Explosive Potential of Gas Mixtures Commonly Used in Anaerobic Chambers. MIKE E. COX. *From Anaerobe Systems, San Jose, California*

The standard gas mixture for use in anaerobic chambers recommended by many microbiology reference books contains 5%–10% carbon dioxide, 10% hydrogen, and the balance nitrogen [1–3].

Table 1. Hydrogen and oxygen concentrations during transition from aerobic to anaerobic conditions with use of 10% hydrogen.

Percent air*		Mixture with 10% hydrogen		Percent oxygen*		Percent hydrogen	Flammable
100.0	+	0	=	20.0	+	0	No†
95.0	+	5.0	=	19.0	+	0.5	No
90.0	+	10.0	=	18.0	+	1.0	No
85.0	+	15.0	=	17.0	+	1.5	No
80.0	+	20.0	=	16.0	+	2.0	No
75.0	+	25.0	=	15.0	+	2.5	No
70.0	+	30.0	=	14.0	+	3.0	No
65.0	+	35.0	=	13.0	+	3.5	No
60.0	+	40.0	=	12.0	+	4.0	Yes
55.0	+	45.0	=	11.0	+	4.5	Yes
50.0	+	50.0	=	10.0	+	5.0	Yes
45.0	+	55.0	=	9.0	+	5.5	Yes
40.0	+	60.0	=	8.0	+	6.0	Yes
35.0	+	65.0	=	7.0	+	6.5	Yes
30.0	+	70.0	=	6.0	+	7.0	Yes
25.0	+	75.0	=	5.0	+	7.5	No‡
20.0	+	80.0	=	4.0	+	8.0	No
15.0	+	85.0	=	3.0	+	8.5	No
10.0	+	90.0	=	2.0	+	9.0	No
5.0	+	95.0	=	1.0	+	9.5	No
0.0	+	100.0	=	0.0	+	10.0	No

* Air contains ~20% oxygen.
† Hydrogen concentration too low.
‡ Oxygen concentration too low.

In previous years, I experienced two explosions in our laboratory while using 10% hydrogen. In both situations, the chamber was in the transition from aerobic to anaerobic conditions. In the first case, I entered the chamber to demonstrate the use of the inoculator sterilizer. The heat of the inoculator sterilizer coil provided the source of ignition inside the chamber. The explosion, while small in energy, forced me out of the chamber. A dense cloud of moisture was observed during the reaction.

In the second event, the anaerobic chamber was sealed closed. The chamber was in the process of flushing to remove oxygen. In this case, there was no path to relieve the accumulating pressure caused by the exothermic reaction. The source of ignition was not identified. The explosive force was sufficient to separate the end of the chamber from the main body.

Normally, there would be no oxygen inside the anaerobic chamber to support combustion. However, during the transition from aerobic to anaerobic or from anaerobic to aerobic conditions, the mixture of oxygen from air and hydrogen in the gas mixture could reach a potentially flammable concentration.

Table 2. Hydrogen and oxygen concentrations during transition from aerobic to anaerobic conditions with use of 5% hydrogen.

Percent air*		Mixture with 5% hydrogen		Percent oxygen*		Percent hydrogen	Flammable
100.0	+	0	=	20.0	+	0	No†
95.0	+	5.0	=	19.0	+	0.3	No
90.0	+	10.0	=	18.0	+	0.5	No
85.0	+	15.0	=	17.0	+	0.8	No
80.0	+	20.0	=	16.0	+	1.0	No
75.0	+	25.0	=	15.0	+	1.3	No
70.0	+	30.0	=	14.0	+	1.5	No
65.0	+	35.0	=	13.0	+	1.8	No
60.0	+	40.0	=	12.0	+	2.0	No
55.0	+	45.0	=	11.0	+	2.3	No
50.0	+	50.0	=	10.0	+	2.5	No
45.0	+	55.0	=	9.0	+	2.8	No
40.0	+	60.0	=	8.0	+	3.0	No
35.0	+	65.0	=	7.0	+	3.3	No
30.0	+	70.0	=	6.0	+	3.5	No
25.0	+	75.0	=	5.0	+	3.8	No
20.0	+	80.0	=	4.0	+	4.0	No‡
15.0	+	85.0	=	3.0	+	4.3	No
10.0	+	90.0	=	2.0	+	4.5	No
5.0	+	95.0	=	1.0	+	4.8	No
0	+	100.0	=	0	+	5.0	No

* Air contains ~20% oxygen.
† Hydrogen concentration too low.
‡ Oxygen concentration too low.

The flammable limits of hydrogen in air are from 4% to 74.6% [4]. Below 4% hydrogen in air, the hydrogen concentration is too low to support combustion. Above 74.6% hydrogen in air, the oxygen concentration is too low. Table 1 shows that when using 10% hydrogen, the percentages of oxygen and hydrogen reach potentially flammable concentrations. Table 2 shows that 5% hydrogen could not produce a flammable mixture.

A 5% hydrogen concentration is adequate to maintain anaerobic conditions below 10 parts per million of oxygen inside an anaerobic chamber. This concentration was validated with use of an Illinois Instruments Model 2550 oxygen meter (Illinois Instruments, Ingleside, IL). The use of 10% hydrogen in anaerobic chambers creates a real and unnecessary danger to equipment and personnel.

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