HELIAIR

Poor Man's Mix

Curt Bowen

Heliair, a term originally coined by Sheck Exley, is the simple process of adding helium to a scuba cylinder then topping it off with air. Heliair, sometimes called "poor man's mix," was implemented in the early deep air days of cave exploration for the reduction of nitrogen narcosis. At this time it was believed that narcosis was the cause of several deaths of divers using deep air. Today, we know that even though nitrogen narcosis may have been a contributing factor, most likely oxygen toxicity was the culprit.

Heliair has multiple advantages and disadvantages for the extended range diver.

Advantages

Nitrogen Narcosis: Heliair reduces the effects of nitrogen narcosis.

Oxygen Toxicity: Heliair reduces the oxygen PO2 exposure levels reducing the possibility of an O2 hit.

Ease of Mixing: Heliair mixtures are easily obtained by adding helium to a scuba cylinder then topping it off using a standard air compressor.

No Fire Hazard: Heliair mixtures don't require handling of 100% oxygen, thus removing any possible fire hazard.

Analyzing: Heliair's nitrogen and helium percentages are a mathematical constant according to the oxygen percentage thus providing the blender with the exact nitrogen and helium percentages.

Ease of Travel: Heliair minimizes the need to carry additional bank cylinders of oxygen to remote dive locations.

Continuous Blending: With the proper mixing chambers, heliair can be pumped directly through a standard compressor.

Disadvantages

Best Mix: In trimix, a PO2 of 1.4ata and an equivalent narcosis depth of 130 feet are desirable. With heliair, to obtain an equivalent narcosis depth of 130 feet, a PO2 of 0.9 to 1.1ata must be accepted — far below the desired 1.4ata PO2. If a PO2 of 1.4ata is obtained then an equivalent narcosis depth must be accepted, much deeper than the desired 130 feet.

Increased Decompression: Due to the fact that optimal PO2s of 1.4 are not obtained, decompression requirements will increase slightly compared to that of the Best Mix.

Partial Pressure Mixing

Two basic formulas are required to mix heliair. The first formula is used to determine how much helium in psi is needed for a desired mix. FHe x Ending Pressure, where FHe stands for fraction of helium.

Example: A ending helium percentage of 24% is desired with an ending pressure of 2640 psi. Formula: $0.24 \times 2640 = 633$ psi helium to be added. The second formula gives the oxygen percentage in the cylinder after topping off with air: 1 - FHe x 0.21 Example: The oxygen percentage in the above 24% mix would be $(1 - 0.24) \times 0.21 = 0.159$ or 15.9%

The mixing process is relatively simple. First drain the scuba cylinder then bank the required psi of helium into the scuba cylinder. Allow time for the helium to cool and the pressure to drop then make the needed corrections. Fill the scuba cylinder with air to the desired ending psi. Analyze the oxygen content with an O2 analyzer. If the oxygen percentage is too low just add more air until the mix is correct. Always round the oxygen percentage down (Example 15.6% to 15%) to the next lower number this will add a small amount of safety to the decompression tables.

Analyzing

It is imperative to analyze your gas right after mixing and then again just before the dive. You should calibrate the analyzer to air (20.9%) and not 100% O2. This will decrease the range of error for the analyzer. Alternate tables or a laptop with decompression software such as Abyss, Voyager, Decom, etc. should be available on-site to recalculate tables in the case of a gas change.

Saving Helium

Due to the high cost of helium, divers try to save every drop. If multiple heliair dives are to be conducted over several days the helium left in the scuba cylinder after a dive can many times be saved. This is done by calculating the helium psi still in the scuba cylinders then adding more helium on top of it Example: heliair 14% O2 / 33% was used on the first dive. Upon returning to the surface the diver has 800

HELIAIR FILL CHART (PSI)

HE%	O2%	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
19	17	38	57	76	95	114	133	152	171	190	209	228	247	266	285
24	16	48	72	96	120	144	168	192	216	240	264	288	312	336	360
28	15	56	84	112	140	168	196	224	252	280	308	336	364	392	420
33	14	66	99	132	165	198	231	264	297	330	363	396	429	462	495
38	13	76	114	152	190	228	266	304	342	380	418	456	494	532	570
43	12	86	129	172	215	258	301	344	387	430	473	516	559	602	645
47	11	94	141	188	235	282	329	376	423	470	517	564	611	658	705
52	10	104	156	208	260	312	364	416	468	520	572	624	676	728	780
57	9	114	171	228	285	342	399	456	513	570	627	684	741	798	855

HE%	O2%	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000
19	17	304	323	342	361	380	399	418	437	456	475	494	513	532	551	570
24	16	384	408	432	456	480	504	528	552	576	600	624	648	672	696	720
28	15	448	476	504	532	560	588	616	644	672	700	728	756	784	812	840
33	14	528	561	594	627	660	693	726	759	792	825	858	891	924	957	990
38	13	608	646	684	722	760	798	836	874	912	950	988	1026	1064	1102	1140
43	12	688	731	774	817	860	903	946	989	1032	1075	1118	1161	1204	1247	1290
47	11	752	799	846	893	940	987	1034	1081	1128	1175	1222	1269	1316	1363	1410
52	10	832	884	936	988	1040	1092	1144	1196	1248	1300	1352	1404	1456	1508	1560
57	9	912	969	1026	1083	1140	1197	1254	1311	1368	1425	1482	1539	1596	1653	1710

This chart provides the amount of helium to add (in psi) to an empty scuba cylinder to create the various heliair mixtures. First, find the desired heliair mixture to the left, then the ending scuba cylinder pressure at the top, intersect these two rows to get the required helium (in psi). Then top off the tank with air. You can also use the chart to determine the amount of helium left in a cylinder after a dive. Many times this helium can be saved.

illustration: C. Bowen

Heliair PO2 & END

Mix							
HE 19% O2 17%	Fill PSI	2600	2800	3000	3200	3400	3600
		494	532	570	608	646	684
	Depth	160	180	200	220	240	260
	PO2	.99	1.1	1.2	1.3	1.41	1.5
	END	122	140	156	172	188	204
HE 24% O2 16%	Fill PSI	2600	2800	3000	3200	3400	3600
		624	672	720	768	816	864
	Depth	180	200	220	240	260	280
	PO2	1.03	1.13	1.22	1.32	1.42	1.51
	END	129	144	159	174	190	205
HE 28% O2 15%	Fill PSI	2600	2800	3000	3200	3400	3600
		728	784	840	896	952	1008
	Depth	200	220	240	260	280	300
	PO2	1.07	1.16	1.25	1.34	1.43	1.53
	END	135	149	164	178	192	207
HE 33% O2 14%	Fill PSI	2600	2800	3000	3200	3400	3600
		858	924	990	1056	1122	1188
	Depth	220	240	260	280	300	320
	PO2	1.08	1.16	1.25	1.33	1.42	1.51
	END	137	150	163	177	190	204
HE 38% O2 13%	Fill PSI	2600	2800	3000	3200	3400	3600
		988	1064	1140	1216	1292	1368
	Depth	240	260	280	300	320	340
	PO2	1.08	1.16	1.23	1.31	1.39	1.47
	END	136	149	161	173	186	198
HE 43% O2 12%	Fill PSI	2600	2800	3000	3200	3400	3600
		1118	1204	1290	1376	1462	1548
	Depth	260	280	300	320	340	360
	PO2	1.06	1.14	1.21	1.28	1.35	1.43
	END	134	145	157	168	180	191
HE 47% O2 11%	Fill PSI	2600	2800	3000	3200	3400	3600
		1222	1316	1410	1504	1598	1692
	Depth	280	300	320	340	360	380
	PO2	1.06	1.12	1.19	1.26	1.33	1.39
	END	133	143	154	165	175	186
HE 52% O2 10%	Fill PSI	2600	2800	3000	3200	3400	3600
		1352	1456	1560	1664	1768	1872
	Depth	320	340	360	380	400	420
	PO2	1.08	1.14	1.2	1.26	1.32	1.38
	END	136	146	156	165	175	184
HE 57% O2 9%	Fill PSI	2600	2800	3000	3200	3400	3600
		1482	1596	1710	1824	1938	2052
	Depth	340	360	380	400	420	440
	PO2	1.02	1.08	1.13	1.18	1.24	1.29
	END	127	136	145	153	162	170

This chart gives the Equivalent Narcosis Depth (END) in fsw, and the partial pressure of oxygen (PO2) in atmospheres absolute for various heliair mixtures. Match up the desired depth with the desired END or PO2. Once located, the desired helium and oxygen percentages are in the left black box. The helium fill psi from 2600-3600 psi are located in the same block just above the depth row.

psi of mix left in his cylinders. The amount of helium in psi still left in the mix can be calculated by taking the fraction of helium times the pressure left in the cylinder. 0.33 x 800 psi = 264 psi of helium still in the scuba cylinder. Let's say the next dive requires a heliair mix of 15% O2 / 28% He. If the cylinders were empty, 739 psi (0.28 x 2640) of helium would be required to make the proper mix at 2640 psi but we have 264 psi of helium still in the cylinders from the first dive. Subtract the psi of helium still in the cylinders from the required psi of helium needed if the cylinders were empty. 739 - 264 = 475 psi of helium to be added on top of the 800 psi still in the cylinders then topped of with air to make the proper 15/28 mix. The only problem with remixing heliair in this fashion is the higher bank pressures needed to remix. If the pressures get to high you will not be able to obtain the psi without a haskel pump. The highest helium bank pressure available will determine if you will need to drain the left over mix in the scuba cylinders completely or just partially.

Transfer Whip

A transfer or fill whip is required to partial pressure fill helium from the bank cylinder to the scuba cylinder. All components of the whip must be designed for high pressure use. If the whip is going to be used for transferring pure oxygen then all components must be oxygen compatible and free of hydrocarbons.

A whip can be purchased whole and ready for use or the components can be purchased and assembled. The following is a list of whip components.

Connector:

An industry standard CGA-580 style connector is required for the helium bank cylinder. Note a CGA-580 to CGA-540 adapter can be purchased to convert an oxygen whip into a helium transfer hose.

Line Filler Valve:

A needle valve is used to control the rate of flow from the bank helium to the scuba cylinder. Transferring any gas for mixing should be done slowly to help minimize heat build up which can cause an error in the final mix.. The best in-the-field technique is to place your ear on the scuba cylinder and crack the needle valve until you can hear the gas flowing.

High Pressure Hose

High pressure hose 3-6 feet in length is sufficient.

Pressure Gauge

Pressure gauges come in a variety of sizes, styles and pressure readings. Digital gauges are recommended but due to their high cost most brewers use analog. Digital dive computers with integrated pressure gauges work very well.

Scuba Yoke

Scuba and DIN fittings are standard per the scuba industry.

Check Valve (optional)

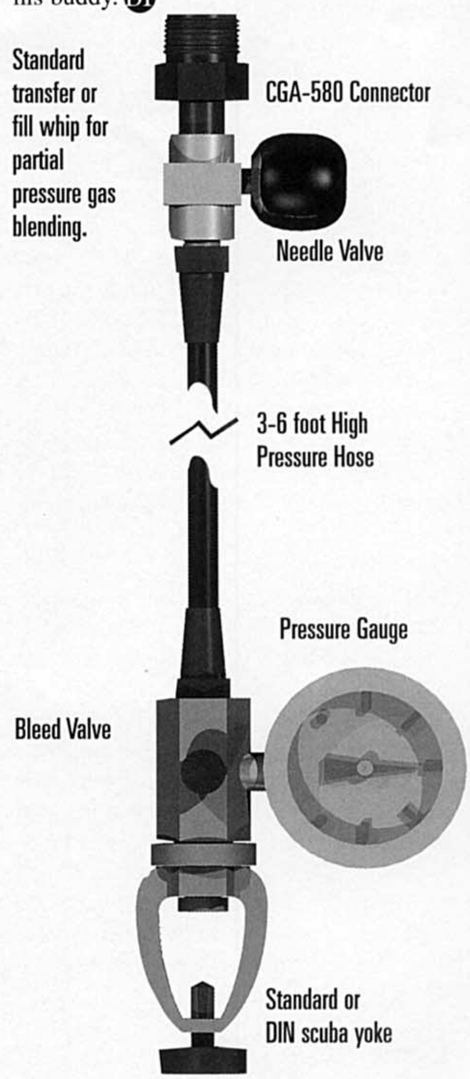
A check valve can be used to prevent backflow of gas into the supply cylinder in the event the scuba cylinder contains more pressure.

Flow Restrictor (optional)

Flow restrictors prevent the fill rate from exceeding a set value thereby preventing excessive heat build up.

Helium Storage Cylinders

Helium comes in a variety of large bank cylinders from your local gas dealer. Cost seems to vary greatly according to your personal business relationship with your local gas company. I usually pay about $60 for a 280-cubic-foot helium bank cylinder, but have heard of divers paying more than $200. You may need to shop around to find the cheapest price. The number of bank cylinders needed will depend on your diving but three seems to work well for the active deep diver and his buddy. DT



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