitting blue. In the situation of lime granule is no longer able to absorb acid contamination, then this acid will release and enter the BTB indicator solution. The BTB indicator will be protonated in the presence of this acid. Protonated BTB has a peak absorption at a wavelength of 427 nm, so the solution turns yellow. Therefore, when the BTB indicator solution turns yellow, it is a sign that the lime granule has to be replaced.

4. Conclusions

The portable fume hood was successfully made, equipped with wheels, electrical installations, lighting, gas inhalers, washing equipment, acid contaminant filter absorbers, and indicators that the acid contaminant absorbent filters need to be replaced.

The average length of time the ability of quicklime granules can function as an acid contaminant absorbent filter in the use of portable fume hoods at 0.5 limestone granules weight; 1.0; 1.5; and 2.0, respectively 222, 589, 880, and 1,219 minutes. This relationship can be estimated with a regression equation Y = 0.619X - 36.71. Which Y is the ability of lime granule to absorb acid contamination, and X is the weight of lime granule.

Brom thymol blue (BTB) can be used as a marker that the quicklime granule on a portable fume hood is no longer able to absorb acid contamination.

5. References

[1] Widiana I W, Jakaria, Mulyono and Sori S 2015 Rancang Bangun Sistem Interlock pada Pengoperasian Fume Hood untuk Mencegah Kontaminasi Silang, *Prosiding Seminar Nasional XI SDM Teknologi Nuklir (Yogyakarta: Sekolah Tinggi Teknologi Nuklir BATAN)* **11** pp 44-51

[2] Kasper J, Ptescavage M, Nurks M, Penman D and Woods B 2013 *Introduction Chemical Fume Hood Testing Improvements Needed to Reduce Health and Safety Risk to EPA Employees Hotline* (Washington, D.C: U.S. Environmental Protection Agency)

[3] Karpf R H 2015 *Basic features of the dry absorption process*. Germany: Ingenieurgesellschaft für Energie- und Umweltengineering & Beratung mbH. pp 4-8

[4] Saswita N and Sulistiyani S 2018 Penggunaan Kapur Tohor (CaO) dalam Penurunan Kadar Logam Fe dan Mn pada Limbah Cair Pewarnaan Ulang Jeans Kabupaten Magelang Tahun 2017, *J. Kesehatan Masyarakat* ***6*** 662–669

[5] Himedia 2015 *Bromo Thymol Blue Indicator* (Mumbai India: HiMedia Laboratories Pvt. Ltd)

Portable fume hood-acid-1

ORIGINALITY REPORT

11%	9%	3%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Program Pascasarjana Universitas Negeri Yogyakarta Student Paper	5%
2	doc-pak.undip.ac.id Internet Source	2%
3	e-journals.unmul.ac.id Internet Source	1%
4	ejournal-pasca.undiksha.ac.id Internet Source	1%
5	Frederick W. Stoss. "Government information and documents and technical reports", Elsevier BV, 2020 Publication	1%
6	sipeg.univpancasila.ac.id Internet Source	1%
7	Submitted to University of New South Wales Student Paper	<1%
8	Submitted to Universiti Kebangsaan Malaysia Student Paper	<1%

9	papers.sttn-batan.ac.id Internet Source	<1%
10	pertambangan.fst.uinjkt.ac.id Internet Source	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		

Portable fume hood-acid-1

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8