ISSN 2176-3135
ICSTI
6th International Congress on the Science and Technology of Ironmaking - ICSTI
42th Ironmaking and Raw Materials Seminar/ 42º Seminário de Redução de Minério de Ferro e Matérias-primas
13th Brazilian Symposium on Iron Ore/ 13º Seminário Brasileiro de Minério de Ferro

IMPLEMENTATION OF THE INTENSIVE MIXER AT SINTER PLANT[1]

Iuri Pinto Mascarenhas[2]
Thiago Pinto Silva[3]
Edilson Pinto Honorato[4]
Braulio Viegas da Silva[5]

Abstract
Against the backdrop of increasing the silica content of iron ore, Usiminas has adopted a strategy to add the pellet feed on sintering process in order to reduce this level and consequently reduce the production cost of hot metal in blast furnaces. To add this type of iron ore, which it was believed to be detrimental to performance indicators in conventional sintering, Usiminas acquired the intensive mixer. The ramp-up was characterized by gradual increases of pellet feed, burnt lime and moisture. It was used up to 25% of pellet coarse in charge of iron ore at sintering process.
Key words: Sinter plant; Intensive mixer; Pellet feed.

[1] *Technical contribution to the 6th International Congress on the Science and Technology of Ironmaking – ICSTI, 42nd International Meeting on Ironmaking and 13th International Symposium on Iron Ore, October 14th to 18th, 2012, Rio de Janeiro, RJ, Brazil.*
[2] *ABM Member; Metallurgical Engineer, Technical Management Reduction Usiminas; Ipatinga, MG, Brazil.*
[3] *ABM Member; Metallurgical Engineer, Research & Development Center Usiminas; Ipatinga, MG, Brazil.*
[4] *ABM Member; Metallurgical Engineer, Industrial Engineering Usiminas; Ipatinga, MG, Brazil.*
[5] *ABM Member; Metallurgical Engineer, Management of Raw Material and Sintering Usiminas; Ipatinga, MG, Brazil.*

ISSN 2176-3135

1 INTRODUCTION

Usiminas adopted the strategy to include in its active the J. Mendes, nowadays Mineração Usiminas S/A (MUSA). The purpose of this inclusion was to make Usiminas self-sufficient in iron ore and sell the rest of production to increase their revenues. With the increasing use of iron ore from the rock itabirite in its plants, there was an increase of silica content in the sinter. The Figure 1 shows this situation for Ipatinga Plant. Thus, it was chose to add the pellet feed at sintermaking to reduce the silica content in the sinter. However, it is known that this action would damage the productivity of sinter machines. So, Usiminas decided after several studies in the Research & Development Center of Usiminas - Unit Ipatinga include the intensive mixer in the sintering process route.

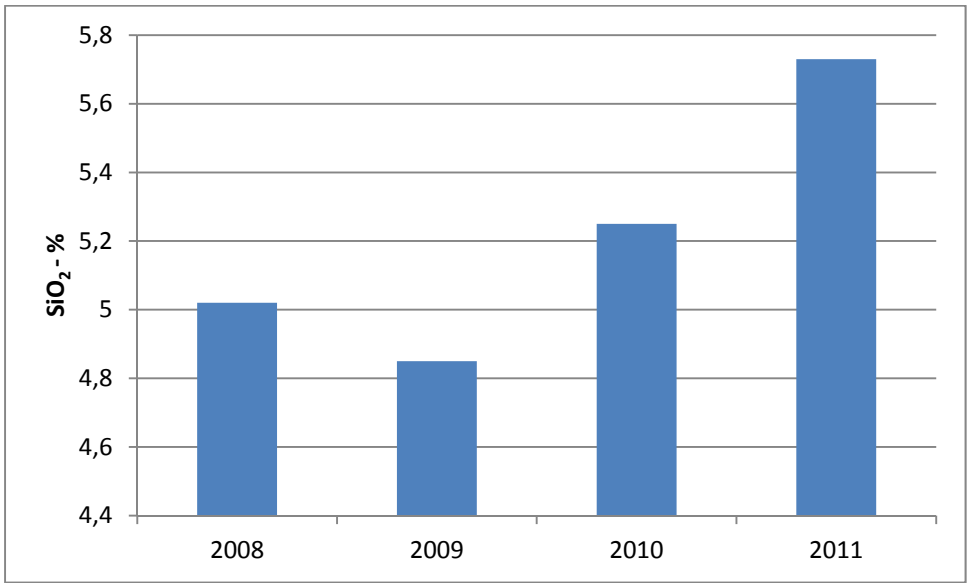


Figure 1. Average content of SiO_2 in the sinter produced by Usiminas - Ipatinga Plant.

1.1 Mineração Usiminas S/A

Usiminas acquired in early 2008 three mines composed by friable and compact itabirites. These mines are located at Serra Azul region, municipality of Itatiaiuçu in the extreme west of the Iron Quadrangle in Minas Gerais, Brazil. Up to now, the capacity of production is about 8.5 millions ton, however the projection is achieve 29 million ton in 2015.

The Figure 2 shows the exploration's projection of two kinds of rocks at Usiminas's mine. It can be noted that in 2014 it will started the production of iron ore from compact itabirite. Also, it can be inferred that the tendency of quality of iron ore will change drastically, probably the average size of particles will decrease to achieve the actual chemical specification or the average size of particles will be maintained with a decline of chemical quality.

ISSN 2176-3135

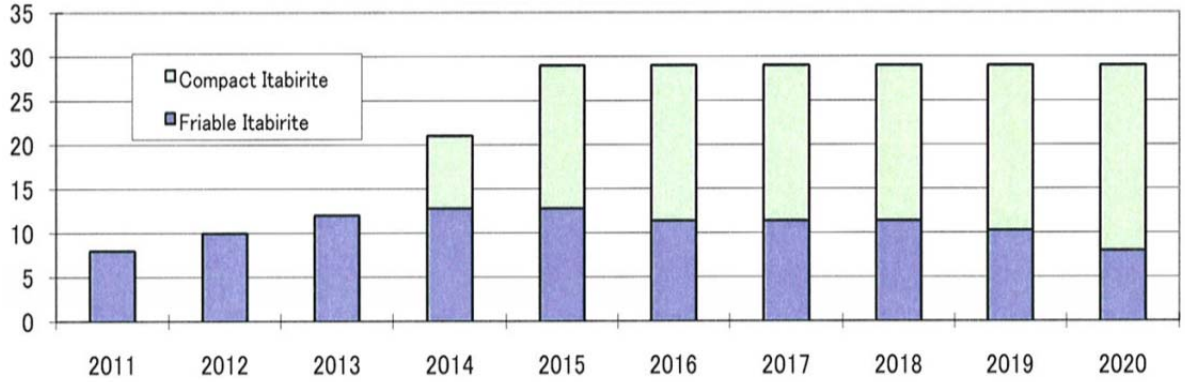


Figure 2. Distribution of the kind of rocks of Mining Musa.

The future of the mine is product manly pellet feed. This can be observed at Figure 3. Also, it can be seen that the production of lumps will finish at 2015. This is one of many indicators of declining of iron ore's quality. In this case, the end of production of lump was due to chemical quality, in other words, the lump won't have enough quality for be sold.

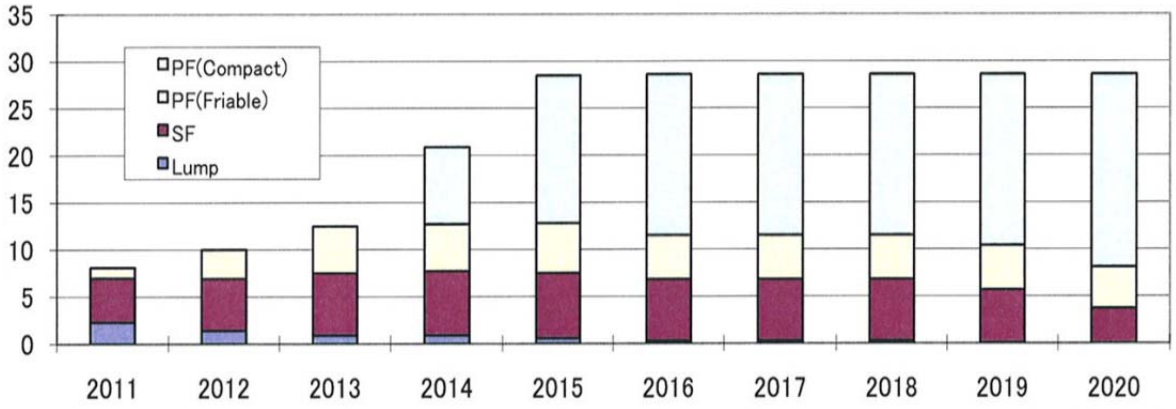


Figure 3. Production's projections for Mining Musa.

1.2 Intensive Mixer

Up to now, the use of intensive mixers in sinter plant in Brazil is few. This equipment can operate in two distinct ways. The first is for mix and the second is for agglomeration. The type of function is based on the speed of the agitators along with the residence time of the mixture in the mixer. In the case of Usiminas, the function of mixer is mix to provide greater homogenization, although the agglomeration function could be activated by changing of parameters of the mixer like agitator rotation and residence time. The Figure 4 shows the arrangement of agitators in the mixer and the Table 1 shows the specification.

ISSN 2176-3135

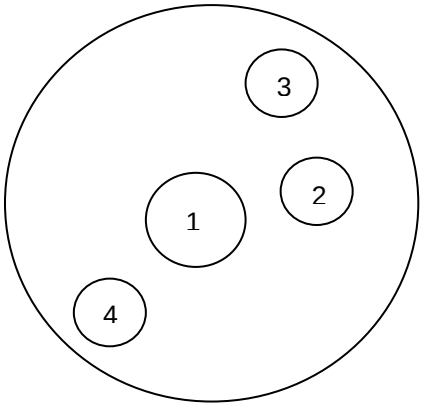


Figure 4. Arrangement of agitators in the mixer at Usiminas - Ipatinga Plant.

Table 1. Specifications of mixer

Volume (m^3)	Rotation agitators (RPM)	Diameter agitators 1 (m)	Diameter agitator 2, 3 e 4 (m)	Nominal capacity (t/h)
10	180 (maximum)	1,0	0,8	800

2 MATERIALS AND METHODS

2.1 Lay-Out

The layout of sintermaking Ipatinga's Plant is showed at Figure 5. It can be noted that the intensive mixer was positioned before the drum granulation, due to the kind of play of intensive mixer that was to mixing and not for nodulation. It was added a bypass for situations that will not be possible use the intensive mixer.
The sintermaking at Usiminas has the same process route until the drum granulation for sinter machine #1 and #2 and has the same process route after sintering belt. So the indicators of quality of sinter like shatter index is the same for the both machines.

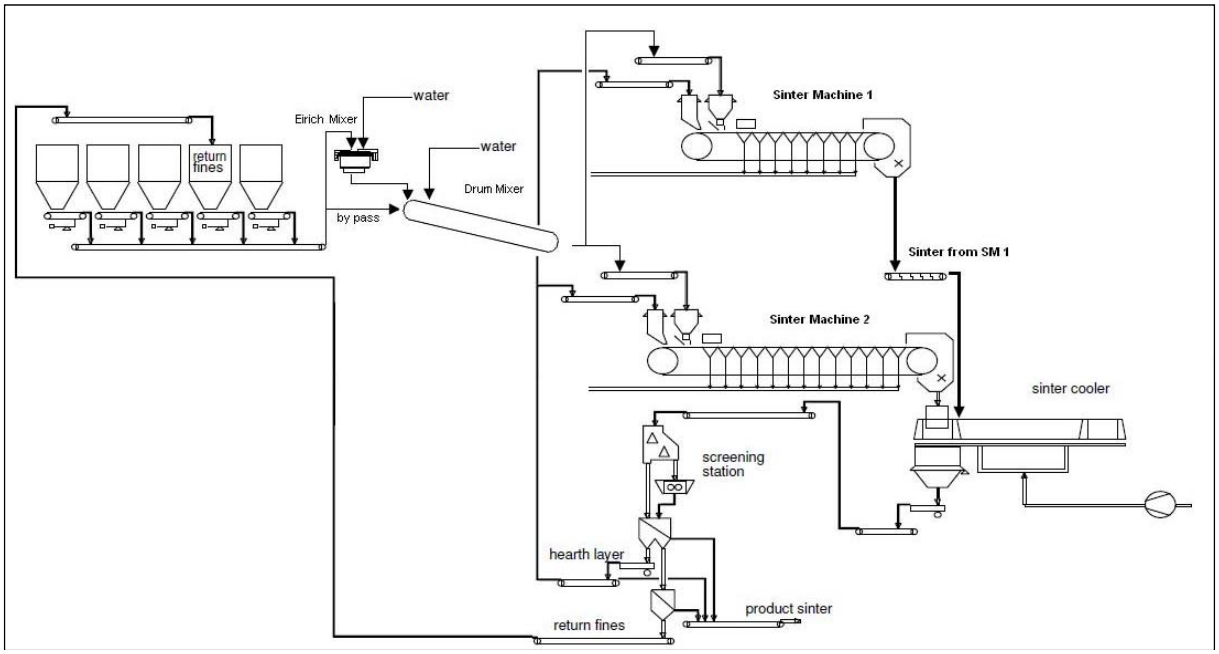


Figure 5. Lay out of sintering plant at Usiminas.

ISSN 2176-3135

During the mixer's installation, the drum was modified. The lifters that occupied 33% of total drum were removed, so it assumed that can be more spaces to granulation take place in drum. This promotes improved granulation cold.

2.2 Ramp up

The ramp up of intensive mixer was planned with gradually increasing participation of pellet feed. The pellet feed was loaded in the bin of the sinter machine, not in the blending step. The Table 2 and Figure 6 show the mainly conditions. The values of burnt lime and moisture were based in results of Research & Development Center of Usiminas. The values of rotation agitator and volume of mix in mixer was suggested by the manufacturer of mixer.

Table 2. Planning of mixer's ramp-up

Steps	Pellet feed (%)	Days	Moisture (%)	Burnt Lime (%)	Agitator rotation (RPM)	Volume of mix in mixer (m^3)
1	0	0-5	6.2-6.5	2.00	135	9.1
2	5	3-5	6.4-6.7	2,25	135	9.1
3	10	3-5	6.5-6.8	2,50	135	9.1
4	15	3-5	6.7-7.0	2,75	135	9.1
5	20	3-5	6.8-7.1	3,00	135	9.1
6	25	-	7.0-7.3	3,25	135	9.1

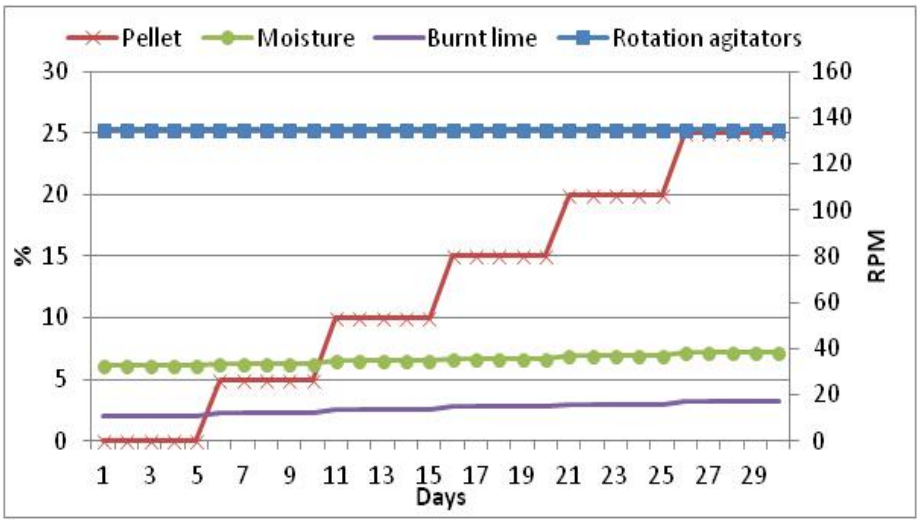


Figure 6. Plan of mixer's ramp-up.

The degree of homogenization of the mixture is directly related to the setting rotation of the agitators. According to residence time the rotation can be reduced.
The residence time is set by the level of material in the mixer and the flow of raw material consumed by sinter machine. The longer the residence time is, reduced will be the time increasing the heterogeneity of the mixture. The level of filling of the mixer should always be the maximum up to 90% of total volume and the residence time should oscillate together with the production.
In order to verify the improved of performance of sintering during and after the start-up of intensive mixer, it was accompanied the productivity and shatter index.

ISSN 2176-3135

3 RESULTS AND DISCUSSION

3.1 Ramp-up

The ramp-up happened a lot of problems, mainly environmental questions. The Figure 7 shows the values planned and the real values.
The first problem was about of the supplying of pellet feed. There is not possible to use pellet feed, because there was not pellet feed on the market. So Usiminas chosen to use a material with worse quality to pellet feed that is the pellet coarse.
The second was the minimum capacity of weighing of bins that is 10% of material inside the bin. So it was not possible to use 5% of pellet coarse on the iron ore burden.
The third problem was the absence of pellet coarse that reached zero availability in yards due to excessive rains preventing the arrival of pellet coarse at Ipatinga.
The fourth problem was chemical quality of pellet coarse, the expectation was that the pellet coarse would came with silica 3.5%, but in reality the silica reached 4.6% so the expected reduction of the silica content in the sinter did not happen. Results obtained at indicated increasing of productivity with pellet feed and reducing of silica of sinter.
With the increase fine contained in iron ore burden and increase burnt lime consumption was necessary to raise the dosage of water, the dosage required unless the water harm the process. The moisture meter, important part for the automatic control of the dosing of water was not working properly, so there is a need to repair the equipment to increase consumption of pellet feed.
Finally there is an increase on the quantity of particles in the range 0.1 mm to 0.8 mm that are considered inert material in the sintering process. Moreover, there was an increase in January of the number of small suppliers (4 to 8) of iron ore for Usiminas – Ipatinga's work.

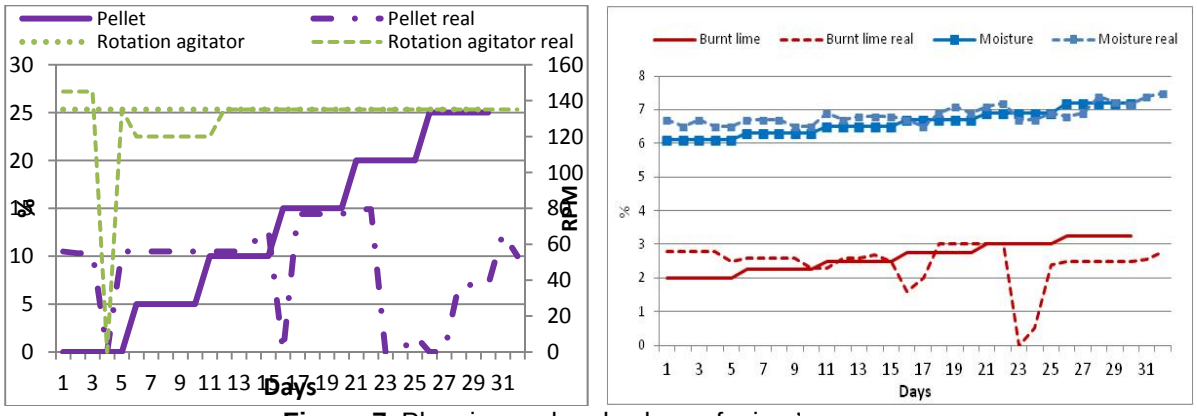


Figure 7. Planning and real values of mixer's ramp-up.

3.2 Operation Results

As it can be seen on Figures 8a and 8b, the productivities of sinter machine #1 and #2 was improved. On the other hand, the mechanical resistance (shatter index) of sinter decreased, Figure 8c. This situation cannot be explained only for adding pellet coarse and intensive mixer.

ISSN 2176-3135

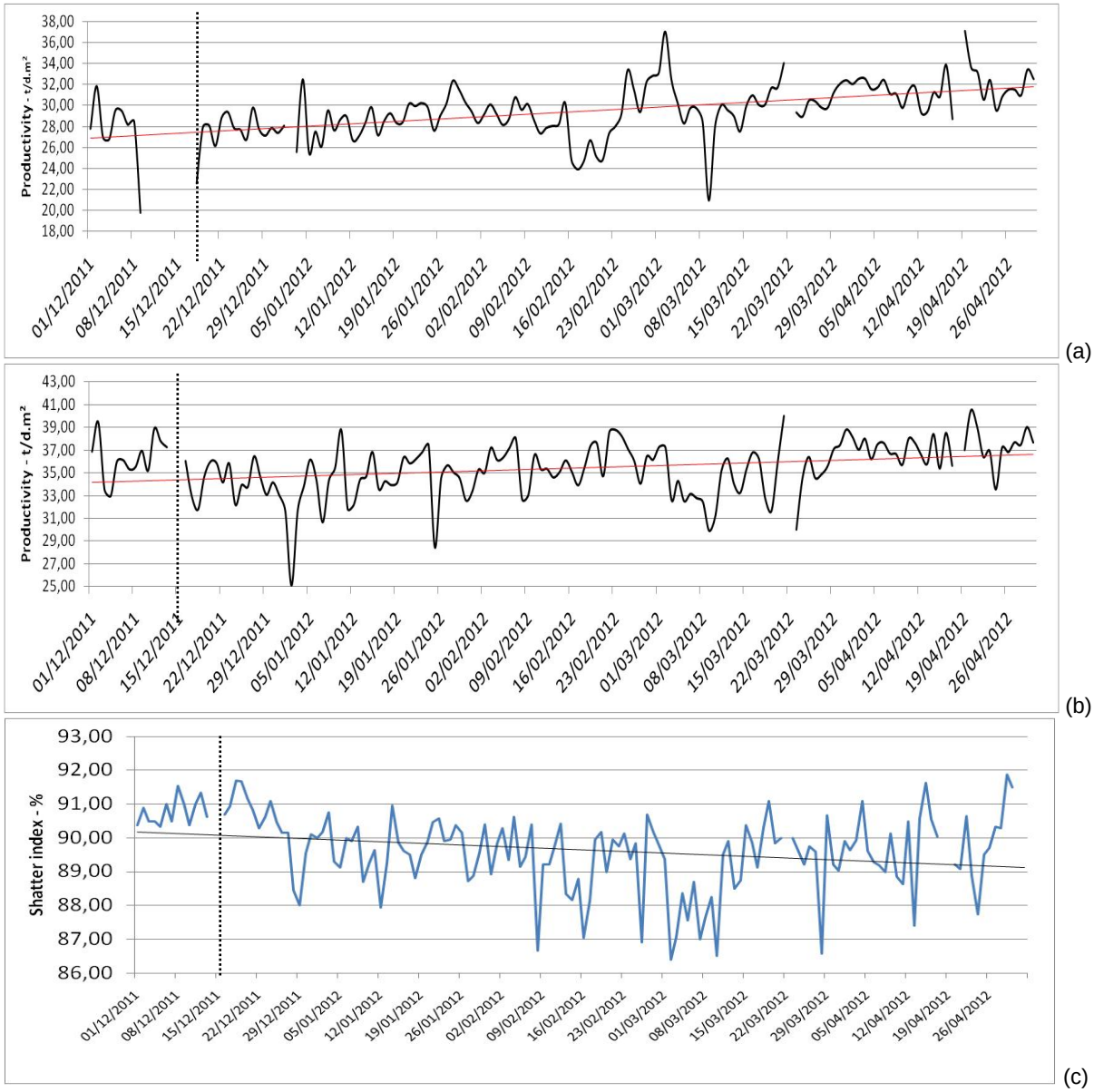


Figure 8. Operation indicators: (a) Productivity of sinter machine #1; (b) Productivity of sinter machine #2 (c) Shatter index.

Figure 9a shows the specific consumption of burnt lime, the behavior of the particle size fraction of the iron ore and participation of pellet coarse in iron ore burden. It may be noted that there was an increase in the burnt lime consumption, due to reduced +1 mm fraction of the iron ores (Figure 9b) and the highest share of pellet coarse at sintermaking.

This way the increase in productivity is related to these factors as well and not only to the using of intensive mixer.

In Figure 9c can be seen that the projected utilization of 25% pellet coarse mix of iron ore was hit a few because of unavailability of this kind of iron ore.

Regarding the rate of operation of the intensive mixer, it can be said that is currently running as well as Figure 9d. In the beginning there were some mechanical, electrical and automation problems, but problems start to normal operation of any equipment.

With the use of intensive mixer there was an increase in about two minutes of residence time of burnt lime in contact with water favors its hydration. Enabling greater use of burnt lime in sinter machine.

ISSN 2176-3135

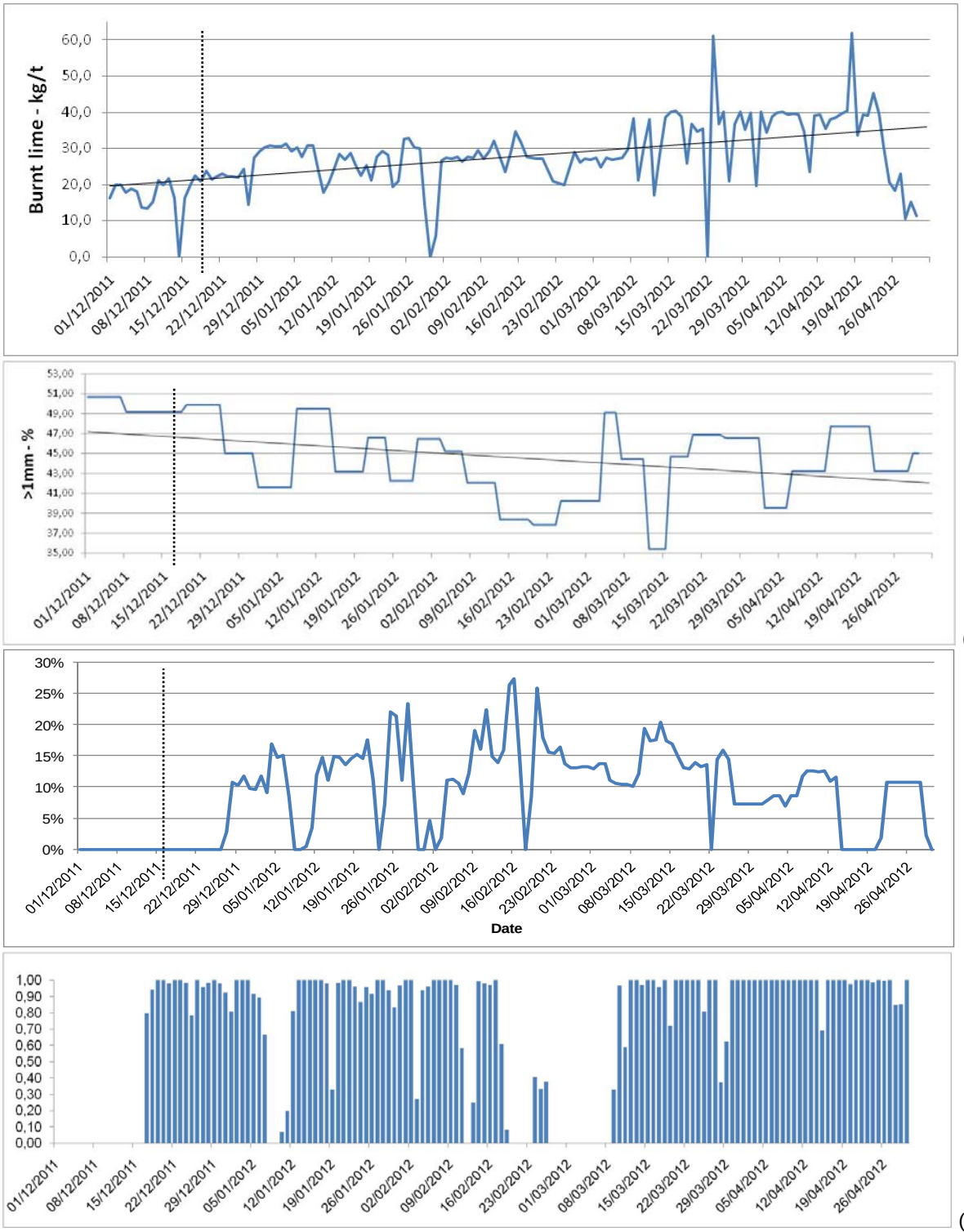
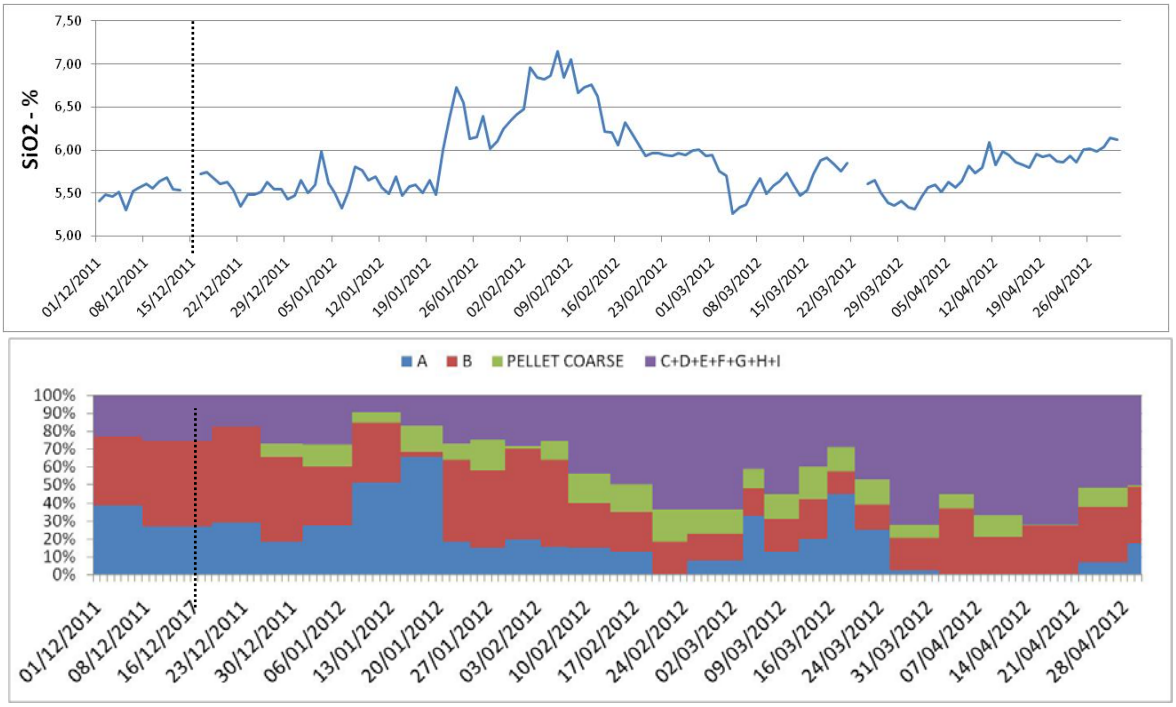


Figure 9. (a) Specific consumption of burnt lime; (b) Particles of iron ore +1 mm; (c) Percentage of the pellet coarse in the iron ore burden; (d) Availability index of intensive mixer.

The expectation with the consumption of pellet feed was to reduce the silica content of the sinter. The participation of pellet feed in the mix of iron ore really decreased the content of silica in sinter, which contain a lower content of this element in its composition compared with sinter feed's (6.52% and 6.22% are the results of silica average of the two largest suppliers of sinter feed in the first four months this year). But with the reduction of stocks of iron ore fines, due to torrential rains that occurred earlier in the year, coupled with the diversification of suppliers of iron ore and

ISSN 2176-3135

consequently the variation of the silica content of fine ores and unavailability of larger volume of pellet feed, prevented the achievement of this goal, as shown in Figure 10.



(a)

(b)

Figure 10. (a) % SiO_2 at sinter; (b) Composition of suppliers of sinter feed and pellet coarse.

To evaluate the effect of intensive mixer together and pellet coarse at sintermaking operational indicators, it was picked up only data in which the mixer was running along with the days that there was consumption of pellet coarse.
Therewith, on the figure 11 is shown in the productivity of sinter machine # 1 and # 2 and shatter index, consumption of pellet coarse and burnt lime. It can be noted that there was an increase in productivity of the machines, but with a decrease in mechanical strength of the sinter. In the same figure it can be observed increase in the consumption of burnt lime and pellet coarse. This situation was expected since previous studies in Research & Development Center of Usiminas indicated that this type of iron ore (pellet coarse) has low capacity to granulate which could affect the operational indicators of sintering and thereby increasing the burnt lime was premeditated. Concerning to drop of mechanical resistance of sinter, it also can be attributed to use of many different iron ore and this iron ores in the sinter plant may have contributed to this drop in resistance due to different physical forms of assimilation.

ISSN 2176-3135

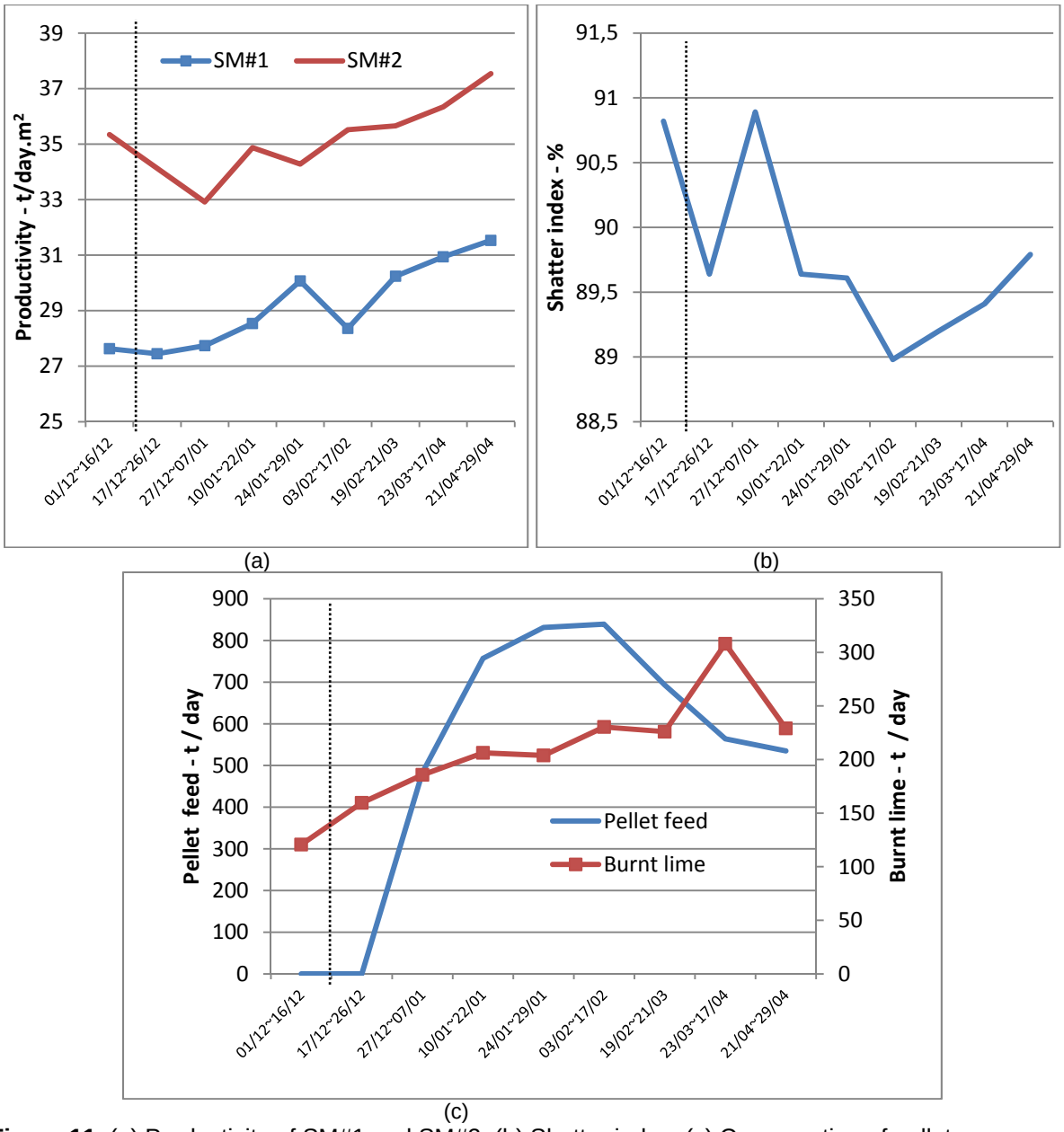


Figure 11. (a) Productivity of SM#1 and SM#2; (b) Shatter index; (c) Consumption of pellet coarse and burnt lime.

4 CONCLUSIONS

The pellet coarse consumption contributed to the reduction of silica sinter, but due to elevation of iron ore suppliers, the reduction of sinter feed stock at the beginning of the year, not resulted in reduction of silica planned

It is hopped in the begging of 2013 a better situation of sinter machine indicators, because the Usiminas mine will be able to supply pellet feed for the Ipatinga Plant.

The effect is much more effective homogenization in the intensive mixer, which was noted by the increase of efficacy of hydration of burnt lime as evidenced by increase in temperature of the mixture.

Increase in about two minutes of residence time of burnt lime in contact with water favors its hydration. Enabling greater use of burnt lime in sinter machine.

The intensive mixer along with the increasing of burnt lime contributed to the increase in machine productivity.

ISSN 2176-3135

The increased homogeneity of the mixture provided by the intensive mixer, improving the relationship between adherent and nucleant. Allied to increase the area of the drum granulation, increases the cold agglomeration.