Comparative analysis of milling results on the tail-end reduction passages of the wheat flour milling process: Conventional *vs.* eight-roller milling system

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Abstract

Introduction of the eight-roller mill into the wheat flour milling process significantly reduces the investment costs and overall energy requirements compared to the conventional milling system. However, the conditions for controlled milling are less favorable and could result in deterioration of flour yield and quality. Paper compares milling results obtained using a conventional process and process with an eight-roller mill employed on the tail-end passages of the reduction system. At the same roll gap and under the same sieving conditions, the flour release was lower in the process with the eight-roller mill compared to the conventional milling system. By decreasing the roll gap and increasing the upper size limit (granulation) of flour in the process with the eight-roller mill it is possible to increase flour yield and decrease milling energy consumption per unit mass of flour produced. This can be achieved without deterioration of flour quality as determined by ash content.

Keywords: wheat flour milling, conventional system, eight-roller mill, tail-end passages.

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The aim of the wheat flour milling process is to obtain the best possible dissociation of the starchy endosperm from the other parts of the grain and to achieve as high as possible flour extraction with the lowest contamination of bran and germ that increase the ash content [1]. It is a gradual reduction process consisting of sequential and consecutive size reduction (roller mills) and separation (plansifters). Roller mills break the wheat kernel such that particles of different sizes also vary in botanical origin and composition [2]. They tend to keep the bran layers relatively intact as large particles, while shattering the endosperm into small particles so they can be separated from bran [3]. This is possible due to differences in the structural characteristics between the anatomic parts of the wheat kernel. These differences are exaggerated by adding water to the wheat prior to milling in process known as conditioning.

The process involves breaking open the kernel, scraping the endosperm from the bran and germ, and gradually reducing the chunks of endosperm into flour [4]. Breaking the wheat kernel is affected by corrugated cast steel rolls that gradually separate the endosperm, bran and germ. The break system has two parts: the head break which releases relatively pure particles of endosperm and tail break, which cleans up the remaining endosperm from bran and releases smaller endosperm particles along with finer pieces of bran and germ [5]. The objective of grinding in the sizing system is to detach the bran pieces attached to endosperm particles (large middlings), while minimizing flour production [5]. Reduction of relatively pure endosperm to flour is achieved by using smooth rolls. Segregation between the kernel parts occurs in plansifters, where sieves separate particles of different size, and in purifiers, where sieves and air-flow separate particles of different size, with specific gravity and shape [6].

The milling industry is also very conservative. After more than 100 years, roller mills and plansifters still remain the primary machines used in the process. Of course, the equipment has been redesigned to such an extent that it has been possible to multiply the throughputs of these machines, but flour process technology has not changed fundamentally [7]. Millers always sought out for possibilities to simplify the process and make it more efficient in terms of reducing the investment, operating and maintaining costs as long as the quantity and quality of the finished products are not affected [8]. Over the years, rationalization of the process has been achieved by increasing the roll velocities, using drum detachers and bran finishers while grinding has been supported with impact milling (intensive detachers) making the shorter roll surface a reality [5,9]. Also, the use of debranning machines to remove the bran ahead of the first break can simplify break and reduction steps of conventional milling [4,10].

Also, the traditional wisdom in flour milling is that after every grinding step the ground material should be

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sieved and the undersize material should be removed before regrinding. This is the reason why the double grinding of intermediate streams before sieving has been one of the most notable process developments in flour milling [11]. Eight-roller mill (a total of 8 rolls in one housing) provides two grinding passages without any intermediate sifting. Introduction of the eight-roller mill into the milling flowsheet provides significant advantages compared to a conventional process. Double grinding without intermediate sifting means that pneumatic conveying of the stock from the roll to the sifter is necessary only after the lower pair of rolls. Fewer pneumatic suction lifts reduce the investment costs and the time needed for the installation of the pneumatic conveying system. Lower pneumatic air requirements result in lower power requirements for the fan and lower filter surface for cleaning the conveying air. There is a significant reduction of sifter surface, less number of roll stands, less spouting and auxiliary components. With less equipment there is less cleaning and maintenance and less space for their installation is required resulting in lower building costs with less area to keep clean and fumigate. Also, within existing limited building space, by replacing the four-roller mills with eight-roller mills, the roll length and therefore the grinding capacity can be significantly increased without need for changing existing sifter passages and pneumatic lifts [5,7–9,12–14].

On the other hand, the eight-roller mill ignores the basic milling principle that after grinding coarse material is separated from the fines. Some of the intermediate materials produced on the upper rolls, normally are not sent to the lower rolls (next grinding passage), which are not designed to mill them. Flour produced in the upper rolls is fed to the lower rolls instead of being sent to the collecting flour conveyor. Also, the material from the upper rolls almost immediately enters the grinding zone of the lower rolls without any cooling (normally occurs in the pneumatic suction lift). The temperature of the stock following the lower rolls could be high and harmful to flour quality and even cause condensation problems in the milling equipment [15]. There are less flour streams to be selected for specialty flours [14].

Number of authors [8,14,16–19] stated that when the first and second breaks are combined into a twin passage there is a shift in particle size distribution compared to a conventional single break system. Eight-roller mill produces more break flour and fine middlings and less coarse middlings and sizings. The flour granulation is finer with the use of the eight-roller mill because the flour released through the first passage is regrinded. The finer flour could also produce whiter flour. With double grinding on smooth rolls the bran particles are more flattened, due to their plasticity and intense compressive forces, and therefore it is easier to separate them from flour [9,14].

Most of the research considering the factors that affect the milling results using the eight-roller mills are focusing on the break system [17,19,20], while relatively little research has been done considering the effects of using this technique in the reduction system. Fistes *et al*. [21] compared the effect that roll gap changes have on the milling results obtained using a conventional process and process with an eight-roller mill employed on the front passages of the reduction system. The results showed that it is possible to achieve similar results to the ones obtained in the conventional process with appropriate adjustment of the roll gap and micron size of the bolting cloths. In contrast to head-end passages, streams that are sent to the tail-end passages of the reduction system are much finer in particle size and contain a large portion of bran with relatively little endosperm mainly from the outer portion of the endosperm. Also, in the wheat flour milling process the set of roll parameters are constantly changing from the beginning to the end of the process. Therefore, findings from the head-end passages cannot be directly transferred to the tail-end passages of the reduction system. These are the reasons why this paper is focusing on the possibilities of using the eight-roller mill on the tail-end passages of the reduction system.

MATERIALS AND METHODS

Material

A sample of the total mass of about 50 kg was obtained from an industrial mill (120 t/day), having five break (1Bk–5Bk), four sizing (1R–4R) and six reduction passages (1M–6M). The stream, which according to the mill flow sheet would have been sent to the 5M, was intercepted end employed in the experiments. It comprises the streams leaving the 5Bk (250/150 μm), 2nd vibro-sifter (>236 μm) and 4M (530/132 μm). Moisture and ash contents of the sample, determined according to ICC standard methods no. 110/1 [22] and 104/1 [23], were 12.8 and 2.22(%)$_{dm}$, respectively.

Milling procedure

The sample was separated into 0.5 kg batches using the automatic sampler divider (Gompper–Maschinen KG). The batches were milled on a Variostuhl (model C Ex 2) laboratory roll stand (Miag). Smooth rolls 0.1 m in length and 0.25 m in diameter were used. Table 1 summarizes the experimental range of variables tested (chosen to be near the ranges likely to be encountered commercially).

The experiments were designed to compare the performance of conventional and eight-roller milling systems employed on the tail-end passages of the red-

Table 1. Summary of experimental range of variables tested

Milling system	Roll surface	Roll gap combinations, mm	Feed rate, kg/cm^{-1} min^{-1}	Differential	Fast roll speed, m/s
Conventional	Smooth	5M-0.08; 6M-0.05	5M-0.14; 6M-0.10[a]	1.25	5
		5M-0.08; 6M-0.04			
		5M-0.08; 6M-0.03			
Eight-roller		5M-0.05; 6M-0.04	5M-0.14; 6M-0.14		
		5M-0.05; 6M-0.03			
		5M-0.04; 6M-0.03			

[a]The slower feed rate on 6M corresponds to the amount of flour removed by intermediate sifting of the stock leaving 5M

uction system (5M and 6M passages in this particular mill). For the conventional milling system the entire stock following 5M was sieved for 3 min on a laboratory sifter (model MLU-300, Bühler) and the part of the stock held on the sieve fitted with 150 µm bolting cloth was milled on 6M. For the eight-roller milling system the entire stock following 5M was milled on 6M without intermediate sifting. Two samples were milled and sifted at the same conditions and a total of 72 grinding runs were performed, 36 on each 5M and 6M.

Milling results

Sieve analysis of the stock following 6M in conventional system was performed using the sieve openings of 350, 250 and 150 µm, along with the bottom collecting pan. For the sieve analysis of the stock following 6M in the eight-roller milling system, two different stacks of sieves were used. The first stack was the same as that mentioned above. In the second, the sieve with the 150 µm bolting cloth was replaced with a sieve having 180 µm bolting cloth. The stock held on each sieve and pan was weighed.

Flour yield, F (%), in the eight-roller and conventional milling systems was calculated from Eqs. (1) and (2), respectively:

$$F(\%) = 100\frac{m_{6M}}{M} \tag{1}$$

$$F(\%) = 100\frac{m_{5M} + m_{6M}}{M} \tag{2}$$

The energy consumption per unit mass of flour produced, E (kJ/kg), in the conventional and eight-roller milling systems were calculated by Eqs. (3) and (4) respectively:

$$E = \frac{P_{5M} - P_{5M}^*}{m_{5M}} t_{5M} + \frac{P_{6M} - P_{6M}^*}{m_{6M}} t_{6M} \tag{3}$$

$$E = \frac{(P_{5M} - P_{5M}^*) + (P_{6M} - P_{6M}^*)}{m_{6M}} (t_{5M} + t_{6M}) \tag{4}$$

Here t (s) is the time of the grinding run determined by the chronometer. The symbols m and M stand for the weights (kg) of the flour and native feed, respectively. Power readings, P (kW) and P^* (kW), correspond to operation with and without the material flow, respectively. The subscripts indicate the milling passage (5M or 6M).

The ash content in flour and other size fractions of the milling output have been determined according to ICC standard method No.104/1 [23]. The analyses were done in two replicates.

Statistical analysis

The significance of the differences between milling results (flour yield, flour ash content and milling energy consumptin) obtained using investigated milling systems have been tested by the paired Student's t-test. The significant level was established at $p < 0.05$.

One-way ANOVA was used to ascertain whether the different roll gap settings significantly affect the ash content and milling energy consumption. Means were compared using the Tukey test at the 95% significance level.

RESULTS AND DISCUSSION

In a roller mill, particles are subjected to shear and compressive forces. The roll parameters such as: the roll gap, the roll differential, the roll velocities, the feed rate, and the type and condition of roll surface, influence the magnitude of the stress and relative contributions of compressive and shearing forces [24]. Also, the nature of deformation (ductile or brittle) depends not only on the applied stresses, but as well on the particle components upon which the stresses act. Compressive stresses are more effective in causing the disintegration of the brittle endosperm material, while bran particles being tough and fibrous are more prone to fracture imparted by shear forces. Under industrial conditions, during the flour milling process, only the roll gap can be adjusted (feed rate to a limited degree) while the other roll parameters remain the same. At the same time, the roll gap is the parameter with the biggest influence on milling results. A number of earlier papers [25–30] showed that the particle size distribution, resulting from milling a particular feed size, critically depends on the ratio of roll gap to input particle size. Changes in the particle size distribution of the stock leaving 6M in the conventional process (Fig.

1a) and the eight-roller milling system (Fig. 1b), brought about by the decrease of the roll gap, followed the same trends.

By decreasing the roll gap, the quantity of material >150 μm tends to decrease while the flour yield (<150 μm) increased. Considering that the 6M feeds were different for the two milling systems, this cumulative size distributions are not to be compared and serve merely to show the trends. By decreasing the roll gap greater compressive forces are imposed, thereby increasing the number of endosperm fractures creating more flour. At the same time, the tougher branny particles are flattened and remain in coarser size fractions of the milling output. The material feeding the rolls of the tail-end passages of the reduction system normally contains a large portion of bran with relatively little endosperm mainly from the outer portion of the endosperm. These branny particles absorb the big portion of the stresses in the grinding zone so there is only a slight increase of the flour yield. The gradient of ash increases from center to the outer layers of wheat kernel [31], so the increase of the ash content indicates the higher contamination of the stock with the bran and germ. By decreasing the roll gap, on both passages and in both milling systems investigated, the flour ash content practically remained the same (there is only slight change without some general trend) but there is a significant increase of the ash content of the coarsest fraction of the stock (Table 2).

This proves the previous conclusion that branny particles absorb the stresses in the grinding zone but they don't pass into the flour because of predominant compressive forces under present grinding conditions (smooth rolls, 1.25 roll differential and small roll gaps), which create more endosperm fractures while flattening the branny particles. With the same gap setting on the 6M in the conventional system, higher flour release is obtained with the bigger roll gap on the 5M because the material entering the 6M, after flour removal by intermediate sifting, contains more endosperm as a result of smaller compressive forces and therefore less number of endosperm fractures.

At the same roll gap setting and under the same sieving conditions, the flour release was lower in the process with the eight-roller mill compared to the conventional milling system (Fig. 2) and the difference is statistically significant ($p < 0.05$).

This is similar to the results obtained in the study of the effects of using the eight-roller mill on the front passages of the reduction system [21]. The flour particles, which are removed from the stock by intermediate sifting in the conventional process, remain in the material feeding the lower pair of rolls of the eight-roller mill. They take on some of the stresses in the grinding zone which otherwise would be used to reduce the remaining coarse particles of the stock. This causes the lower flour yield and the finer flour granulation as a result of further grinding of flour particles. Posner and

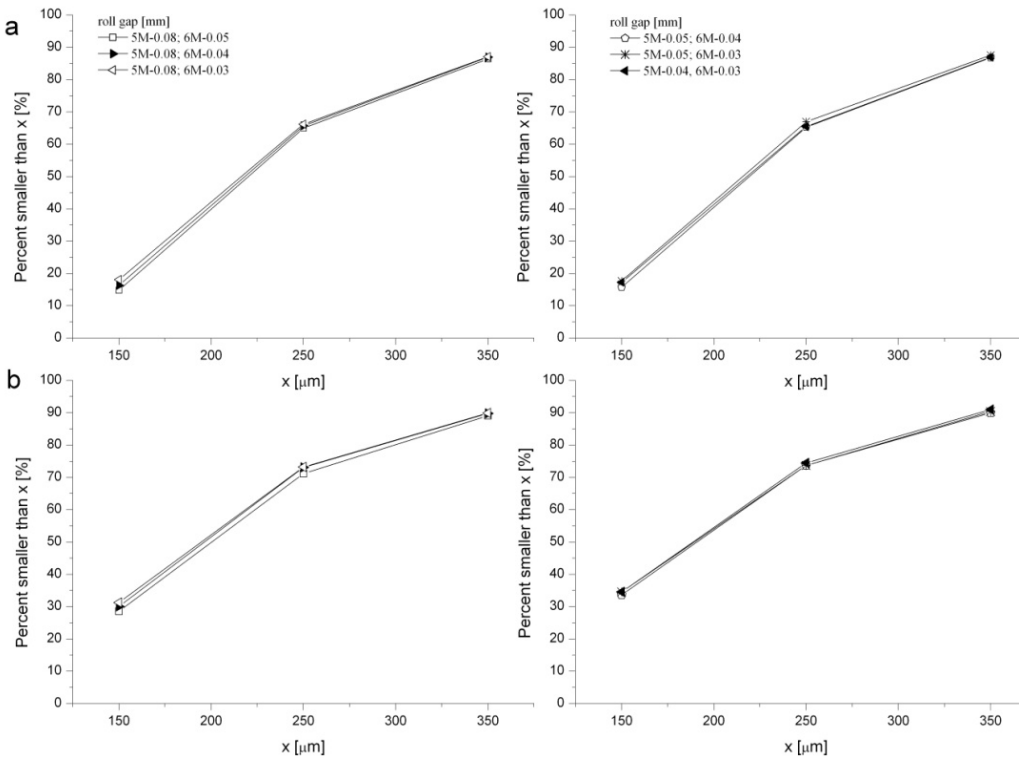

Figure 1. Cumulative size distributions of the stocks following 6M milled through different roll gaps in the a) conventional milling system and b) eight-roller mill system.

Table 2. Ash content in the size fractions of the stock following 5M and 6M in the conventional and eight-roller milling systems; values for a particular column, milling system and grinding passage differ significantly when followed by different letters

Milling system	Grinding passage	Roll gap, mm	Ash content, $(\%)_{dm}$			
			>350 µm	350/250 µm	250/150 (180[a]) µm	<150 (180[a]) µm
Conventional	5M	0.08	4.08 a	3.37 a	1.73 a	1.04 a
		0.05	4.20 b	3.39 a	1.81 b	1.03 a
		0.04	4.26 b	3.46 b	1.87 b	1.04 a
Conventional	6M	5M-0.08; 6M-0.05	4.31 a	3.53 a	2.10 a	1.44 a
		5M-0.08; 6M-0.04	4.35 b	3.56 a	2.13 ab	1.45 a
		5M-0.08; 6M-0.03	4.39 c	3.56 a	2.19 ab	1.41 b
		5M-0.05; 6M-0.04	4.43 d	3.55 a	2.23 b	1.45 a
		5M-0.05; 6M-0.03	4.44 d	3.55 a	2.24 b	1.40 b
		5M-0.04; 6M-0.03	4.45 d	3.52 a	2.23 b	1.40 b
Eight-roller	6M	5M-0.08; 6M-0.05	4.13 a	3.55 a	1.89 a (2.15 a)	1.14 a (1.16 c)
		5M-0.08; 6M-0.04	4.22 b	3.52 a	1.94 ab (2.16 ab)	1.13 a (1.11 b)
		5M-0.08; 6M-0.03	4.36 c	3.54 a	1.98 b (2.14 a)	1.14 a (1.11 b)
		5M-0.05; 6M-0.04	4.38 c	3.54 a	2.08 c (2.22 bc)	1.17 a (1.12 b)
		5M-0.05; 6M-0.03	4.40 c	3.56 a	2.07 c (2.19 abc)	1.19 a (1.20 a)
		5M-0.04; 6M-0.03	4.42 c	3.53 a	2.06 c (2.23 c)	1.13 a (1.15 c)

[a]In the second stack of sieves for the eight-roller milling system, the sieve with the 150 µm bolting cloth was replaced with a sieve having 180 µm bolting cloth

Hibbs [5] also observed this reduced grinding efficiency and stated that the lower pair of rolls should be considered to be 0.75 of their actual length because regrinding material made up of significantly different particle sizes and quality is less effective.

The other probable cause of lower flour yield in the eight-roller milling process is underbolting. This is a condition that occurs when insufficient sifter area is allocated for the separation and the material that passes over the screen contains particles smaller than the sieve aperture [5]. The absence of intermediate sifting between two grinding operations increases the amount of material on 6M and therefore the load of the sifter surface is higher compared to a conventional system. Also, the amount of flour in the stock following 6M is considerably higher in the eight-roller milling process while the granulation of flour is finer (because of regrinding) which makes it harder to be sifted.

The problem of underbolting led to a construction of eight-roller mills which include some intermediate sifting. The first solution is based on the fact that the heavy material exiting from the nip of the upper pair of rolls is thrown farther than the flour and light material. A baffle arrangement below the upper rolls separates the fines and therefore they bypass the lower rolls. The second solution is a centrifugal sifter below the upper rolls to separate the fines to bypass the lower rolls [5].

The savings with the eight-roller mill can be fully exploited only if it is possible to achive similar milling results to those obtained with a conventional mill. By decreasing the gap setting on the eight-roller mill on both 5M and 6M, without changing the sieving conditions, it is possible to achieve flour yield similar to the one obtained with the conventional milling system (Fig. 2: conventional: 5M-0,08 mm, 6M-0,05 mm; eight-roller 5M-0,05 mm, 6M-0,04 mm; conventional: 5M-0,08 mm, 6M-0,04 mm; eight-roller 5M-0,05 mm, 6M-0,03 mm or 5M-0,04 mm and 6M-0,03 mm). This had no influence on ash content of the flour and there is no statistically significant difference ($p > 0.05$) compared to the ash content in the total amount of flour following 6M in the conventional system (Table 3).

It needs to be pointed out that even though there is no significant difference between two milling system considering the ash content in the total amount of flour, there is a significant difference between the ash content of the flour streams following 5M and 6M in the conventional milling system (Table 2). Pojić *et al.* [32] also observed significant difference between the ash content in the tail-end reduction flours. These flour streams are mixed together in the process with the eight-roller mill therefore reducing the number of flour streams that could be selected for flour blending.

It is obvious that in the area of very tight roll gaps (0.03–0.05 mm), decrease of the roll gap setting is not followed with noticeable increase of the flour yield (Fig. 2). Considering the relatively short duration of the grinding runs (21–23 s) and the long interval between them, heating of the rolls did not take place even when the roll gaps were very tight. However, in the industrial conditions the undesirable heating of the rolls could occur especially in the cases of tight roll gaps and increased feed rate to the rolls (increased friction between particles and between roll surface and particles). This

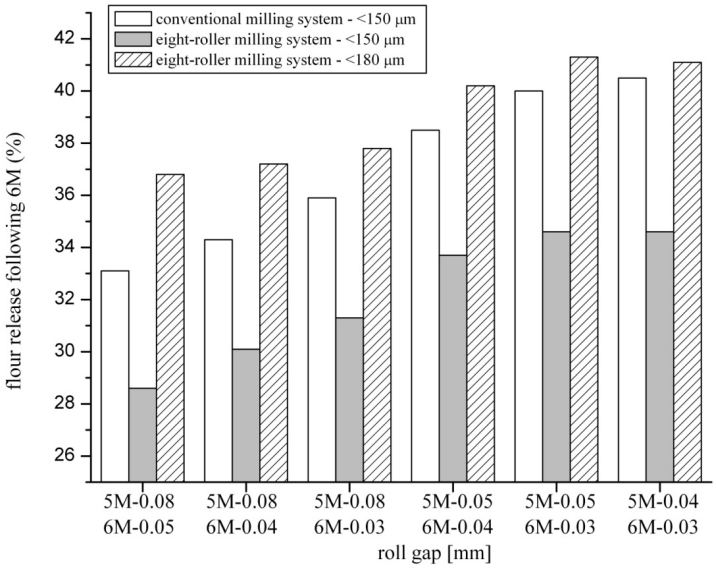

Figure 2. Flour release following 6M in the conventional and eight-roller milling system.

Table 3. Ash content in the total amount of flour and milling energy consumption following 6M in the conventional and eight-roller milling systems; values for a particular milling result differ significantly when followed by different letter

Roll gap, mm	Ash content, $(\%)_{dm}$			Milling energy consumption, kJ/kg		
	Conventional system	Eight-roller system		Conventional system	Eight-roller system	
	< 150 µm	< 150 µm	< 180 µm	< 150 µm	< 150 µm	< 180 µm
5M-0.08; 6M-0.05	1.15 abc	1.14 ab	1.18 bc	50.7 a	51.9 a	35.2 j
5M-0.08; 6M-0.04	1.16 abc	1.13 ab	1.11 a	58.1 b	59.0 bg	53.4 ak
5M-0.08; 6M-0.03	1.15 abc	1.14 ab	1.11 a	65.4 cd	73.8 h	57.3 kb
5M-0.05; 6M-0.04	1.16 abc	1.16 abc	1.12 a	67.6 d	76.2 h	62,6 gc
5M-0.05; 6M-0.03	1.15 abc	1.18 bc	1.18 bc	85.2 e	87.8 e	75.1 h
5M-0.04; 6M-0.03	1.15 abc	1.13 ab	1.15 abc	96.9 f	102.3 i	87.1 e
5M-0.08; 6M-0.05	1.15 abc	1.14 ab	1.18 bc	50.7 a	51.9 a	35.2 j

problem is present in the conventional process as well, but is even more likely to occur in the eight-roller milling system. The material from the upper rolls of the eight-roller mill almost immediately enters the grinding zone of the lower rolls without any cooling. The higher temperature of the rolls and therefore the increased temperature of the stock in the grinding zone of the lower rolls could change the nature of deformation (shift from brittle to ductile) and decrease the milling efficiency.

Previous considerations along with the inefficient sifting in the process with the eight-roller suggested that appropriate changes of the sieving conditions are necessary in order to increase flour release in the process with the eight-roller mill. Sifting efficiency depends on a number of different factors such as disposable sifter area, cloth tension, number of gyrations per min, feed rate to the sifter, flour flowability, etc. [33–35]. Increase of disposable sifter area in the process with the eight-roller mill in order to increase sifting efficiency is not a solution especially considering that a significant reduction of sifter surface is one of the main advantages of eight-roller milling system compared to a conventional system. Under industrial conditions, replacement of the sieves in the plansifter (changing the sieve aperture) is probably the easiest way to change the sieving conditions and therefore influence the sifting efficiency. However, the flour quality must not be affected by these changes. Replacing the 150 µm sieve with the sieve having 180 µm bolting cloth resulted in a significant increase in the flour yield (Fig. 2). It is evident that the increase in the flour yield, as a result of increasing the sieve aperture in the process with the eight-roller mill, is much noticeable at bigger roll gaps with flour release (<180 µm) significantly higher compared to flour release in conventional system (<150 µm). In the area of tight roll gaps flour release in the process with the eight-roller mill is similar to the flour release in conventional process. This confirms the previous statement that in the area of extremely tight roll gaps milling efficiency decreases. Changing the sieve size from 150 to 180 µm increases the upper size limit

of flour while the flour ash content was not affected (Table 3).

However, there is significant increase of the ash content of the size fraction 250/180 μm compared to the size fraction 250/150 μm (Table 2). This proves that the particles in the size range 180/150 μm are similar to those smaller than 150 μm. However, it also points out that on the end passages of the reduction system replacement of the sieves should be done carefully in order not to increase flour ash content.

Variostuhl laboratory roll stand has a relatively short roll length compared to roll stands used in commercial mills. This makes it easier to reproduce the certain feed rate to the rolls. Constant feed rate is very important considering the power readings and reliable energy consumption data. In both milling systems, as roll gap decreased milling energy consumption rose (Table 3). By decreasing the roll gap the flour yield increased. This contributes to the reduction of milling energy consumption because Eqs. (3) and (4) define energy consumption relative to the mass of flour obtained. On the other hand, decrease of the roll gap increases the power requirements in the operation with the material flow and as a result the milling energy consumption grows. Scanlon *et al.* [26] also reported that energy consumption is significantly related to roll gap setting.

At the same roll gap setting and under the same sieving conditions milling energy consumption in the eight-roller mill process is slightly higher compared to that in the conventional milling system (Table 3). It is mainly due to the lower flour yield in the eight-roller mill process. The heavier load to 6M rolls in the process with eight-roller mill (no intermediate sifting and flour removal) increases the power requirements and also contributes to higher energy consumption. Increasing the flour release, by increasing the sieve openings from 150 to 180 μm or decreasing the roll gap, it is possible to significantly reduce energy consumption in the process with the eight-roller mill (Table 3).

CONCLUSION

Introduction of the eight-roller mill into the wheat flour milling flow sheet significantly reduces production costs. These advantages can be fully exploited only if it is possible to achieve milling results close to those obtained in the conventional system. Under the same set of roll and sieving parameters, the eight-roller mill employed on the tail-end passages of the reduction system produces less flour compared to a conventional approach. By decreasing the roll gap setting and especially by increasing the upper size limit of flour it is possible to increase flour release in the process with the eight-roller mill. This way the actual energy consumption per unit mass of flour produced is decreasing. However, in the area of extremely tight roll gaps increase of the flour yield, brought about by the increase of the uper size limit of flour, is small. At the same time there is a significant increase in milling energy consumption as a result of increase in power requirements. Adjustments of the sieve aperture were not followed by increase of the flour ash content. The streams which are usually sent to the tail-end passages of the reduction system contain a large portion of the kernel outer layers and they can be designated as relatively low quality streams compared to the streams on other milling passages. This is the reason why these changes of the sieving conditions are limited in order to avoid deterioration of flour quality as determined by ash content.

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IZVOD

UPOREDNA ANALIZA POKAZATELJA EFEKTIVNOSTI USITNJAVANJA OSEVAKA NA POSLEDNJIM PROLAZIŠTIMA IZMELJAVANJA U KLASIČNOM I POSTUPKU SA PRIMENOM OSMOVALJNE STOLICE

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Uključivanjem osmovaljne stolice u tehnološki postupak mlevenja pšenice ostvaruju se, u poređenju sa klasičnim mlevnim postupkom, višestruke investicione, energetske i operativne uštede u potrebnom prostoru u objektu, pneumatskom transportu međuproizvoda mlevenja, potrebnoj sejnoj i filtracionoj površini, elementima gravitacionog trasporta, troškovima održavanja i dr. Sa druge strane, primenom osmovaljne stolice, pogoršavaju se uslovi za efikasnost i selektivnost usitnjavanja što potencijalno može imati negativne posledice na prinos, asortiman i kvalitet brašna i iskorišćenje zrna. Pomenuto ukazuje na potrebu optimizacije parametara usitnjavanja i prosejavanja mliva u postupku sa osmovaljnom stolicom. U radu je data uporedna analiza efekata usitnjavanja ostvarenih na poslednjim prolazištima mlevenja osevaka primenom klasičnog i postupka sa osmovaljnom stolicom. Pri istom vođenju valjaka i pri upotrebi istog sloga sita za prosejavanje mliva, u postupku sa osmovaljnom stolicom ostvaruje se manji prinos brašna nego u klasičnom postupku. Nižim vođenjem valjaka i korekcijom sloga sita u postupku sa osmovaljnom stolicom (povećanje veličine otvora sejnog tkiva na kome se brašno izdvaja kao propad) povećava se prinos brašna u pomenutom postupku usled čega se smanjuje specifični utrošak energije po jedinici mase brašna. Pri tome ne dolazi do promene sadržaja pepela u brašnu. Odgovarajućim vođenjem valjaka i prilagođavanjem veličine otvora sejnih tkiva u slogu sita mogu se u postupku sa osmovaljnom stolicom ostvariti efekti usitnjavanja bliski efektima u klasičnom postupku, a istovremeno se ostvaruju značajne investicione i energetske uštede što doprinosi racionalizaciji proizvodnje.

Ključne reči: Mlevenje pšenice • Klasičan postupak • Osmovaljna stolica • Mlevenje osevaka