SYSTEMS & MANAGEMENT
Electronic magazine

ACCUMULATION OF COSTS IN PROCESS: A PROPOSAL ON A STEEL INDUSTRY

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Summary

this article aims to propose the cost accumulation system of a steel industry using the method of equivalent units of production. By its nature, the study is defined as exploratory, with qualitative approach, applying a case study. The survey was conducted with a steel industry of Pará state. Data were obtained for management reports, provided by the management of the industry, which describe the cost centers, production inventories, flowcharts of production processes and values in stock. It is proposed segregation of the stocks from the main production processes. There were prepared six cost flows tables for each proposed stock, applying the degree of completion for the assessment of equivalent units in each production cycle. Creating more stocks using the method of equivalent units results in benefits to managers by the disclosure of the processes and control these individually stocks, identifying costly processes to industry and the recognition of more accurate cost, the use of the cost of efforts employees in the period. It is suggested that studies be made in companies in other industries with application of the accumulation of costs and the degree of finishing system.

Keywords: Cost Accumulation per Process, Production Equivalent Units, Production Process, Finishing degree.

1. INTRODUCTION

The global scenario has undergone several transformations, both in the political and economic outlook and in the management of organizations. According Beuren, Sousa et Raupp (2003), analysis of cost information is relevant to the decision-making process in organizations, both at the time of the sale price of the definition and the management of costs and decisions that result incentives to products more profitable.

Given the importance of the processes and activities by which it adds value to customers, and how they are consumers of organization resources, Ching (1995) reports the importance of having mechanisms to ensure management of these processes and activities.

For Garrison et Noreen (2001, p. 57), the essential goal of any management costing system should be providing cost data to help managers to plan, control, directing and making decisions. Nevertheless, the requirements of external reporting, financial and tax often greatly influence how the costs are accumulated and synthesized in management reports.

The term system is used here to define the set of administrative components, record, flows, procedures and criteria that act and interact in a coordinated manner to achieve certain goal, which in this case is the cost of production and product (Leone, 2000).

Accumulation system is how the entity assigns costs to a particular object costs. According to Hansen et Mowen (2001), accumulation of costs is the act of recognizing and registering them, thereby defining how the organization accumulates the costs incurred. A database that allows managers to analyze the information to assist in decision making and in view of the relevant costs is created.

Regarding costing systems, Maher (2001) presents three systems: the production order costing system; the

PROPPI / LATEC
DOI: 10.20985/1980-5160.2016.v11n2.1100

Electronic Journal of Management & System
Volume 11, Number 2, 2016, pp. 228-241
DOI: 10.20985/1980-5160.2016.v11n2.1100

cost of system operation; and the costing system process. The latter is the object of study of this work.

The accumulation system processes are found where there is identical production units continuously (Horngren, 1985). The costs in these storage systems should be retained in departments, with no separate records of costs to the production units.

In the production cycle, it can be partially completed units, but the units must be measured with the aid of equivalent units of production, so that efforts are recognized applied in a given period (Hanse et Mowen, 2003).

One of the motivations for this research was the lack of studies that address the treatment of costs accumulation in industrial enterprises and demonstrate the process of accumulation and the application of equivalent units in the production cycle.

Because the importance of controlling costs for manufacturing entities and a good determination of these, the work aims to answer the following question: **how it works the process for cost accumulation and application of equivalent units of production in an industry?**

Considering the present problem, the research aims to demonstrate the operation of a cost accumulation system for process, with application of equivalent production units in an industrial company in the state of Pará. In addition, the study aims to describe the production processes and products provided, with their characteristics.

The research is organized into five sections, beginning with this introduction; soon after, the conceptual approach on cost accumulation, cost accumulation system procedures, production equivalent and degree of finish; as a result, presents the methodology used in the research; then analyzing the obtained data; and in the last session, the conclusions of the study limitations and suggestions for future research.

2. 2. THEORETICAL BENCHMARK.

In the following step, there are presented the theoretical pillars of this work. It is not intended to exhaust the subject, but to present points that contribute to the understanding of the work.

2.1. Cost accumulation systems

The costs of storage systems are designed to do the survey and the accumulation of manufacturing costs during production, i.e., take into account the form of productive organization of companies to determine the value of this production.

A cost accumulation system corresponds to a subsystem of an organization of cost system that has the function of accumulating costs in an organized manner, considering the way the company operates the decisions that need to take and yet their cost objects (Borinelli, Beuren and Guerreiro, 2003).

Some of the utilities cost systems are: set prices, identify products with very expensive to produce, evaluate stocks, among others. Structured cost systems provide information on productivity, contribution margins, waste, planning, and other essential information for business management (Lopes et Rocha, 2010).

Accumulation systems refer to mechanisms used in successive transfers values to the goods or services offered by companies. Thus, Machado (2005, p. 120) says that the accumulation system takes care of the cost accumulation process, and its design is associated with the entity's production system.

In his own, Horngren (1985) comments that the detailed process of cost allocation to products ranging from certain companies to others and says that there are two ways of costing of products: in order of production and the costing procedures.

Some authors consider a third form of accumulation system: the costing of operation which, as Maher (2001, p.186.), is a hybrid system between the cost per order and cost per process. In the Production by the Order, the costs are accumulated in a special account for each order or order that account for receiving costs when the order is closed.

Martins (2010, p.145) explains that:

> If you complete an accounting period and the product is still in process, there is no closure, remaining costs previously incurred in the form of development in assets, in assets; when the order is terminated, will be transferred to finished goods inventory or cost of goods sold, as appropriate.

In continuous production, the costs are accrued in the accounts representing the various production lines; are always those accounts closed at the end of each period (month, week, quarter or year, as the minimum accounting period of the company's costs), the accounts are not closed as the products are manufactured and stored, but

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DOI: 10.20985/1980-5160.2016.v11n2.1100

only when the end period. In the calculation of process, costs are not evaluated unit by unit, but on the basis of the average cost of the period (by dividing the total cost by the quantity produced) (Martins, 2010, p. 145).

The cost per transaction (or hybrid) is used in the manufacture of products that have some common features and some specific characteristics, and this operation is a standardized method of manufacturing a product, repeatedly run (Maher, 2001, p. 186).

Some differences between the costs of storage systems for production order for process and operation are in Table 1, briefly.

According to Garrison et Noreen (2001, p. 104), the accumulation of the cost is simpler in costing procedures than the cost of production order, in the first, rather there are hundreds of individual production orders, the costs are appropriate only the production departments. As the study is focused on the accumulation of system processes, this issue will be further explored in the next section.

2.2. Cost accumulation systems process

Practically all the works that deal with cost accounting deal with the subject "costing procedures", which can be best characterized as a process and called for cost accumulation system.

The process for cost accumulation system, according Horngren (1985), is often found where there is a mass production of identical units in sequence of various processes, dividing the cumulative costs of a period by the amount produced in the period to reaching general unit costs and average.

In the cost per case, costs are accumulated by department, not being made separate records of costs for products.

Each manufacturing stage usually develops in a productive section (department), in which they are incurred direct costs and indirect costs, generating products whose characteristics do not allow the unit control, in which case the monitoring of costs is made by: batch, family, group or production line, and fitting accumulation by processes (Marion et Ribeiro, 2011).

The cost per process is costing method in which costs are also assigned to homogeneous units, in a given period, and is used when the product is produced in a continuous flow.

According to Garrison et Noreen (2001, p. 101), "The cost per process is particularly employed in companies that transform raw materials into homogeneous products." In addition, the cost of processes is often employed in companies that use some kind of calculation cost by processes in their assembly operations and also in companies producing gas, water and electricity, that is, this type of funding is used in a wide range of companies.

In this kind of system costs, the various processes that make up the production of the product are identified and, from that, search is costing these processes, which can be via the department, via cost center and via central results; and, as a result, are found-which and how many products have been worked on each process in a given period to assign costs to these products (Borinelli, Beuren and Guerreiro, 2003).

Some key features that relate the process for cost accumulation systems, as Borinelli, Beuren and Guerrero (2003), are:

> The products are produced on a large scale for sale in general; typically provide similar products, i.e., a single product is made continuously in large quantities; production is organized in processes, departments or sections different from each other; they seek to fund the process, identifying the resources

Table 1 - Differences between the costs of storage systems in order, process and operation.

Accumulation by Order of Production	Accumulation by Process	Accumulation by Operation (Hybrid)
1. Production orders are executed each period, each one with different specifications;	1. A single product is manufactured continuously or in several periods. All units manufactured are equal;	1. It is used in the manufacture of products that have some common characteristics and some specific features;
2. The costs are accumulated by order, individually;	2. The costs are accumulated by department;	2. The cost of direct materials differ, but with the same conversion costs;
3. The unit cost is calculated by order.	3. The unit costs are calculated by department.	3. The unit costs of materials differ between products, but the conversion costs are the same.

Source: Own elaboration.

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> consumed, both in physical units and in monetary values, by processes.

It should be noted that inventories are determined by the cost accumulation methods (PEPS), first in, first out, in which current period costs are tracked separately from initial inventory costs, and weighted average where no separation of the initial inventory costs (Maher, 2001).

In some situations, a department usually has units partially completed in its final stock and count their production, and does not seem reasonable to assume that they equate to fully completed units, thus, becomes these semi-finished units in an equivalent number of finished units (Garrison et Noreen, 2001).

2.3. Method of equivalent production units

By checking any time of a continuous production cycle, there may be partially completed product units and completely finished product units.

Considering the partially finished production, Hansen et Mowen (2003) report that these units should be measured according to equivalent units of production, to reflect the effort expended on completed units and partially completed. The authors define the "equivalent production units are complete units that could have been produced given the total amount of productive effort expended in the period under consideration" (Hansen et Mowen, 2003, p. 167).

According to Maher (2001), there are two simple scenarios in the allocation of costs to products: in the first, there is no initial stock or final products manufacturing; and the second scenario is the same as the first, except that at the end of the period, only part of the units is completed.

Guerreiro, Catelli et Cornachione Jr. (2000) report that there is a consensus in the definition of the basic procedures involving the quantification of the finished production units, in the conversion process in units of equivalent finished units through the use of a percentage of completion, in calculating the unit cost and assessment of production and product inventory in manufacturing.

As mentioned by Rodrigues et al. (2000), to establish a relationship between the costs and the period units produced, one can determine the unit cost of production resorting to the concept of equivalent units.

The method of equivalent units basically consists in converting the product units in progress, in units equivalent to a finished product, utilizing a degree of completion of the ongoing production, as a percentage, according to the criterion value stocks, using PEPS, UEPS, or Cost Weighted Average (Rodrigues et al., 2000).

When there is no initial stock at a time, per unit costs, according the Wolcott et Eldenburg (2007), are the same for the method of PEPS cost and the weighted average method.

2.3.1. Production Units Equivalents by Weighted Average

In the calculation of equivalent units by the weighted average method, the calculation of unit costs is made by combining the initial inventory costs with the costs incurred in the period.

The above idea is reinforced by Eldenburg et Wolcott (2007, p. 226), explaining that "initial inventory costs are included in the average calculation along with all costs incurred in the period."

The weighted average, the initial stocks are added to the production period, and applied the finishing level only in ending stocks for calculation of equivalent units for the period. After applying the finishing level in ending stocks in proportion to direct materials and conversion costs (can they have different degrees of finish), add to the cost of the units of the initial stock and units launched in the period, and the result divided the total units of the period (finished units with units of the final inventory after the calculation of equivalent units). This division results in cost per equivalent unit, which, multiplied by the number of units transferred and the number of equivalent units in ending inventory, resulting in total cost transferred and the total cost of the period (Maher, 2001, p. 171).

2.3.2. Production Units Equivalents at PEPS

In the calculation of equivalent units at PEPS, there is the need for separation of the initial stock for the activities in the current period, and the unit cost of the period only covers its activities.

According to Hansen et Mowen (2003, p 170.):

> Under the PEPS costing method, the equivalent units and manufacturing costs in the initial inventory of products in process are excluded from the calculation of unit cost of

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the current period. Thus, the PEPS recognizes that work and carried costs of the previous period belong rightfully to that period.

Maher (2001, p. 174) shows, with the aid of a table, how the method of equivalent production units through the PEPS. It is applied the degree of completion for both the units of the initial stock as to the units of the final inventory because the PEPS costs appropri ate in the period must be purged of this period, i.e., equivalent units recognized in the past period should be excluded the initial stock of this period. Applies the degree of completion in the initial stock, the units started last season and finished in this period, and at the end stock, the proportion of the effort employed in the units started in the current period but not yet finished.

After the calculation of equivalent production units, we add the equivalent units of the initial stock to units started and completed in the period and also the equivalent units of the final inventory.

To find the cost per equivalent unit, we divide the cost of the units launched in the period by the total of distributed units (the sum of equivalent units of the initial stock, the units started and finished the period and equivalent units of ending inventory).

To find the value of the initial stock, we multiply the cost per equivalent unit (both direct material and conversion costs) by equivalent units of the initial stock. Then, we add the result to the value that was already in the initial stock.

The units started and completed in the period follows the same method of initial stock, however, we multiply the cost per equivalent unit of the units started and completed in the period.

The final inventory costs result from the multiplication of equivalent units of ending inventory by the cost of equivalent units of direct materials and conversion costs.

So, we find both the value of opening stocks, the units that began and ended in the period, and the closing stocks.

2.3.3. Degree of Finish

Much has been talked about level for the calculation of equivalent production units. Guerreiro, Catelli et Cornachione Jr. (2000, p. 8) state that "the processing plants in processing equivalent finished units is done through the finishing degree of concept."

There is a need to estimate the degree of finish where the material and other features are added during the production process, and an important aspect to be noted is that the degree of sizing must have economic significance, and not only physical and should represent how much a processing unit would receive the cost burden that would be required to start it and finish it completely (Guerreiro, Catelli and Cornachione Jr., 2000).

For the calculation of equivalent production units, was proposed by Guerreiro, Catelli et Cornachione Jr. (2000), there is the knowledge of the stages of the product manufacturing process (sm) of standard unit cost of the product accumulated to a stage specific (sc), the unit cost of the finished product (fp) and the amount of process product at the particular stage (ap). The calculation of the degree of sizing is given by the product of the sum of the quantity of product in case the specific stage with the standard unit cost of the finished product divided by the product of the quantity of product sum in case the specific stage the unit cost of the product finished.

3. METHODOLOGICAL ASPECTS

This section aims to explain what type of research used in the study, what were the procedures used to collect the data and how their treatment and systematization.

3.1. Type of search

The study, as to its nature, is classified as exploratory once it seeks to clarify the process by accumulation of system characteristics in an industry. As said Gil (2008, p. 27), "exploratory research has as main purpose to develop, clarify and modify concepts and ideas, with a view to formulating more precise problems or searchable hypotheses for further studies," and "usually involve lifting bibliographic and documentary, non-standardized interviews and case study."

It was applied the case study like the way to study design. According to Yin (2001, p. 32), the case study is to "[...] an empirical research that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly defined. " The case study is characterized as a "deep and comprehensive study of one or a few objects, in order to allow its broad and detailed knowledge" (Gil, 2008, p. 57). Using the case study is through the integration of the issue and the reality of the company, which legitimizes the use of case study.

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The study has a qualitative approach, which is justified to the extent that the research focuses more on improving the understanding of the accumulation of costs by processes in industry than in its numerical representation of the study. Gerhardt et Silveira (2009, p. 31) state that "qualitative research is not concerned with numerical representation, but with the deepening of understanding of a group [...]", considering themselves the "[...] aspects of reality that cannot be quantified [...] ".

3.2. Data collecting

The case study will be done in an industry located in the Pará state Southeast. The industry is a Steel factory, a corporation privately held, working with production of a raw material in the production of steel, called pig iron. The Steel factory works with the extraction of iron ore, Vegetal Coal, Limestone and Pebble, which led to high temperatures and the reaction of raw materials, produce the product of this industry: The Pig Iron.

As the option of the company, its name will not be published, and in the research, the company name shall be Marabá Steel Factory.

Data were collected with the help of semi-structured interviews with those responsible for accounting and for Steel production sector, with the following matters related questions: the existence of opening stocks and end by period; number of departments and/or cost centers; amount of inventories; processes for the manufacture of the product; product characteristics; application of equivalent production units; and knowledge of the calculation of the degree of completion of uncompleted units.

After the application of semi-structured interviews was provided by the administration to direct documentation of Steel factory, which consisted of: flowchart of steel production processes; balance sheet inventory containing the balances of synthetic and analytical accounts; list of productive cost centers; production report containing information of costs and the units produced for the year 2014.

3.3. Data processing

The data provided by the company will be organized into reports and tables, so there is a better view of the current situation of the company. By means of the disclosure of the company's costs accumulation system, systematization of proposals will be made of the cost of production flow by processes that the Steel factory showed in their flowchart of industrial production processes.

Tables will be organized containing the tonnage and cost in initial inventory, tons and units costs initiated and completed in the period and amount of tons and unfinished units costs at the end of stock. In these costs accumulation flows for each process, the method of equivalent units by the degree of completion of uncompleted units will be applied. The proposed values are fictitious, because the company does not have such data.

4. CASE STUDY IN MARABÁ STEEL FACTORY

They are presented in this section of the research: the situation of the company, according to documents sent by the administration; the proposed costing procedures, in which the authors will propose a systematic structure of the cost of production flow for process and explanation of this method, demonstrating the results of applying the costing procedures in Marabá Steel Factory.

4.1. Descriptive analysis of the case study: Marabá Steel Factory

The product generated in the industry is called Pig Iron. In Marabá Steel Factory, there is only the production of that item, with shape and unique size. This characteristic meets the definition of Horngren (1985), the production of identical units. It was also identified that the production is continuous, with average monthly output of 8,000 tons for export. Corroborating the idea Horngren (1985), the products meet the mass production characteristics, following several continuous processes, characterizing the process by accumulation system in Marabá Steel Factory.

The Steel Factory works with iron Ore extraction, Charcoal, limestone and pebble. These are the raw materials used in the production process. The raw materials are carried to the oven at high temperatures, which may affect the chemical processes required for the formation of Pig Iron.

The industry is composed of five major departments, which receive direct and indirect costs of production: Industrial Management; Foreign Coal; Industrial; Maintenance; and Forest. Production of Pig Iron moves mainly by the industrial department. Table 2 shows the company's production cost centers, which are fully related to the Industrial Department, receiving the direct costs and production-related indirect.

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Table 2 - production costs centers of Marabá Steel Factory.

PRODUCTION COST CENTER
02.01.01 Pig Iron Production
02.01.01.01 Pig Iron Production
02.01.01.01.0001 Blast Furnace
02.01.01.01.0002 Loading Area
02.01.01.01.0003 Runnig Area
02.01.01.01.0004 Casting Area
02.01.01.01.0005 Machine Room
02.01.01.01.0006 Coal discharge
02.01.01.02 Tumbling
02.01.01.02.0001 Tumbling
02.01.01.03 Screening of Raw Materials
02.01.01.03.0001 Screening of Raw Materials
02.01.01.04 Sieving
02.01.01.04.0001 Ore Sieving
02.01.01.05 Sinter Production
02.01.01.04.0001 Sintering

Source: Own elaboration.

According the Table 2, the cost centers receiving the direct costs of production of Pig Iron are: Blast Furnace, Loading Area, Running Area, Casting Area, Machine Room, Coal Unloading, Tumbling, Sieving of Raw Materials, Sieving Ore and Sintering. It is emphasized that these cost centers are included in the Industrial Department, which carried over the processes necessary for the formation of the product, in which the direct and indirect costs are accumulated.

For this case study, we need to approach the production process of Pig Iron, to further highlight the way in which the costs are accumulated in each process by industry cost accumulation system.

Figure 1 shows briefly the production process of Pig Iron, since the entry of raw materials in the production process until the completion of the product (shipping).

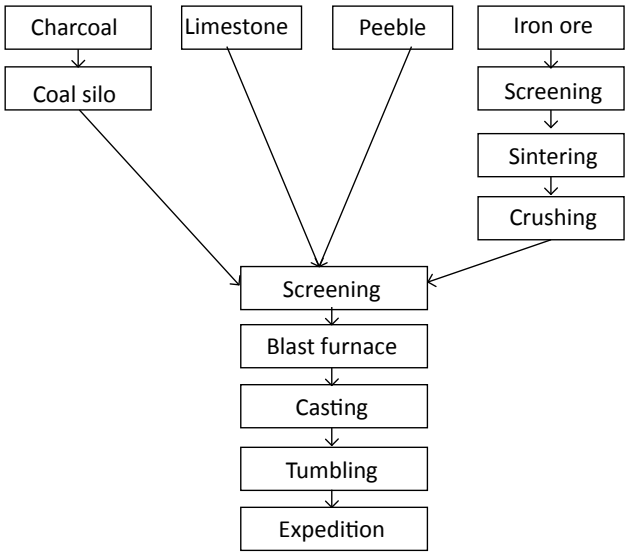

Figure 1 - Summary of the pig iron production process - Marabá Steel Factory.
Source: Own elaboration.

In the process shown in Figure 1, the raw materials enter the industrial sector, the coal and iron ore transit through other processes until they reach the screening that takes the material to the blast furnace. The coal after extraction is stored in the coal silo and ordered to screening. The iron ore is sieved goes to sintering and then to crushing department, following to the second screening, with the coal, limestone and pebble. After screening, all raw materials are brought to the blast furnace, where there are chemical reactions necessary for the formation of Pig Iron. Going out blast furnace the Pig Iron is intended to phase casting and tumbling, where the product is completed. After this process the product goes to the expedition, ending the Pig Iron production process.

Production is continuous with exit to the market periodically, so the production at the end of each period are in various stages of progress, with products in stock of raw materials, stock in sintering, in stock tumbling, among others.

Products in the initial stock and final feature costs accumulation system and require the application of equivalent units of production. Table 3 shows the stocks that Marabá Steel Factory remains in its operating cycle.

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Table 3 - Steel Stocks List at Marabá Steel Factory

ACCOUNT	DESCRIPTION
1.0.4	Stocks
1.0.4.01	Raw Materials
1.0.4.01.0001	Raw Materials
1.0.4.02	Products in Development
1.0.4.02.0001	Products in Development
1.0.4.03	Finished Products
1.0.4.03.0001	Finished Products
1.0.4.04	Merchandise for Resale
1.0.4.04.0001	Merchandise for Resale
1.0.4.05	Auxiliary Materials
1.0.4.05.0001	Auxiliary Materials
1.0.4.06	Warehouse
1.0.4.06.0001	Warehouse
1.0.4.06.0003	Maintenance Material
1.0.4.7	Provisions and Adjustments
1.0.4.7.0001	(-)Provision for Losses
1.0.4.7.0002	Shipping to apportion
1.0.4.7.0003	Shopping Return

Source: Own elaboration.

The stock of Marabá Steel Factory is composed of: stock of raw materials, inventory work in progress, finished goods inventory, inventory of goods available for sale, warehouse, maintenance equipment, provision for losses, freight to apportion and return shopping.

The stock of raw materials consists of the stock of Coal, Limestone, Pebble and Iron Ore. The stock of work in progress consists of all processes from the output of the stock materials of raw materials to the shipment phase, as shown in Figure 1. The finished products in the production process out of the stock of work in progress for finished goods inventory. When the product is prepared for industry output, it is available for sale, moving the finished goods inventory to stock of goods available for sale. This is the way that Marabá Steel Factory treats its inventory, and there is a breakdown of inventories for production.

The metric unit of measurement of minimum Marabá Steel Factory costs consists of tons produced per period. According to the data collected, the average monthly export is 8 tons of Pig Iron.

The article proposes that the industry make subgroups in the stock of work in progress, introducing the most important processes, according to Figure 1. After detailed inventory, it is proposed that the process for cost accumulation is made in each production department, them using the system of equivalent production units.

4.2. Proposal for costing procedures

This item contains the proposals of the departmental structure of the industry and the systematization of the Pig Iron production cost flows.

4.2.1. Departmental structure

This article proposes that the industry constitutes the following stocks: screening of iron ore, sinter, screening raw materials, blast furnace, casting and tumbling. With the inclusion of these stocks in the production process, the balance sheet would be presented as Table 4:

Table 4 - Steel Stocks List at Marabá Steel Factory.

ACCOUNT	**DESCRIPTION**
1.0.4	Stocks
1.0.4.01	Raw Materials
1.0.4.01.0001	Raw Materials
1.0.4.02	Products in Development
1.0.4.02.0001	Sieving Ore
1.0.4.02.0002	Products Sintering
1.0.4.02.0003	Screening of Raw Materials
1.0.4.02.0004	Products in Blast Furnace
1.0.4.02.0005	Products Casting
1.0.4.02.0006	Products Tumbling
1.0.4.03	Finished Products
1.0.4.03.0001	Finished Products
1.0.4.04	Merchandise for Resale
1.0.4.04.0001	Merchandise for Resale
1.0.4.05	Auxiliary Materials
1.0.4.05.0001	Auxiliary Materials
1.0.4.06	Warehouse
1.0.4.06.0001	Warehouse
1.0.4.06.0003	Maintenance Material
1.0.4.7	Provisions and Adjustments
1.0.4.7.0001	(-)Provision for Losses
1.0.4.7.0002	Shipping to apportion
1.0.4.7.0003	Shopping Return

Source: Own elaboration.

According to Table 4, it was the inclusion of six stocks in the synthetic account of work in progress inventories.

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DOI: 10.20985/1980-5160.2016.v11n2.1100

Table 1 - Flow accumulating the weighted average cost - screening process of iron ore.

FLOW OF COSTS OF STEEL PRODUCTION - SCREENING ORE				
		Equivalent amounts (tonnes)		
Physical flow	**Physical Amounts**	**Direct Materials**	**Indirects Costs**	**Direct Labor**
Amount to be distributed				
Initial stock	4			
Tons initiated in the period	8			
Total	12			
Production Distribution				
Completed and transferred	8	8	8	8
Final stock	4	4,0	1,2	1,6
Total	12	12,0	9,2	9,6
Cost Flow	**Total**	**Direct Materials**	**Indirects Costs**	**Direct Labor**
Costs to be awarded				
Costs in the initial stock	R$ 437.500,00	R$ 387.500,00	R$ 30.000,00	R$ 20.000,00
Tons initiated in the period	R$ 1.075.000,00	R$ 775.000,00	R$ 200.000,00	R$ 100.000,00
Total	R$ 1.512.500,00	R$ 1.162.500,00	R$ 230.000,00	R$ 120.000,00
Cost per equivalent production		**R$ 96.875,00**	**R$ 25.000,00**	**R$ 12.500,00**
Allocation of costs				
Cost of tons transferred	R$ 1.075.000,00	R$ 775.000,00	R$ 200.000,00	R$ 100.000,00
Inventory costs end	R$ 437.500,00	R$ 387.500,00	R$ 30.000,00	R$ 20.000,00
Total	R$ 1.512.500,00	R$ 1.162.500,00	R$ 230.000,00	R$ 120.000,00

Source: Own elaboration.

For each stock will be an exemplification of cost accumulation in each case with fictitious values that approximate the reality of the company described in the analyzed trial balances.

4.2.2. Systematization of the cost of production flow

The study aims to structure an appropriate cost accumulation system to the state of the industry. Table 1 shows the cost accumulation process in the first case, the stock screening of iron ore.

In Table 1, the screening department receives 8 tons of iron ore, which joins the existing 4 tons in the department. They are fully completed in the period 8 tons, and 4 remain with different degrees of finish. Applying the equivalence of production, we noted that 4 tons at the end stock are 100% completed regarding direct material (4 tons); 30% in relation to the overhead (1.2 tons); and 40%, relative to direct labor.

The costs initial stock totaled R$ 437,500.00, of which R$ 387,500.00 of direct materials; R$ 30,000.00, overhead; and R$ 20,000.00, of direct labor.

In the period we are used R$ 1,075,000.00, of which R$ 775,000.00 of direct materials, R$ 200,000.00 overhead and R$ 100,000.00 in direct labor.

It was showed a total cost in the period of R$ 1,512,500.00, of which R$ 1,162,500.00 of direct materials divided by 12 tons (8 completed and 4 in the final stock), or R$ 96,875.00 for tonne; R$ 230,000.00 overhead, divided by 9.2 tons (8 completed and 1.2 equivalents to 4), or R$ 25,000.00 per ton and R$ 120,000.00 in direct labor, divided by 9.6 tons (8 completed and 1.6 equivalent to 4), or R$ 12,500.00 per ton.

The amounts transferred to the sintering are: 8 tons x 96,875.00 (per tonne) for the direct materials; 9.2 tons x 25,000.00 (per tonne) for the indirect costs; and 9.6 tons x 12,500.00 (per tonne) for the direct labor. Total amount transferred: R$ 1,075,000.00.

The values in the final stock in screening are: 4 x 96,875.00 tons (per tonne) for the direct materials; 1.2 tons x 25,000.00 (per tonne) for the indirect costs; and 1.6 tons x 12,500.00 (per tonne) for the direct labor. Total value at the end stock: R$ 437,500.00.

Tables 2, 3, 5 and 6 following Table 1 the same process, differing only in the degree of finished end stock production.

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Table 2. Flow of cost accumulation by the weighted average - synthesising department

FLOW OF COSTS OF STEEL PRODUCTION - SYNTHESIS				
		Equivalent amounts (tonnes)		
Physical flow	**Physical quantities**	**Direct Materials**	**Direct Costs**	**Direct Labor**
Production to distribute				
Initial stock	4			
Tons initiated in the period	8			
Total	12			
Production Distribution				
Completed and transferred	8	8	8	8
Final stock	4	4,0	2,4	3,2
Total	12	12,0	10,4	11,2
Cost Flow	**Total**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Costs to be awarded				
Costs in the initial stock	R$ 417.500,00	R$ 387.500,00	R$ 20.000,00	R$ 10.000,00
Tons initiated in the period	R$ 1.275.000,00	R$ 775.000,00	R$ 300.000,00	R$ 200.000,00
Total	R$ 1.692.500,00	R$ 1.162.500,00	R$ 320.000,00	R$ 210.000,00
Cost per equivalent production		**R$ 96.875,00**	**R$ 30.769,23**	**R$ 18.750,00**
Allocation of costs				
Cost of tons transferred	R$ 1.171.153,85	R$ 775.000,00	R$ 246.153,85	R$ 150.000,00
Final inventory costs	R$ 521.346,15	R$ 387.500,00	R$ 73.846,15	R$ 60.000,00
Total	R$ 1.692.500,00	R$ 1.162.500,00	R$ 320.000,00	R$ 210.000,00

Source: Own elaboration.

Table 3 - Flow of cost accumulation by the weighted average - screening department of raw materials

FLOW OF COSTS OF STEEL PRODUCTION - SCREENING OF RAW MATERIALS				
		Equivalent amounts (tonnes)		
Physical flow	**Physical quantities**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Production to distribute				
Initial stock	4			
Tons initiated in the period	8			
Total	12			
Production Distribution				
Completed and transferred	8	8	8	8
Final stock	4	4,0	1,6	2,0
Total	12	12,0	9,6	10,0
Costs flow	**Total**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Costs to be awarded				
Costs in the initial stock	R$ 605.000,00	R$ 575.000,00	R$ 20.000,00	R$ 10.000,00
Tons initiated in the period	R$ 1.700.000,00	R$ 1.150.000,00	R$ 300.000,00	R$ 250.000,00
Total	R$ 2.305.000,00	R$ 1.725.000,00	R$ 320.000,00	R$ 260.000,00
Cost per equivalent production		**R$ 143.750,00**	**R$ 33.333,33**	**R$ 26.000,00**
Allocation of costs				
Cost of tons transferred	R$ 1.624.666,67	R$ 1.150.000,00	R$ 266.666,67	R$ 208.000,00
Final inventory costs	R$ 680.333,33	R$ 575.000,00	R$ 53.333,33	R$ 52.000,00
Total	R$ 2.305.000,00	R$ 1.725.000,00	R$ 320.000,00	R$ 260.000,00

Source: Own elaboration.

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Table 4 - Flow accumulation of costs by the weighted average - blast furnace department

FLOW OF COSTS OF STEEL PRODUCTION - SCREENING BLAST FURNACE				
		Equivalent amounts (tonnes)		
Physical flow	**Physical quantities**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Production to distribute				
Initial stock	0			
Tons initiated in the period	8			
Total	8			
Distribuição da produção				
Concluídas e transferidas	8	8	8	8
Estoque final	0	0,0	0,0	0,0
Total	8	8,0	8,0	8,0
Cost Flow	**Total**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Costs to be awarded				
Costs in the initial stock	R$ 0,00	R$ 0,00	R$ 0,00	R$ 0,00
Tons initiated in the period	R$ 1.800.000,00	R$ 1.150.000,00	R$ 350.000,00	R$ 300.000,00
Total	R$ 1.800.000,00	R$ 1.150.000,00	R$ 350.000,00	R$ 300.000,00
Cost per equivalent production		**R$ 143.750,00**	**R$ 43.750,00**	**R$ 37.500,00**
Allocation of costs				
Cost of tons transferred	R$ 1.800.000,00	R$ 1.150.000,00	R$ 350.000,00	R$ 300.000,00
Final inventory costs	R$ 0,00	R$ 0,00	R$ 0,00	R$ 0,00
Total	R$ 1.800.000,00	R$ 1.150.000,00	R$ 350.000,00	R$ 300.000,00

Source: Own elaboration.

Note that in Table 3 are a direct addition of material, because it is the only department in the production process that undergoes addition of other components.

Table 4 shows no initial stock or end of the raw material, all the department receives is processed and passed on to the casting within the same period.

In Table 2, the sintering department receives 8 tons of iron ore coming from the screening process, joining the 4 tons already in the department. The stage of completion for the application of equivalent units are: 100% for direct materials (4 tons); 60% compared to indirect costs (2.4 tons); and 80% relative to direct labor (3.2 tons).

In Table 3, the screening department receives 8 tons of raw materials, which are derived from the screening process iron ore and inventories of raw materials of limestone, pebble and coal, joining the 4 tons already in Department. The stage of completion for the application of equivalent units are: 100% for direct materials (4 tons); 40% compared to indirect costs (1.6 tons); and 50% relative to direct labor (2.0 tons).

In Table 4, the blast furnace department receives 8 tons of raw materials originating from the sieving process of raw material. There is no beginning and ending stock in this process, since the end of each period all material transiting the blast furnace are transferred to the casting. No application of equivalent production plants.

In Table 5, the casting department receives 8 tons of pig iron, coming from the blast furnace, joining the 4 tons already in the department. The stage of completion for the application of equivalent units are: 100% for direct materials (4 tons); 40% compared to indirect costs (1.6 tons); and 50% relative to direct labor (2.0 tons).

In Table 6, the tumbling department receives 8 tons of pig iron, coming from the casting process, joining the 4 tons already in the department. The stage of completion for the application of equivalent units are: 100% for direct materials (4 tons); 40% compared to indirect costs (1.6 tons); and 50% relative to direct labor (2.0 tons).

After tumbling, the pig iron is transferred to the dispatch to the completion of the product and the transfer to inventories of finished products.

4.3 Results of funding application for processes

In each stock was made an accumulation system model procedures. The method of calculation of inventories is the weighted moving average, and the system of accumulation by processes has been adapted to this form of calculation.

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Table 5 - Flow Cost accumulation by the weighted average - casting department

FLOW OF COSTS OF STEEL PRODUCTION - CASTING				
		Equivalent amounts (tonnes)		
Physical flow	**Physical quantities**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Production to distribute				
Initial stock	4			
Tons initiated in the period	8			
Total	12			
Distribuição da produção				
Concluídas e transferidas	8	8	8	8
Estoque final	4	4,0	1,6	2,0
Total	12	12,0	9,6	10,0
Cost Flow	**Total**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Costs to be awarded				
Costs in the initial stock	R$ 605.000,00	R$ 575.000,00	R$ 20.000,00	R$ 10.000,00
Tons initiated in the period	R$ 1.900.000,00	R$ 1.150.000,00	R$ 400.000,00	R$ 350.000,00
Total	R$ 2.505.000,00	R$ 1.725.000,00	R$ 420.000,00	R$ 360.000,00
Cost per equivalent production		**R$ 143.750,00**	**R$ 43.750,00**	**R$ 36.000,00**
Allocation of costs				
Cost of tons transferred	R$ 1.788.000,00	R$ 1.150.000,00	R$ 350.000,00	R$ 288.000,00
Final inventory costs	R$ 717.000,00	R$ 575.000,00	R$ 70.000,00	R$ 72.000,00
Total	R$ 2.505.000,00	R$ 1.725.000,00	R$ 420.000,00	R$ 360.000,00

Source: Own elaboration.

Table 6 - Flow of cost accumulation by the weighted average - tumbling department

FLOW OF COSTS OF STEEL PRODUCTION - TUMBLING				
		Equivalent amounts (tonnes)		
Physical flow	**Physical quantities**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Production to distribute				
Initial stock	4			
Tons initiated in the period	8			
Total	12			
Production Distribution				
Completed and transferred	8	8	8	8
Final stock	4	4,0	1,6	2,0
Total	12	12,0	9,6	10,0
Cost Flow	**Total**	**Direct Materials**	**Indirect Costs**	**Direct Labor**
Costs to be awarded				
Costs in the initial stock	R$ 605.000,00	R$ 575.000,00	R$ 20.000,00	R$ 10.000,00
Tons initiated in the period	R$ 2.000.000,00	R$ 1.150.000,00	R$ 450.000,00	R$ 400.000,00
Total	R$ 2.605.000,00	R$ 1.725.000,00	R$ 470.000,00	R$ 410.000,00
Cost per equivalent production		**R$ 143.750,00**	**R$ 48.958,33**	**R$ 41.000,00**
Allocation of costs				
Cost of tons transferred	R$ 1.869.666,67	R$ 1.150.000,00	R$ 391.666,67	R$ 328.000,00
Final inventory costs	R$ 735.333,33	R$ 575.000,00	R$ 78.333,33	R$ 82.000,00
Total	R$ 2.605.000,00	R$ 1.725.000,00	R$ 470.000,00	R$ 410.000,00

Source: Own elaboration.

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For the application of equivalent units need to separate stocks in direct materials, indirect costs and direct labor for each will be applying a degree of finish to the calculation of equivalent units in production has not yet completed in each process.

The calculation of the degree of completion is for the industry and responsible for each sector, which will identify, at the end of the period, as the product has already been completed for the whole to leave the stage in the process.

After defining the degree of completion for each process at the end of the period, it is estimated equivalent units for the calculation of the cost of the units started and completed in the period and the calculation of costs held at the end of stock. This system recognizes the period the efforts used in the preparation of products not yet finished, through its equivalence in relation to the finished units.

After the disclosure of the actual situation of the company, there was a proposal that stocks were made for each manufacturing process of Pig Iron. It was shown in Tables 1 to 6 cost accumulation system for each process with the application of the method of equivalent production units according to the degree of finish of not yet finished.

By clearing individually each process, the industry has a greater power to control their costs and can identify which stage of production is more costly and take appropriate decisions, this process generates a more accurate cost of production. The cost accumulation system uses the period all employees efforts in uncompleted units, generating greater control of production.

5. CONCLUSIONS

This study aimed to propose a system of accumulation of costs by processes in a steel industry with the application of the method of production units in the reality of the company. We used a case study to verify the reality of the company with respect to its cost accumulation system. They were provided by the managerial company's management reports of the year 2014, containing accurate information for the study was conducted.

The company works with the development of only one product, called Pig Iron with homogeneous characteristics in a continuous process for export. The company's characteristics meet the concept of cost accumulation system processes

It was found that the industry does not have a control of the various production processes. Thus, it was suggested by research that there was a breakdown of the processes in stocks which reflect the reality of the company. The company was using only a stock of work in progress that contains all processes, from the time the matter to the work in progress until the formation of the product to the finished product inventory.

It was suggested the creation of six stocks that provided evidence of the product development processes, as follows: ore screening, sintering, sieving of raw materials, blast furnace, casting and tumbling.

For each proposed process was demonstrated with the aid of tables, flow accumulation of production costs, by applying a degree of finish on the units not yet completed for calculating the equivalent production units of each process.

Segregation processes in the stock of work in progress, the company gets a better control of their costs and can identify which production process is more costly. This detail of the process generates a more accurate cost in each production phase, avoiding the mistakes that assessment only way process ends up generating in the calculation of costs.

The limitation of the study was not to have used the actual values of the company, only approximate values period cost and quantity produced. The amounts were not disclosed because they were not allowed by the management of industry. It is suggested for future research the application of the study in the context of other segments, with different production processes and the deepening of the degree of completion for calculation of equivalent production units.

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