United States Patent [19]

Walker

[11] **3,861,160**

[45] **Jan. 21, 1975**

[54] **PROCESS FOR SAFE STORAGE, HANDLING, AND USE OF ACETYLENE**

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[73] Assignee: **Tenneco Chemicals, Inc.,** Saddle Brook, N.J.

[22] Filed: **Aug. 9, 1973**

[21] Appl. No.: **387,173**

[52] **U.S. Cl.** ..... **62/48,** 48/197 FM, 252/372

[51] **Int. Cl.** **F17d 11/00**

[58] **Field of Search** .... 62/48; 48/197 FM; 252/372; 44/52

[56] **References Cited**

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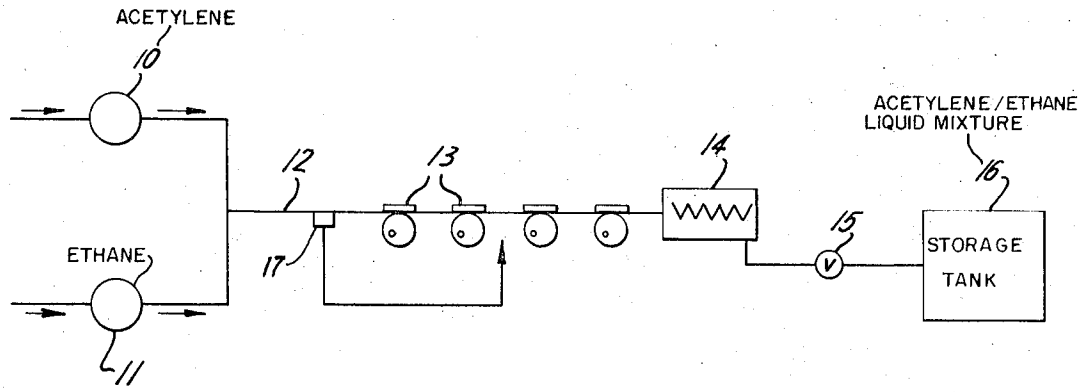
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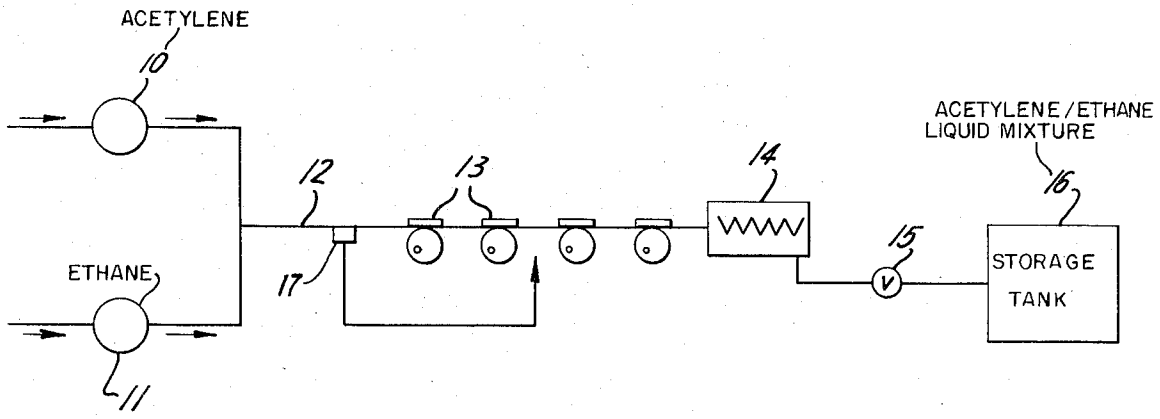
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[57] **ABSTRACT**

Acetylene and ethane are blended to form mixtures that are safe toward deflagration under any conditions of compression. The blends are then compressed and condensed to form liquids that can be safely stored, transported, and used as a source of acetylene in chemical reactions.

3 Claims, 1 Drawing Figure




ACETYLENE
10
ETHANE
11
12
13
14
15
V
16
17
ACETYLENE/ETHANE
LIQUID MIXTURE
STORAGE
TANK

PROCESS FOR SAFE STORAGE, HANDLING, AND USE OF ACETYLENE

This invention relates to a method for the safe handling, storage, and use of acetylene.

Acetylene is an energy-rich, highly-reactive compound that is an intermediate in the manufacture of such important industrial compounds as acetaldehyde, vinyl chloride, vinyl acetate, acrylonitrile, and chlorinated ethylenes.

Because of the well-known hazards of working with compressed acetylene on a large scale, most of the early work on the reactions of acetylene was directed toward those reactions that can be conducted at essentially atmospheric pressure. The study of the chemistry of acetylene received a great impetus from the work of W. A. Reppe and his group on the high pressure reactions of acetylene. The resulting intense interest in acetylene chemistry has resulted in a considerable amount of research to discover means that will reduce the risk in handling acetylene under pressure.

Two general methods are used to minimize the danger of explosive decomposition of acetylene under pressure. One method involves diluting the acetylene with an inert gas, such as nitrogen or carbon dioxide. The second involves designing the apparatus so as to avoid any large free space in the system, for example, by using small bore lines for carrying acetylene feeds or by packing the lines and vessels with steel tubes or Raschig rings. In addition, the apparatus is generally built to withstand pressures at least about twelve times the operating pressure since the energy of deflagration of acetylene is enough to increase the system pressure about elevenfold. These methods are not completely satisfactory because they leave the acetylene in an unstable condition in which deflagration will occur in the presence of an ignition event.

In accordance with this invention, it has been found that acetylene can be blended with ethane to form mixtures that can be stored, transported, and used at high pressures without danger of deflagration. These mixtures which contain up to about 40 mole percent of acetylene cannot be exploded no matter how high the temperature or pressure or how violent the initiator is used.

Ethane has an unusual combination of properties that makes it an exceptionally valuable diluent for acetylene. In addition to its exceptional ability to suppress deflagration of acetylene, ethane has the further advantage that its relative volatility is very close to that of acetylene over all ranges of temperature. Because acetylene-ethane mixtures can be separated only by multiple-stage, low temperature rectification processes, there is no danger of inadvertent physical separation of ethane from the acetylene. As is shown in Tables I and II, methane, ethylene, and propane, which have previously been suggested as diluents for acetylene, do not share this property, and they have critical temperatures that are quite different from those of acetylene and ethane.

When acetylene is separated from the acetylene-ethane mixtures of this invention by chemical reaction, a fail-safe condition results as the unreacted material becomes richer in ethane, thereby assuring a safe concentration of the deflagration suppressor. Because ethane is inert under all reaction conditions for acetylene, its presence in the reaction mixture does not give rise to side reactions. Following its use as deflagration suppressor in mixtures with acetylene, ethane can be recovered and reused, or it can be used as a fuel at the reaction site. In addition ethane is low in cost and readily available in most industrial areas.

Table I

Vapor Pressure (Atmospheres)	Temperature at Indicated Pressure (°C.)				
	Methane	Ethane	Ethylene	Acetylene	Propane
1	−161.5	−88.6	−103.4	−84.0	−38
2	−155	−75.0	−90.8	−71.6	−31
5	−130	−52.8	−71.1	−50.2	−20
10	−120	−32.0	−52.8	−32.7	−5
20	−110	−6.4	−29.1	−10.0	+20
30	−100	+10.0	−14.2	+4.8	
40	−90	23.6	−1.5	16.8	
50	−80	—	+8.9	26.8	
60	—	—	—	34.8	

Table II

	Critical Temperature (°C.)	Critical Pressure (Atmospheres)
Methane	−75	46
Ethane	32.3	48.2
Ethylene	9.6	50.7
Acetylene	36.0	62
Propane	96	43.0

In the practice of this invention, acetylene is blended with ethane under low pressure to form mixtures that contain about 20 to 49 mole percent of acetylene and 60 to 80 mole percent of ethane, and preferably about 30 to 35 mole percent of acetylene and 65 to 70 mole percent of ethane. The mixtures are compressed to high pressure and then stored as a liquid or used as a source of acetylene for chemical reactions.

The conditions under which the mixtures are prepared are not critical. In most cases the acetylene and ethane are blended at a temperature between about 20° and 50°C. and a pressure between about 1 atmosphere and 3 atmospheres. It is generally preferred to form the mixtures at ambient temperature (25°C.) at a pressure of 1.1 to 2 atmospheres. The resulting mixture is compressed to about 5 to 200 atmospheres, preferably 10 to 50 atmospheres and used as a source of acetylene for chemical reactions or condensed to a liquid stage for transportation and storage.

The invention is illustrated by the following examples.

EXAMPLE 1

The preparation and storage of an acetylene-ethane mixture are shown schematically in the drawing. Acetylene and ethane at ambient temperature (25°C.) and at a pressure of 8 psig are mixed in the ratio of 35 moles of acetylene to 65 moles of ethane as they flow from their supply manifolds **10** and **11**, respectively, into

compressor line **12**. The gas mixture is fed into multistage compressor **13** where it is compressed to 200 psig. It is then fed into a liquid ammonia refrigerated heat exchanger **14** in which it is liquefied at −23°C. The liquid acetylene-ethane mixture is pumped through pump **15** to storage tank **16** at 200 psig and stored at this pressure.

The acetylene-ethane mixture in the compressor line **12** flows past a continuous infrared monitor **17** which shuts down the compressor **13** as soon as a mixture containing more than about 35 mole percent of acetylene appears in the compressor line.

EXAMPLE 2

A. Butynediol is produced industrially by a process in which acetylene and aqueous formaldehyde 12% CH_2O) are passed concurrently at a pressure of 5.0 to 5.5 atmospheres and a temperature of 90°–100°C. over a copper acetylide catalyst on granular silica gel. The excess acetylene is recovered and recycled. The liquid product, which contains about 30 percent of butynediol, is distilled to separate unreacted formaldehyde and propargyl alcohol from the butynediol.

This reaction between acetylene and formaldehyde is slow and inefficient. The conversion of acetylene to butynediol is about 50 percent. The space-time yield is only 1.0 kg. of butynediol per liter of catalyst per 24 hours. Because the acetylene is in a deflagrating condition, the reaction must be carried out in process equipment that is built to withstand a maximum pressure of 1,000 atmospheres (14,700 psia).

B. When the acetylene used in the foregoing process for the production of butynediol is replaced by the nondeflagrating acetylene-ethane mixture whose preparation and storage are described in Example 1, the reaction with formaldehyde can be carried out safely at a pressure of 100 atmospheres (1,470 psia). At this pressure, the reaction takes place rapidly, and there is a substantially higher conversion of acetylene to butynediol.

The replacement of acetylene by an acetylene-ethane mixture makes it possible to carry out the process at an appreciably higher pressure and thereby increase the capacity of a plant by 300 percent or more. Alternatively, the process using the acetylene-ethane mixture can be carried out in smaller, less costly processing equipment since the equipment need withstand a maximum pressure of about 200 atmospheres, rather than the maximum pressure of 1,000 atmospheres that may be encountered when acetylene in a deflagrating condition is present.

What is claimed is:

1. The process of storing and handling acetylene at high pressures without danger of deflagration that comprises the steps of

a. mixing acetylene with ethane at a temperature in the range of 20° to 50°C. and a pressure in the range of 1 atmosphere to 3 atmospheres, thereby forming a gaseous mixture that contains up to 40 mole percent of acetylene,

b. subjecting said gaseous mixture to a pressure in the range of about 5 to 200 atmospheres, and

c. cooling the compressed gaseous mixture to liquefy it.

2. The process of claim **1** wherein step (a) acetylene is mixed with ethane at ambient temperature at a pressure in the range of 1.1 to 2 atmospheres.

3. The process of claim **1** wherein in step (b) the acetylene-ethane mixture is compressed to a pressure in the range of 10 to 50 atmospheres.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,861,160 Dated Jan. 21, 1975

Inventor(s) David G. Walker

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 44, change "49" to -- 40 --.

Column 3, line 16, insert -- (-- before "12%".

Signed and sealed this 11th day of March 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

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