ALTERNATED CONVERTER OPERATION AT C. S. HUACHIPATO, CHILE[1]

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Summary

In view of the limitation of a two-converter and a single gas exhaust system layout, the conventional BOF Shop operation at Compañíía Siderúrgica Huachipato (CSH) considers the processing of steel with one operating converter while a second vessel is laid off for repair or in standby mode. With an alternating converter scheme, increased production continuity is achieved both by minimizing repair work and converter lining replacement times and maximizing the alternated converter operation. Production priority is given to the converter with a longer refractory life.

Key-words : Converters, Productivity, Operational Factor.

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1. INTRODUCTION

Compañía Siderúrgica Huachipato S.A. (CSH), located in Talcahuano, Chile, is an integrated steel works that supplies about 70% of Chile's steel market.

The CSH BOF Converter Shop has a maximum production level of 1,200,000 MT of liquid steel per year by processing hot metal in two 110 MT LD converters. The BOF Shop steel production is intended for the two downstream continuous casters, one for slabs and one for billets, which receive steel in an alternating supply, to assure the continuity of both casters.(1)

Even though the majority of BOF steel shops across the world are somehow tailored to satisfy consumer demand, this is not the case of the CSH BOF Shop, since the steel mix product ranges from the ultra low carbon (< 0.04%) to high carbon (1%) steels, all grades produced by using original non-adapted converters.

The production capacity increase of CSH over the past 30 years has required different investment plans, such as the installation of the current two continuous casting machines to replace a blooming mill, new rolling mills, etc.

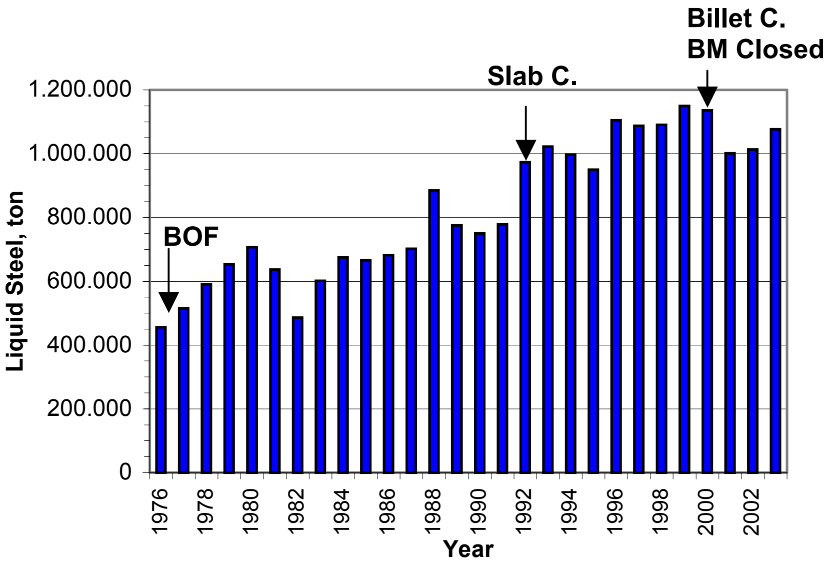

Figure 1. CSH's annual liquid steel production.

Thus, a production limitation condition occurred across the plant, with the BOF Shop regarded as the main bottleneck.

2. DEVELOPMENT

From its 1976 startup, the CSH BOF converter operation was conceived with one processing converter and a second one under repair or relining work or in standby mode. As a matter of fact, the CSH BOF Shop building is provided with a single gas exhaust and flushing system for both converters.

On the basis of that design, the continuous operation of a single-converter steel shop provides a maximum yearly output of 1.2 million tons. However, the BOF Shop output is largely diminished by periods when the converter working lining needs to be repaired for wear and also affected by operational breakdowns such as hood breakages, crane downtime and others. Production flexibility is likewise affected due to time lost either to stoppages resulting in hot metal backlogs in torpedo ladles, which in turn derive in unprocessed hot metal derived to plate iron, or the alteration of the regular blast furnace casting schedules with a negative influence upon the operational continuity.

In the alternated converter (or "one and a half converter") operational scheme, the aim has been to maximize the operational periods with two available converters, using both on an alternating basis, due to the limitation to perform simultaneous heat blows in each converter, given the BOF Shop facilities restrictions, mainly intended for a common gas exhaust and flushing system.

By alternating two converters, further productivity is achieved on the basis of a cycle of two heats that can be made independently, without affecting each other, considering it is basically the heat blow stage that limits the joint operation of the two converters. The following figure allows a glimpse into the two converter alternated scheme during normal heat processing cycles.

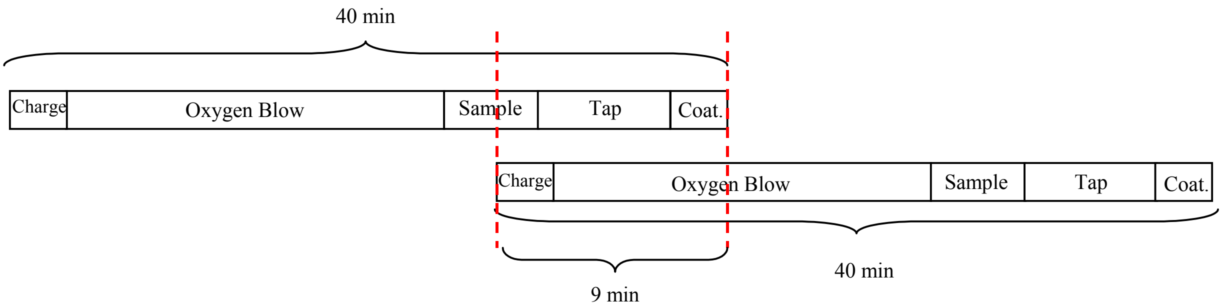

Figure 2. Heats cycle in converters alternance.

Thus, an usual 40 minute tap-to-tap time can be reduced to 31 minutes based on alternating converters. Under optimum oxygen blow supply conditions and using some sampling methods such as celox sensors or a sub-lance, the sampling time can be lowered even further to reach an in-between heat time of 20 minutes.

Among the major factors which had to be dealt with in order to have this procedure implemented, the converter change had to be considered on the basis of shared equipment such as the gas exhaust system and the dart insertion machine. In all, during the early trials, the converter change operation involved a 20 minute period.

Limit switches and safety pins in the sprinkler water saturation cones were replaced in the system, isolating the exhaust gas suction from the converters. This modification from mechanical (endless screws, gears) to hydraulic parts was the main change that permitted a reduction from the original 20 minutes to only one minute in the converter change period.

The in-plant steam supply scheme to the system was modified with independent valves for each converter: Originally, such valves were intended to isolate each converter so that steam would not be supplied to the converter system in stand-by mode. With the alternating converter program, the valves to both converters remain open; thus, steam available in the stand-by converter lines can be shifted to the operating converter resulting in a reduction of in-plant steam consumption.

3. RESULTS AND DISCUSSION

The alternating converter operation scheme has permitted a significant increase of the CSH BOF Shop output by taking advantage of the nonprocessing time, such as stoppages for tube replacement, refractory coating and other such downtime. This way, from an average of 31 heats per day achieved in previous years -counting out scheduled maintenance days and blast furnace downtime- a 32 heat per day average was reached in 2004. Likewise, in an alternating converter program a daily CSH production record was set at 39 heats with 4,260 tons.

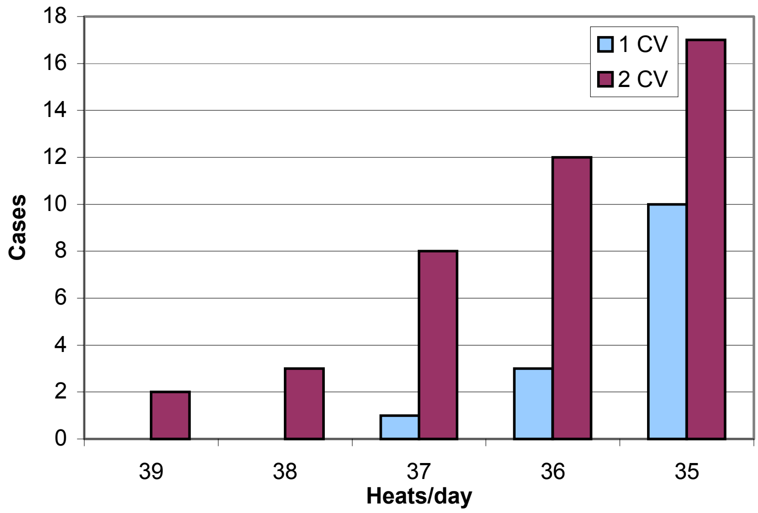

Figure 3. Total cases over 35 heats/day. Year 2004.

The operational flexibility attained under this method has reduced the stoppage-related nonprocessing time such as taphole replacement, slag coating, lance height measurement, vessel mouth cleanup and other such downtime typically not considered in a delay scheme, as these are part of a normal converter process. Likewise, failure-related stoppages, such as the independent exhaust gas circuit or the individual converter oxygen lance system breakdowns, have been reduced. The following figure shows the operational stoppage-related time percentage within periods with either one or two converters in 2004, the year when such scheme was implemented.

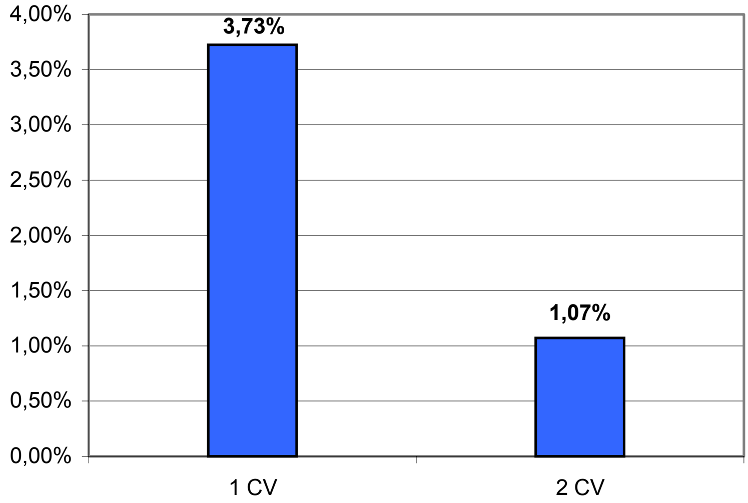

Figure 4. Stoppage-related times by converter operation periods. 2004.

By means of an alternating converter operational scheme, the processing time has set record heat times at the CSH BOF Shop, where a 17 minute tap-to-tap time has been achieved in optimum oxygen and supplies availability conditions. The real worth of this achievement can be seen in the capability of speeding up the production rate after scheduled maintenance or failure-related stoppages in the production line comprised by the BOF Shop, Ladle Metallurgy and Continuous Casters, which may in turn derive in a hot metal backlog and the occasional product loss in terms of quantity and opportunity, as it may be hot metal loss to plate iron due to such backlog.

Next, both the average and minimum tap-to-tap times are shown as they were attained in one or two converter cycles in 2004.

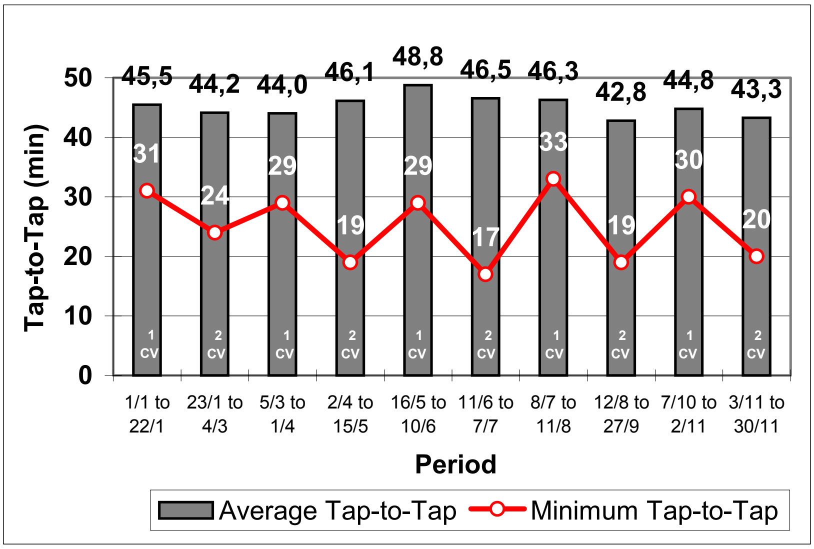

Figure 5. Average and minimum tapping times between heats by operative period.

It must be noted that even though the average tap-to-tap time is similar in both the single or dual converter operation, this is mainly due to failure-related time delays resulting in production stoppages, such as continuous caster interruptions or crane breakdowns.

The CSH Blooming Mill shutdown in 2000 was associated to an increase of the total number of heats processed in the converters as ultra low carbon steels (ULC), which in turn derived in converter lining average life reduction due to larger refractory wear under more aggressive converter operation conditions.

The possibility of reducing the so-called idle time under the alternating converter scheme has allowed the CSH BOF Shop enough time to carry out refractory protection tasks,[2, 3] such as gunning or slag coating, which on a single converter operation are inefficient as there may not be enough time for the gunning material to properly set.

The following figure represents the converter lining life increase attained with an alternating converter operation.

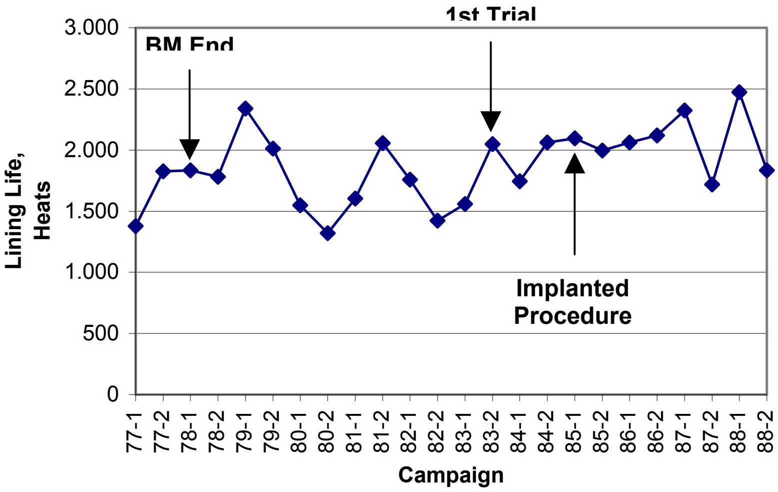

Figure 6. Evolution of BOF refractory lining life.

Even though the alternated converter procedure has achieved significant development and has been set as a standard production practice in CSH BOF Shop, the present operational conditions do not permit the direct shift of both converters in every heat, but only the processing of short heat sequences in one and the next converter (e.g. 3-1, 3-3 or another such sequence). Some significant investment must be made by CSH in order to achieve a larger alternating rate between both converters and to assure steel quality and productivity with the final aim of maximizing the BOF Shop production under this operational procedure.

Additional effort is being made in order to reduce the time for working lining replacement and repairs at the independent section of the gas exhaust and flushing system, so as to maximize the operation period with two converters.[2] At present, the original six week period has been decreased to a three and a half week repair period with an ultimate ten day target.

4. CONCLUSIONS

The operation of the steel shop with both converters in alternated regime minimizes the production periods with just one converter. Such extra time span is used in refractory change and hood repair tasks.

Given the present availability of a single gas exhaust system, the simultaneous dual operation of both converters is impossible. However, these two converters can be feasibly alternated with each other. Thus, a significant amount of stoppages, such as taphole replacement and slag coating work as well as failure-related delays from lance system breakdowns, hood repairs or any such delays, are subsequently absorbed by the second converter operation.

The CSH BOF Shop operational idle time reduction with an operational factor increase has caused this plant to be no longer a bottleneck in CSH. Thanks to a joint converter operation this shop has reached a record high of 1,207,000 MT of liquid steel in 2004.

The operational flexibility acquired with this procedure has permitted the BOF Shop to aim for a yearly output of 1,350,000 MT of liquid steel on the basis of minimizing the single converter availability period. Such production target represents a 12.5% increase of CSH's production capacity

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