



Development and Application of Low Cost Acetylene Gas Apparatus as Diagnostic Instrument for Higher Secondary School Students

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Abstract: The main aim of this research study was to develop an authentic and concrete low cost Acetylene Gas apparatus as a diagnostic instrument which could be used to determine higher secondary school students' comprehension and understanding of hydrocarbon compound called Ethylene (C_2H_2) or Acetylene gas. Science as compared to Arts is a discipline taught through activities. Especially, Chemistry cannot be taught without any proper activity. Therefore, curriculum developers tried to include such type of contents and material that were not only helpful for students but for the teachers as well. At the same time teachers also tried to find out appropriate teaching strategies and low cost/ no cost material to teach chemistry in better way. But unfortunately, there was no apparatus for the production of Acetylene Gas. For the development of the low cost apparatus for the production of Acetylene Gas, 20 students from grade Twelve non randomly selected from Danish Public School and College, Bat Khela. The developed apparatus was applied in different institutions, where experimental study was adopted. For this purpose two groups were taken, one was control and other was experimental group (N=30) in each institution. The experiment group was thought through an apparatus made of low cost material while the control group was taught the same topic conventionally by the researcher himself. The low cost apparatus was applied in four different higher secondary schools. The research work was completed in two phases, i.e., fabrication of apparatus and application of this fabricated apparatus. It was concluded that lecture delivered by low cost apparatus was much more effective than the lecture delivered by the conventional method for students' conceptual and creative thinking. Therefore, it is strongly recommended that the teachers be trained to teach and create scientific situations through activities through low cost apparatus.

Keywords: Concrete low cost Acetylene Gas apparatus, (C_2H_2) or Acetylene gas and Combustion test

1. Introduction

It is a vibrant fact that science cannot be taught in a traditional manner as compared to Arts subjects. It must be taught with the help of activity. It develops the creative thinking of the students. For activities, instructional Audio Visual aids are used in laboratory. Students are motivated by these activities and through which they learn easily

and purposefully. Because in such type of activities students are directly involved hands activities not only enhance student's self-image, but also help to increase their understanding of nonverbal communication in the form of vocabulary. Moreover, teaching through activities not only makes the environment interesting for the learners but also helps the teacher in teaching learning process, due to which the learning becomes better and beneficial. According to Khitab (2016) Young students are instinctively researchers' explorers. They need to provide an environment in which they can explore freely. This leads to creative and right environment for learning. In such type of environment students enhance their learning through discussion and teamwork which boosts their creativity. Anwar (2019) explained that what was taught through activity it has created motivation and improve their academic performance at higher secondary level. In science education, especially in Chemical education or chemistry education, teaching, teachers mostly use activity based teaching science subject in already existing laboratories to enhance students creative thinking.. It is a well-known fact that biology and Physics can be easily taught in the laboratory, but in teaching Chemistry teaching the case is different because a well-furnished and well equipped laboratory is required. Developed countries have well equipped chemistry laboratories along with blended learning. It is almost impossible for poor and developing countries to provide such type of chemistry laboratory. However, this deficiency may be overcome if low cost/no cost fabricated apparatus are provided. In this article the researcher tried his best to fabricate one low cost apparatus for teaching of an important topic of the preparation of Acetylene gas along with important reactions.

1.1 Significance of Study

The main and ultimate aim of this study was to fabricate an apparatus on low cost basis that could produce Acetylene gas. This will certainly help the teachers to teach chemistry in proper way to give conceptual understanding to students. Moreover, this will increase the capacity of the teachers to develop more apparatus. This will also help the curriculum developers and writers to include such type of low cost material in curriculum

1.2 Research Objectives

- To develop of real low cost apparatus as a diagnostic instrument for the preparation of Acetylene Gas
- To observe the physical chemical and properties of Acetylene gas through this apparatus.
- To find out the applications of this low cost / no cost apparatus

2. Literature Review

Many researchers have worked on the development and fabrication of low cost apparatus .Singh and Kaur (2012) concluded that below average science teachers (N=50) in secondary school use low cost teaching material fabricated in laboratories. Similarly, Ali and Papaiah (2015) mentioned that science teachers did not perform to teach science subjects. However, the researcher adds that 50% of the science teachers at secondary schools used low cost equipment. And science teachers used these apparatus already existed in laboratories. According to Khitab (2004) Pakistan is also a developing country and one cannot find a separate Chemistry laboratory. That's why the Government of Pakistan trains science teachers time and time again to fabricate low cost teaching material under the auspices of Second Education Project assisted by bank. The investigator of this research article was a lead Master Trainer of that project.

According to (Shafiq, Personal communication, March 2010) stated that science teachers should develop low cost apparatus by themselves and children in science laboratories. This will not only increase the creativity level of students but also clear the difficult concepts. At the same time the scientific environment of teaching learning will also be created. Hands-on activity increases students learning skills and tendencies to observe and analyze. As Yitbarek (2012), is of the opinion that teaching through low cost apparatus is a very powerful observational tool of

learner as it increases his proficiency to be creative, elucidate and ensure the real science. Low cost apparatus is alternative to high cost equipment that removes the financial complications of any education institution. Similarly, Ara (1998) also emphasizes on the use of low cost material for science teaching as these apparatus develop students competency, confidence and efficiency at secondary level and this is the strong reason to use such type of apparatus. Mishra and Yadav (2013) believe that low cost apparatus can change the scenario of costly scientific equipment. Tesfaye et al. (2011) has also expressed concerns over the unavailability of the cost apparatus in the laboratories. Consequently, the demand of the use and applications of such type of low cost apparatus that are made from local available resources increase further. Usman (2000) while describing the learner rote memorization, has mentioned that the academic performance of the students was poor in science subjects because there were no apparatus available in the school laboratories. Adeniyi (1999) and Khitab (2004) have concluded in their studies that though science teaching ability, competence and skills are indispensable but for the science teachers it is very difficult to accomplish and perform experiments due to lack of adequate apparatus and functional laboratories.

3. Methodology

3.1 Sample and Sampling Technique

As this study required two phases, therefore, two sampling techniques were used.

- Convenient sampling technique was used in this study. 20 students ranging age 16 to 18 years studying in XIth and XIIth classes were selected from Danish Public College Bat Khela for the fabrication of low cost apparatus
- For the application of the developed low cost apparatus, four higher secondary schools were randomly selected from District Di (lower). The randomly selected students from these institutions belonged to the same race and religion and were of middle socioeconomic status.

3.2 Research Paradigm

The main objective of this research paper was to develop of low cost apparatus as a diagnostic instrument for the preparation of Acetylene Gas along with the applications of this low cost / no cost apparatus; therefore, the students have multiple approaches towards the development of this apparatus. Consequently, post positivist is the approach of this research. The existing of multiple realities is the belief of this approach.

3.3 Procedure of Instrument Development and its Administration

For the fabrication of the low cost apparatus the researcher himself visited the sample institution, Danish Public School and college Bat Khela. After stating the aims and objectives the researcher sought proper permission from the head of institution. This was a co-education institution. Being a subject specialist in Chemistry, the researcher taught the topic of Acetylene gas. And put all the related material in front of the participants in order. All the aims and objectives were explained to participants. The researcher monitored the participants all the time. All participants did their work in groups. Each group leader presented their report. Each submitted report was thoroughly discussed and a lot of modification in the apparatus took place. After which a beautiful and complete apparatus was created. Acetylene Gas was practically produced from the prepared apparatus. But still more improvement was needed therefore, the students were asked to improve further. Participants further worked to improve it to bull out of every gangers. The procedure is given below.

4. Procedure

Material: Two Empty Pepsi bottles, drop set. Balloon, Glue or Tape

Chemicals: Calcium Carbide with water

4.1 Fabrication of the Diagnostic Apparatus

- Make a small hole near the lid of a Pepsi bottle at a distance of 5 Cm and fix a drop set with the help of glue or tape. Fix a balloon on its mouth that will control the huge amount of producing gas during the reaction of Calcium Carbide with water. This Pepsi bottle is called reacting chamber.
- Tie another Pepsi bottle to the first one with metallic wire that will serve as a water reservoir. Water will flow from bottle .2 (Reservoir Chamber) to bottle .1 (Reaction Chamber)
- Connect both bottles with a small piece of drop set that allows water to flow from the water reservoir bottle to another bottle.
- Put pieces of Calcium Carbide in the bottle through the thread as shown in the fig.1

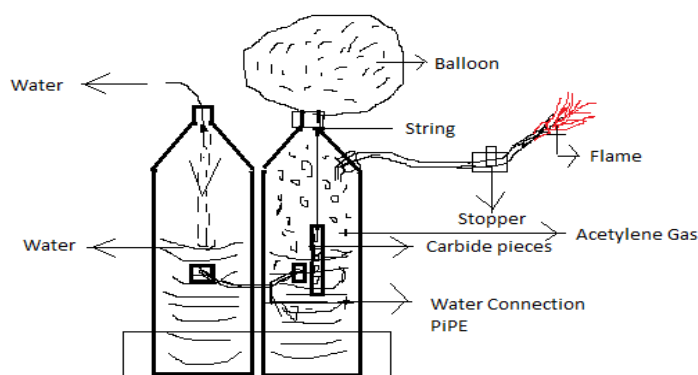


Fig 1. Developed low cost apparatus

Fabricated Low Cost Apparatus



Presented Low Cost Apparatus Modified Low Cost Apparatus Developed Low Cost Apparatus
 Fig 2. Developed low cost apparatus (original)

4.2 Chemical Reaction

The chemical reaction occurred in the reacting chamber. The simplest process in which calcium carbide reacts with water to produce acetylene gas and calcium carbonate is as under.



The breaking of CaC_2 and H_2O occurs and new bonds of C_2H_2 and Ca(OH)_2 are formed as shown in the following Fig. 3.

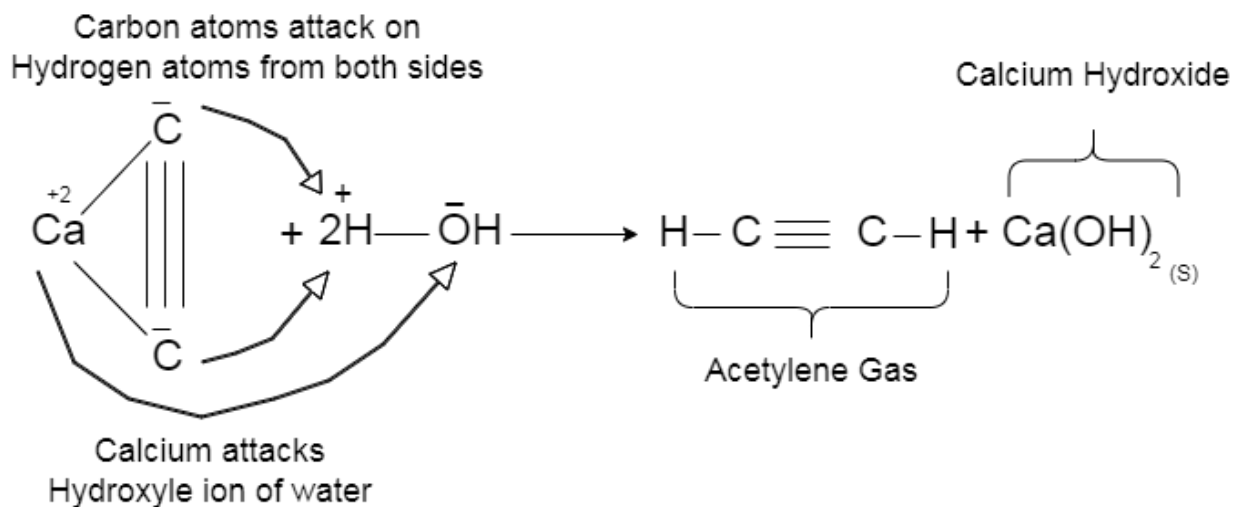


Figure 3. Breaking of Calcium Carbide and Hydrogen oxide (water) to form Acetylene Gas and Calcium Hydroxide

4.3 Observations

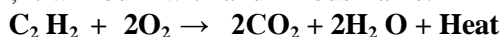
- It was observed that a large amount of Acetylene gas was produced which was vented through drop set
- When a lighted matchstick was brought to the outlet of the drop set, a large flame was produced which continued to burn.

4.4 Physical Properties

In the activity, it can be noticed that Ethyne gas is colorless with a sweetish odour

4.5 Combustion Test

On ignition, it will burn with a luminous flame.



4.6 Application of Low Cost Apparatus and Students Achievement

The fabricated apparatus was applied in four different institutions. The researcher taught the same topic of Acetylene gas to traditional group with traditional method using only board and marker and data was collecting through achievement test. The same topic was taught to experimental group with low cost apparatus in the same day in different class having no interval.. Then the achievement test was applied to the experimental group .This test was developed on the basis of students out comes learning. The test was MCQs type with four options. The obtained information was tabulated. Then t-test was applied. Cohen’s D effect size was also calculated to find the strength of mean difference .Tables show below shows the details.

Table 1. Comparison of Control and Experimental groups

Name of Institution	Groups	Mean	Standard Deviation	t-test	Sig(two tailed)	Effect size Cohen’s d
1 G.H.S.S. Mian Brangola Dir (L)	Experiment	21.90	3.48	6.47	.000	0.85
	Control	17.80	5.46			
2 G.H.S.S. Chakdara Dir (L)	Experiment	19.89	3.91	6.32	.000	0.82
	Control	18.70	5.22			

3	G.H.H.S Taoda China Dir (L)	Experiment Control	20.70 17.70	3.14 5.32	6.34 6.41	.000 .000	0.8.4 0.88
4	G.H.S.S. Khar Malakand	Experiment Control	21.70 17,15	3.125 5.61			

Significance level $P < 0.05$

Df =29

G.H.S.S =Government Higher Secondary School

Table,1, justifies that there was significant difference between the achievement scores of the control and experimental group at 0.05 levels .the experimental groups mean scores show that these group performed well in their achievement test. And the same case is found in standard deviation. Higher standard deviation (SD=5.46, 5.22 , 5.32 and5.61) of control group means that there was variation of score among students than the experimental group. Cohen's D effect size also favors experimental group. This is exactly what proves that lecture delivered by low cost apparatus was very useful helpful and favorable.

5. Conclusion

In this study the researcher fabricated a low cost apparatus as a diagnostic apparatus with help of higher secondary school students and then this apparatus was applied in four other different higher secondary schools.it was found that when this apparatus was use for teaching. The students developed their comprehension and understanding. It was also concluded that students found the curriculum difficult when taught in traditional way. And they are forced to memorize all the text material. Students' conceptual understanding may not increase due to this rote memorization. Such a scenario can be improved when the teacher make from waste domestic material around us, i.e. Pepsi bottles etc. and use theses in laboratories. This kind of work will happen when teachers and students are anchored to use laboratories instead of common classrooms.

5.1 Recommendations

From this diagnostic apparatus and its application it is clear that proper training and refresher courses must be arranged teachers. Such program should be arranged frequently for the students as well , so they are aware of low cost apparatus. Also, curriculum developers must be clear to include such topics that can be easily taught using low cost apparatus.

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