

The Use Of Neox As A Breathing Gas

By Todd Baldi

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Background

- Presentation yesterday detailed Ken Clayton's dives on the Billy Mitchell fleet off the Virginia Capes in the mid-1990's.
- Dives still remain impressive to this day.
- Clayton's dives served as a laboratory for mixed gas experimentation.
- Clayton used Neon and Argon based gases and utilized exotic dive tables.

Pushing further...

- During 1990, Clayton descended to the Ostfriesland in 1990 in 380 feet of water. He continued his exploration from 1990 – 1996 for the remaining nine ships in the Billy Mitchell fleet.
- During his exploration, he used an exotic Neox decompression gas during his dives to the Frankfurt (415 fsw) and USS New Jersey (380 fsw).
- He also used Argon based dive gasses for decompression.

Overview

- Goal of this presentation is to investigate if Neox has any practical application in today's technical sport diving realm.
- At the time of Clayton's dives, all diving was done primarily with open circuit scuba.
- Rebreathers were scarce compared to today.
- Does Neox make sense with a rebreather?
- What role does Argox play?

Ken Clayton



Ken Clayton continued

- Orchestrated one of the most impressive deep / technical wreck diving careers in our history.
- Located and dove the Billy Mitchell fleet
- Ten shipwrecks ranging from 220 fsw – 420fsw
- Pioneered new and exotic gas mixes during the time.
- Still impressive to this day!!!!



Historical background

- Jon Hulburt spoke to Ken Clayton about using Neon as a decompression gas after diving the Ostfriesland wreck in 340 fsw heliox dive.
- Jon is one of diving's innovators and best known for inventing the “jon line” for deco hangs.
- Ken decided to “go out and try it”

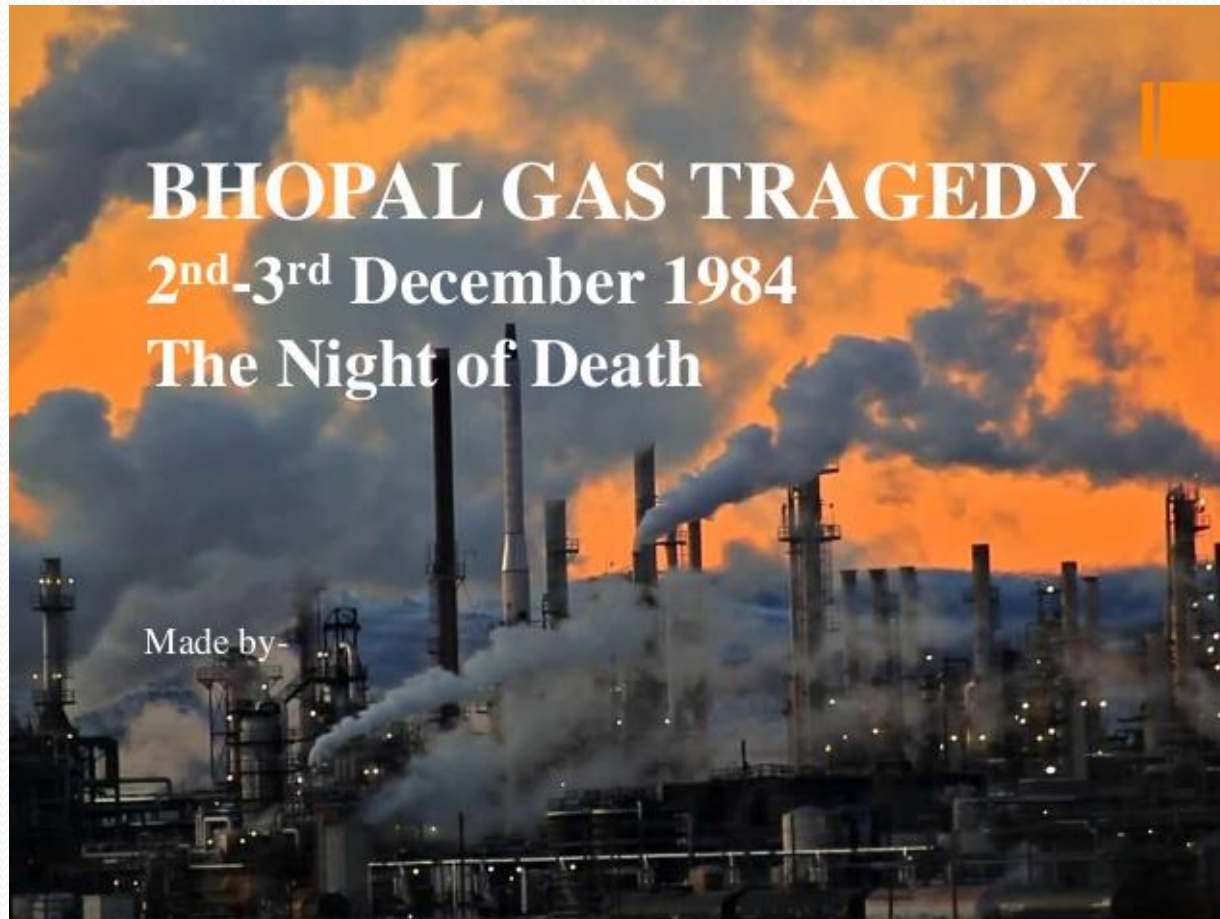
Dive! Dive! Dive!



Bhopal gas tragedy

- Union Carbide was one of the world's largest gas suppliers and was coming off the 1984 Bhopal gas tragedy, a toxic gas release that killed 3,787 related to the gas release and caused 558,125 injuries.
- Union Carbide was in a public relations nightmare and looking for projects to boost its image.

Public relations

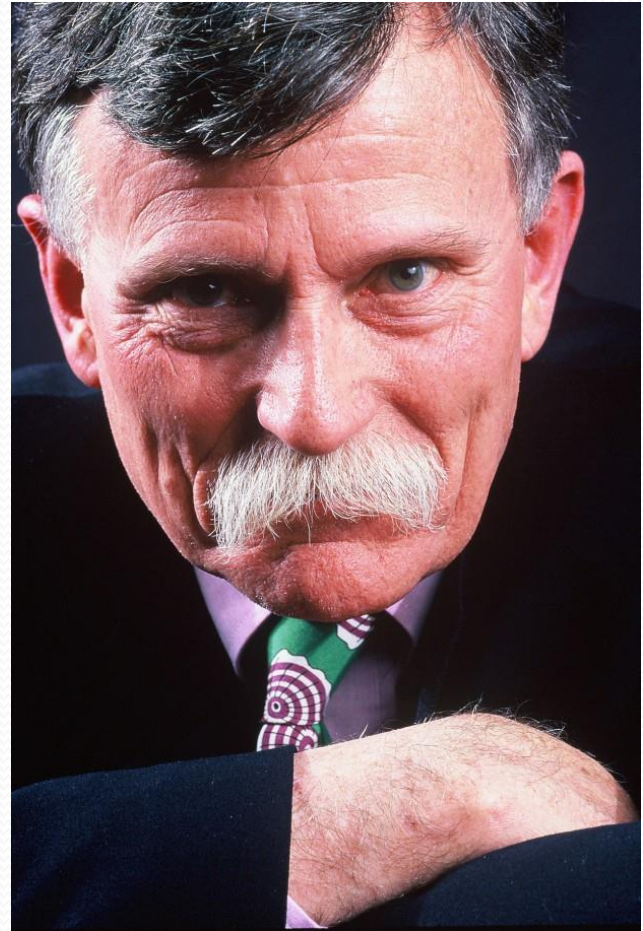


And you thought Helium was pricey!

- Clayton reached out and arranged delivery of 2,000 square feet of research grade neon from UC's facility in East Chicago. Neon as roughly \$4 a cubic foot or \$8,000 for his three dives!
- Most recent pricing I could find was \$20-24 cubic foot. Or \$40,000 - \$48,000 in 2017 dollars!

Dr. “Wild Bill” Hamilton

- Clayton reached out to Dr. Bill Hamilton, a technical diving table wizard and guru, is one of three people who has dove a neon based gas mixture other than various world navies.



“A nice round number – Sheck Exley”

- The other two? Ken Clayton and Hans Keller on his “infamous” 1,000 foot dive off Catalina island.
- Possibly Harvey Stork? (May have breathed off Clayton’s bottles during deco)



Neox

- Ken first used the neox mixture on his dives to the Frankfurt located in 415 feet of water of the “Southern Drill Grounds” of the Virginia Capes



Why use Neox?

- Very viable gas that can and has been used for diving.
- The only person with any serious practical experience in R.W. "Wild Bill" Hamilton.
- The only people that have done any real diving on it are Union Carbide and various world navies. (Tables developed by Bill Hamilton).
- Hans Keller – Only recreational dive (to 1,000 feet!) other than Ken Clayton.

Cons

- Cost: HUGE, as high as \$10.00 per breath in open circuit diving.
- Neon can only be used in any practical application with CCR.

Biggest drawback

- Decompression sickness.
- Very little hard data is available on the use of Neon in breathing gases.
- Special Warning: If you do choose to employ the use of Neon be aware that recompression treatment for DCS involving Neon is often unsuccessful.
- DCS involving Neon does not appear to respond well to standard recompression treatment!!
- Helium is difficult enough to treat!

Atomic Weight

Inert Gas And Oxygen Molecular Weights, Solubilities and Narcotic Potency							
Table 1.		H2	He	Ne	N2	Ar	O2
	A (amu)	2.02	4.00	20.18	28.02	39.44	32.00
	S (atm -1)						
	blood	0.0149	0.0087	0.0093	0.0122	0.0260	0.0241
	oil	0.0502	0.0150	0.0199	0.0670	0.1480	0.1220
	p	1.83	4.26	3.58	1.00	0.43	

More reasons

- The density has been tested and it is not excessive at depth.
- The decompression characteristics are not radically different from helium.
- Any decompression differences should be looked on with suspicion.

Additional facts

- The advantages of crude neon are that:
 - It can be purchased worldwide
 - It has relative good voice qualities compared to neon;
(Probably the reason why people used it in the first place)
 - It has less thermal loss for a diver in a bell.
- None of these advantages speaks to a diver performing a dive entirely on CCR.

The end? Or not....????

- In the end its use was abandoned for Helium as it offered no advantages to open circuit divers.
- Primarily used due to voice distortion compared to helium. Not really an issue if you are not speaking underwater.
- Use of a helium descrambler.
- Helium appears good enough for all purposes.
- It should be noted that Union Carbide's tables were used with crude neon which included 25% helium. Clayton's dives used research grade neon or "pure" neon.

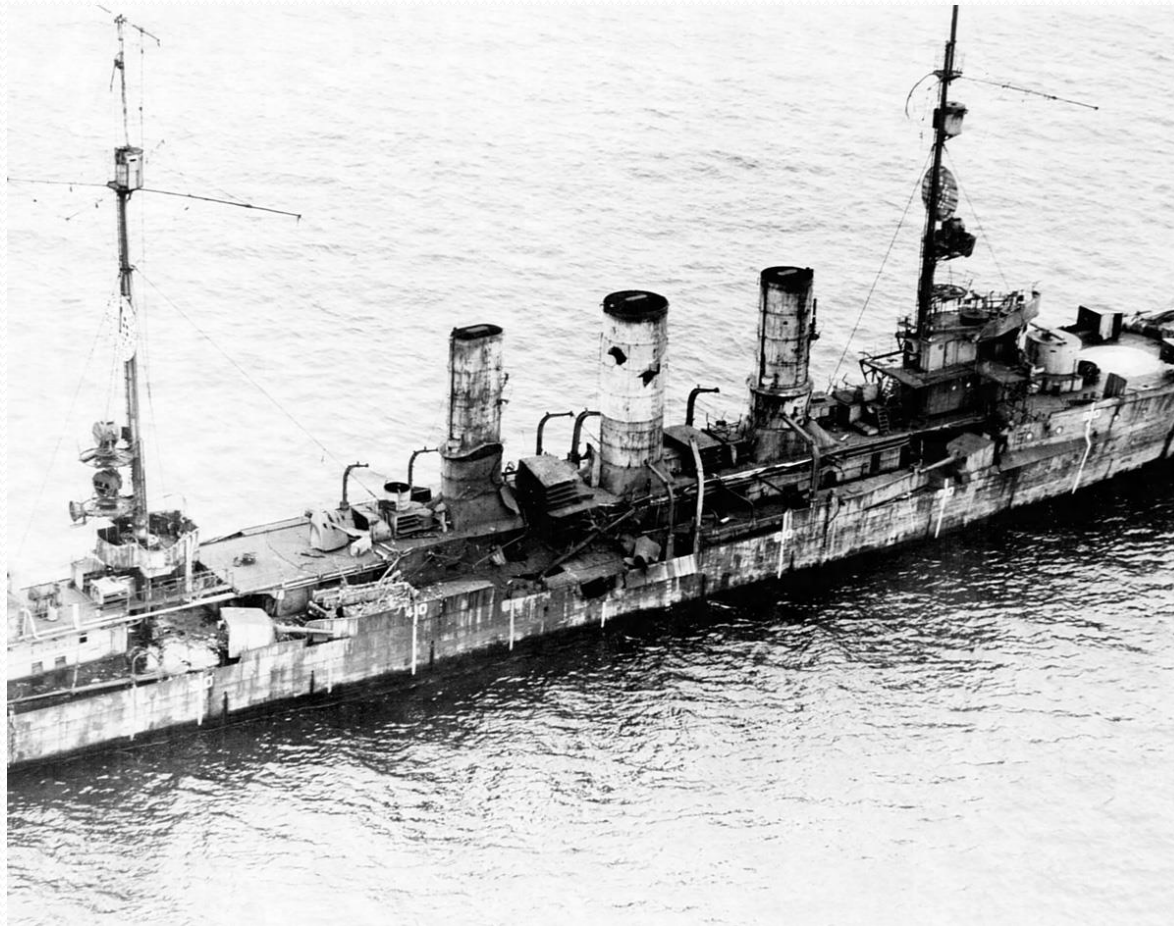
Clayton's dive itself



Neox dives

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The “Big Frankfurter”




Descent to the abyss

One with a neox mixture in stage bottles that he decompressed on using a 21% oxygen / 79% neon mixture to test the decompression tables



Deco schedule

- Subsequently used them on a 7 gas mixture dive:
 - 12% Heliox
 - 12% Neox (in doubles separated by isolator valve)
 - 27% nitrox
 - 70% argox
 - 45% argox
 - Pure oxygen
 - Air to the surface

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- Neox and Argox resulted in 55 minute decompression savings. (More on this later)
 - Dove these mixtures on the Frankfurt and twice on the USS New Jersey.
 - 340 FSW for 20 minute dive

Deco savings

- At the time, helium was thought to have a decompression “penalty” in tables.
- Not like today. Helium is a “friendly” gas!
- Deco hang times were extremely long at the time.
- Deco “savings” of 55 minutes may have simply been the mathematical decompression algorithm and not an actual savings.
- Crude neon included 25% helium versus pure research grade neon.
- Data inconclusive. Clayton admitted this in his emails.

Let's talk about Argox for a minute...

- Keller and Buhlmann (1965) report a 300 fsw heliox dive with either argon-oxygen or nitrox decompression, both of similar total decompression times and both without DCS in a very few subject profiles.
- These only show that the helium-to-argon switch can be done, not that it has any advantage over a helium-to-nitrogen switch.

Argox

- Others have breathed Argox (including this author!)
- Most people inject argon in their drysuit to say warm.
- Thought was to breath it and you would stay warmer.
- Massive headache!
- Extremely narcotic at depth.
- Start deco deeper at 40 fsw.
- Mimics oxygen profile until you get to 20 fsw as a deco gas to maximize washout.
- Keep extremely warm.

Atomic Weight

Table 1.

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S (atm ⁻¹)						
blood	0.0149	0.0087	0.0093	0.0122	0.0260	0.0241
oil	0.0502	0.0150	0.0199	0.0670	0.1480	0.1220
p	1.83	4.26	3.58	1.00	0.43	

Looks good on paper!



Will Bill Hamilton email

Todd,

I still have all the Clayton stuff. We had some trouble making the neon look enough better so that we (Ken) could get some neon donated.

John Chatterton asked me to see if I could improve deco with argon and I never really got into it, so don't know. I doubt if it will be worth the trouble.

Cheers

rwh

Clayton continued...

I was a Chem major and disagreed with Bill for the following reasons: 1. the molecular weight of neon is 20 compared to Helium's 4 and therefore Neon should disperse more slowly. 2. Most importantly, they used Neon which was a by product of the distillation of liquid air and has up to 25% Helium in it. Whereas the gas Co., Praxair, gave me free research grade, pure Neon. Now, UHMS in one of their scientific articles said that tests were showing that in the case of a mixture of two or more gases it appeared the least dense gas would come out of the tissues first. Thus, the impure Neon mixture that Bill and Co. based their tests on would appear to be coming out like Helium. I gave Bill instructions to generate tables for me that were different than his stock set. *It worked for me, but a couple of dives do not prove a point.* To be continued.

Ken Clayton emails from 2007

Bill hamilton was a member of a small Co. that belonged to Union Carbide in the 1970's. They did research on Neon and even have a patent on its use--Bill gave me permission to use it. Anyway their initial thought was that it was a big improvement on Helium and could be used down to 700 feet. Then they got very conservative and said only to 500 feet and that the deco stops would be similar to Helium.

Ken Clayton emails from 2007

OK, have eaten lunch, talked to Bill Hamilton and found my tables. Probably my most imaginative dive was one in which I used seven different mixes to utilize the Deep tissue inert gas subsaturation counterdiffusion principle. We calculated I saved about 50 min. off decompression over the standard four gas mix. I descended to 20 fsw on air, then switched to 12% O₂/Helium to 330 fsw and half the bottom, then to 12% O₂/Neon for the rest of the bottom time.

Ken Clayton emails from 2007

then to the first deco stop at 170 where we went on 27% O₂/nitrogen, then to 110 fsw where we went on 40% O₂/Argon, then on to 100% O₂ for the 20 and 10 fsw stops, and finally back on air to the surface. I had isolated the manifold on my doubles to have one tank with the HE and the other with the NE. I have tables using Neon as a travel mix, a bottom mix and a deco mix. I have Argon tables for deco with 40% or 70% O₂, I'm still searching for my portable, underwater, slate tables for verification. Later, K. Clayton

Tables

finally found the table slates. The seven gas dive I did actually saw a switch to 40% O₂/Argon at 110, then a switch to 70% O₂/Argon at 40 and finally 100% O₂ at 20 and 10. Back to the surface on air. Later, KRC

Conclusion

- Helium is good enough.
- Neox and Argox offer very little, if any, advantages.
- Oxygen “window” or lack of inert gas is key and is preferably versus diving funky / expensive / hard to find gasses.
- Neon and argon probably could be used in some context but cost and operational complexity probably do not warrant its regular use.
- Occam's Razor – “The simplest explanation is usually the right one.”

John Chatterton

“The whole Aqua Corps Mindset in Diving, where all sorts of impossible things were now possible!! Neon was part "look what I can do" Super Geeking, part marketing, part Star Trek.”

Gratuitous photo!



Questions?

- The end!

Thank you for listening!