Evaluation of the BioFlo® 320 Process Capabilities

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Abstract

This paper characterizes the capabilities of the BioFlo 320 in terms of key process parameters including oxygen transfer rate (OTR), volumetric mass transfer coefficient (kLa), tip speed, mixing time, and water consumption. These data enable quantitative analyses of bioprocess engineering parameters, thus allowing potential users to gain insight into the system’s cell culture and fermentation capabilities.

Introduction

Historically, stirred-tank fermentors and bioreactors have been the favored design for culturing all types of submersed cultures including suspension and anchorage-dependent mammalian, insect, yeast, plant, and microbial cell culture. The times and time designs offer scalability and proven reproducibility which is pivotal for cost-saving process development and productivity. However, the glass or stainless steel vessels, the ancillary systems, and the single-use equipment have usually remained separate.

In order to meet the demand of improved process flexibility and cost savings, Eppendorf recently developed a new bioprocess controller, the BioFlo 320, seen in Figure 1. It combines the capabilities of accessible and single-use systems into one advanced bioprocess control station.

Design Specifications

As the newest offering from the Eppendorf bioscience portfolio, the BioFlo 320中秋设计 and utility rate one of the art package. An industrial design, utilizing stainless steel single-use vessels, intelligent sensors, Ethernet connectivity, and an enhanced software package are only a few of the features that set it apart from the competition. The BioFlo 320 is also available with various types of impellers including the packed-bed and cell enhanced software package. An industrial design, autoclavable and single-use systems into one advanced bioprocess control station.

Figure 2 illustrates the dimensions of the BioFlo 320 stainless-steel dish-bottom vessel. Table 1 provides dimension specifications for both stainless-steel dish-bottom and water-jacketed vessels. Table 2 provides dimension specifications for the Rushton (6-blade) and pitched blade impellers (3-blade).

Vessel type Stainless steel dish-bottom (single wall) or water-jacketed (double wall) Vessel size 1 L 3 L 5 L 10 L Vessel height (H) cm 17.4 22.5 24.9 32.3 Vessel height (H0) cm 17.4 22.5 24.9 32.3 Vessel diameter (D) cm 17.0 18.6 17.4 21.1 Heights (H0) Vessel ID in 1.20 2.0 1.5 1.5 Heights (H0) Vessel ID in 1.20 2.0 1.5 1.5

Table 1: BioFlo 320 vessel dimensions

Table 2: BioFlo 320 vessel and impeller dimensions

Mixing Time

Mixing time is one of the criteria used to describe the quality and mixing efficiency of a vessel [1]. Proper mixing improves gas and cell distribution, enhances cell culture oxygen consumption, and reduces the chances of oxygen transfer. Eppendorf’s BioFlo 320 series of bioprocess vessels offers mixing times at the same tip speed of 0.6 m/s.

Conclusion

The BioFlo 320 characterization revealed excellent bioprocess engineering parameters, including:

- Proportional design and superior scalability between various vessel sizes
- Excellent mixing time at 0.6 m/s
- Superior calibration and excellent mixing efficiency
- High oxygen transfer under both fermentation and cell culture conditions
- Fast mixing time across all vessels
- High oxygen transfer and high mixing time for applications

A detailed evaluation of the BioFlo 320 process capabilities is provided in the following sections.

Oxygen Transfer – Stainless Steel Dish-Bottom Vessels

The OTR is the rate at which oxygen is transferred from air to liquid in a vessel. OTR is of critical importance for the selection, design, and scale-up of bioprocess systems [2]. Since oxygen is often the limiting factor during aerobiotic fermentation, the OTR is commonly used as a reference for a vessel’s fermentation capabilities. Therefore, the OTR is most often obtained by the method of oxygen transfer rate, whereby the OTR is achieved without any additional oxygen supplementation of the broth vessel. The BioFlo 320 is capable of delivering precision air flow of up to 20 Standard Liters per Minute (SLPM), allowing high OTR’s to be achieved without any additional oxygen supplementation.

In addition to the OTR, oxygen transfer can also be represented in the form of kLa, the volumetric mass transfer coefficient. The kLa is important to establish aeration efficiency and to quantify the effects of the operating variables on the process of dissolved oxygen [3]. Figure 3 shows the kLa values obtained using BioFlo 320 cell culture vessels with aeration by macrosparger (ring sparger).

Water Consumption Rate

Definition

The amount of water used to maintain internal vessel temperature of 30 °C with 50 WL heat input, and cooling liquid of 37 °C at 5 °C. For this test, 1 L, 3 L, and 10 L stainless-steel dish-bottom vessels were chosen as they are the most typical choice for exothermic fermentations requiring rapid temperature transfer for cooling.

Results:

1 L stainless-steel dish-bottom vessel = 1.6 L
10 L stainless-steel dish-bottom vessel = 15.1 L

Vessel Heating and Cooling Capacity

Cooling Capacity: Maximum internal vessel temperature of 37 °C with a controlled heat input (WLJ) and cooling liquid maintained at 5 °C.

Max Temperature: Maximum achievable controlled temperature with maximum aeration rate and no gas flow and 0.0 VVM.

Water Consumption Rate: Rate at which the injection of the highest temperature differences of 100 °C cool output between 37 °C and 20 °C under maximum aeration rate, without gas flow, and with cooling liquid maintained at 5 °C.

Mixing Time

Mixing time is one of the criteria used to describe the quality and mixing efficiency of a vessel [1]. Proper mixing improves oxygen transfer, nutrient delivery, as well as pH and temperature homeostasis, thus providing an optimized culture environment throughout the entire vessel. Mixing time studies were conducted using the pH disturbance and recovery method as previously described [2] and results can be found in Table 3. To maintain scalability between various vessel sizes, all mixing times were obtained at the same tip speed of 0.6 m/s.

Table 3: Mixing time of BioFlo 320 water-jacketed vessels equipped with a single pitched blade impeller

REFERENCES: