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ROLLER SCREENS UNDERSIZE GAPPING EVALUATION IN DRUMS BALLING PROCESS[1]

Benito Barbabela e Silva [2]
Marcelino Panzera de Souza [3]
José Antônio de Paiva [4]
Ênio Pereira [5]
Éderson Alexandre Fonseca [6]
Ernane Márcio de Castro Martins [7]
Vander Lúcio Martins [8]

Abstract

Balling performance is critical to pellets sintering process and has important influence on traveling grates productivity. In contrast with disks, balling drums presents narrower size dispersion results and lower return rates although it is more impacted by any change in control variables. Its layout calls the attention to the roller screens which are not only classifiers but also act directly on green pellets kinetics. Facing restrictions on the physical quality of feed which impacts negatively on balling performance and increases pellets average size, a study on the roller screens undersize gapping was carried out and the pattern changed from 9,2mm to 8,9mm. In Fabrica plant where abrasion is the quality parameter that restricts production rate, such change recovered green pellets best average size, balling performance and created a potential for increasing traveling grate productivity.

Key words: Drums; Balling; Roller screens.

AVALIAÇÃO DA GABARITAGEM DE *UNDERSIZE* DAS PENEIRAS DE ROLOS NO PROCESSO DE PELOTAMENTO A TAMBOR

Resumo

O desempenho da etapa de pelotamento é fundamental para o processo de sinterização de pelotas e interfere diretamente na produtividade de uma usina de pelotização. Diferentemente do processo a disco, o pelotamento a tambor apresenta menor retorno e resultados com menores dispersões, entretanto é mais impactado pela mudança das variáveis que o controlam. Seu *layout* chama atenção para o papel não apenas classificador das peneiras de rolos mas também como agente direto na formação das pelotas verdes. Diante de um cenário com restrições à qualidade física do feed que impacta negativamente no rendimento do pelotamento e aumenta o tamanho médio das pelotas cruas formadas, um estudo do padrão de gabaritagem do *undersize* destas peneiras foi realizado e a abertura desta fração alterada de 9,2mm para 8,9mm. Tal mudança recuperou o melhor tamanho médio das pelotas verdes e gera um potencial para aumento da produtividade de grelha na Usina de Fábrica onde a abrasão é o parâmetro de qualidade que restringe o nível de produção.

Palavras-chave: Tambor; Pelotamento, peneira de rolos.

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2 *Metallurgical Engineer; Fabrica Pelletizing Plant, VALE; Ouro Preto, MG; benito.silva@vale.com*
3 *Mining Technician; Fabrica Pelletizing Plant, VALE; Ouro Preto, MG; marcelino.souza@vale.com*
4 *Mining Technician; Fabrica Pelletizing Plant VALE; Ouro Preto, MG; jose.paiva@vale.com*
5 *Electromechanical Technician; Fabrica Pelletizing Plant, VALE; Ouro Preto, MG; enio.pereira@vale.com*
6 *Electromechanical Technician; Fabrica Pelletizing Plant, VALE; Ouro Preto, MG;ederson.fonseca@vale.com*
7 *Metallurgical Engineer M.Sc.; Fabrica Pelletizing Plant, VALE; Ouro Preto, MG; ernane.martins@vale.com*
8 *Metallurgical Technician; Fabrica Pelletizing Plant, VALE; Ouro Preto, MG; vander.martins@vale.com*

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1 INTRODUCTION

Particles agglomeration kinetics in pelletizing drums is approached for decades. Nevertheless, although advances came through, it was not completely clarified and industrial process response remains subjected to surging behavior which is dependent on plants and process parameters such as binder dosage, moisture content, drums inclination and length.

Firstly proposed by Kapur *apud* Sastry Fuerstenau(1) and reviewed by Iveson et al.(2), granulation kinetics growth is split in three stages: nucleation and wetting (capillary forces predominance), coalescence (abrasion transfer and breakage) and layering (snowballing).

It was determined that a similarity solution to an integro-differential equation of balling kinetics by the non-random coalescence mechanism results in the following expression for the median granule-size $D_m(t)$

$$D_m(t) = Ct^{\alpha} \quad (1)$$

where *t* is granulation time, exponent *α* depends on the growth mechanism and the specific rate constant *C* is a function of water and bentonite contents of the granulation charge(3).

Abouzeid, Seddik and El-Sinbawy(4) studied for the first time the specific rate constant, C, for iron ores from El-Gedida deposit, Baharia Oasis, Egypt by varying binder dosage and feed moisture content. It was also evaluate physical properties of green pellets produced.

When compared to disks, drums produce pellets with interesting physical quality and excellent process yield summarized in table I: narrower size dispersion, lower pellets mean size, higher granulometry index. These characteristics are mainly due roller screens role. While in balling disks they are merely classifiers, in balling drums circuits they act also directly on green pellets kinetics.

Table 1. Iron ore balling process

	Disks	Drums
Return Rate *	28%	12%
Recycle Load Rate *	-	200 – 500%
Moisture (%wt)	9,7	10,7
>18,0mm**	3,0%	0,8%
>16,0mm**	7,0%	2,3%
>12,5mm**	52,4%	32,6%
>10,0mm**	32,3%	59,6%
>8,0mm**	4,1%	3,9%
>6,3mm**	0,5%	0,4%
>5,0mm**	0,1%	0,1%
<5,0mm**	0,5%	0,4%
Out of specification 8-18mm**	5%	1,7%
Granulometry Index**	0,61	1,82

Although they present higher performance, balling drums are more impacted than disks when any control parameter is out of its specification limits. This is the background faced by Fabrica pelletizing plant where the production of pellet feed with specific surface area within specification limits is being directly affected by the beneficiation plant yield and supply as a result of mineralogical complexity of itabirite

* Compared to new feed rate
** Indurated Pellets

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and hematite deposits. Figure 1 illustrates how specific surface area is directly proportional to green pellets mean size. As blaine index increases, the percentage of pellets retained on on-size main lower sieve (10mm) raised and the tonnage indicated by dynamic balance installed in recycle load conveyor follows the same tendency evincing a major presence of seeds (lower pellets) in balling circuit.

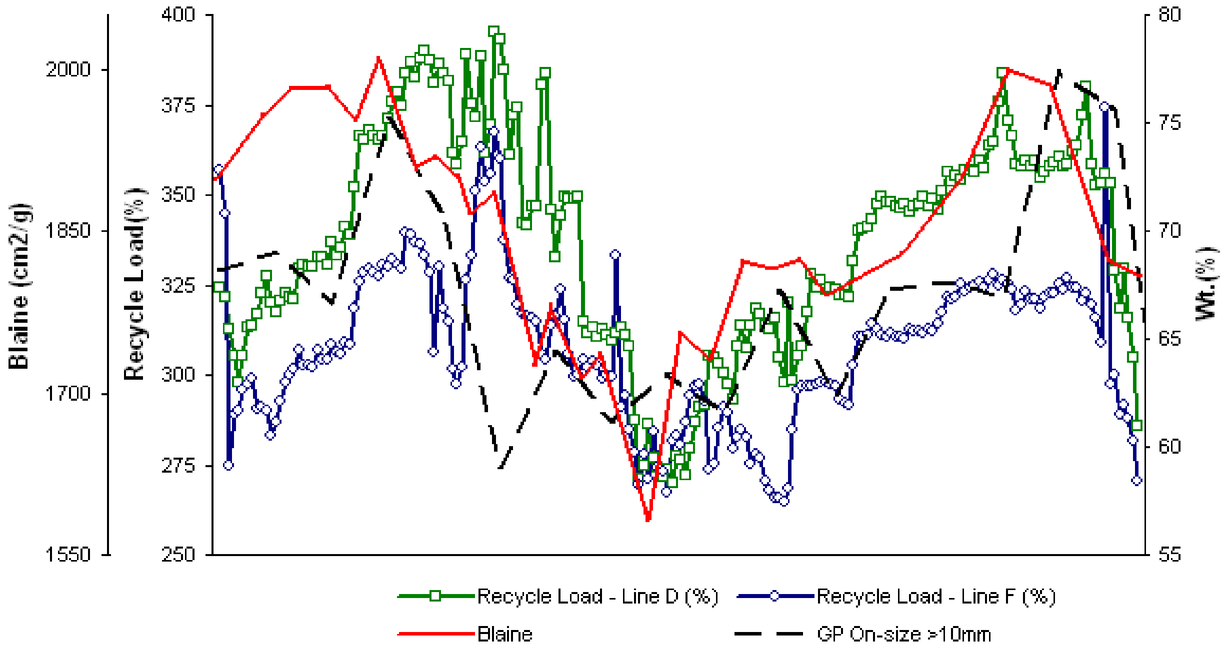

Figure 1. Blaine index influence on green pellets size.

Circumstances dealt in Fabrica pelletizing plant are unique in Latin America due its balling process done in 7 drums circuits with total nominal capacity of 700t/h. There, the importance of controlling pellets dispersion is relevant mainly because plant productivity is limited by abrasion parameter which presents strong correlation to pellets mean size.[5,6] In order to optimize pellets induration, green balls granulometry ought to be evaluated and reduced. Three factors were approached: reduce feed moisture content, rise bentonite addition and reduce roller screens gaps. The former could not be optimized due its negative effect on balling performance and green pellets quality. Second one would impact on chemical impoverishment of indurated pellets. Finally, this paper presents the study performed to evaluate the effect of changing roller screens undersize gaps on green pellets mean size.

2 MATERIALS AND METHODS

Balling drums operation consists of a simple feedback circuit, in which a rotating drum, whose axis is inclined at a small angle to the horizontal, is supplied with a constant flow of damp raw ore, plus undersize returns. During the first couple of meters of charge's progression through the drum the fresh feed material is taken up by the production of new seeds (nucleation), after which the surviving pellets grow by a variety of mechanisms (coalescence and layering). At drums discharge end, pellets are classified through roller screens gaps, where the undersize fraction is recycled to the charge end of the drums, and then they will participate of a further growth stage.[7] Bigger pellets follow to roller screens inferior part where they are classified through on-size gaps going to the feeder. Oversize is declassified to return beyond the rolls.

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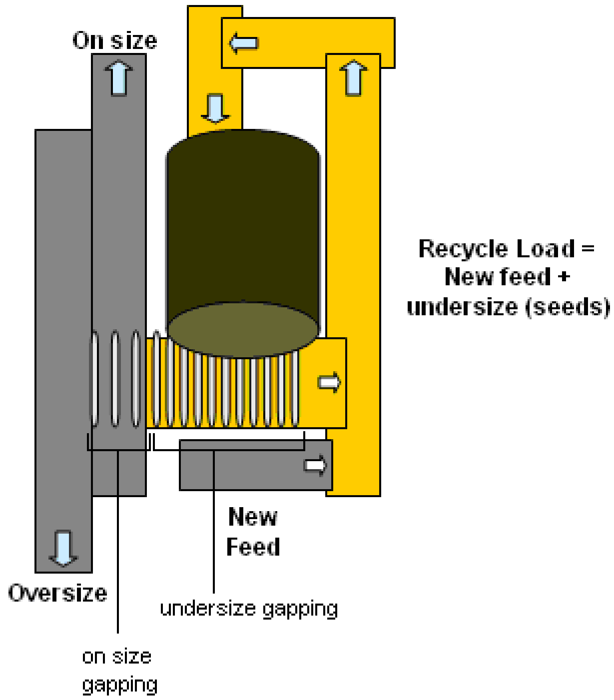

Figure 2. Balling production line.

To obtain narrower size dispersion and reduce green pellets mean size which could optimize indurated pellets abrasion, 8,7mm roll templates were manufactured to roller screens undersize gaps replacing the 9,3mm used. To evaluate the influence of such variable and estimate the best gaps for Fabrica balling circuits, 2kg samples were collected on on-size and seeds (placed below the superior part of the screen) conveyors. They were dried in oven at 105ºC and classified in 5,0mm; 6,3mm; 8,0mm; 10,0mm; 12,5mm; 16,0mm e 18,0mm screens. Experiments were performed with pellet feed with the following physical characteristics: blaine index: 1780±120cm^2/g; moisture content: 10,1±0,2wt%; bentonite dosage: 0,58±0,02wt%.

3 RESULTS AND DISCUSSION

Cumulative number fraction curves for on-size and seeds conveyors are present in Figures 3 and 4 respectively. As can be seen, the reduction of undersize gaps reduced pellets and seeds mean size.

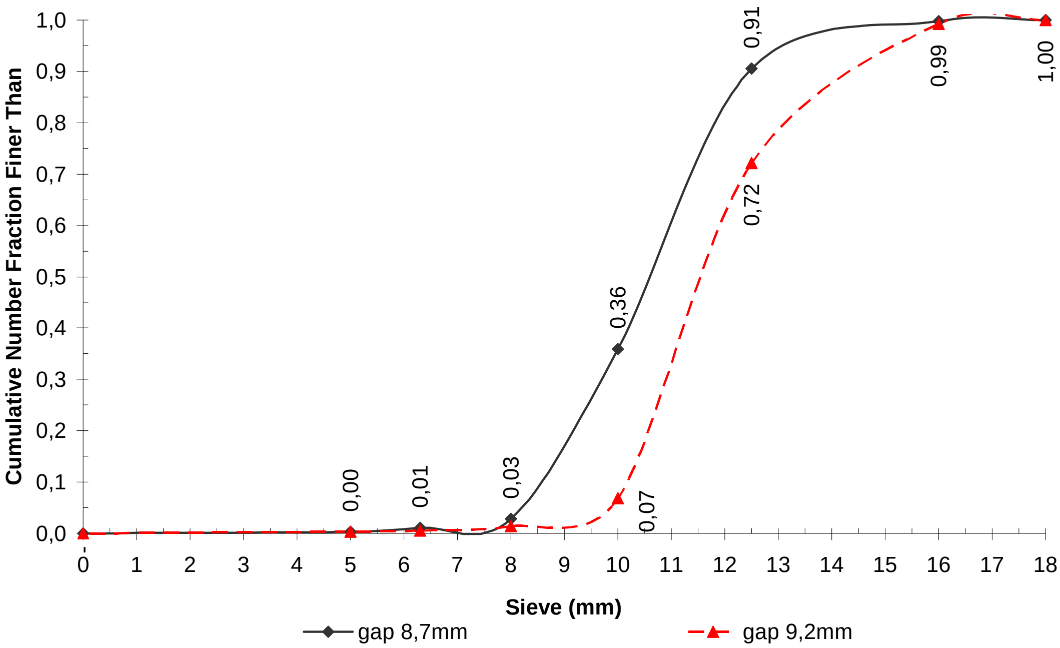

Figure 3. On size cumulative number fraction.

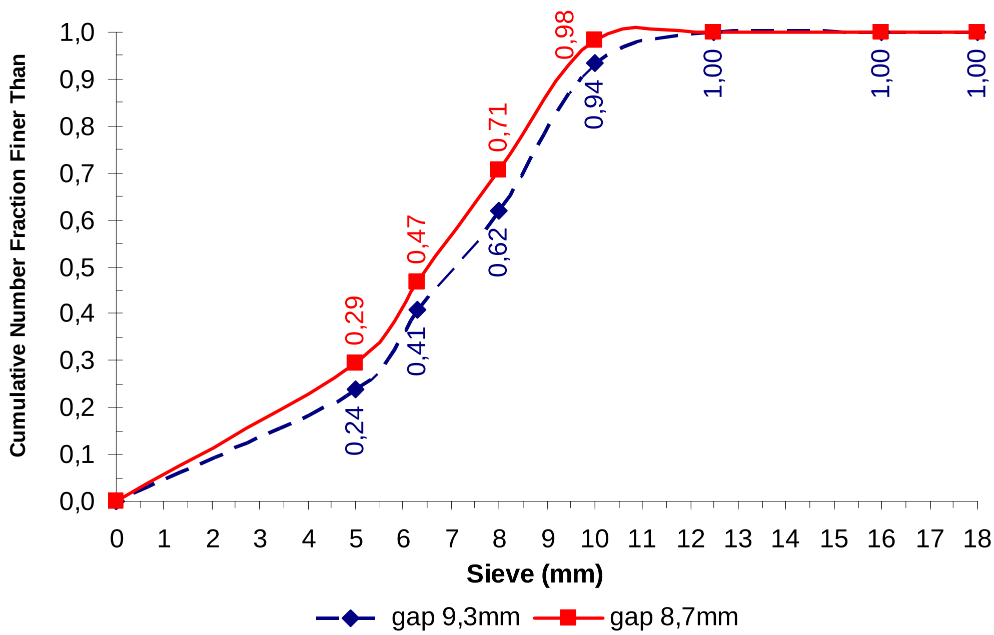

Figure 4. Seeds cumulative number fraction.

Based on results gotten and considering that roller screens performance is little affected for small changes in gaps length, an estimative for a range of rolls templates (Figure 5) was done by plot translation in order to determine green pellets best mean size and dispersion. Table II presents the expect fraction for each of on-size main sieves.

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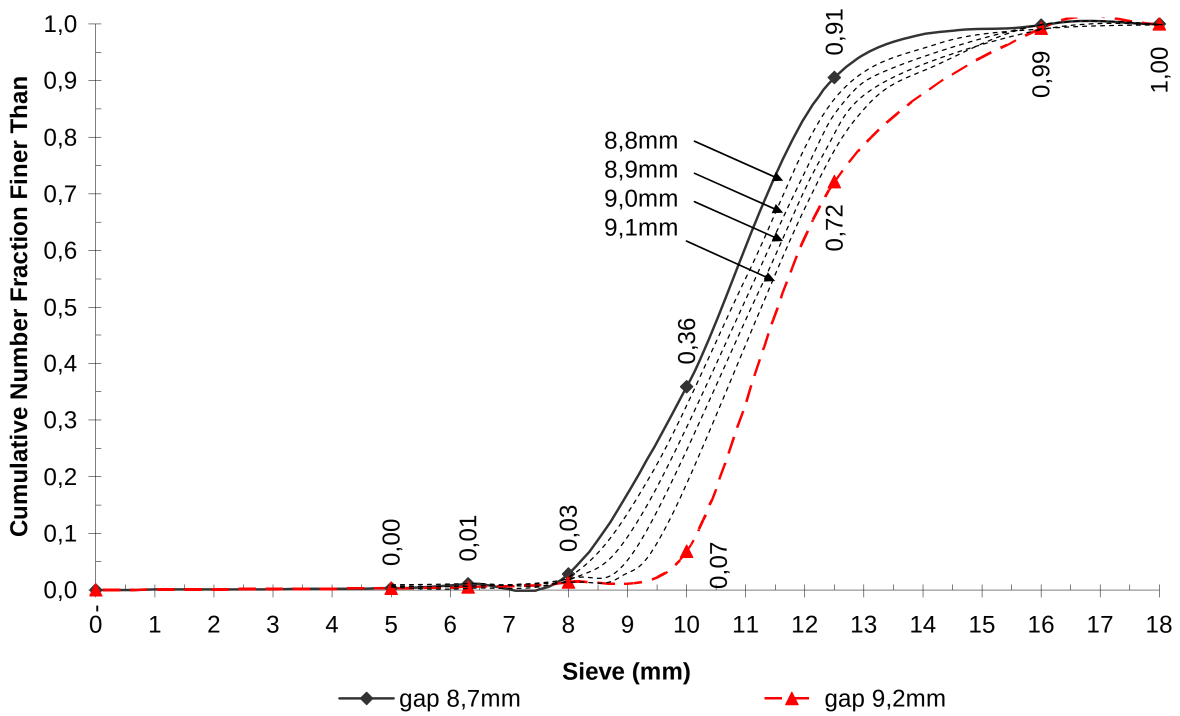

Figure 5. Estimated on size cumulative number fraction.

Table 2. Estimated pellets mean size and retained simple fractions on on-size sieves

		Undersize Gap					
	On-size sieve (mm)	**8,7**	**8,8**	**8,9**	**9,0**	**9,1**	**9,2**
Estimated Retained Fraction	>12,5	0,093	0,119	0,173	0,188	0,231	0,270
	>10	0,546	0,550	0,563	0,590	0,607	0,624
	>8	0,329	0,300	0,234	0,191	0,131	0,075
	Estimated green pellet mean size (mm)	10,7 ± 0,3	10,8 ± 0,3	11,2 ± 0,3	11,3 ± 0,3	11,6 ± 0,3	11,8 ± 0,4

Green pellets mean size and the length of roller screens undersize gaps are plotted in Figure 6. The relationship extracted close meets the same tendency observed by Meyer[(8)] on recycle load variation promoted by undersize gaps changes. Although the aims of these studies are completely different, they are extremely linked and confirm the observations of each other.

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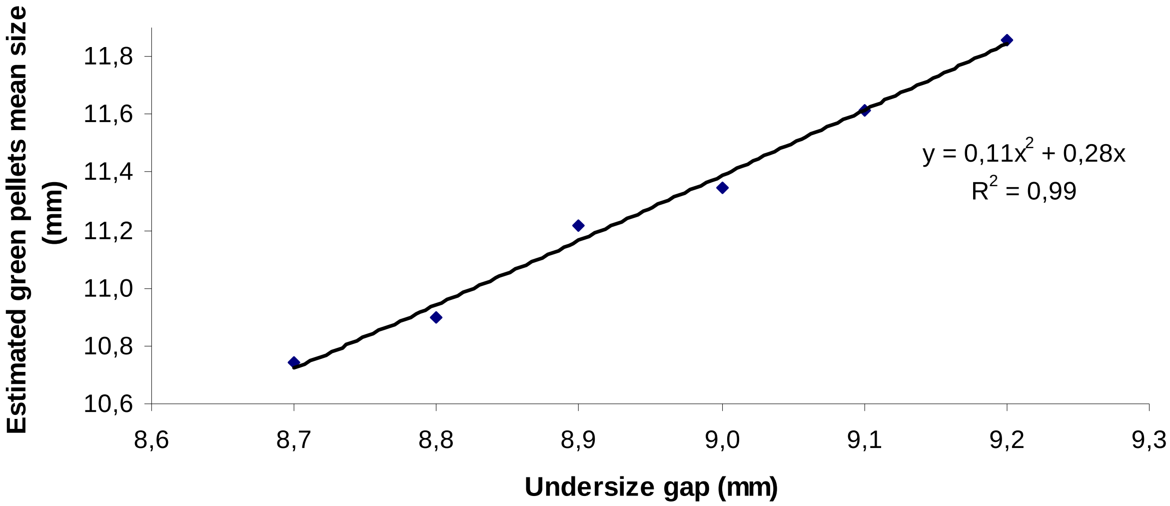

Figure 6. Undersize gap's influence on green pellets mean size.

Wellstead et al.[7] widely discuss about balling operation difficulties due to surging phenomena on product and recycle load conveyors as a result of growth mechanisms in drums and screens non-linearity (also called constitutive relation). Attempts to reduce such behavior using mathematical modeling by changing drums layout are also approached. Simulations of recycle hold-up, tandem operation and partial feedback methods demonstrated that last one is the most effective way to avoid surging response. This latter is based on simple reduction of the total amount of undersize pellets which fits well to the method applied in this study. Pellets that were before returned and represented the range of seeds with bigger diameter are now being classified as on-size compounding its smaller range. Recycle load rate decreased approximately 8% also evincing the migration of seeds from undersize to on-size conveyor. Carter and White *apud* Wellstead *et al.*[7] describe that surge amplitude is ± 20% of recycle load mean value.

Important evidence which indicates a possible improvement on balling performance could be noted on undersize rate reduction on induration machine feeder. This can be explained by the decrease of feed rate in drums which benefits green balls growth by layering mechanism.[9] Reducing new feed/seeds ratio not only supports high yield but also avoids slippage occurrences.

For Fabrica pelletizing plant, 8,9mm gaps presented the best green pellets size which could improve balling performance without any detriment to bed permeability in induration machine. Evolution of feeder undersize rate is plotted in Figure 7 when gaps configuration was gradually modified in each of the seven lines.

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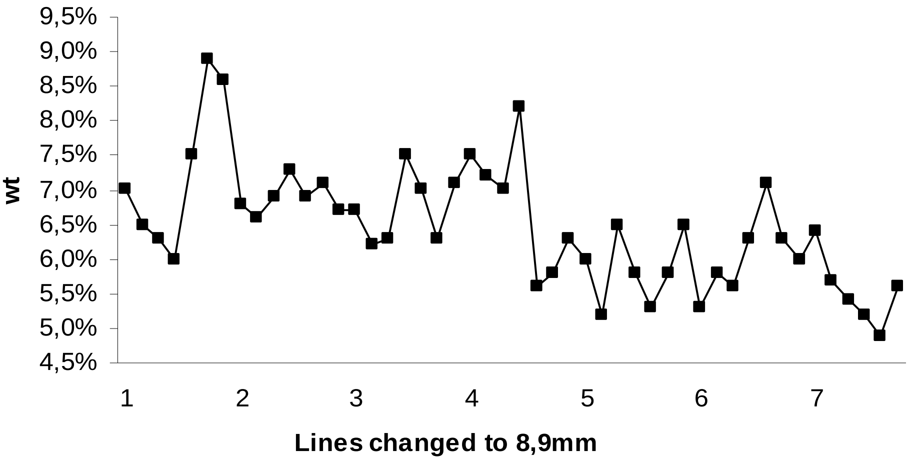

Figure 7. Feeder undersize rate evolution.

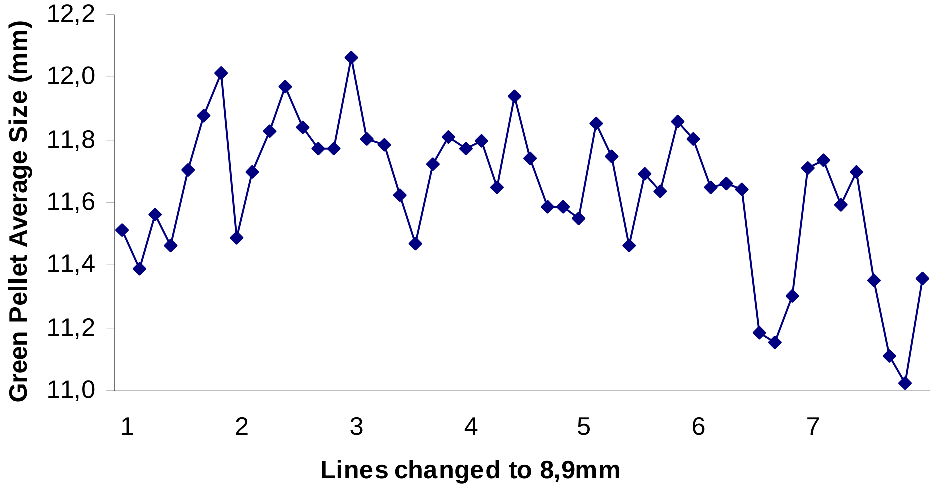

Figure 8. Evolution of green pellets mean size.

4 CONCLUSION

The evaluation of roller screens undersize gap was performed. For Fabrica balling-drums, reduction of undersize gaps from 9,2mm to 8,9mm demonstrated an improvement of process performance by reducing undersize feeder and recycle load rates. Green pellets mean size was also reduced presenting excellent perspectives to reduction kinetics of indurated pellets in blast furnaces as topochemistry theory explains. This study close meets the same tendency of Meyer(8) evaluation and confirms partial feedback method efficiency.(7)

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