Zysense Multigas Analyzer MGA-400 and MGA-800

Following market research and customer suggestion, Zysense has investigated the feasibility of a new type of analyzer to bring onto the growing platform of instruments. Studies suggest the following gas molecules are of interest for medical research, specifically many of the molecules found in exhaled breath. The forthcoming Zysense multi-gas analyzers will be customized to measure the following gases, which can be reliably measured in parts per million levels from exhaled breath on a continuous basis for research applications.

Nitric Oxide: (Measurement range 0-50 ppm)

The first electrochemical sensor is custom designed to accurately measure the level of nitric oxide in parts per million levels. This sensor is designed for multi gas measurement, and was engineered to mitigate the impact of other trace gases in the gas stream. However, please note that this sensor is NOT designed for use in analyses investigating NO at the parts per billion or parts per trillion levels.

The electrochemical sensor is designed to withstand continuous use for a period of two years.

For ultra-low levels of detection in parts per billion levels it is recommended to use *Zysense NOA-280i* (The Gold standard Nitric Oxide measurement device used by major research institutions around the world). The concentration of exhaled nitric oxide can be measured in ppb (particles per billion), and is commonly elevated in atopic diseases, including asthma and allergic rhinitis. It took nearly two decades following its introduction until fractional exhaled nitric oxide (FeNO) measurement became as part of standard asthma diagnosis guidelines. The role of FeNO has been established in asthma management, as it is a non-invasive marker for eosinophilic airway inflammation, and it is related to treatment responsiveness.

Carbon Monoxide: (Measurement range 0-50 ppm)

A new carbon monoxide electrochemical sensor was developed to measure exhaled CO in exhaled breath applications. The *Zysense MGA-400* will have an inline dryer to reduce the moisture levels in the gas.

Exhaled carbon monoxide (CO) is found around 1-10 ppm concentration levels and increases with the up-regulation of the heme-oxygenate expression in airways. Therefore, its breath levels are elevated in smokers and patients with airway disease. Exhaled CO (eCO), similar to exhaled nitric oxide (eNO), has been evaluated as a strong candidate for a breath biomarker of pathophysiological states, including smoking status, and inflammatory diseases of the lung and other organs. eCO values have been evaluated as potential indicators of inflammation in asthma, stable COPD and exacerbations, cystic fibrosis, lung cancer, or during surgery or critical care. The utility of eCO as a marker of inflammation, and potential diagnostic value remains incompletely characterized. Among other candidate “medicinal gases” with therapeutic potential, (e.g., NO and H2S), CO has been shown to act as an effective anti-inflammatory agent in preclinical animal models of inflammatory disease, acute lung injury, sepsis, ischemia/reperfusion injury and organ graft rejection. Current and future clinical trials will evaluate the clinical applicability of this gas as a biomarker and/or therapeutic in human disease.

Ammonia (Measurement range 0-50 ppm)

Ammonia is of extreme interest to medical researchers and the *Zysense MGA-400* can be expanded to measure Ammonia, Nitrogen Dioxide, and Nitric Oxide in a simultaneous gas stream. Nitrogen Dioxide and Nitric Oxide are oxidation products of Ammonia, and the degree of Ammonia conversion can be accurately measured using the *MGA-400*.

In addition, Ammonia is readily oxidized to Nitrogen dioxide, and the *Zysense NO2 to NO converter* can be used to convert Nitrogen dioxide back into Nitric Oxide. This multi-gas stream can be measured by *Zysense NOx Plus*, as itcan measure NO, NO2, and O2 levels in a given gas flow in a continuous manner.

Ammonia is a ubiquitous byproduct of protein metabolism. Ammonia measurement can therefore help clinicians assess various disease and wellness states. However, ammonia is difficult to measure accurately, via blood or breath, because it is very reactive. Though commonly used, blood assays have numerous drawbacks, including basic concerns about accuracy of results. But the major problem with blood assays is the reality that they are only ever collected episodically. This is important because ammonia physiology, much like blood glucose and many other metabolic processes, are fluid and ever changing and require constant monitoring and re-evaluation to have a bigger picture of what is happening physiologically. In contrast, breath assays are fully non-invasive and can be completed rapidly, thereby easily enabling repeated, consecutive measures. Thus, breath ammonia measurement may be attractive to researchers and clinicians because it may address a serious unmet need in a unique way. Breath collection, however, presents unique concerns. Whereas phlebotomy inherently carries the jeopardy of error in several unpredictable ways (e.g., tourniquet time, sweat contamination, blood cell hemolysis, delay in laboratory measurement, etc), breath measurement researchers must contend with a different group of novel challenges: variability in breathing, contamination with oral mucosal or bacterial ammonia, influence of ambient air and apparatus humidity and temperature, etc. Indeed, it is unwise to underestimate the task of fully understanding how to develop experimental equipment used to diagnose humans, let alone using experimental procedures to discover unknown biology. In part due to these obstacles, breath ammonia has not yet met its potential.

Nitrogen Dioxide

Nitrogen Dioxide is a trace contaminant especially during Nitric oxide therapy and it is critical to measure the levels of Nitrogen dioxide in the gas stream. ***Zysense MGA-400*** has an electrochemical sensor that measures Nitric oxide levels (0-10 ppm).

If the levels of Nitrogen Dioxide is over 2 ppm, ***Zysense Nitrogen Dioxide converter*** is coupled with the gas stream that coverts Nitrogen Dioxide to Nitric Oxide.

Hydrogen Sulfide: (Measurement range 0-50 ppm)

Breath H2S levels have been associated with oral and hepatic malodor for quite some time. Recently, this molecule has gained noteriety as a biological transmitter, and it is suggested to play a role in neutrophil involvement in the airways.

According to Jungyang Jung (citation?) "H2S acts as a signaling molecule in the cell signal transduction pathways within the nervous system, the circulation system, and in many other organs. In the central nervous system (CNS), H2S is associated with various physiological processes, including neuroprotection and neurotransmission. H2S inhalation has shown a neuro protective function in a mouse model of Parkinson's disease (PD). H2S has also been shown to protect neurons from apoptosis and degeneration by exerting anti-inflammatory effects and upregulating antioxidant enzymes. H2S also show signs of protecting neurons from oxidative stresses by reducing the level of reactive oxygen species (ROS) and the aggregation of lipid peroxidation products. Furthermore, H2S inhibits the biological activity of peroxynitrites(ONOO−) formed in the reaction of nitric oxide (NO) with superoxide anion. H2S functions as an antioxidant by scavenging ROS directly and by reducing glutathione disulfide (GSSG). Increased levels of ROS are found at inflammation sites. Removal of ROS can occur by supplying homocysteine, and stimulated H2S synthesis expedites the antioxidant activity. High levels of H2S cause generation of ROS and reactive nitrogen species (RNS), whereas lower amounts of H2S react with hydrogen peroxides (H2O2), ONOO−, and oxide ion (O2−). Additionally, H2S functions as an antioxidant by attaching to particular agents, such as glutathione (GSH), superoxide dismutase (SOD), N-nitroarginine methyl ester (L-NAME), and vitamin C".

Volatile Organic Compounds: (Not measured by ***Zysense MGA-400 or MGA-800*** but new development underway to be launched by ***Zysense*** in 2019 that can measure specific VOC components in ppm and ppt levels)

Volatile organic compounds (VOCs) became of particular interest in the last three decades, as their quality and quantity change in several systemic and respiratory disorders, and VOC measurements might aid the early detection of respiratory disorders such as lung cancer.