Optimization of the air flow rate in a laboratory scale horizontal continuous dry stirred media mill

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Abstract. Dry grinding in stirred media mill comes to the front in the recent years, as the demand grows for the production of fine products. The present paper deals with the operation of a self-developed laboratory scale horizontal continuous dry stirred media mill. The mill was equipped with a measurement and data acquisition system, so the air flow rate and pressure drop in the mill can be measured continuously. In the recent period notable developments were carried out in the milling system, and as a result the air flow rate was significantly increased. To evaluate the operation of the new design grinding experiments were carried out at different air flow rates, and its effect on the product fineness was investigated. The applied grinding media diameter and rotor tip speed has a remarkable influence on the air flow rate of the mill, which influences the residence time and thus the product fineness.

Keywords: dry grinding, stirred media mill

INTRODUCTION

Dry grinding in stirred media mill is a prosperous technology for the production of fine and submicron materials. However in this field numerous problems should be solved for the wider application of the dry stirred media mills, like effective prevention of the aggregation and agglomeration of fine particles, application of grinding aids, etc.

Horizontal dry stirred media milling was investigated in the recent times by Altun et al. (2015), where dry grinding in a prototype continuous horizontal stirred mill was carried out to investigate the effect of operating parameters. The effect of the chamber diameter and stirrer design on cement grinding was investigated in the same type of stirred mill Altun et al. (2014). Later, 3 types of grinding aids (glycol-based, TEA-based and TIPA-based) were tested Altun et al. (2015). The effect of grinding aid on the limestone product fineness and flow ability was investigated in detail by Prziwara et al. (2017). The theoretical basis of media milling was investigated by Faitli (2017a, 2017b).

In the present paper the effect of the operational parameters on the air flow rate are investigated.

EXPERIMENTAL

A continuous dry stirred media mill was developed and built, where the material transported in the mill mainly by air. The effective volume of the mill is 520 cm^3. Online measurement and data acquisition system were developed to the grinding system. The measuring system is capable to measure the pressure after the mill (p1) and the pressure drop in the venture tube (Δp), the velocity of the air in the venturi tube is calculated and therefore the volumetric flow rate of the air (Q) can be determined as well.

$$Q = A_1 v_1 = A_2 v_2 \qquad (1)$$

The mill operates in open circuit; the parts of the milling system are as follows (Fig 1): 1. Screw feeder; 2. Stirred media mill; 3. Filter; 4. Venturi tube; 5. Fan; 6. Data acquisition system; 7. Mill engine. The stirred media mill is equipped with a six specially shaped triangle discs. The mill is double-walled to cool the grinding chamber. The operation of the motor and the ventilator was regulated by a frequency controller, so the rotor's revolutions per minute and circumferential speed could be adjusted. During the grinding experiments 0.6 grinding media filling ratio was used.

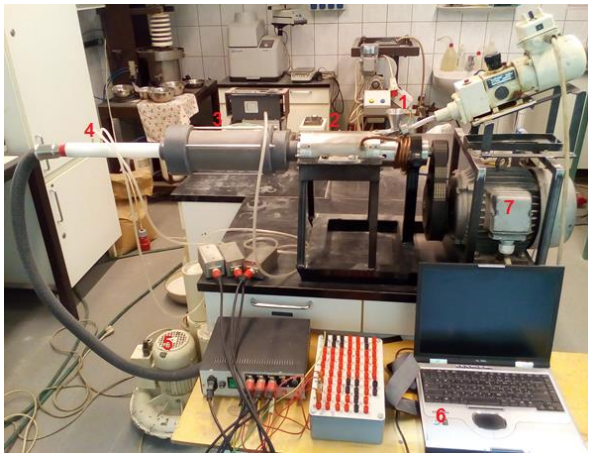

FIGURE 1. The grinding system

During the grinding experiments 0.8-1 and 1-1.2 mm zirconium silicate grinding media were used. The feed rate was constant during all grinding experiments 0.6 kg/h.

Results and discussion

In the Fig 2 the effect of the operational parameters on the air flow rate as a function of grinding time are presented. The air flow rate decreases in all cases as a function of the grinding time. This is due to the fact that the material layer continuously thickens on the filter surface, but also shows that the air flow rate unfortunately not constant during grinding.

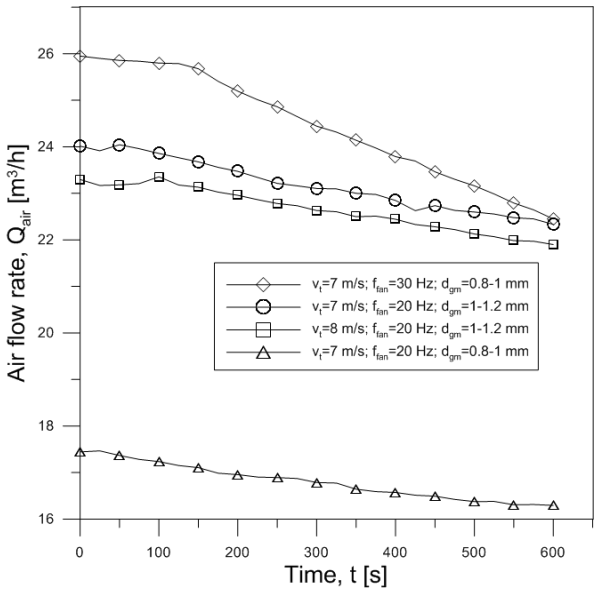

FIGURE 2. Effect of the operational parameters on the air flow rate

The grinding media diameter, rotor tip speed also has an influence on the air flow rate of the mill, namely, the bigger the grinding media, the higher the air flow rate. The higher the rotor tip speed the lower the air flow rate. The frequency of the fan's engine electricity and thus the revolution of the fan's rotor also have a great influence on the air flow rate. As we can see numerous grinding parameter influences the air flow rate, which influences the residence time of the material in the mill and thus the product fineness.

ACKNOWLEDGMENTS

The described work/article was carried out as part of the "Sustainable Raw Material Management Thematic Network – RING 2017", EFOP-3.6.2-16-2017-00010 project in the framework of the Széchenyi2020 Program. The realization of this project is supported by the European Union, co-financed by the European Social Fund. This paper was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences.

REFERENCES

Altun, O., Benzer, H., Enderle, U., 2014. The effects of chamber diameter and stirrer design on dry horizontal stirred mill performance. Miner. Eng. 69, 24–28. doi:10.1016/j.mineng.2014.07.008

Altun, O., Benzer, H., Toprak, A., Enderle, U., 2015. Utilization of grinding aids in dry horizontal stirred milling. Powder Technol. 286, 610–615. doi:10.1016/j.powtec.2015.09.001

Faitli, J., 2017a. Continuity theory and settling model for spheres falling in non-Newtonian one- and two-phase media. Int. J. Miner. Process. 169, 16–26. doi:10.1016/j.minpro.2017.09.010

Faitli, J., 2017b. Theory and Experimental Verification of Continuum- or Discrete Element-like Behavior of Ground Solid – liquid Mixtures, in: In: H Benzer (ed.) Proceedings of the 15th International Symposium on Comminution and Classification. Izmir, Turkey, 11th-14th Sept. pp. 1–44. doi:10.1096/fj.201700158RR.

Prziwara, P., Breitung-Faes, S., Kwade, A., 2017. Impact of grinding aids on dry grinding performance, bulk properties and surface energy. Adv. Powder Technol. 14–16. doi:10.1016/j.apt.2017.11.029