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TPP TubeSpin® Bioreactor
Shaking Cells - Orbit and Rate per Minute (RPM)

For the cultivation of mammalian cells in a TubeSpin® bioreactor, TPP recommends a shaking diameter (orbit) of D=50 mm [1]. A larger shaking diameter generally improves oxygen transfer and mixing efficiency, which is particularly beneficial for shear-sensitive cells cultivated at lower shaking speeds, such as 150 rpm or less [2][3].

When switching between shakers with different orbits, the shaking speed must be adjusted to maintain consistent experimental conditions.

Relative centrifugal force (RCF) is expressed as a multiple gravitational acceleration (× g) and depends on the speed in revolutions per minute (RPM). It is a function of both radius and velocity.

Mathematical relationship

1. **Calculation of RCF:**

RCF is calculated first with the given orbit r_1.

r = radius of the shaking diameter D in cm

$$\Rightarrow r = {}^{D}/_{2}$$

$$RCF = 1.118 \times 10^{-5} \times r_1 \times (RPM)^2$$

2. **Calculation of RPM with new orbit r2:**

$$xRPM = \sqrt{\frac{RCF}{1.118 \times 10^{-5} \times r_2}}$$

Conversion Example

Initially, a diameter of 50 mm and 180 rpm are used (shaker 1). What is the speed required to maintain the same experimental conditions if the orbit is changed to 30 mm?

Shaker 1: Orbit D = 50 mm (→ r_1 = 2.5 cm) Speed = 180 RPM	Shaker 2: Orbit D = 30 mm (→ r_2 = 1.5cm) Speed = x RPM

$$RCF = 1.118 \times 10^{-5} \times r_1 \times (RPM)^2$$

$$RCF = 1.118 \times 10^{-5} \times 2.5 \times (180)^2$$

$$RCF = 0{,}91$$

$$x\,RPM = \sqrt{\frac{0{,}91}{1.118 \times 10^{-5} \times 1.5}}$$

x = 232 RPM

Conclusion: When using a 30 mm orbit in an incubator, the shaking speed should be set to 232 RPM.

Important

Always test:

- the influence of the shaking speed on cell growth or shear stress
- the optimal filling volume

Literature

[1] TPP TechDoc

[2] https://handling-solutions.eppendorf.com/sample-handling/mix-shake/principles/detailview-principles/news/shaker-orbit-revolving-in-space-around-the-samples/

[3] Characterization of Gas-Liquid Mass Transfer Phenomena in Microtiter Plates. Hermann R., Lehmann M., Buechs, J. Biotechnology and Bioengineering (2003); Vol. 81, No. 2, pp 178-186

[4] https://www.sigmaaldrich.com/DE/de/support/calculators-and-apps/g-force-calculator

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