

LESSON PLAN

Date _____

Trade:- Welder

Name _____

Week No:- Nine

Subject :- Calcium carbide-property and uses. Acetylene gas properties and generating methods. Acetylene gas purifier, hydraulic back pressure valve and flash back arrestor.

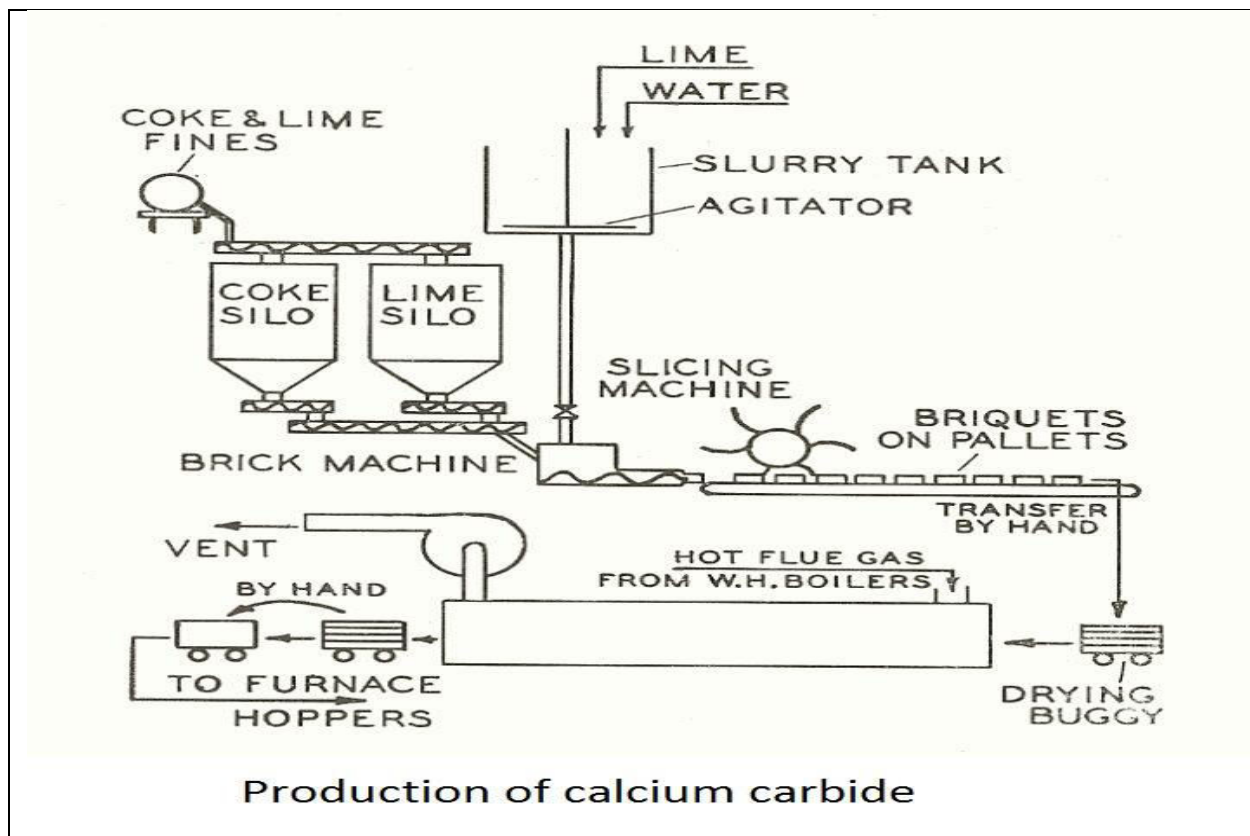
Motivations:- in previous week we learned about Arc length-types-effects. Polarity –types and applications.

PREPARATION: - Teaching Aids:-Chalk, Charts,

INTRODUCTION: - Calcium carbide is a chemical compound and its react with water and produce acetylene gas. It is made by lime and cock.

PRESENTATION:-

Topic	Information Point	Spot Hint
Calcium Carbide	This is a mixture of lime and cock which mixed in furnace. It produces acetylene by react with water.	
<p>Properties and production of calcium carbide</p> <p>Chemical formula CaC_2 Molar mass 64.099 g/mol.</p> <p>Appearance White powder to grey/black crystals Density 2.22 g/cm³ Melting point 2,160 °C (3,920 °F; 2,430 K) Boiling point 2,300 °C (4,170 °F; 2,570 K) Solubility in water decomposes</p> <p>Structure Crystal structure Tetragonal [1] Space group D_{174h}, I4/mmm, tI6 Coordination geometry 6 Thermochemistry</p> <p>Std Molar entropy (So₂₉₈) 70 J·mol⁻¹·K⁻¹ Std enthalpy of formation ($\Delta_f H_{o298}$) -63 kJ· mol.</p> <p>Calcium carbide are grey or brown and consist of about 80–85% of CaC_2 (the rest is CaO (calcium oxide), Ca_3P_2 (calcium phosphide), CaS (calcium sulfide), Ca_3N_2 (calcium nitride), SiC (silicon carbide), etc.).</p> <p>In the presence of trace moisture, technical-grade calcium carbide emits an unpleasant odor reminiscent of garlic.</p> <p>Applications of calcium carbide include manufacture of acetylene gas, and for generation of acetylene in carbide lamps; manufacture of chemicals for fertilizer; and in steel making.</p> <p>Production Calcium carbide is produced industrially in an electric arc furnace from a mixture of lime and coke at approximately 2200 °C.</p> <p>This method has not changed since its invention in 1892: $\text{CaO} + 3 \text{C} \rightarrow \text{CaC}_2 + \text{CO}$ The high temperature required for this reaction is not practically achievable by traditional combustion, so the reaction is performed in an electric arc furnace with graphite electrodes.</p> <p>The carbide product produced generally contains around 80% calcium carbide by weight.</p> <p>The carbide is crushed to produce small lumps that can range from a few mm up to 50 mm.</p> <p>The impurities are concentrated in the finer fractions.</p> <p>The CaC_2 content of the product is assayed by measuring the amount of acetylene produced on hydrolysis.</p>		



ACETYLENE

INTRODUCTION

Acetylene (C_2H_2) is colorless gas used as a fuel and a chemical building block. As an alkyne, acetylene is unsaturated because its two carbon atoms are bonded together in a triple bond having CCH bond angles of 180° . It is unstable in pure form and thus is usually handled as a solution. Pure acetylene is odorless, but commercial grades usually have a marked odor due to impurities.

In 1836 acetylene identified as a "new carburet of hydrogen" by Edmund Davy. The name "acetylene" was given by Marcellin Berthelot in 1860. He prepared acetylene by passing vapours of organic compounds (methanol, ethanol, etc.) through a red-hot tube and collecting the effluent. He also found acetylene was formed by sparking electricity through mixed cyanogen and hydrogen gases. Berthelot later obtained acetylene directly by passing hydrogen between the poles of a carbon arc.

MANUFACTURE

Acetylene manufacture by following processes

1. From calcium carbide
2. From paraffin hydrocarbons by pyrolysis (Wulff process)
3. From natural gas by partial oxidation (Sachasse process)

Nowadays acetylene is mainly manufactured by the partial oxidation of natural gas (methane) or side product in ethylene stream from cracking of hydrocarbons.

Acetylene, ethylene mixture is explosive and poison Zigler Natta catalyst. There so acetylene is selectively hydrogenated into ethylene, usually using Pd-Ag catalysts.

Acetylene was the main source of organic chemicals in the chemical industry until 1950. It was first prepared by the hydrolysis of calcium carbide, a reaction discovered by Friedrich Wöhler in 1862.



Calcium carbide production requires extremely high temperatures, $\sim 2000^\circ C$, necessitating the use of an electric arc furnace.

Also hydrocarbon cracking is carried out in an electric arc furnace. In which electric

arc provides energy at very high flux density so that reaction time can be kept at a minimum. There so the design of the electro-thermal furnace is one of the important factors.

In one design (Huels process) gaseous feedstock enters the furnace tangentially through a turbulence chamber, then passes with a rotary motion through pipe in which the arc is passed between a bell shaped cathode and anode pipe. The rotary motion of the gas causes the arc to rotate and thus reducing fouling. The arc is operated at 8000kw D.C. at 7000volts and 1150amp cathodes are said to last 800hours while anodes only 150hours.

In other design, fresh hydrocarbon and recycle gas are fed to the arc. The effluent reaction gases are quenched and purified. 35%w purified acetylene along with 17%w ethylene and 10%w carbon black, H₂ and other products in minor amount is obtained in one pass through furnace.

The difference is that the arc is rotated by means of an external magnetic coil, and quenching is carried by propane and water in 1st and 2nd step respectively. Some propane cracking improves the yield of acetylene. The propane quench cools the arc gases to 1095°C in 0.0001 to 0.0004 sec while the water quench cools the mixture to 300°C in 0.001 to 0.003 sec. Power consumption is 12.36kwhr/kg of pure acetylene. 21-22%v acetylene is obtained in the product gases.

1. From calcium carbide

Raw materials

Basis: 1000 cu ft. acetylene

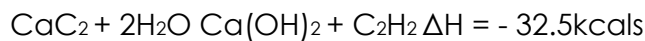
Calcium carbide (85%) = 100kg

Water = 815kg

Sources of raw material

Calcium carbide is manufactured from lime and coke in 60:40 ratio in electric furnace at 2000-2100°C temperature.

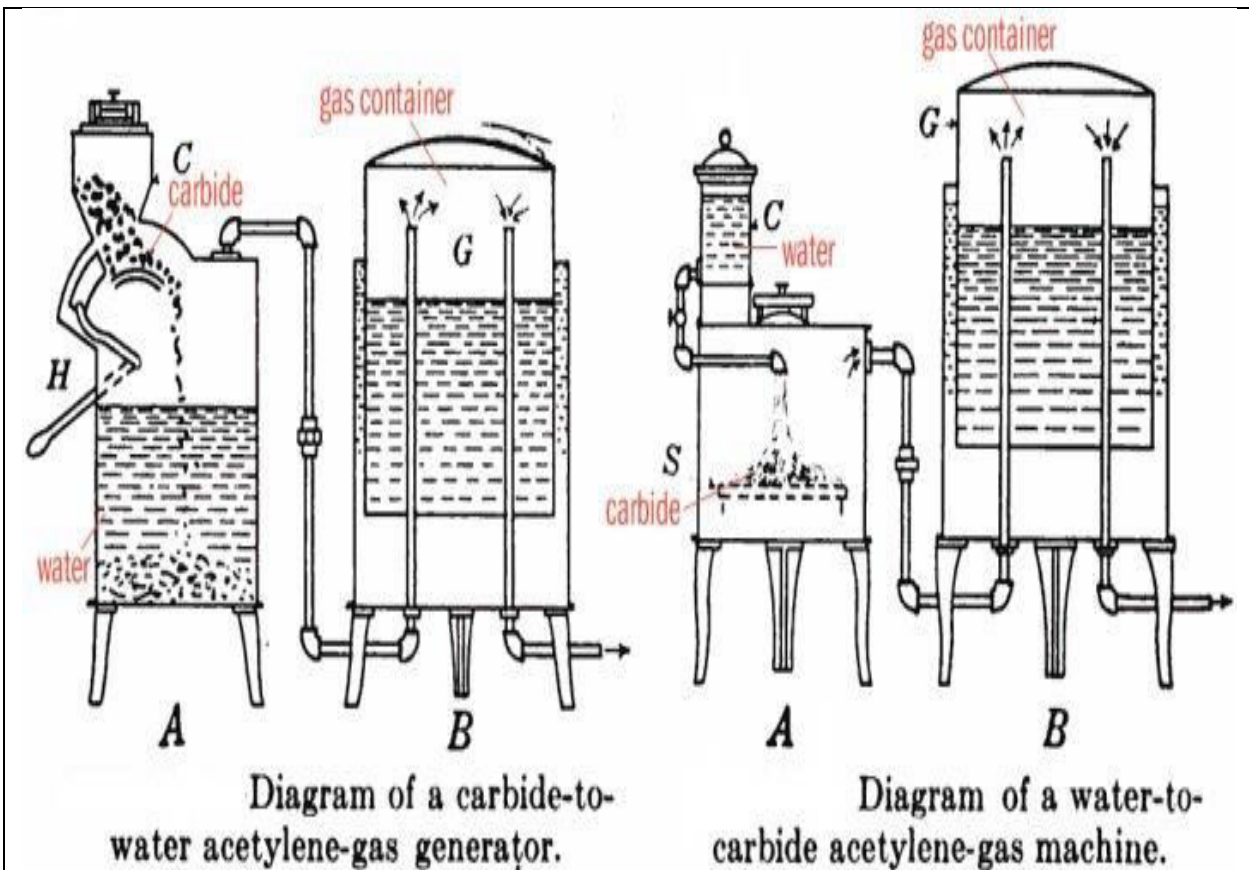
Reaction



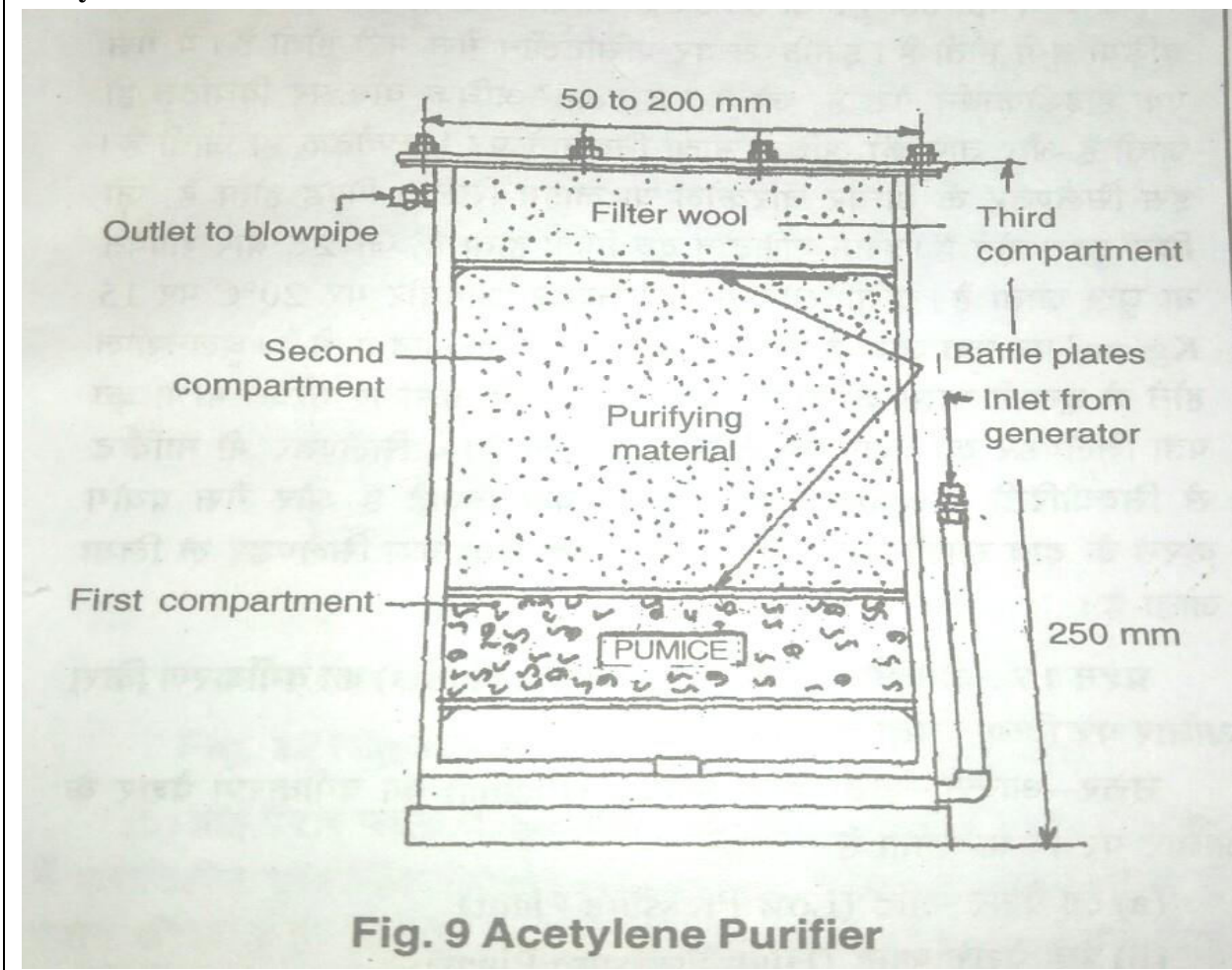
Manufacture calcium carbide is added to large quantity of water releasing acetylene gas and calcium hydrate as residue. Later is discharged in the form of lime slurry containing approximately 90% water.

In the dry process, in order to eliminate the waste of calcium hydrate equal amount of water is added to CaC₂ (1:1 ratio) in a generator. The heat of reaction (166 Btu/ft³ of acetylene) is used to vaporize the excess water over the chemical equivalent, leaving a substantially dry calcium hydrate which is suitable for reuse as a lime source. The temperature must be carefully controlled below 150°C at 15psi pressure throughout the process because the acetylene polymerizes to form benzene at 600°C and decomposes at 780°C. Further with air-acetylene mixture explodes at 480°C. The crude acetylene gas containing traces of H₂S, NH₃ and phosphine (PH₃) from generator is either scrubbed with water and caustic soda solution or sent to purifier where the impurities are absorbed by the use of iron oxide or active chlorine compounds. The dry gas is fed to cylinders or sent to manufacturing units.

Safety and handling:- Acetylene is not especially toxic but when generated from calcium carbide it can contain toxic impurities such as traces of phosphine and arsine. It is also highly flammable. Concentrated or pure acetylene can easily react in an addition-type reaction to form number of products like benzene, vinyl acetylene etc. These reactions are exothermic and unlike other common flammables do not require oxygen to proceed. Consequently, acetylene can explode with extreme violence if the absolute pressure of the gas exceeds about 200kPa (29 psi). The safe limit for acetylene is 101kPag or 15 psig. That so it is shipped and stored by dissolving in acetone or dimethylformamide (DMF), contained in a metal cylinder with a porous filling.



Acetylene Purifier:-



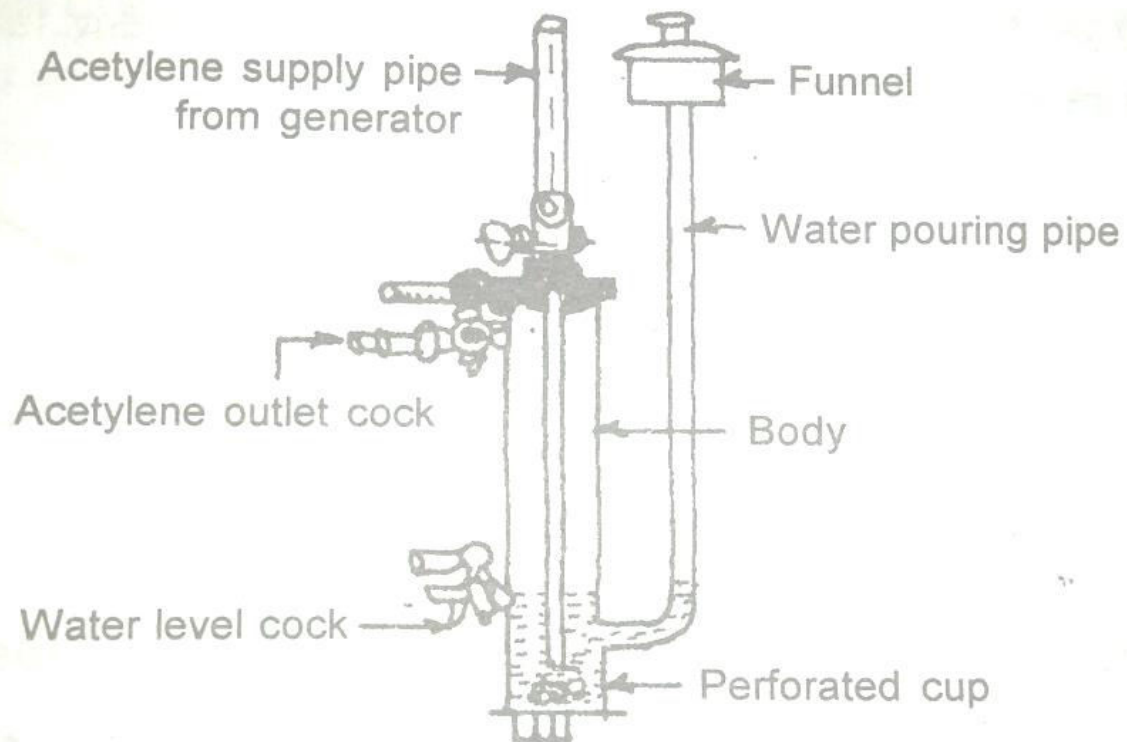


Fig. 24 Water Seal

Components of Acetylene plants

Low pressure dryer

- The pressure vessel charged with solid anhydrous carbide which absorbs the moisture in the gas.

Purifier

- This section are used for purify and absorb gases like hydrogen sulphide, phosphate etc

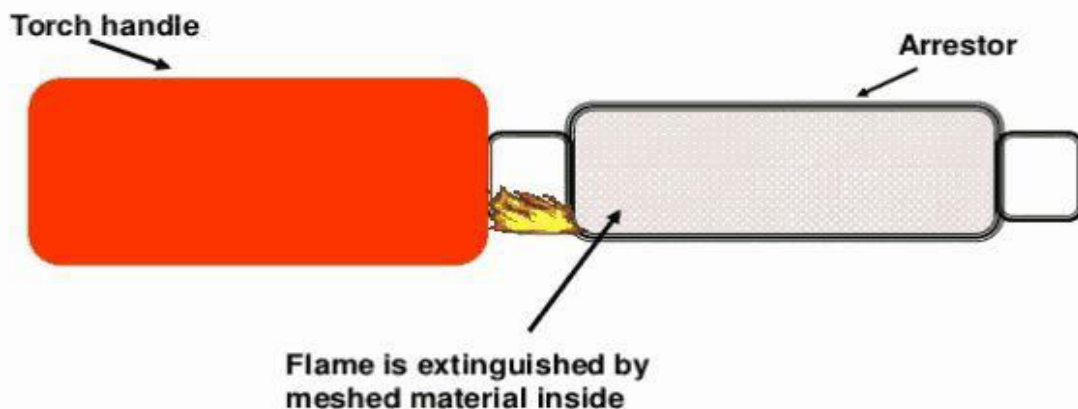
Ammonia Scrubber

- It consist a vertical vessels fitted with level gauge and water mark up line . The ammonia scrubber all the water soluble impurities like ammonia.

Flashback Arrestors



- Flashback arrestors are designed to prevent a flashback from reaching upstream equipment.
- They offer added safety and often include reverse flow check valves in a single unit.



Questions:-

1. What is Calcium carbide and how its made?
2. Write properties of Acetylene gas.
3. What is flash back arrester?

Next Week:- Oxygen gas and its properties. Production of oxygen by air liquefaction.

Charging process of oxygen and acetylene gases. Oxygen and DA cylinder , color coding for different cylinders. Gas regulator types and uses.

Assignments:-

Calcium carbide-property and uses. Acetylene gas properties and generating methods. Acetylene gas purifier, hydraulic back pressure valve and flash back arrestor.

Checked By.....

Instructor.....