Collection of Free and Dissolved Gases from Water Wells

Both free and dissolved gases can be sampled from water wells by using the "Bubble Pail Method" (Keech and Gaber, 1982, "Methane in Water Wells", WWJ, February, PP 32-36). The bubbler pail can be constructed easily with two buckets and appropriate tubing configured to control the water flow as shown in Figure 1.

Water enters the system through the tube marked "flow in" and rises through an upright tube (the standpipe) and fills the first bucket. The overflow from the first bucket is directed into the second bucket, which is used for calculating the water flow rate. Sample collection bottles are filled with water and inverted over the standpipe allowing free gas to collect and displace the water from the inverted sample bottle. The water flow rate is determined by stopwatch, recording the time required to fill the second bucket.

By recording the water flow rate, length of the test and the volume of gas collected, the percentage of gas in the water can be determined. The concentration of methane in the collected free gas should be analyzed in a laboratory to determine the composition of all combustible gases. This should include methane through butanes at a minimum. The detection limit for the heavier hydrocarbons needs to be in the 10 ppb range. Portable combustible gas meters should be used for determination of methane levels in the field.

An example calculation from a typical gas bubbler would be as follows: 1) flow rate 3 liters/minute, 2) length of test 5 minutes yielding 3) a total water volume of 3l/minute X 5 minutes = 15 liters of water tested. If the gas volume collected during this time is 750 ml (0.75 liters) then the percent gas in water is 0.75/15, or 0.05 which is 5%. If the laboratory gas concentration is 30% methane then the percent methane in water is 5% of 0.30, which is 1.5%. The Michigan Department of Public Health considers the water as safe from explosions if this percentage is less than 1% methane in water by volume. It would be interesting to look up California's regulation for methane in water wells.

We generally measure the water volume collected by weighing the sample bottles when empty and then reweighing the bottles after collection and calculating the volume of gas collected by subtracting the weight of the empty bottle. Weighing the filled sample bottles not only provides the most accurate way to measure the volume of gas collected, but also allows an estimate of gas volumes collected when there is very little free gas available.

Whenever adequate volumes of free gas are available, then this free gas sample also provides the very best sample for stable carbon isotope analysis.

In addition to the free gas sample, it is possible to collect a completely filled water bottle (no headspace) for analysis of the dissolved gas content. This sample is collected by placing additional sample bottles into the bubble pail system and

flowing the water from the standpipe into the bottle, replacing all the air in the bottle with water. The bottle is filled underwater, excluding ambient air, and providing a full bottle of water having no headspace.

A 10 ml water sample is exchanged with nitrogen in the analytical laboratory using a syringe, providing a 10 ml headspace. The bottle is shaken vigorously before analyzing the headspace volume for its contents of methane and other combustible gases. We strongly recommend that these two samples for the free and dissolved gases be collected in 125 ml septem capped bottles. The standard 40 ml VOA bottles have often been used for this purpose, but they are not gas tight and should be used only for BTEX analysis. In this case we would also recommend that at least one sample be collected and analysed for benzene.

The water levels of the monitor wells should be measured both before and after the test and the volume of water tested should exceed three well volumes. However, if possible it is desirable to pump the wells beyond the three volumes and to collect a series of free and dissolved gas samples on timed intervals, such as every fifteen minutes over the lifetime of the pump test. This will give true duplicate samples that will provide very high quality data regarding the levels of gas charging of the shallow aquifers. A plot of the gas concentration versus time (i.e. volume of water pumped) is unequivocal information as to the amount of gas charging of the shallow aquifers within the areas occupied by the water wells tested.

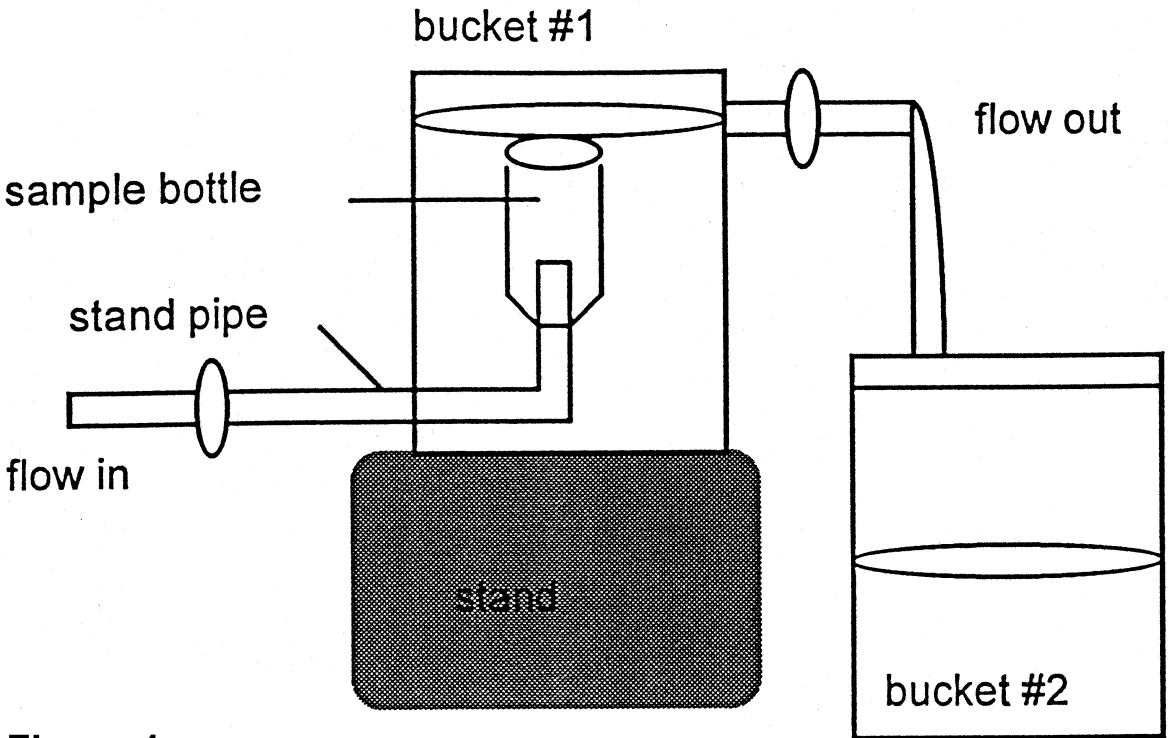
bucket #1
flow out
sample bottle
stand pipe
flow in
stand
bucket #2

Figure 1