Determination of $k_L a$ Values of Single-Use Bioreactors

Single-use bioreactors are increasingly used in research, process development, and production. Like conventional reusable systems they have to allow the setup of optimal growth conditions. A sufficient supply of oxygen is crucial for aerobic bioprocesses, and the velocity of oxygen entry into the culture medium is often described by the volumetric mass transfer coefficient ($k_L a$). Because single-use bioreactors offered by different manufacturers vary in parameters critical for oxygen transfer—like mixing, power input, and gassing strategies—they are often not directly comparable to each other and to conventional glass and stainless steel vessels. Even $k_L a$ values experimentally determined by the manufacturer or users are not necessarily comparable, because the results might differ dependent on the method used.

DECHEMA published guideline for $k_L a$-determination

To help the users to objectively compare the performance of bioreactors in terms of oxygen transfer, the DECHEMA expert group on “Single-Use technology in biopharmaceutical manufacturing” developed a standard operating procedure (SOP) for $k_L a$ measurements. Using this protocol, different manufacturers experimentally determined the $k_L a$ values of single-use bioreactors they offer. A DECHEMA report summarizes the results [2], (Figure 1). It also describes in detail the SOP used, to offer scientists a guideline to determine the $k_L a$ values for any bioreactor of interest.

$k_L a$ values of Eppendorf BioBLU® Single-Use Vessels

Eppendorf determined the $k_L a$ values of two single-use vessels for microbial applications, namely the Eppendorf BioBLU® 0.3f Single-Use Vessel with a maximum working volume of 250 mL and the Eppendorf BioBLU 1f Single-Use Vessel with a maximum working volume of 1.25 L (Figure 2). For both vessels the Eppendorf application lab measured $k_L a$ values > 500 h$^{-1}$, which is considerably higher than the values of the other lab-scale fermentors tested (Figure 3).
Outlook
In their report, the DECHEMA group also published guidelines for the experimental determination of specific power input for bioreactors and the mixing time, and they plan to develop further SOPs, such as one for the determination of the volumetric mass coefficient for CO2. These protocols will be valuable guidelines to standardize experiments for the characterization of bioreactor performance and to facilitate their comparison.

References