British Journal of Pharmacy

https://doi.org/10.5920/bjpharm.2017.26

British Journal of Pharmacy

www.bjpharm.hud.ac.uk

Proceedings of the 8th APS International PharmSci 2017

Twin-screw granulation – a systematic analysis of process parameters

Margarethe Richter*[,a], Waseem Kailaly, Hussaini Bello[b]

[a]Thermo Fisher Scientific, Dieselstraße 4, 76227 Karlsruhe, Germany; [b]School of Pharmacy, Faculty of Science and Engineering, University of Wolverhampton, Wolverhampton, UK

ARTICLE INFO

Received: 31/03/2017
Accepted: 07/08/2017
Published: 11/07/2018

*Corresponding author. Tel.: +49 721 4094 105
E-mail: margarethe.richter@thermofisher.com

KEYWORDS: twin-screw granulation; continuous manufacturing; particle size distribution

SUMMARY

Twin-screw granulation has a significant advantage over traditional granulation methods leading to the possibility of continuous manufacturing. Although this technology has drawn attention in recent years, the general understanding of the process is limited. This study gives a brief overview of the most important process parameters and their influence on product quality. Experimental results from a benchtop granulator and an in-line particle size measurement have been analysed. From this basic study conclusions can be drawn how to tailor the particle size distribution in twin-screw granulation. The most crucial parameters are the liquid-to-solid ratio and the filling level of the screws.

BY 4.0 Open Access 2017 – University of Huddersfield Press

INTRODUCTION

Twin-screw granulation has drawn attention in recent years. Its possibility of continuous manufacturing allows the user to speed up manufacture in research and development, be flexible in production and produce in high and constant quality. A deep process understanding is the key to take the advantage of this fast development. Therefore, this study summarises the influence of the process parameters on the product quality.

MATERIALS AND METHODS

The granulation has been performed on the Thermo Scientific® Pharma 11 benchtop extruder (Thermo Fisher Scientific, Karlsruhe). The machine has been converted using the "TSG-Kit" that includes longer screw shafts (L/D = 40 ¾). The granules have been analysed in-line using the Eyecon$_2$ Particle Analyser (Innopharma Technology, Dublin). Fig. 1 shows the set-up that has been used for this study including the gravimetric Mini-Twin Feeder (Brabender Technologie, Duisburg) and a peristalic pump for liquid feeding. For the trials a placebo formulation of 62.8% lactose, 32% corn starch, 5% PVP 30 and 0.2% talcum has been granulated using water. The process parameters total throughput, liquid-to-solid ratio (L/S), screw speed and barrel temperature as well as the screw configuration have been varied independently in this study.

Fig. 1. *Set-up for the benchtop twin-screw granulation*

https://doi.org/10.5920/bjpharm.2017.26

RESULTS AND DISCUSSION

As published by several other authors, e.g. Thompson (2010), Keleb (2004) and Beer (2014), the liquid-to-solid ratio has a significant influence on the granule quality. Increasing L/S increases the mean mass diameter, the size and the amount of oversize particles and reduces the amount of fines.

If the throughput (the total feeding rate of the granulator) is increased the particle size distribution of the granules becomes wider and the mean mass diameter (d_{50}) of the granules is bigger. The opposite effect can be seen if the screw speed is increased.

Then, a narrower particle size distribution can be reached and the d_{50} is smaller. Fig. 2 summarises the effect of these two process parameters on the mean mass diameter of the granules. Both, throughput and screw speed change the filling level of the screws significantly. If the screws are filled with more material (larger throughput and lower screw speed) the material is compressed more resulting in larger particles. A similar effect can be observed changing the screw configuration. Here, more kneading zones lead to a higher filling level and thus to larger granules. These results are in good agreement with Djuric (2008) and Thompson (2010).

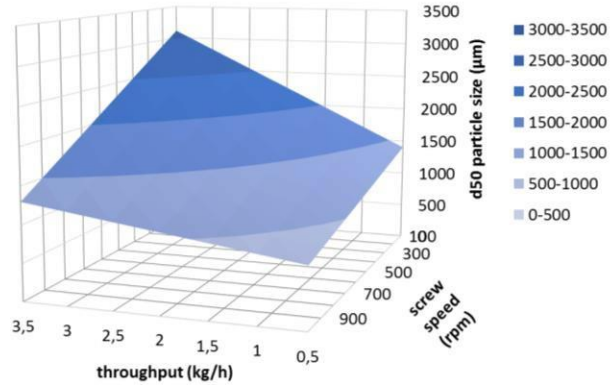

Fig. 2. *Surface plot of the mean mass diameter over throughput and screw speed.*

CONCLUSIONS

The liquid-to-solid ratio and the filling level of the screws are the most crucial parameters for twin-screw granulation. The latter is highly influence by the throughput of the material through the granulator, the screw speed and the screw configuration. Based on this general data the particle size distribution in a twin-screw granulation process can be easily tailored.

ACKNOWLEDGEMENTS

The author thanks Innopharma Technology for the supply of the Eyecon$_2$ and the help in analysing the data.

REFERENCES

Beer, P., Wilson, D., Huang, Z., and De Matas, M., 2014. Journal of Pharmaceutical Sciences, 103(10), 3075–3082.

Djuric, D., and Kleinebudde, P., 2008. Journal of Pharmaceutical Sciences, 97(11), 4934–4942.

Keleb, E. I., Vermeire, A., Vervaet, C., and Remon, J. P., 2004. International Journal of Pharmaceutics, 273(1-2), 183–194.

Thompson, M. R., and Sun, J., 2010. Journal of Pharmaceutical Sciences, 99(4), 2090–2103.