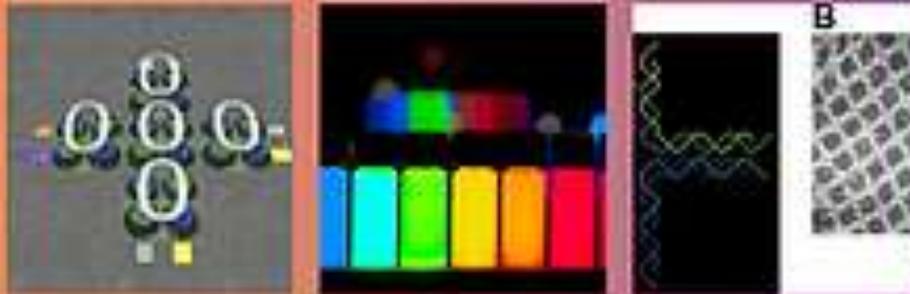


PHYSICS TOMORROW LETTERS

MATERIAL SCIENCE



Impact factor 2

Design Analysis of Low-Pressure Acetylene Generators used in Chhattisgarh State

The Low-Pressure Acetylene Generators used calcium carbide to generate Acetylene gas. The generated low-pressure Acetylene is used with an oxygen cylinder extensively by Gas welders in Chhattisgarh state for oxy acetylene welding. This low-pressure oxy acetylene welding is used mostly in automobile body repairing work. In this research paper mainly four types of popular generators are used to study for producing low-pressure Acetylene. The design construction and working of these lookalike generators are similar but their capacities and safety to hold the Acetylene gas are different. These generators are selected by the gas welders as per the experience and skill developed by them. The safety features in these low-pressure acetylene generators are rarely followed by the gas welders in the state. These Low-pressure Acetylene generators are preferred over the Acetylene cylinder due to low-cost Acetylene generation. In this research paper with help of CAD modeling these four popular Acetylene generators design and the capacity of each generator are calculated. In these four types of low-pressure acetylene generation, prefabricated generators are found safest to operate and the Top charged Acetylene Generator is found unsafe and required very high skill of operation. These design analysis study of these popular models will certainly help to standardize the dimensions of the Acetylene generators for their safe working.



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RESEARCH PAPER.

Keys: Acetylene, Generator, Volume, Dome, Charge

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1. Introduction

The Acetylene generators are used along with oxygen cylinders to weld and repair automobiles quit extensively in Chhattisgarh state. These generators are used Calcium Carbide with water to produce the Acetylene gas. This type of welding is considered as low pressure welding where welding pressure is required only 0.1 bar [1]. This type of Acetylene generation is used with Oxygen in auto body minor repairing [2]. Other than automotive repair low pressure gas welding is also used for joining of thin ferrous and non ferrous materials, air craft industries and sheet metal, fabrication plant [3]. Generally 16 gauges to 22 gauges mild steel sheets are welded using theses generators [2]. The dimensions of all the popular generators are gathered from the 11 District of Chhattisgarh. They are Raipur, Durg, Rajnadaon, Balod, Dhamtari, Kanker, Kondagaon, Jagadapur, Sukma, Dantewada, Bijapur and Narayanpur. As per BIS (Bureau of Indian Standards) SP: 12-1975 Handbook of Gas Welders the Low pressure Acetylene generators are divided as Water to Carbide and Carbide to Water [4]. But these classification are little confusing to exactly naming the generators. These generators can be clearly classified further as [5]-

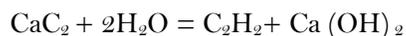
1. Pre-fabricated Acetylene generators.
2. Fabricated Acetylene generators.
 - A) Open Dome type
 - B) Submerged Dome type
 - C) Top charging type

There are few more popular models are used in these classification. But the Analysis is done on only those which can hold the maximum calcium carbide (CaC_2). Almost all the generators are made with mild steel sheet of 16 gauges (1.5189 mm).

The pre-fabricated generators are available readymade in market and consider the safest in operation. Whereas fabricated generators are made as per expertise developed by welder. The fabricated acetylene generators can be found in various dimensions but their working is same.

Factors Affecting Safety Dimensions-

For deciding the safety dimensions of any above describe generators it must be capable of holding 1kg of Calcium Carbide (CaC_2). As it is common practice of welders in state that they purchase this quantity and as per their job requirement they used the quantity. The quantity used by them always depends on the type of Acetylene generators they used. Theoretically



Let this equation depend upon mole concept. One mole of calcium carbide gives one mole of Acetylene. Then mole is converted into weight and calculated. At STP at 0° and 1 atm 1mole =22.4 Liters. Therefore 1 kilogram Calcium Carbide will generate 350 Liters of Acetylene Gas. That means the volume of the generator must have minimum storage capacity of 350 Liters. This Acetylene generation is possible when the carbide is pure in nature. In the market we generally get impure carbide. The impure carbide generates less acetylene than theoretically. So 1 kg of Calcium Carbide (CaC_2) makes 300 Liters of Acetylene Gas [6].

The other factor is water. All Acetylene generators use water to generate Acetylene gas with carbide. Quantity of water can only be seen in Top and submerged dome type acetylene generators. As in fabricated generator and top charging type Acetylene Generators no water level can be seen.

2. Detailed Design Analysis of Acetylene Generators

2.1. Prefabricated Acetylene Generator

The prefabricated acetylene generator is Water to Carbide Type .It is very popular with new budding welders. The Figure 1.1 (a) shows the actual generator. In figure 1.1 (b) and 1.1 (c) shows the three dimensional model. In figure 1.1 (d) the wire frame diagram of generator is shown. The popular dimensions are 16 inch (408 mm) height and 10" (254 mm) outside diameter. The different in side dimensions are shown in figure 1.1 (e). As the wire frame diagram shows 4" (101.6 mm) diameter and 8" (203.2 mm) in length pipe at a slant is provided at bottom to charge the carbide. A semi circular shape of tray 6 1/2 inch (165.1 mm) in length, 3 1/2 inch (88.9 mm) in width and height of 2" inch (50.8 mm) is generally used to charge the carbide at bottom. The water is filled in the top dome and inserted in the bottom pipe with help of globe valve. The generated carbide is reached at top through a 1/2 inch (12.7 mm) pipe. Figure 1.2 (f) shows the total volume is of only 22.1 Liters. For safety generally no hydraulic back pressure valve is used. The advantage of this prefabricated acetylene generator is a high pressure of acetylene gas can be obtained due to its close structure. The disadvantage is the quantity of water inside the tank cannot be seen.



Figure 1.1(a)



Figure 1.1(b)



Figure 1.1(c)



Figure 1.1(d)



Figure 1.1(e)

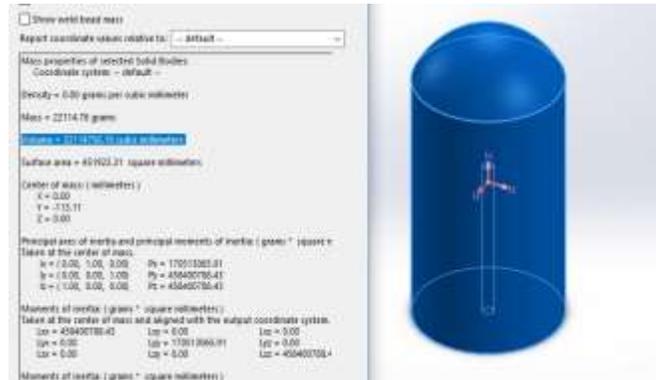


Figure 1.1(f)

Figure 1.1 | (a) Prefabricated Acetylene Generator, (b) Prefabricated Acetylene Generator Rear View, (c) Prefabricated Acetylene Generator Front View, (d) Prefabricated Acetylene Generator wire frame, (e) Dimension of Prefabricated Acetylene Generator, (f) Prefabricated Acetylene Generator Capacity calculation

2.2. Top Dome Acetylene Generator

It is water to carbide type generator. The figure 1.2 (a) and 1.2 (b) illustrate the actual generator. In figures 1.2 (c) and 1.2 (d) shows the three dimensional model. The wire frame diagram is shown in figure 1.2 (e). In this generator the carbide is charged at the bottom same as in prefabricated acetylene generator. The generated acetylene is reached at top and lifts the upper dome to hold the generated acetylene gas. There are two types of pipeline systems found in top dome acetylene generator. It is single pipe and double pipe for acetylene gas convey. In single pipe line system a $3/4$ inch (19.05 mm) pipe size is used to deliver acetylene gas from the bottom to top dome. In double pipe line system as shown in figure 1.2 (f) two pipe lines are used. Both are $1/2$ inch (12.7 mm) in diameter. One pipe line delivers the generated acetylene at bottom to top dome and the other takes the acetylene from the top to the base and from the base to the hydraulic back pressure valve.

Two most popular models are used. The first outer dimensions are $18\frac{1}{2}$ inch (469.9 mm) in height and 18 inch (457.2 mm) in diameter. The top dome size of this model is 18 inch (457.2 mm) in height and 12 inch (304.8 mm) in diameter. The second outer dimensions are 24 inch (609.6 mm) in height and 18 inch (457.2 mm) in diameter. The top dome size of this model is 18 inch (457.2 mm) in height and 12 inch (304.8 mm) in diameter. Figure 1.2 (g) shows the dimensions of first model explained as above and the dimensions when the top dome is charged fully. Figure 1.2 (h) as per this popular dimension having total volume is only 73.366 Liters. The advantage of top dome generator is high volume storage and disadvantage is top dome is unsafe if acetylene generation is too high the top dome will blow.



Figure 1.2(a)



Figure 1.2(b)



Figure 1.2(c)



Figure 1.2(d)

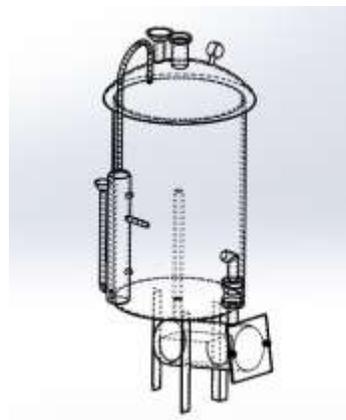


Figure 1.2(e)



Figure 1.2(f)

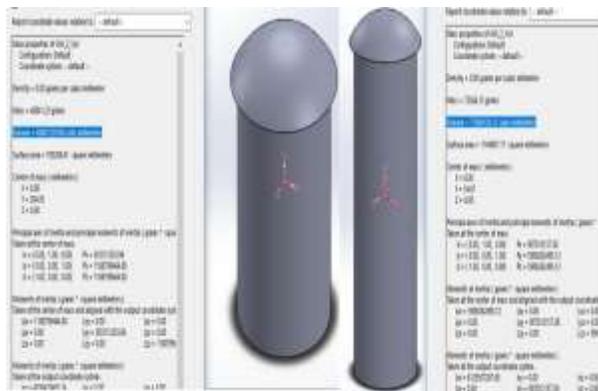


Figure 1.2(g)

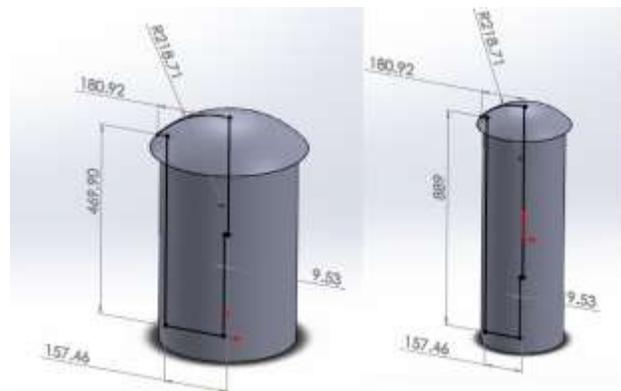


Figure 1.2(h)

Figure 1.2 (a) Top Dome Acetylene Generator Single pipe, (b) Top Dome Acetylene Generator Double pipe, (c) Top Dome Acetylene Generator Side view, (d) Top Dome Acetylene Generator Front view, (e) Top Dome Acetylene Generator wire frame, (f) Inside view of Top Dome Acetylene Generator, (g) Top Dome Acetylene Generator Capacity calculation, (h) Dimension of Top Dome Acetylene Generator

2.3. Submerged Dome acetylene Generator

It is carbide to water type generator. The figure 1.3 (a) and 1.3 (b) shows the actual submerged dome acetylene generator. In figures 1.3 (c) and 1.3 (d) shows the three dimensional model. In this generator the carbide is charged in the submerged dome with a hanging circular box as shown in figure 1.3 (e). The generated acetylene gas is lifting the submerged dome as the acetylene gas is generated. There are two popular models are used. The first model having outer casing of 24 inch (609.6 mm) in height and diameter of 12 inch (304.8 mm). The inner casing is of 18 inch (457.2 mm) in height and 10 inch (254 mm) in diameter. The second model having outer casing of 28 inch (711.2 mm) in height and diameter of 16 inch (406.4 mm). The inner casing is of 25 inch (635 mm) in height and 15 inch (381 mm) in diameter. Figure 1.3 (f) is showing the detailed dimensions of second model in without and fully charged condition. Figure 1.3 (g) as per this popular dimension having total volume is only 161.44 Liters. For safety generally hydraulic back pressure valve is used in this type of generator. The advantage of submerged dome acetylene generator the volume is higher and disadvantage is the submerged dome is unsafe as excessive acetylene generation the dome can lift upward.



Figure 1.3(a)



Figure 1.3(b)



Figure 1.3(c)

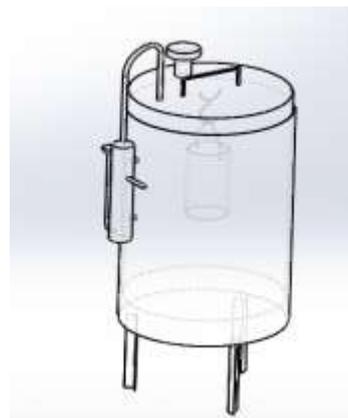
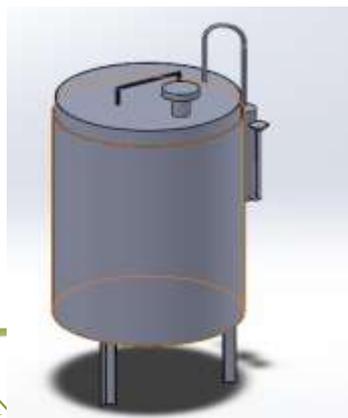


Figure 1.3(d)

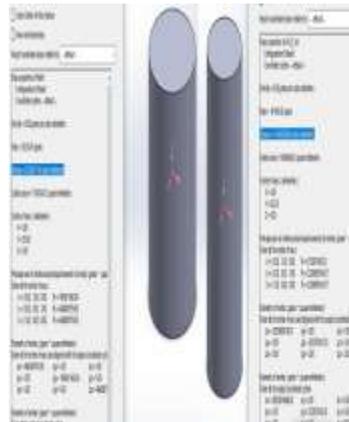


Figure 1.3(e)



Figure 1.3(f)

Figure 1.3(g)

Figure 1.3 | (a) Inside view of Submerged Dome Acetylene Generator, (b) Rear view of Submerged Dome Acetylene Generator, (c) Front view of Submerged Dome Acetylene Generator, (d) Rear view of Submerged Dome Acetylene Generator, (e) Submerged Dome Acetylene Generator wire frame, (f) Submerged Dome Acetylene Generator Capacity calculations, (g) Dimension of Submerged Dome Acetylene Generator

2.4. Top Charged Acetylene generator

It is carbide to water type generator. The figure 1.4 (a) and 1.4 (b) shows the actual top charged acetylene generator. In figures 1.4 (c) and 1.4 (d) shows the three dimensional model .The carbide is directly mixed with water to generate acetylene gas. Mostly a household LPG (Liquid petroleum gas) cylinder is used for making acetylene gas. 1.4 (e) shows a wire frame diagram of this generator. Two top charged acetylene generators are popular. The first is described as above and the dimensions are shown in figure 1.4 (f). The second popular dimensions is 30 inch (762 mm) in height and 10 inch (254 mm) in diameter .but the first model used extensively rather than second model . Figure 1.4 (f) is showing the detailed dimensions of first model based on LPG. Figure 1.4 (g) as per this popular dimension having total volume is only 34.221 Liters. For safety generally hydraulic back pressure valve is used in this type of generator. The disadvantage of top charged acetylene generator are high skill is required and it is unsafe.

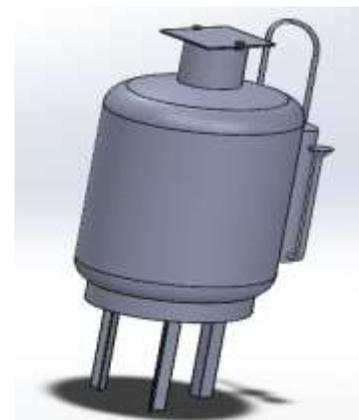


Figure 1.4(a)

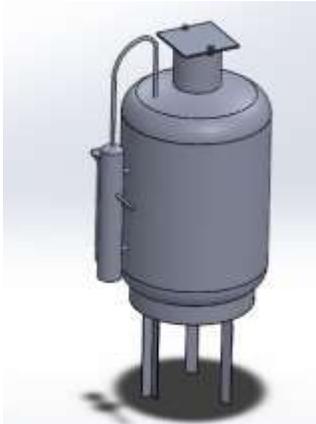


Figure 1.4(d)

Figure 1.4(b)

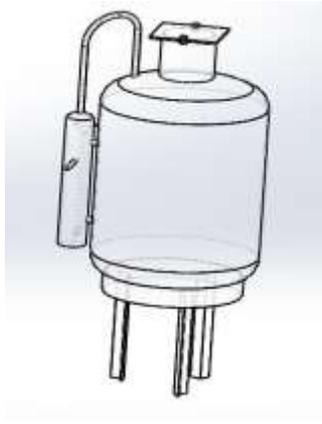


Figure 1.4(e)

Figure 1.4(c)



Figure 1.4(f)

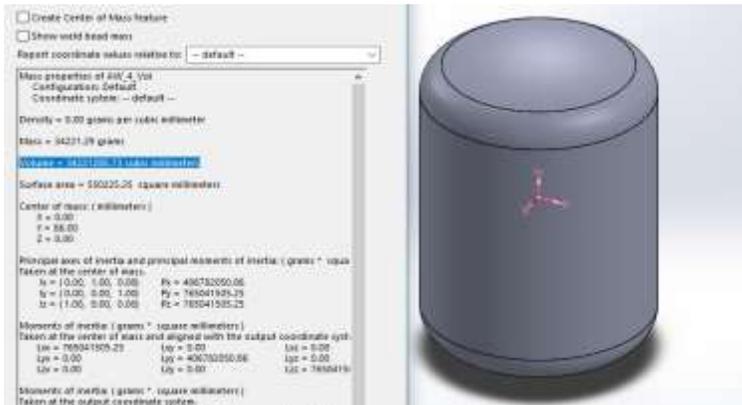


Figure 1.4(g)

Figure 1.4 | (a) Top Charged Acetylene Generator manufactured on LPG cylinder, (b) Top Charged Acetylene Generator manufactured, (c) Side view of Top Charged Acetylene Generator, (d) Front view of Top Charged Acetylene Generator, (e) Top Charged Acetylene Generator wire frame, (f) Dimension of Top Charged Acetylene Generator on LPG cylinder, (g) Top Charged Acetylene Generator Capacity calculations on LPG cylinder

4. Conclusion

The above Analysis shows that no Acetylene generators having capacity to hold 300 liters of produced Acetylene gas. Clearly at the time of charging utter safety is to be followed. So the welder must have the experience while charging the calcium Carbide. The pre-fabricated acetylene generator must be modified to show the water level. Then only it will in safe category. The top charging Acetylene generator having less volume the water level cannot be seen. No safety gauges are installed. So it is considered to be highly unsafe. In top and submerged dome type Acetylene Generator the volume is higher. But due to weight of dome the dissolved Acetylene with water is escaped from the gap between Outer and Inner casing.

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