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# Investigations into the movement of milled medium in the bowl of a ring-roller mill

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ABSTRACT

This paper presents the results of testing the grind material movement in a ring-roller milling system. The tests were carried out in a 1:4 scale model of an RP-1043x`milling system. The aim of the test was to determine material bulk shapes within a range of parameter changes of a model grinding system i.e. table–roller distancing, pile-up ring height, coal feed and table's rotary speed. Based on the measurements of material layer thickness on the table, its average radial velocity was calculated. The results were then supplemented with tests based on the movement of markers over the surface layer of the coal bulk. These tests enabled the material's average radial and tangential velocities in the surface layer to be determined.


## 1. Introduction

Ring-roller mills are considered to be an important element in heat and electric-power production technology. The efficiency and dynamics of the milling machines directly affect the power and flexibility of the whole unit, and the milling quality has an influence on the boiler's efficiency and the NOx emission level. An analysis of the present state of knowledge, as well as observations of mills currently in use lead to the conclusion that the quality and efficiency of the milling processes and the wear of the milling elements are affected by the movement of the material on the mill's table.

Mroczek and Czepiel [1–3] studied the impact of the table's angular velocity on the milling effect and the efficiency of the ball-ring mill. These authors point out that there is an optimal rotary velocity of the table corresponding to the highest obtained milling effect. Increasing the velocity above this boundary value results in the exclusion of a certain part of the material feed from the milling process. This is caused by a faster material outflow from the milling system and a decrease in the thickness of the crushed layer which, consequently, results in a smaller crushing area and number of milling cycles the layer undergoes.

It is frequently emphasized that an increase in material fed onto the table should be respectively followed by an increase in the table's rotary velocity [1–4]. Operating in this way prevents an excessive accumulation of material on the table, and, in an extreme case, the milling system from being covered. There are, of course, systems for controlling the table's rotary velocity but, in practice, one particular velocity is predominantly applied. Thus, it is essential to determine the optimal table rotary velocity that guarantees the maximal milling efficiency within the range of the unit's usual charge [1,5,6]. Feige [5] and Höffl [6] point out that an increase or decrease of velocity from this optimal value results not only in lower efficiency but also in more powerful consumption by the mill.

An inappropriate choice of rotary velocity may also considerably precipitate the wear of the milling elements [7], and consequently also decrease the mill's efficiency.

It is important to note that optimization of the rotary velocity in ring-roller and ring-ball mills should be met in relation to the ring's height. It is the ring that controls the thickness of the material on the table; therefore, the use of high-profile rings should go together with an increase in the table's rotary velocity [5,6,8,9].

Experiments and observations confirmed that the bulk shape of the material on the table explains a lot about information on its movement [10]. Determining this shape and carrying out appropriate calculations enables the material's average radial velocity to be found. Going further, observation of the movements of markers over the bulk surface brings additional information about the outer layer of the material. The shape of the bulk material itself also gives a lot of information on the amount of material gathering on the table, and on changes of its accumulation related to changes of the table's rotary velocity.

In order to observe and register the above interrelations, a 1:4 scale model of an RP-type ring-roller mill was constructed, including a measurement system for determining the thickness of the bulk material as a function of its radius. The model allowed experiments to

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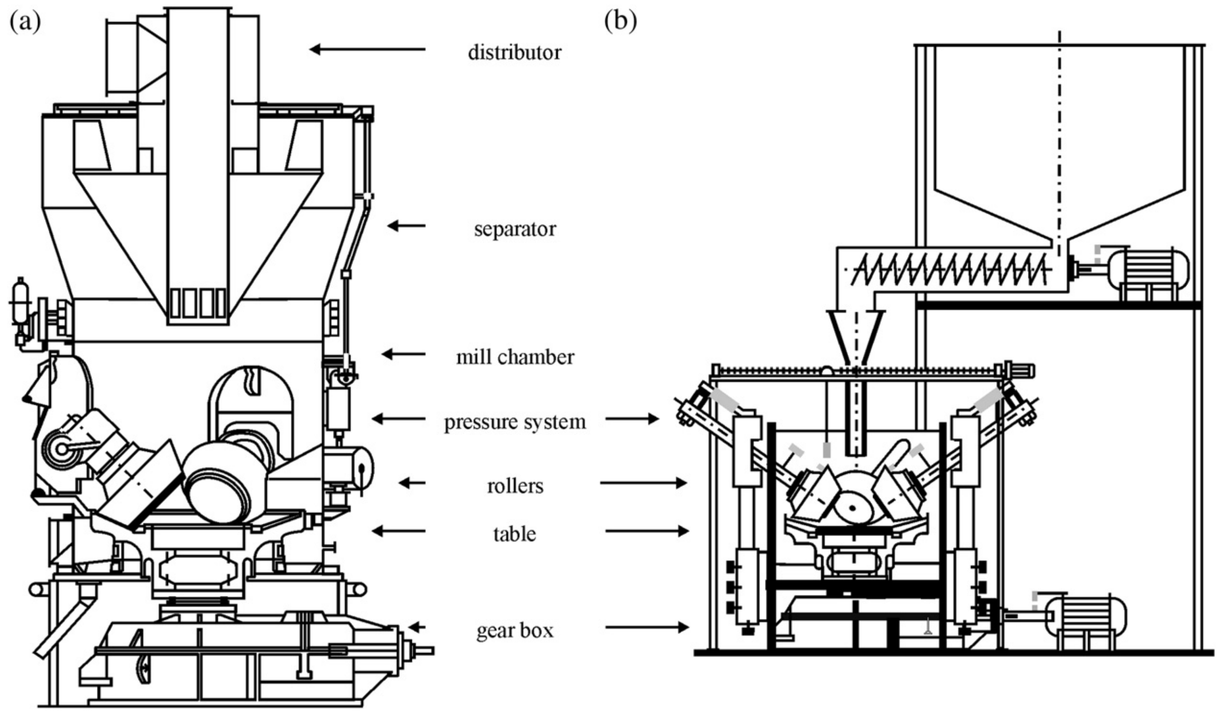


**Fig. 1.** Pictorial schemes of (a) industrial ring-roller mill, (b) 1:4 scale model of the milling system (distributor, separator, mill chamber, pressure system, rollers, table, gear box).

be performed using a wide range of operational parameters of the mill.

## 2. The test stand

In order to carry out this research, a 1:4 scale model of an RP-1043x`milling system was built. The basic elements of the RP-1043x` mill and the test stand are schematically shown in Fig. 1 and Plate 1. The constructional and operational parameters for both the industrial unit and the model are given in Table 1.

The main elements of the milling system are the table with a slanted track and a set of three cone-shaped rollers. During the test, the stream of material was fed by a conveyor, through a hopper, onto the rotating table. The conveyor's shaft was driven by a 4 kW DC motor coupled with a motor reducer. Adjustments of the conveyor's revolutions were set by means of a measurement card. Between the hopper and the conveyor there was a truncated cone-shaped orifice with built-in rings to dispense the grind material uniformly onto the table's centre.

An electric motor propelled the table's rotation through a two-stage angular gear. Changes of the table's rotary velocity were controlled by means of an inverter, also connected to the measurement card. A pile-up ring (with adjustable height) was mounted around the edge of the table. The shaft coupling the gear to the table was equipped with blades for raking the milled product that poured out over the ring.

The rotary velocity of the rollers, as well as that of the table and the feeding screw, was measured with reed relay transmitters. Measurements of the pressure on the grinding material were performed by means of strain gauges mounted on the brackets parallel to the axles

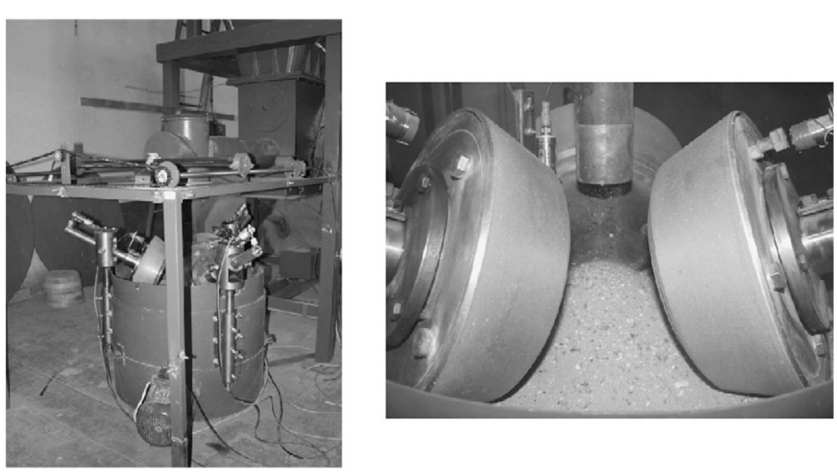

**Plate 1.** 1:4 scale model milling system.