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Operations Manual

MONITORING SCUBA AIR QUALITY BY COLORIMETRY

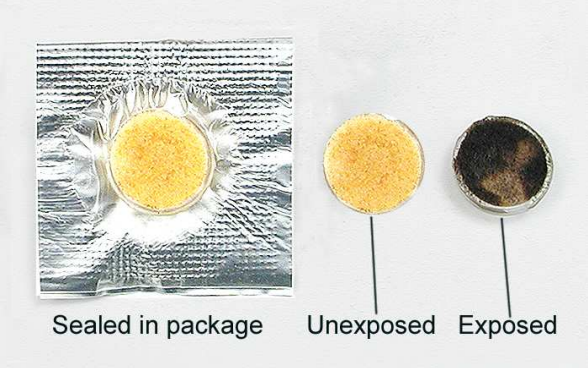
FOR SAFETY AND EFFICIENCY:
PLEASE READ THIS MANUAL
PRIOR TO USE OF THIS PRODUCT

MONITORING SCUBA AIR QUALITY BY COLORIMETRY

The high quality of today's scuba diving air is the result of a steady evolution in compressing and processing systems. Various individual components for air entrainment have markedly improved over the past 50 years. One such beneficial product is the colormetric air monitor, which has been used extensively to oversee and maintain the quality of divers' air. These rather inexpensive (under $100.00) devices rely on simple color changes (colorimetry) to indicate the presence of unwanted contaminants within the air stream. Colorimetric chemicals have been successfully used to detect unacceptable levels of carbon monoxide, carbon dioxide, oil vapor, and moisture in scuba air.

The most common monitor (GMC #44070) marketed today usually detects moisture and carbon monoxide. These two parameters are of particular interest because (A) carbon monoxide is the most deadly contaminant that might enter the air stream, and (B) moisture levels can be used to tell when the air filter cartridges should be changed, as well as to assess the overall efficiency of the moisture removal system. The sensors used in these devices are simple plastic (or parchment) colored disks that can be viewed through a small window in the pressure housing.

Carbon monoxide (CO) is a deadly gas that can enter the system within fouled ambient air or can be generated internally if certain mechanical malfunctions occur. The acceptable level of this pollutant in dive air is 10 parts per million (ppm) or less. Most air monitors contain a yellowish-tan colored disk which will turn coal-black in the presence of carbon monoxide. The disk is sensitive within the range of approximately 25 – 100 ppm, but the reaction is a time-driven event with 50 ppm usually designated as the "threshold value." For example, a CO concentration of 50 ppm will cause a distinct reaction within about five minutes. Higher levels will react faster, but even very low levels can be detected given sufficient time. Any observant operator should note that a significant problem is occurring long before much air has been processed.

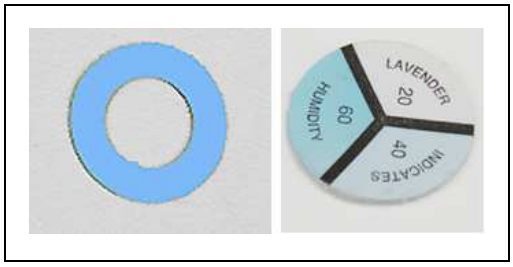


Because colorimetric CO sensors to not react instantaneously, they should be viewed as "early warning systems" or "emergency situation alarms." Electronic CO detectors are available today that can sense very low monoxide concentrations within seconds, but they are quite expensive (often several thousand dollars), so not many dive operations have them. Inexpensive CO sensors that operate at ambient atmospheric pressures are readily available, but those functioning at very high pressures remain quite expensive.

Such sensors are usually employed only where CO is known to be an on-going problem in the ambient air source, thereby making swift detection essential. Of course, commercial dive operations with “large budgets” often commonly employ them.

Air monitors have historically also been used to detect the level of moisture in scuba air. This is a very important factor because (A) high water content in scuba air may condense inside the dive tank where it can promote internal corrosion or (B) may enter the valve and regulator, causing accelerated corrosion, deterioration of parts and/or create cold-water freeze-ups. (C) Moreover, excessive moisture causes premature saturation and failure of the chemical filters used for air purification, subsequently releasing absorbed pollutants back into the air stream. Proper use of colorimetric devices can mitigate these problems by determining the correct time when filter chemicals should be renewed!

Moisture monitoring is a simple process: The sensor is a small ring of paper parchment saturated with cobalt chloride, which imparts a bright, sky-blue color to the disk. Depending on the level of cobalt chloride present, this ring will change color when exposed to specific moisture levels. As the water content of the air rises, the blue color fades, slowly becomes pink, and finally stark white. Most of the sensors employed for diving air begin to fade at a relative humidity of 45%, which corresponds roughly to a dewpoint in the range of -40 to -50ºF. Therefore, when the blue color fades into pink, the desiccant chemicals in the filters are about to expire. Once that happens, the resulting high moisture will quickly inactive the other filtrants (such as activated carbon), and the air cleansing process will be compromised. Bottom line: When the blue color is almost lost, change your filter chemicals and all the aforementioned problems associated with high moisture should be avoided!



Special models of the monitor (GMC #44075) are occasionally used to produce very dry air. These units contain a single, multi-phase moisture-sensing disk (GMC #44076) which can detect relative humidity as low as 20% or less. These disks are used to monitor special desiccant filter cartridges that can produce air with extremely low dew points for applications like ice diving or very deep diving in frigid waters. The dew point, of course, is the temperature to which the air must be chilled before any water will “dew out” as liquid.

Colorimetry can be used to determine an end point value for your filter chemicals. If the one has a hour meter on the compressor, simply track the number of “running hours” since you last changed filters to the point where the humidity sensor fades from blue to pink. Repeat this procedure 3 - 4 times and take an average. This value is the “longevity function” of your chemical filters, or in simple terms, how long your filter cartridges will last as an average, measured in “running hours.”

Prudent operators will usually subtract a few hours from the average to create a small safety factor, thereby lessening the chance of ever over-running the end point. Filtrant longevity can also be determined by manually tracking "running time," but using an automatic hourmeter is far easier.

The sensor disks in air monitors should be replaced periodically (usually yearly). The yellow CO disk (GMC #44077) darkens with age, slowly turning brown from tiny traces of carbon monoxide present in even the cleanest air; it should be replaced whenever any discernible discoloration has occurred. If the blue moisture ring (GMC #44073) changes color, it can be regenerated by exposure to very dry air, but most people merely replace the device because it's very inexpensive, as is the CO sensor.

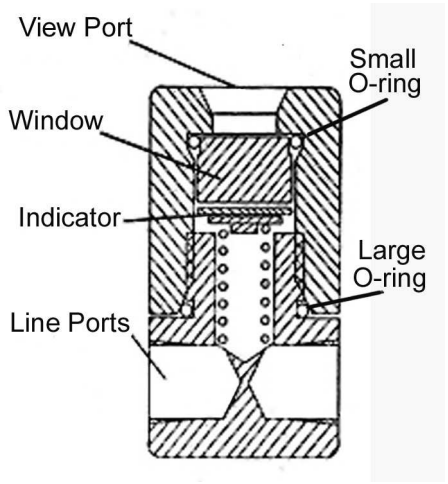
INSTALLING AND USING COLORIMETRIC AIR MONITORS

INSTALLATION: Air monitor housings are usually simple to install. Nearly all models have two ¼" female NPT ports across the base of the pressure housing that are easy to adapt into any piping system. **THERE IS NO DIRECTION OF FLOW REQUIRED, BUT THE DEVICE MUST BE PIPED IN-LINE SO THAT GAS FLOWS IN ONE PORT AND OUT THE OTHER.** Flows up to 50 cu. ft. per minute can be accommodated. The unit is usually placed in-line after the chemical filter tower, usually at the tower's outlet port, but it can be put anywhere along the outgoing air line between the last filter and the air storage bank or fill panel. On occasion, monitors are incorporated into air distribution panels / fill stations downstream from the storage vessels. Obviously, the actual plumbing requirements for any given monitor will depend upon the point of installation selected, the type and brand of fittings involved, the operating pressure, etc. Global's Tech Support Dept (414-774-1616) can help you with plumbing considerations.

If the filtration system contains multiple filter towers, the very best place for the monitor is between the desiccant tower and the final (multiplex) filter(s). In this particular position, it warns when the drying chemical in the first tower has expired, but before the multiplex chemicals (charcoal, Hopcalite, calcium chloride, etc.) in the final tower are inactivated by increased moisture levels, since these final filtrants are still protected by some desiccant present in most multiplex cartridges. Changing cartridges at this point usually provides an excellent safety margin against unwanted saturation of the final filter and possible subsequent pollution of your entire system. However, depending upon the air processing system, retrofitting an air monitor between filter towers can be a difficult plumbing job. Many prefabricated filter systems have special connectors linking the towers together and complete disassembly of the filtration components may be necessary to install the monitor.

OPERATION AND TROUBLESHOOTING: The CO sensor comes in a foil wrapper and should not be opened until it's needed. Once opened, install the disk within 2 hours. Sensors have a shelf life and should not be stored for extended periods (years). Buy a spare with the intention of using it within approximately one year. The disk simply rests atop a spring within the metal housing.

The #44070 housing has two internal 0-rings which appear to identical, but are actually one size apart. The smaller 0-ring (#48518) seals the lens into the housing, whereas the larger one (#48519) seals the two halves of the housing together. If these seals are reversed, the unit will eventually leak when pressurized.



If a dangerous level of carbon monoxide enters the air stream, the tan / yellow color of the disk will turn intense brown and then dark black. Of course, the processed air should not be used until the situation is remedied. Over time, the tan / yellow hue may discolor or fade into shades of brown from aging effects, usually caused by minute traces of CO or other organics present in even the cleanest air. For this reason, the disk should be renewed yearly. Anytime the disk unexpectedly or dramatically changes color, the disk should be replaced and the cause of the erratic change should be investigated.

The moisture sensor should show an intense, sky-blue color if the dewpoint of the air is correct (about -50^0 F or lower). As the moisture level rises, this color will fade into a washed-out blue hue, followed by a pink color, and then stark white. The filter cartridge (or packed chemicals) should be changed just as the blue color is lost. As already mentioned, the disk can be regenerated by placing it in dry air or gently heating it in an oven at about 200^0 F. However, since the disks are very inexpensive, most technicians simply replace them periodically as needed. If left to regenerate with a given system, some hours may be required to regain the intense blue color because the entire system must again achieve and hold a low dewpoint.

If using the multi-phase disk that shows three dewpoint levels (humidities of 20 - 40 – 60%), the desiccants should be changed after the 40% phase has turned pink and the 60% phase is starting to lose its blue color. Of course, if super-dry air is desired, change the chemicals earlier, when the 20% phase starts to turn pink. **Remember that it is very important to maintain dry air because moisture rapidly inactivates the downstream filter chemicals**. If saturated by water molecules, these chemicals can even release the pollutants they have absorbed into your system, thereby contaminating your stored or delivered air.

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