TPP Techno Plastic Products AG
Zollstrasse 7, CH-8219 Trasadingen, Switzerland
Tel. +41 (0)52 687 01 87, Fax +41 (0)52 687 01 77
info@tpp.ch, www.tpp.ch

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 enhances aeration, which is particularly beneficial for shear-sensitive cells that require low 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 of 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 relative centrifugal force (RCF):**

Relative centrifugal force (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 r_2:**

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

Conversion Example:

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

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

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

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

$$RCF = 0{,}91$$

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

$$x = 232 \text{ RPM}$$

Fazit:

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 optimum filling volume

Sources of information:
[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

www.shakingtechnology.com

Disclaimer

TPP products are for research use only and not for clinical, diagnostic or therapeutic use. All products are intended for use by trained personnel that are familiar with safe laboratory practices.

TPP assumes no responsibility for damage or defects resulting from improper or unauthorized use. It is the responsibility of the user to store, handle, and use the products in accordance with the instructions provided.

TPP does not warrant the completeness or accuracy of this TechDoc. TPP's recommendations are intended as general guidelines and may not cover all possible scenarios. TPP shall not be liable for any indirect, incidental, consequential, or special damages arising out of the use or inability to use the information in this TechDoc.

Swiss law governs these terms of use and any resulting legal matters.