

MCQ Gas Blender 100 Series Application:

The use of gas mixtures dynamically created in the hemoglobin study

MCQ Gas Blender 100 Series



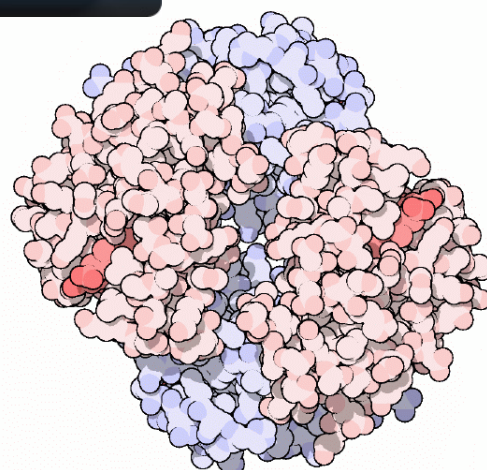
Introduction

Over the last century, the hemoglobin study has been, and still is, the keystone in our understanding of human physiology. The importance of the role of hemoglobin and the studies undertaken over this molecule have allowed, starting from the pioneering works of enlightened minds such as Linus Pauling, Max Perutz and many others until today worldwide research, the birth and maturation of a new scientific branch: the molecular medicine. Being a fundamental component in the complex respiratory system of all the vertebrates, the hemoglobin has always been a high interesting scientific subject, widely researched by using physical, chemical, physiological, and genetic methods. All these intense efforts allow modern medicine to have an unparalleled knowledge of hemoglobin molecular basis, DNA relations, structure-related functions and more importantly its related diseases and their treatment. Nevertheless, hemoglobin study constantly proves new and deeper connections between this molecule and other complex biological systems that then require new experimental approaches to be developed.

The Role of Hemoglobin

Hemoglobin is a macromolecule made up of four protein molecules, the globulin chains called myoglobin, connected together. The normal adult hemoglobin molecule contains 2 alpha-globulin chains and 2 beta-globulin chains. The dry content of the red blood cells, the most abundant cells in vertebrate blood, is composed up to 97% of hemoglobin. Its main function is to transport oxygen (O_2) from the lungs to tissues (taking role of oxygen binding protein, the hemoglobin increases the total blood oxygen capacity seventyfold) and to return carbon dioxide (CO_2) from the tissues to the lungs or gills. Each globulin chain contains an iron ion embedded in a porphyrin molecule called heme, which directly binds the oxygen molecule and which is also responsible for the red color of blood. The heme also specifically interact with the two other gases, carbon monoxide (CO) and nitric oxide (NO), both with important biological roles. The interaction between carbon dioxide and hemoglobin is instead carried out by the amino-terminal residues of the protein.

Hemoglobin



1



MCQ Gas Mixer Manager

2

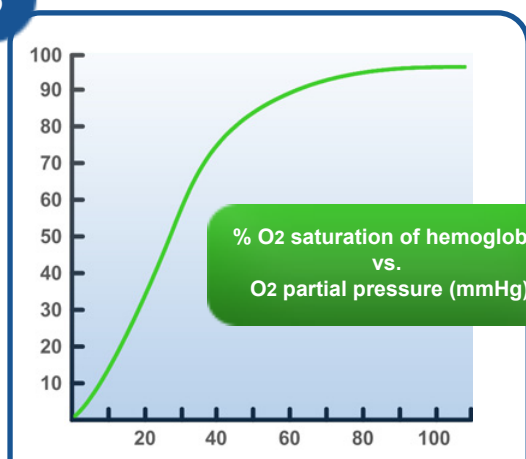
Gas Mixer Manager Configuration

Gas Mixture Composition

Nitrogen:	85%	170 sccm
Oxygen:	10%	20 sccm
Carbon dioxide:	5%	10 sccm

Oxygen partial pressure: 75 mmHg
(corresponding to 10% in total flow)

3



Hemoglobin binding curve

The three steps that allow you to collect the data required to create an hemoglobin oxygen saturation binding curve plot with the MCQ Gas Blender 100.

Step 1. Use the MCQ Gas Mixer Manager to control the Gas Blender 100. **Step 2.** Change the amount of oxygen in the gas mixture to collect data about your working system at different oxygen partial pressures. **Step 3.** Use collected data to create the binding curve plot.

Hemoglobin branches of study

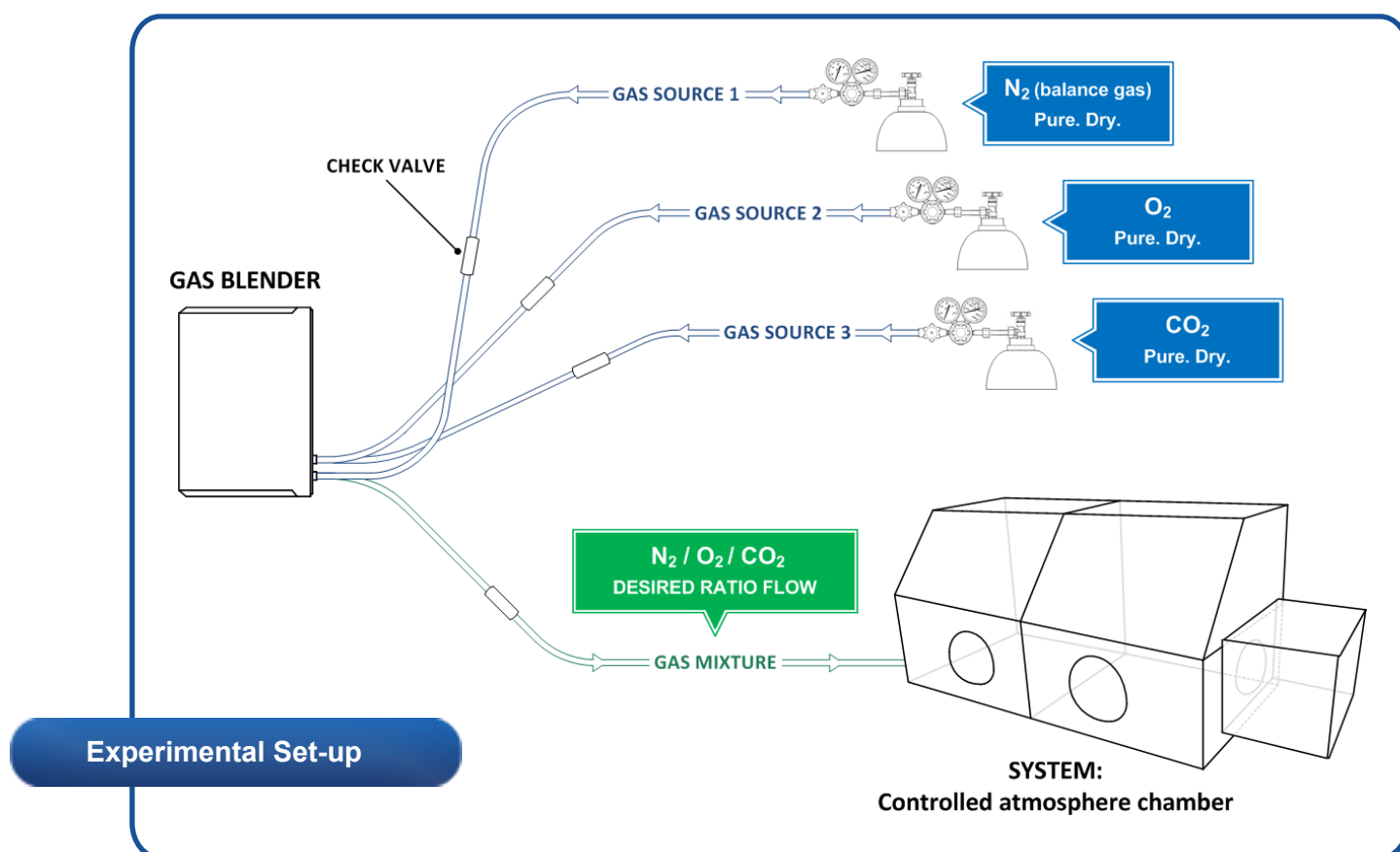
Even if the hemoglobin is perhaps the best studied of all macromolecules, it has not revealed all its secrets yet, leading to a need for a deeper research to be undertaken. Since hemoglobin takes a crucial role in the complex systems at the base of life itself, its related diseases are well known and well studied. Moreover the presence of hemoglobin in all the vertebrates, with slightly differences that distinguish them from each other, offers the possibility to undertake both animal [1,2] and human blood experimentation [3,4]. Sickle cell disease and thalassemia are two of the major examples of hemoglobin research application. The Sickle cell disease, a syndrome connected with a hemoglobin gene mutation, has been studied since the early years of the past century but an efficient cure is still far from being discovered (patients affected by this disease still have an average life expectancy of 45 years). The thalassemia, a disease connected to an incorrect hemoglobin rate of synthesis, causes underproduction of normal globin proteins leading to the accumulation of abnormal hemoglobin molecules (with less oxygen binding capacity) inside blood stream. Either or both these syndromes may cause anemia, which is another common topic of hemoglobin research. Other common applications range over the tumor research field [5,6], the study of cardiovascular disease [7,8], diabetes cure development [9], carbon monoxide poisoning [10,11] and many more.

The MCQ solution

The common hemoglobin experimental hardware configuration required a controlled atmosphere chamber in which a proper gas mixture is flown [12]. The components of this mixture are usually O₂ and CO₂ with N₂ as the balance gas. Rate of O₂ and/or CO₂ in the mixture may varies depending on the experiment but a fine control that allows to monitor and adjust the rate during the procedure, i.e. a dynamic mixture management, is always required. For these applications MCQ instruments suggest the use of the MCQ Gas Blender 100 Series, a high precision instrument designed to work with 3 components dynamic gas mixtures. Each gas media is connected to a dedicated instrument channel and for each channel MCQ guarantees high accuracy (1.0% of set point), high repeatability (0.16% of reading value) and a fast response time for set point change (50ms). The MCQ Gas Blender 100 Series is a versatile instrument, easy to configure and adaptable to

many different lab-application. The instrument works with dry, non-aggressive gas media and the channels are always calibrated with native gases following customer's request. MCQ also provide software for the gas mixture management, the MCQ Gas Mixer Manager. Easy to use, compatible with any common desktop or laptop pc, MCQ Gas Mixer Manager allow taking a complete control over the instrument and its functions, letting the user to start working with dynamic gas mixtures immediately.

coming out mixture can be adjusted with ease, monitored and modified by the user via to the MCQ Gas Mixer Manager software. In the diagram shown below the working system is a controlled atmosphere chamber. This kind of chambers control internal humidity and temperature and allow the user to handle the system with apposite gloves. Even if this configuration is an optimal experimental choice, the MCQ Gas Blender 100 can adapt efficiently to a wide range of other working set-up.



Hardware Configuration

A simple example of MCQ Gas Blender 100 Series hardware configuration is represented in the image below. The instrument works with dry, non-aggressive gases. The gas sources can be both pure or mixtures (in our example pure gases have been chosen for simplicity). The gas cylinders are connected to the instrument through 6 mm diameter tubes and a check valve is installed along each line as backflow prevention device. Each gas media is connected and controlled by a dedicated channel of the Gas Blender 100. Another 6 mm tube finally connects the instrument to the working system in which the experiment takes place. The relative amount of O₂ and CO₂ in the

References

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