CT3P LOCKSURE DESIGN PERFORMANCES

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Because your environmental monitoring matters – We have the right design

INTRODUCTION

Protection and security of environmental monitoring samples until their final reading is essential to avoid any false result that will compromise product quality and patient safety. In addition, false results have an impact on batch release and cause lengthy and complex investigations.

The design of the plates combined with the quality of the culture media has a direct influence on the growth of microorganisms. The plate design plays a role in the media dehydration or aeration rate leading to potential toxicity for the microorganisms

In order to master and minimize the impact on microbial growth, bioMérieux has worked with a team of experts in fluid dynamics at the Centre Scientifique et Technique du Bâtiment (CSTB) from Nantes in France, who master cutting edge technologies on experimental simulations in climatic wind tunnel and numerical simulations (CFD) of aerodynamics. Using these capabilities we evaluated the influence of the plate design of culture media dedicated to environmental monitoring.

MATERIAL AND METHODS

Use of advanced technology for the air flows study of plate designs

PLATE DESIGN

Three different designs of Count-Tact plate were compared using this technology in order to analyze the fluid dynamics and their influence on the media properties (Table 1). Plate Design "S" is considered as the Standard for this study as providing high performance results for more than 15 years to healthcare industries. These three designs have similar dimensions, except in the total height and venting lug height leading to influence the volume of air inside the plate.

Dimension	Design S	Design A	Design B
Total height of the plates (H)	H	1,14xH	
Total width of the plates (W)	W		
Number of venting lugs (L)	L		
Height of venting lugs (h)	h		h/3,75

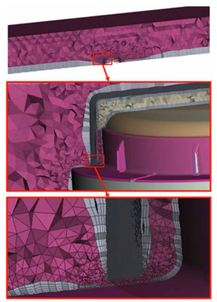
Table 1. ~~Plate desig~~

- Design S and Design A only differ in the total height of the plate.
- Design S and Design B differ from the total height of the plate and the height of the venting lugs.
- Design A and Design B only differ in the height of the venting lugs.

AIR FLOW SIMULATIONS

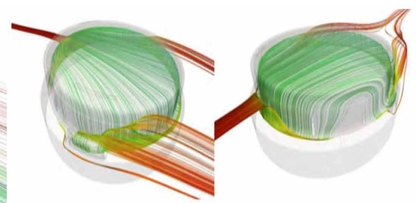
The simulation of the flow inside and around the plate was performed with OpenFOAM, an open source Computational Fluid Dynamics code. This software solves the Navier-Stokes equations in a discretized volume called mesh. The main challenge for the simulations of the air flow inside the plate was the meshing process of the very small interstices used for the plate ventilation. The mesh quality, which includes the generation of the so-called boundary layer mesh, was of major importance for the reliability of the simulations.

This required to generate more than 12 million cells to model the volume of air of one single plate. Each flow simulation then required 8 to 10 hours of parallel computing on a node of 18 processors. Those simulations are then as computationally demanding as the ones performed to model the wind on a high-rise tower in the Paris La Defense.

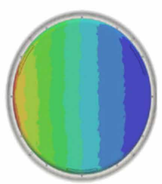


RESULTS

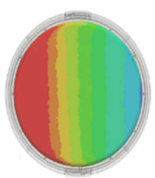
AIR FLOW SIMULATIONS



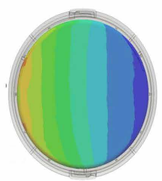
GRADES OF AIR FLOW SPEED



Design S



Design A



Design B

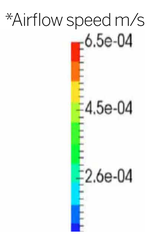


Plate type	Renewal of the air volume inside the plate (vol.h)	Average Speed Airflow 1mm/agar (m/S)
Plate Design S	12,2*	1.9e-4
Plate Design A	19,7	3.2e-4
Plate Design B	11,8	2.0e-4

**The volume of air in the Design S (Standard) is renewed 12,2 times in 1 hour, ie. 293 times in 24h*

- The design A has different airflow speeds compared to design S due to the difference in volume in the plate. The designs A has different airflow speeds compared to design B due to the difference in height of the venting lugs.
- The gradients (color scale*) show that design A has a higher air exchange rate than designs S and B. Design A has an air exchange rate superior to 62% compared to Design S (Standard). Design B has a similar air exchange rate to Standard S.

IMPACT OF THE DIFFERENT DESIGNS ON PERFORMANCE AND QUALITY

Assay	Design S	Design A	Design B
Growth Promotion Properties	+	+	+
Total Shelf-life	+	–	+
Resistance to dehydration	+	–	++
Exudation limitation	+	–	+

The media with the Design S (Standard) provides high growth promotion properties during the total high shelf-life as well as resistance to dehydration and limitation of exudation. The same culture media but with a different design allowing more exchanges of air (as Design A), impacts directly the quality of the media with an increase rate of exudation and dehydration, and with a decrease the total shelf-life.

DISCUSSION

This study has demonstrated the direct impact on the design of plates on the exchange of air inside the plate. Even small changes in design could modify the airflow speed inside the plate, therefore impacting the media quality (exudation and dehydration) and performances within the time (Total Shelf-Life). The plate design has a direct influence on its aeration, therefore, influencing the microorganism recovery from environments and the risk of false negative results.
Thus, this study clearly showed that the plate design play an important role in the quality of the end results of environmental monitoring testing. The design should respect a right and appropriate balance of aeration rate to allows enough aeration for microorganisms growth and at the same time minimizing culture media degradation. Plate design matters!

During the development and design of its new LockSure plate, bioMérieux has analyzed the influence on fluid dynamics to develop the best design of plates, which, combined with its performances, allows to reach high quality pharmaceutical requirements.