Revista de Educação e Pesquisa em Contabilidade
Journal of Education and Research in Accounting

Periódico Trimestral, digital e gratuito publicado pela Academia Brasileira de Ciências Contábeis

ISSN 1981-8610

REPeC, Brasília, v. 11, n. 2, art. 6, p. 226-248, Apr./Jun. 2017
Available online at *www.repec.org.br*
DOI: http://dx.doi.org/10.17524/repec.v11i2.1536

Teaching Case: The Allocation of Joint Costs in Processes with Multiple Splitoff Points at Refinaria Fluminense S. A.

Abstract

The purpose of the Refinaria Fluminense S.A. case is to illustrate the operation of an oil refinery and the challenges that accountants and managers face in assessing the costs of oil products, evaluating inventories, ascertaining the results of refinery operations and analyzing decisions to continue processing individual products to increase their value added. It was designed for discussion in the subjects of Management or Cost Accounting in undergraduate and postgraduate courses in Accounting, Administration and Production Engineering. The narrative begins with information that shareholders are demanding that management take steps to increase the company's profitability. In analyzing the profitability of products manufactured and marketed, managers realize that they do not sufficiently understand the distribution and behavior of product costs. Convinced of the importance of this information, managers decide to hire a cost specialist who promises to solve their doubts and help them analyze the decisions they will have to make to meet the shareholders' wishes. Students are then asked to take on the role of the specialist and develop the proposed questions. One of the most relevant contributions of the case is that it provides the opportunity for students to confront the stylized textbook exposures with the conditions found in companies. This is particularly true in the case of the application of the net realizable value method in processes with multiple splitoff points, a case rarely commented on in the vast majority of books.

Key words: Joint production processes. Joint cost allocation. Multiple splitoff points. Oil refineries.

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Published in Portuguese and English. Original Version in Portuguese.

Received in 1/12/2017. Ask to Revise on 4/30/2017. Resubmitted on 2/5/2017. Accepted on 5/3/2017 by Dr. Paulo Roberto da Cunha (Assistant Editor) and by Dr. Orleans Silva Martins (Editor). Published on 5/26/2017. Organization responsible for the journal: Abracicon

1. Introduction

The objective of the Refinaria Fluminense S.A. case is to illustrate, in a very simplified way, the operation of an oil refinery and the challenges that accountants and managers have to face in order to determine the costs of oil products, to use these costs to determine the costs of inventories and the results of operations and analyze decisions to continue processing individual products in order to increase their value added.

The refining plant described was inspired by the Paulínia Refinery (REPLAN), the largest refinery in Brazil, owned by Petróleo Brasileiro S.A. - Petrobras. The hypothetical company is presented as a 43-year refinery where the production process flows properly. However, its administrative activity is limited to the minimum essential to its operations.

In this context, two factors "disrupt" the company's status quo: the requirement of shareholders to increase the profitability of the business and the possible imposition, signaled by the competent governmental authorities, of lower emission levels of diesel pollutants.

Given this scenario, managers realize that they need to review the products marketed by the Refinery and control their costs. As one might suppose, however, they are faced with the characteristic difficulties of operations involving joint costs, such as a production process with four splitoff points and intermediate products which are not regularly marketed, and therefore have no market prices.

Aware of the importance of this information, even without understanding it properly, managers decide to hire a cost specialist who promises to solve their doubts and help them analyze the decisions they will have to make. Students are then asked to take on the role of the specialist and develop the proposed questions. The characters and the situation portrayed seek to provide a reference for the reality found in companies, intending to leave the level of theory and simplified and automatic solutions.

Thus, we tried to demonstrate, throughout the case, that the subject can be approached from several angles and with different levels of complexity, not only providing for the calculations, but mainly reflecting on the utility of the information produced, the advantages and disadvantages of applying the different cost allocation methods and the concepts involved. The case also provides discussions on the relevance of accounting information and the use of costs for pricing, thus complementing the contents of the chapters of cost accounting and management accounting books dealing with costs of joint products and by-products. Since they generally use examples of excessively naive production processes in exposures and exercises, underestimating the actual intricacies found in companies, the case of the Refinaria Fluminense S.A. allows students to experience a situation closer to reality in a controlled way.

One of the most relevant aspects of this work is that the production process of the refinery in question has multiple splitoff points, a problem rarely mentioned in the accounting books (Horngren & Foster, 1987; Lowenthal, 1986) and which requires some caution, especially in the distribution of joint costs through the net realizable value method.

2. The Refinery

The Refinaria Fluminense S.A. was founded in 1973 and is located in the city of Rio de Janeiro. In 1995, the processing capacity of its refinery was increased from 45,000 m3 / day to 66,000 m3 / day of oil, equivalent to 415,000 barrels of oil per day. The top managers of the refinery are Antônio Dantas, the current president; Carlos Mendes, operations director, and Fernando Gonçalves, administrative director. The number of administrative staff is quite small, but all members are highly qualified, reflecting the company's focus on excellence in operational activities.

Despite the commitment of top management to the efficiency of operations, the company's shareholders have been complaining for some time that the profitability of the business is below expectations. To aggravate the situation, government officials have recently signaled the possibility of imposing a reduction in the emission levels of diesel pollutants from 500 particles of sulfur per million to 50 particles of sulfur per million, which will necessarily require changes in manufacturing processes, resulting in an increase in production costs.

Concerned with the pressures of the shareholders and with the consequences of the probable demands by the authorities, Dantas decided to meet with Mendes and Gonçalves on January 3, 2017, in the morning, to examine the problems and define how they could be faced.

3. The Meeting

As soon as Dantas showed everyone the seriousness of the facts and spoke about the need to cut costs, Gonçalves said that his team had been reduced for three months, and that it could not lose new employees without compromising the results that everyone expected from administrative activities.

Mendes, chief operating officer, agreeing with Gonçalves, pointed out that his team was qualified and very efficient, and that cuts in the operational area could reduce the quality of the processes and increase the risks of operations. He specifically and vehemently defended the need to take proper care in processing and moving oil and its byproducts to protect employees, the community surrounding the refinery, and the environment. He also pointed out that, according to the most recent physical production monitoring report, the refinery processed 12.5 million barrels of oil in December 2016, or 403,000 barrels a day, indicating that it was using 97% of its installed capacity.

After hearing the directors, Dantas said: "I understand and agree with you. As we are operating very close to our installed capacity, we do not control the prices of the derivatives we produce and we cannot make new cuts in the administrative area or in the operational area, all we can do is study the production costs of the refinery in depth, the products we are manufacturing and the possibilities of subjecting them to new processes in order to add value to them."

Mendes, chief operating officer, said that, in order to elaborate these analyses, he would need reliable financial information. Dantas then asked Gonçalves if the accounting department regularly generated cost and profitability reports per product, and he replied that no, but that it would not be difficult to provide the information that Mendes was requesting. After the meeting, Gonçalves requested that the Accounting Manager verify what information Mendes would need and take steps to provide them on a priority basis.

4. The Profitability Report of Products

In the afternoon of the following day, the president received a copy of the product profitability report for the month December 2016, which had been requested by Mendes, and got very worried. He saw that two products were causing losses and then asked Gonçalves for explanations. But the Director of Administration acknowledged, with some discomfort, that he would need to look more closely at the source of the identified losses.

Gonçalves told the president: "The Accounting Department has few employees and everyone is very committed to complying with tax obligations and preparing the quarterly and annual financial statements. These activities occupy all available time, restricting our ability to provide managers with the information and clarification they need as would be desirable. "

Mendes warned Dantas that cutting costs, indiscriminately, would be a danger. He then suggested that it would be better to hire a specialized cost consultant to analyze the operations of the refinery and to help managers evaluate the decisions that would need to be made. The president agreed. And so Pedro Souza, a consultant specialized in costs, was hired. His mission was to review the product costing system and give the support the managers desired.

Pedro and the company's senior management had a meeting to align the expectations before the actual start of the consulting service.

Dantas made it clear that, in addition to the review of the costing system, he wanted an economic feasibility assessment of the following possibilities:

- Subjecting diesel and gasoline to additional processing to obtain products of higher added value;
- Attending, if necessary, requests from some petrochemical industries interested in buying small quantities (marginal businesses) of Naphtha and Cracked Naphtha.

The President also expressed concern about the possibility that the competent authorities would impose a reduction in the emission levels of diesel fuels, with a consequent increase in production costs.

The consultant advised managers that he was familiar with methods of costing and analyzing joint products and by-products, but had never provided services to an oil refinery.

As the professional was highly recommended and had an excellent reputation in the market, Mendes and Gonçalves offered to provide the best accounting and operational staff so that he could carry out high quality work with the required urgency.

5. The Production of Oil Products

The employees nominated by Mendes and Gonçalves showed Pedro the refinery and explained to him in detail how oil is processed to give rise to its various by-products. The following are some notes Pedro made based on the information he was provided with.

The refinery receives crude oil and processes it to obtain Liquefied Petroleum Gas (LPG), Gasoline, Diesel, Aviation Kerosene (AVK), Fuel Oil and Coke. The proportion of each of these derivatives is determined by the type of oil being processed and the characteristics of the refinery facilities.

Although there are several types of oil, which give rise to different product proportions and provide different expected profits, the flexibility to choose among those types that at one moment promise higher expected profit than others is limited by the fact that each refinery is designed to make the most of one type of oil. The Refinaria Fluminense S.A. was specifically designed to process Brazilian oil and to maximize, based on this product, the production of more noble derivatives such as diesel and gasoline, and to avoid the production of lower fuel oil and coke.

To assemble a flow chart of the production process and to determine the costs of production of the various petroleum products, Pedro gathered the following information:

- Crude oil arrives at the refinery through pipelines and is stored in tanks. From the tanks, it is sent to the Atmospheric Distillation Unit, where it is heated to give rise to liquefied petroleum gas (LPG), Naphtha, Diesel / Kerosene mixture, and Atmospheric residue;
- LPG, because it is ready for commercialization, is stored in spheres;
- Naphtha is transferred to the Naphtha Hydrotreatment Unit, and from there to the Catalytic Reform Unit where gasoline is obtained, which is stored in tanks because it is a final product;
- The Diesel / Kerosene mixture goes to the Diesel and Kerosene Hydrotreatment, where two products come out: Hydrotreated Diesel and Aviation Kerosene (AVK). They are then stored in their tanks because they are end products;

- The Atmospheric Residue is sent to the Vacuum Distillation Unit where Coke, Fuel Oil and Diesel are obtained. Coke is unloaded in trucks for sale; Fuel Oil is stored in tanks; and Diesel is transferred to the Catalytic Cracking Unit;
- At the Catalytic Cracking Unit, the Diesel chain chains are broken to obtain LPG, which is stored in tanks, Fluid Catalytic Cracking Diesel and Cracked Naphtha;
- The Fluid Catalytic Cracking Diesel is transferred to the Diesel and Kerosene Hydrotreating Unit to produce Diesel and QAV;
- Cracked Naphtha goes to the Cracked Naphtha Hydrodesulfurization Unit, from which gasoline is obtained, which is stored in tanks.

6. Survey Executed at the Offices

After visiting the refinery facilities, Pedro visited the offices, where he verified the information displayed in Tables 1 and 2, referring to the operation executed in December 2016, when 12,500 thousand barrels of crude oil were processed.

Table 1
Inputs and products per Unit

	Inputs (in thousands of barrels)		**Products (in thousands of barrels)**	
Atmospheric Distillation Unit	Oil	12.500	LPG	380
			Naphtha	1,800
			Diesel / Kerosene	5,350
			Atmospheric Residue	4,970
Naphtha Hydrotreatment and Catalytic Reform Unit	Naphtha	1.800	Gasoline	1,800
Vacuum Distillation Unit	Atmospheric Residue	4.970	Diesel	3,410
			Coke	760
			Fuel Oil	800
Catalytic Cracking Unit	Diesel	3.410	LPG	275
			Fluid Catalytic Cracking Diesel	2,400
			Cracked Naphtha	735
Diesel and Kerosene Hydrotreatment Unit	Diesel / Kerosene	5.350	*Hydrotreated Diesel*	7,280
	Fluid Catalytic Cracking Diesel	2.400	AVK	470
Cracked Naphtha Hydrodesulfurization Unit	Cracked Naphtha	735	Fuel	735

Source: the authors, 2016.

Table 2

Prices practiced in December 2016

Product	R$/barrel
Oil	190.00
Liquefied Petroleum Gas (LPG)	58.00
Gasoline	270.00
Diesel	236.70
Aviation Kerosene (AVK)	228.00
Fuel Oil	160.00
Coke	2.70

Source: the authors, 2016.

Pedro verified the costs of the refining processes for December 2016, which are registered in Table 3; and that the refinery incurs R$52,000.00 of debts in the sale of Cokes.

Table 3

Costs of Refining Processes

Processed load (barrels)	Unit	Fixed Costs (R$)	Variable Costs (R$/barrel)
12,500,000	Atmospheric Distillation	3,750,000	0.50
4,970,000	Vacuum Distillation	6,545,000	1.50
1,800,000	Naphtha Hydrotreatment	1,600,000	3.00
1,800,000	Catalytic Reform	2,800,000	4.00
7,750,000	Diesel and Kerosene Hydrotreatment	4,300,000	2.00
3,410,000	Catalytic Cracking	3,950,000	5.00
735,000	Cracked Naphtha Hydrodesulfurization	1,325,000	5.00

Source: the authors, 2016.

The accountant informed Pedro that the costs presented to the president in the January 4 report were obtained by allocating the joint costs to the main products using the physical units method. He also informed that there were no initial or final inventories in the month of December 2016.

The consultant compiled data on the possibility of subjecting gasoline and diesel to specific processes to produce Gasoline and Premium Diesel. The expectation is that there will be good acceptance in the market for 1 million barrels of Premium Gasoline and 2 million barrels of Premium Diesel. According to market surveys, Premium Gasoline could be sold at R$ 300 a barrel, while Premium Diesel could be sold for R$ 250 a barrel.

Pedro found that the expected cost of the conversion process from Gasoline to Premium Gasoline would be R$ 10.00 per barrel, while the expected cost of the Premium Diesel Conversion process would be R$ 9.00 per barrel. The technical area of the refinery reported that, in any of these processes, there would be no gain or loss in the quantities produced.

Regarding the possibility of eventually meeting the requests of some petrochemical industries interested in buying small quantities (marginal businesses) of Naphtha and Cracked Naphtha, according to the refinery's sales area, the expected price of the offers is R$ 250.00 per barrel. According to the consultant's estimates, reducing the emission of sulfur particles in diesel from the current level of 500 to 50 particles per million will impose an incremental cost of R$ 32.00 per barrel of diesel produced on the refinery plant.

After the survey, Pedro had some certainties, but he still had to make some critical choices that would certainly have a significant impact on the final report that he will have to prepare at the end of the project. The first certainty is that he will need to schematically represent the refinery's production process so as not to get lost in the costing job. He is not sure though about what method to recommend in order to allocate the joint costs. He decided to hear the opinion of the refinery's accountant.

"I still do not know which joint cost allocation method I should use. Both the physical units method and the net realizable value method have advantages and disadvantages. We know that the former is simple and works in any company, but it can generate strange results. Alternatively, we have the second, which allocates costs to products based on their ability to generate revenue, but it is cumbersome and difficult to implement. In addition, the refinery has multiple splitoff points, rarely addressed in traditional cost books, which complicates the application of the net realizable value method. I wonder if the benefits of a more equitable cost allocation will outweigh the costs of implementing and operating the net realizable value method. On the other hand, we both know that the only utility of the unit costs obtained by allocating the joint costs is to determine the cost of inventories and to calculate the results. There is no point in using this information to analyze decisions. What do you think about all this?"

After listening to Peter's considerations, the accountant felt this would be a long conversation, and invited him to have a coffee and snack to deal with these matters with the care they required. Regarding the other orders from Dantas, Pedro did not see any problem to attend them. These assessments depended on concepts and techniques presented regularly in the courses and books on which there is a broad consensus.

Take on the role of Peter as a cost consultant and discuss the following questions.

7. Questions

Q1 - Assume, like Pedro, that without proper representation of the refining process, it will be difficult to do the costing of the products manufactured at Refinaria Fluminense S.A. Therefore, prepare a flow diagram that schematically represents the production process of the refinery and determine the quantities of products obtained in December 2016.

Q2 - Rank the refinery's products as main joint products or by-products. Justify your rating. Knowing that there are several methods for the accounting treatment of by-products, choose a method to be applied in the case and defend your option.

Q3 - Use the **physical units method** to calculate the costs of the main products produced in December 2016. Based on this information, determine the total and unit gross profit of the main products and by-products and the profit of the refinery.

Q4 - Use the **net realizable value method** to calculate the costs of the main products produced in December 2016. Based on this information, determine the total and unit gross profit of the main products and by-products and the profit of the refinery.

Q5 - Assist the administration in evaluating whether there is merit in producing and selling Premium Gasoline and Premium Diesel, justifying your recommendation.

Q6 - Provide subsidies to managers to decide whether to accept the proposed purchase of Naphtha and Cracked Naphtha by the petrochemical industry, based on their advice.

Q7 - Evaluate the impact of meeting the requirement to reduce the current level of sulfur particles present in diesel in the result of the Refinaria Fluminense S.A. How should the refinery management respond to this requirement? Is it possible to meet this desire of society without passing on the increase of costs to the price?

Q8 - After all the calculations and evaluations performed, Pedro still was not sure as to which joint cost allocation method should be proposed to the refinery's management. Recommend using one of the methods proposed in questions 3 and 4 and justify your answer by presenting the advantages and disadvantages of the method that you think is most appropriate.

Q9 - Reflect on the usefulness and relevance of the accounting information produced based on the joint cost treatment. How can cost-based decisions be made in an environment such as the Refinaria Fluminense S.A.?

8. Teaching Notes

8.1 Educational Objectives

The case of the Refinaria Fluminense S.A. was designed to make students experience in a controlled manner the problems experienced by accountants and administrators in a company that operates a decomposition process. They will have the opportunity to schematically represent the production process; identify the products manufactured at each stage of the production process; classify them as joint products and by-products; define which values will be assigned to by-products; use two different methods to allocate joint costs to joint products; and use cost information to analyze decisions to further process some products by adding value to them.

Since some of the intermediate products that give rise to the main products of the Refinaria Fluminense S.A. do not have market prices, one of the questions in the case asks the students to distribute the joint costs through the net realizable value method. This question will cause students to encounter multiple splitoff points and find that this possibility is not generally considered in Accounting books. They will then have the opportunity to realize that the multiple splitoff points complicate, but do not prevent the application of the net realizable value method. In this regard, the case shows that the problems encountered in the daily life of companies are not always as simple as the chapters that deal with costs of joint products and by-products in textbooks.

Kaplan (2007) calls cases like the Refinaria Fluminense S.A. computational cases. He uses such cases (e.g., Wilkerson Company and Sippican Corporation) to provide managers with insight and confidence about the concepts and techniques that are employed to analyze or answer the proposed questions. Not to train consultants or project leaders to develop and deploy cost systems.

The case of the Refinaria Fluminense S.A. can be applied in the classes of Cost Accounting or Management Accounting in undergraduate and postgraduate courses in Accounting, Administration and Production Engineering.

8.2 Theoretical Framework

8.2.1. Introduction

Horngren (1972), Backer and Jacobsen (1974), Horngren and Foster (1987), Cashin and Polimeni (1981, Shillinglaw (1982), Horngren and Foster (1987), Horngren, Foster and Datar (2000), Hansen and Mowen (2001), Maher (2001), Martins (2003), Jiambalvo (2009), Horngren, Datar and Rajan (2012), and Horngren, Datar and Rajan (2015) show that accounting concepts and techniques for accounting analysis and treatment of the joint product and by-product costs have long been consolidated, and that no significant innovation has emerged in this area recently. It also shows that the chapters on this subject are short because there are few concepts that need to be presented, and the techniques used in determining and analyzing costs are simple. Nevertheless, this subject deserves to be treated with a certain deference to the fact that it challenges beliefs strongly rooted in the imaginary and discourse of accountants and non-accountants.

The first concerns the relevance of the information produced and reported by Accounting. In the case of joint products and by-products, the costs allocated to them are only used to determine the costs of inventories and to determine the results of enterprises. Because there are no rational means to measure the contribution of the different production factors to the manufacture of the different products, the only way to determine the costs of these products is to distribute the production costs proportionally among the products.

The models suggested and used differ only in the proportionality factors, but they do not eliminate the arbitrariness in the allocation of costs. Therefore, all authors end up explaining that any method that distributes all production costs to all products can be used. You only have to choose one, which should be used consistently over time, and should be duly explained in the notes to the financial statements. The authors then caution that allocated costs should not be used to analyze decisions. For some decisions, only the production costs of all products are concerned, and for others, only the costs of the last process.

The second belief that is contradicted in the case of joint products and by-products is that it is necessary to know the costs of producing a product to determine its price. Since there are different equally acceptable methods to determine the production costs of joint products and by-products, and each of these methods generates different figures which are not explained by the factors used in the manufacturing of the products, there is no way to decide which method to choose to determine prices. And to annoy the uninitiated even more, some recommended methods for allocating production costs to joint products are based on prior knowledge of the sales prices of products that should be based on their production costs, which are unknown.

Finally, studying accounting concepts and techniques for accounting analysis and treatment of the costs of joint products and by-products is important because they are applied in several industrial enterprises and because they evidence some of the limits of accounting that should be properly understood by all who prepare or use the financial statements.

8.2.2 Accounting Treatment of Costs of Joint Products and By-products

In this section, the main concepts and techniques for the accounting treatment of costs of joint products and by-products are briefly presented. The usual references to the authors of the works consulted will not be included here or in the following sections, but it is essential to clarify that the following text is based freely on the works written by the teachers named in the previous section.

Decomposition or analysis operations are operations in which one or more materials are processed in order to, from a point called Splitoff Point, give rise to several products. A physical relation exists between these products that prevents one from being obtained independently of the others. Oil refining is an emblematic case of a decomposition operation.

The process that originates the various products is called a Joint Process, and the products that result from it are generically called Joint Products. Costs incurred in joint processes are known as Joint Costs. They are incurred for the manufacture of all joint products and differ from the costs incurred in the processes, giving rise to a single product. These costs are called Separable or Specific Costs.

As the relations between materials, processes and joint products are complex and unobservable, there is no way to determine the contribution of the different production factors used in the processes for the production of each of the joint products. Therefore, the costs incurred in the manufacture of each of the joint products cannot be rationally determined either.

To prepare a company's balance sheet and income statement, accountants need to divide the production costs between the product units in the inventories and the units that were sold. The impossibility of measuring the costs of the production factors employed in the manufacture of each of the joint products compels the accountants to resort to arbitrary methods to allocate the joint costs to the joint products. The only restriction is that, under accounting rules, including the accrual basis, the method chosen distributes all production costs to all products, is used consistently over time, and is duly explained in the notes to the financial statements.

The choice of procedures used in preparing the financial statements is influenced by the materiality of the transactions that will be reported. In case a method for allocating joint costs to joint products is chosen, materiality leads the accountants to separate the joint products into two categories. In the first, there are the main products, which are the most important and whose costs have a greater impact on the value of inventories and on the formation of company results; and the second contains by-products that are less relevant and whose costs have less impact on the value of inventories and on the formation of corporate results. The relative importance of the products is usually measured by the portion their sales represent in the total sales of the companies. The proposed procedures for allocating production costs to the main products are more elaborate than the proposed procedures for by-products.

In general, there are three different but equally valid methods for dealing with by-products. The first is to assign them no value. In this case, all joint costs should be divided among the main products. The existence of inventories of by-products should be reported in the explanatory notes and, when these products are sold, the amounts earned should be reported as other operating revenues.

The second method that can be used to treat by-products is to assign them the net realizable value, which corresponds to the difference between the estimated sales price less costs incurred to finish them and sell them. This amount should be deducted from the joint costs that will be allocated to the main products. It is worth noting that this method is endorsed by CPC 16 (R1).

The third method that can be used to treat by-products is to assign them the net realizable value less a profit value considered normal. This amount should be deducted from the joint costs that will be allocated to the main products As for the methods to allocate the joint costs to the main products, there are two broad categories. In the first are the methods that allocate costs based on the quantities of manufactured products. These include the physical units method, used in the case of the Refinaria Fluminense S.A. This method attributes the same weighted average cost to all products. Because the physical units method does not take into account that different products are marketed at different prices, it may cause some products to seem unduly deficient.

The second category of methods for the allocation of the joint costs to the main products contains the methods based on the sales prices of the products. These include the net realizable value method. This method appropriates the joint costs to the major joint products proportionately to the sum of the final sales value of the output of each product minus its specific or separable costs. It should be used in cases where at least one of the major products cannot be sold as it is at the splitoff point, i.e. there is no sale price at the splitoff point for at least one of the major products. This is the second method used with some adjustments in the case of Refinaria Fluminense S.A.

It is important to note that this method ensures that all products are individually profitable if the set of joint products is profitable. As the specific costs of each product may vary, however, it causes the profit margins of the major joint products to be different after the specific costs have been computed.

The Conceptual Framework for Preparation and Disclosure of Financial Reports - CPC 00 (R1) states that, in order to be useful, financial information must be relevant and reliably represent what it is intended to represent. According to the standard, the information will be relevant if its disclosure has the potential to alter the decisions that are being analyzed by its users.

Taking as a reference the criterion for judging the usefulness of the financial information expressed in this CPC, it can be argued that the costs of the joint products are not useful financial information because they are obtained by means of proportional distributions that do not necessarily reflect the contribution of the production factors to the production of each joint product and, as will be discussed below, they should not be used to analyze decisions. Nevertheless, due to a lack of choice, these are the costs reported in the financial statements of the companies that perform decomposition operations

8.2.3. The Net Realizable Value Method in Environments with Multiple Splitoff Points

Lowenthal (1986) discussed the use of the net realizable value method in environments with multiple splitoff points as a practical problem that is common in complex operations and considered two possible solutions. The first applies when intermediate products have a common physical measure. In this case, it proposes that the joint net realizable value be distributed to intermediate products in proportion to the quantity produced of each product. If the intermediary products do not have a common physical measure, however, it raises the possibility of simply distributing the net realizable value arbitrarily.

It is imperative to recognize that these considerations are really very uninviting. Thus, readers are asked to await the presentation of the answer given to question 4 to objectively see the problem and the solution proposed by Lowenthal (1986). The solution that we decided to use in the answer to question 4 is based on the fact that the intermediary products that will share the net realizable values have common physical measures.

8.2.4. Cost Concepts and Techniques to Analyze Decisions

The chapters of the books dealing with the costs of joint products and by-products refer to two types of decision. The first type refers to the decisions on the group of joint products and by-products. And the second contains the decisions regarding the further processing of each of the joint products and by-products to add value to them.

When analyzing decisions on joint products and by-products considered as a group, it is irrelevant to know the costs of each individual product. The nature of decomposition operations obliges companies to manufacture all products, or not to manufacture any of them. Therefore, what should be considered is whether the total revenue from the sale of all products exceeds the costs necessary to produce and market them.

In the analysis of the decision to process a product after the splitoff point, the joint costs are irrelevant costs (sunk costs), since the product has already been obtained. Additional processing should be performed whenever incremental total revenue (revenue from the sale of the product after specific processing less revenue from the sale of the product as it lies at the splitoff point) exceeds the total incremental cost (the cost of the specific processing that will be executed).

8.3. Suggestions for a Teaching Plan

The case of the Refinaria Fluminense S.A. was designed for investigation in a two-hour session to discuss concepts and cost techniques for the analysis and accounting treatment of costs of the joint products and by-products. The session should preferably be conducted with a group already familiar with basic cost topics, since discussion requires participants to be familiar with cost concepts and classifications, cost accumulation systems and incremental analysis.

Since the case analysis requires prior knowledge of the accounting treatment options for joint products and by-products and the cost analysis models applicable in the context of decomposition (or analysis) operations, it is recommended that teachers planning to use this case insist that students read the chapters of one or more books that deal with this subject in some detail. The bibliography that integrates this article, although it is not exhaustive, lists some books the students can benefit from. But there are certainly other books that are the same or better than the ones referenced.

If they feel that students will not be able to pre-read the chapters of the recommended books, teachers should seriously consider using a two-hour lesson to formally present content that students will need to master in order to answer the questions and discuss the case.

Considering that students will have to prepare a flow chart and several tables with calculations to answer the questions, and that this cannot be done during the class in which the case is discussed, it is suggested that teachers ask students to answer the questions previously. In this way, the time of the class can be dedicated to the comparison of different groups or students' answers and to the clarification of the doubts that may have arisen in the elaboration of the answers.

It is always interesting that teachers allow some time for students to report on experiences they have had or are having with decomposition operations. If no one has had this kind of experience, it is recommended that teachers take the initiative to provide examples and to tell cases of companies that produce and sell joint products and by-products.

It is noteworthy, however, that it is not common for the books to bring examples of decomposition operations carried out beyond the industrial environment. This, however, does not mean that these examples do not exist or are not relevant. One case that can be mentioned, due to its prominent nature, is found in the entertainment industry. Companies like the Walt Disney Company and Dreamworks, which produce animations, perform decomposition operations to the extent that, in addition to selling the display rights of the animations, they sell the rights to use the specially created characters and play movie soundtracks, among the various revenue sources that result from the animations they produced.

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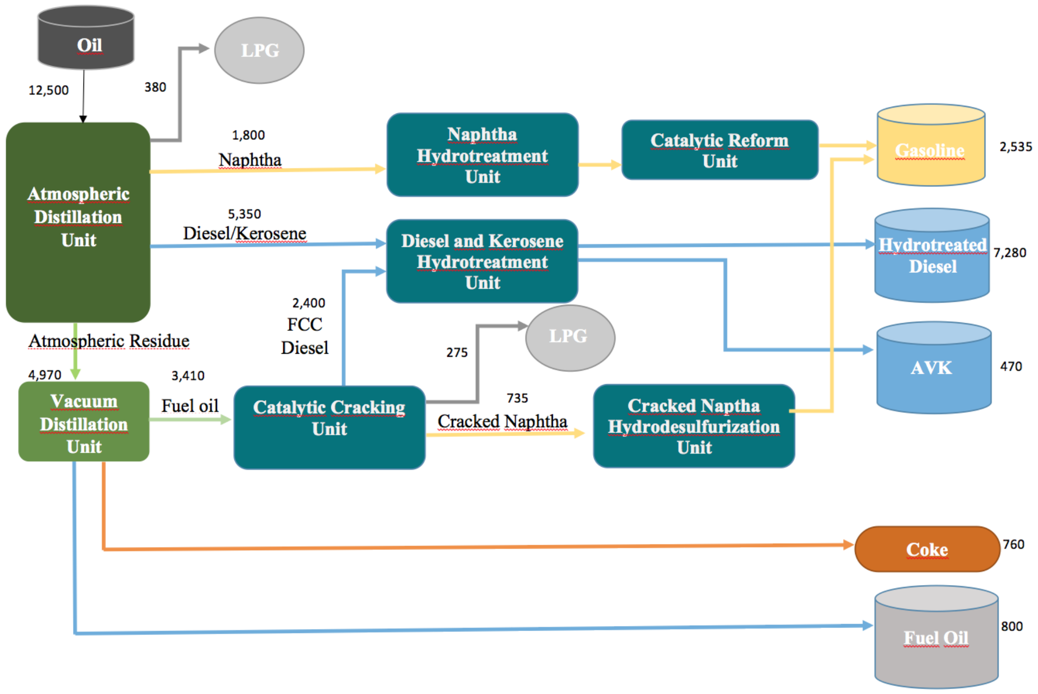
Attachment: Answers to the Questions

Question 1

Picture 1 presents the flowchart of the Refinaria Fluminense S.A.'s production process and the amounts of intermediate and end products obtained from the processing of 12,500,00 oil barrels in December 2016.



Picture 1. Flowchart of production process (in thousands of barrels)

Source: Adapted from Impact Report on the Environment – RIMA for the modernization of REPLAN - Paulínia, Paulínia (SP) Refinery – Lazzarini (2005).

Teachers who are planning to use the case can consider the possibility of attaching the flowchart of the production process to the case if they perceive that its elaboration will surpass the students' skills.

Question 2

As all products manufactured in December 2016 were sold, the total revenue from Refinaria Fluminense S.A. was R $ 2,682,828 and the share of sales of each product in total sales was as follows: LPG - 1.416%; Gasoline - 25.512%; Diesel - 64.23%; AVK - 3.994%; Fuel Oil - 4.71%; Coke - 0.076%.

In order to separate the by-products from the main products, based on the relative value of sales, it is necessary to judge as from which percentage a product should be considered relevant and therefore main. In this analysis, the authors chose to consider only Coke as a by-product. All other products were considered main because their sales were greater than 1% of total sales. But students should be shown that this is an arbitrary decision that will affect the costing procedures, the values of the inventories presented in the balance sheet and the cost of the goods sold, which will be compared to the income in the income statement.

In this analysis, the authors chose not to attribute any value to Coke, considering that this is one of the three possible options for the accounting treatment of by-products. In this respect, the students are free to choose and defend the treatment method of by-products, with no correct or incorrect answer.

Question 3

Figures 4 to 8 present the calculations of the costs, income per product and income of the refinery for December 2016, based on the premise that the joint costs were located to the main products based on the **physical units method**.

The readers should confront the figures with the flowchart presented in the answer to question 1.

Figure 4
Atmospheric Distillation Unit

Product	Quantity (barrels)	%	Joint Cost (R$)	Unit Cost (R$/barrel)
LPG	380,000	3.04	72,504,000.00	190.80
Naphtha	1,800,000	14.40	343,440,000.00	190.80
Diesel/Kerosene	5,350,000	42.80	1,020,780,000.00	190.80
Atmospheric Residue	4,970,000	39.76	948,276,000.00	190.80
Total	12,500,000	100.00	2,385,000,000.00	

Source: the authors, 2016.

Figure 5
Vacuum Distillation Unit

Product	Quantity (barrels)	%	Joint Cost (R$)	Unit Cost (R$/barrel)
Gasoline	3,410,000	81.00	779,420,703.09	228.57
Fuel Oil	800,000	19.00	182,855,296.91	228.57
Total	4,210,000	100.00	962,276,000.00	

Source: the authors, 2016.

Figure 6
Catalytic Cracking Unit

Product	Quantity (barrels)	%	Joint Cost (R$)	Unit Cost (R$/barrel)
FCC Diesel	2,400,000	70.38	563,345,949.39	234.73
LPG	275,000	8.06	64,550,056.70	234.73
Cracked Naphtha	735,000	21.55	172,524,697.00	234.73
Total	3,410,000	100.00	800,420,703.09	

Source: the authors, 2016.

Figure 7
Diesel and Kerosene Hydrotreatment Unit

Product	Quantity (barrels)	%	Joint Cost (R$)	Unit Cost (R$/barrel)
Hydrotreated Diesel	7,280,000	93.94	1,506,655,601.49	206.96
AVK	470,000	6.06	97,270,347.90	206.96
Total	7,750,000	100.00	1,603,925,949.39	

Source: the authors, 2016.

Figure 8

Income statement December 2016 according to physical units method

	Gasoline	Hydrotreated Diesel	Aviation Kerosene	Fuel Oil	Liquefied Petroleum Gas	Coke	Refinaria Fluminense
Quantity (barrels)	2,535,000	7,280,000	470,000	800,000	655,000	760,000	
Price/bbl	270,00	236.70	228.00	160.00	58.00	2.70	
Total income (R$)	684,450,000.00	1,723,176,000.00	107,160,000.00	128,000,000.00	37,990,000.00	2,052,000.00	2,682,828,000.00
Costs (R$)							
Diesel		1,506,655,601.49					
Aviation Kerosene			97,270,347.90				
Fuel Oil				182,855,296.91			
Liquefied Petroleum Gas					137,054,056.70		
Naphtha	343,440,000.00						
Cracked naphtha	172,524,697.00						
Naphtha hydrotreatment	7,000,000.00						
Catalytic reform	10,000,000.00						
Cracked Naphtha Hydrodesulfurization	5,000,000.00						
Total cost	537,964,697.00	1,506,655,601.49	97,270,347.90	182,855,296.91	137,054,056.70		2,461,800,000.00
Gross profit (R$)	146,485,303.00	216,520,398.51	9,889,652.10	-54,855,296.91	-99,064,056.70		221,028,000.00
Gross profit (R$/barrel)	57.79	29.74	21.04	-68.57	-151.24		
Sales expense (R$)						52,000.00	52,000.00
Profit (R$)						2,000,000.00	220,976,000.00

Source: the authors, 2016.

As can be seen in Tables 4 to 7, all cost allocations made unit product costs equal, as expected. In addition, since the allocation of the joint costs did not take into account the sales prices of the products, two products appeared to be unduly deficient, as evidenced in bold in Table 8.

Question 4

Tables 9 to 19 present the calculations for costing, product income and refinery output for the month of December 2016 on the assumption that the joint costs were allocated to the main products based on the **net realizable value method**.

It is again recommended that readers compare the tables with the flowchart presented in the answer to question 1.

The standard presentation of the net realizable value method in didactic texts assumes that a joint process originates two joint intermediate products that are processed separately to become two main products that are marketed regularly; and that intermediate joint products do not have known market prices because they are not marketed as they are at the splitoff point. In this case, the net realizable values of the intermediate products are determined by deducting the costs of the processes separate from the sales figures of the main products produced.

Differently, in the Refinaria Fluminense S.A., there are sequences of splitoff points. For example, the Atmospheric Distillation Unit produces four joint products, including them the Diesel / Kerosene blend; and the Catalytic Cracking Unit produces three products, including the FCC Diesel. None of these products are marketed regularly and therefore do not have market prices.

The Diesel / Kerosene blend and FCC Diesel are processed in the Diesel / Kerosene Hydrotreatment Unit to produce the Hydrotreated Diesel and Aviation Kerosene. Comparing this situation to the standard presentation of the didactic texts, it is evident that the usual teachings are insufficient to distribute the costs of the Atmospheric Distillation Unit and the Catalytic Cracking Unit based on the net realizable value method.

A possible solution to this problem is offered by Lowenthal (1986). It consists of dividing the value obtained by deducting the cost of the Diesel / Kerosene Hydrotreatment Unit from the sum of the sales figures of the Hydrotreated Diesel and Kerosene Aviation production proportionately to the quantities produced of the Diesel / Kerosene blend and FCC Diesel, as these two products have the same physical measuring unit. This is certainly not the only situation in the Refinaria Fluminense S.A. where conventional teachings are insufficient and demands the application of the solution proposed by Lowenthal (1986). Thus, the solution used to determine the net realizable values of the Diesel / Kerosene blend and the FCC Diesel was also used in the other cases where similar problems occurred, as can be seen in Tables 9 to 19.

Table 9
Net Realizable Value of Naphtha and Cracked Naphtha

Product	Quantity (barrels)	Price (R$)	Sales Value (R$)	Hydrotreatment of Naphtha (R$)	Catalytic Reform (R$)	Cracked Naphtha Hydrodesulfurization (R$)	Net Realizable Value (R$)
Naphtha	1,800,000	270	486,000,000	7,000,000	10,000,000		469.000.000
Cracked Naphtha	735,000	270	198,450,000			5,000,000	193.450.000
Total	2,535,000						

Source: the authors, 2016.

Table 10
Net Realizable Value of FCC Diesel and Diesel/Kerosene

Product	Quantity (barrels)	Price (R$)	Sales Value (R$)	Hydrotreatment of Diesel/ Kerosene (R$)	Net Realizable Value (R$)	NRV (R$/ barrel)
Hydrotreated Diesel	7,280,000	236.70	1,723,176,000.00			
Aviation Kerosene	470,000	228.00	107,160,000.00			
Total	7,750,000		1,830,336,000.00	19,800,000.00	1,810,536,000.00	233.62

Source: the authors, 2016.

Table 11
Net Realizable Value of Gasoline

Product	Estimated Sales Value (R$)	Catalytic Cracking (R$)	Net Realizable Value of Gasoline (R$)	Quantity (barrels)	NRV (R$/barrel)
FCC Diesel	560,682,116.13				
LPG	15,950,000.00				
Cracked Naphtha	193,450,000.00				
Total	770,082,116.13	21,000,000.00	749,082,116.13	3,410,000.00	219.67

Source: the authors, 2016.

Table 12
Net Realizable Value of Atmospheric Residue

Product	Estimated Sales Value (R$)	Vacuum Distillation (R$)	Net Realizable Value of Atmospheric Residue (R$)
Gasoline	749,082,116.13		
Fuel Oil	128,000,000.00		
Total	877,082,116.13	14,000,000.00	863,082,116.13

Source: the authors, 2016.

Table 13
Cost Distribution of Atmospheric Distillation Unit

Product	Quantity (barrels)	Net Realizable Value (R$)	%	Joint Cost (R$)	Cost (R$/barrel)
LPG	380,000	22,040,000.00	0.85	20,186,591.58	53.12
Naphtha	1,800,000	469,000,000.00	18.01	429,560,410.70	238.64
Diesel/Kerosene	5,350,000	1,249,853,883.87	48.00	1,144,749,995.02	213.97
Atmospheric Residue	4,970,000	863,082,116.13	33.14	790,503,002.70	159.05
Total	12,500,000	2,603,976,000.00	100.00	2,385,000,000.00	

Source: the authors, 2016.

Table 14
Cost Distribution of Vacuum Distillation Unit

Product	Quantity (barrels)	Net Realizable Value (R$)	%	Joint Cost (R$)	Cost (R$/barrel)
Gasoline	3,410,000	749,082,116.13	85.41	687,095,085.64	201.49
Fuel Oil	800,000	128,000,000.00	14.59	117,407,917.06	146.76
Total	4,210,000	877,082,116.13	100.00	804,503,002.70	

Source: the authors, 2016.

Table 15

Cost Distribution of Catalytic Cracking Unit

Product	Quantity (barrels)	Net Realizable Value (R$)	%	Joint Cost (R$)	Cost (R$/barrel)
FCC Diesel	2,400,000	560,682,116.13	72.81	515,550,540.29	214.81
LPG	275,000	15,950,000.00	2.07	14,666,119.86	53.33
Cracked Naphtha	735,000	193,450,000.00	25.12	177,878,425.49	242.01
Total	3,410,000	770,082,116.13	100.00	708,095,085.64	

Source: the authors, 2016.

Table 16

Mean Cost of Liquefied Petroleum Gas

Origin	Production Cost (R$)	Quantity (barrels)	Cost (R$/barrel)
Atmospheric Distillation	20,186,591.58	380,000	53.12
Catalytic Cracking	14,666,119.86	275,000	53.33
Total	34.852.711,44	655.000	53,21

Source: the authors, 2016.

Table 17

Cost Distribution of Diesel/Kerosene Hydrotreatment Unit

Product	Diesel / Kerosene (R$)	FCC Diesel (R$)	Diesel/kerosene Hydrotreatment (R$)	Cost	Hydrotreated Diesel	Aviation Kerosene
Diesel/ Kerosene	1,144,749,995.02					
Diesel FCC		515,550,540.29				
Total (R$)	1,144,749,995.02	515,550,540.29	19,800,000.00	1,680,100,535.31		
Total Quantity (barrels)				7,750,000.00		
Cost (R$/ barrel)				216.79	216.79	216.79
Quantity (barrels)					7,280,000	470,000
Total Cost (R$)					1,578,210,567.36	101,889,967.95

Source: the authors, 2016.

Table 18
Cost of Gasoline

Product	Production Cost (R$)	Catalytic Reform (R$)	Naphtha Hydrotreatment (R$)	Cracked Naphtha Hydrodesulfurization (R$)	Total (R$)
Naphtha	429,560,410.70	10,000,000.00	7,000,000.00		446,560,410.70
Cracked Naphtha	177,878,425.49			5,000,000.00	182,878,425.49
Total	607,438,836.19	10,000,000.00	7,000,000.00	5,000,000.00	629,438,836.19
Quantity					2,535,000
Unit Cost (R$/ barrel)					248.30

Source: the authors, 2016.

Table 19
Income Statement December 2016 using net realizable value method

	Gasoline	Hydrotreated Diesel	Aviation Kerosene	Fuel Oil	Liquefied Petroleum Gas	Coke	Refinaria Fluminense
Quantity(barrels)	2,535,000	7,280,000	470,000	800,000	655,000	760,000	
Price (R$/barrel)	270.00	236.70	228.00	160.00	58.00	2.70	
Total Income (R$)	684,450,000.00	1,723,176,000.00	107,160,000.00	128,000,000.00	37,990,000.00	2,052,000	2,682,828.000
Costs (R$)							
Gasoline	629,438,836.19						
Diesel		1,578,210,567.36					
Aviation Kerosene			101,889,967.95				
Fuel Oil				117,407,917.06			
Liquefied Petroleum Gas					34,852,711.44		
Total Cost	629,438,836.19	1,578,210,567.36	101,889,967.95	117,407,917.06	34,852,711.44		2,461,800,000
Gross Profit (R$)	55,011,163.81	144,965,432.64	5,270,032.05	10,592,082.94	3,137,288.56		221,028,000
GP (R$/barrel)	21.70	19.91	11.21	13.24	4.79		
Sales expense (R$)						52,000	52,000
Profit (R$)						2,000,000	220,976,000

Source: the authors, 2016.

As is clear from Tables 13 to 16, all cost allocations made product unit costs different, as expected. In addition, as the allocation of the joint costs took into account the sales prices of the products, all products were individually profitable, since together they are profitable. In spite of this, the profit margins of the different products were different, again as expected.

Question 5

In the analysis of the decision to process a product after the splitoff point, the joint costs are irrelevant since the product has already been obtained. Additional processing should be performed whenever the incremental income exceeds the incremental cost.

Considering that the additional processing of ordinary gasoline to transform it into Premium Gasoline will generate an incremental income of R$ 30.00 (R$ 300 - R$ 270) per barrel, and will oblige the refinery to incur an incremental cost of R$ 10 per barrel; each barrel of Premium Gasoline produced and sold will increase the profit of the Refinaria Fluminense S.A. by R$ 20. Therefore, executives should be encouraged to produce and sell Premium Gasoline.

Applying the same logic in the case of Premium Diesel, an incremental income of R$ 13.30 (R$ 250 - R$ 236.70) and an incremental cost of R$ 9.00 will be noted, making each liter of Premium Diesel produced and sold increase the refinery's profit by R$ 4.70. Therefore, the production and sale of Premium Diesel should also be recommended.

Question 6

The analysis of the decision not to submit a product to an additional process should follow the same analysis model of the decision to submit a product to an additional process. In this case, what we want to know is if the savings resulting from the non-completion of the additional process will exceed the reduction of the income due to the sale of a product with lower added value. It should be noted that the composition of the costs that will be eliminated will depend on the size and the time horizon of the decision. In marginal decisions, only variable costs will be eliminated; and, in long-term decisions, some fixed costs will be eliminated, apart from variable costs.

It is essential to clarify that, as the sales considered in the question will be possible, the cost savings in the operations of Naphtha Hydrotreatment, Catalytic Reform and Hydrodesulfurization of Cracked Nafta will be limited to the variable costs. In the case of Naphtha, for each barrel sold, the refinery will give up R$ 20 (price of gasoline minus the price of naphtha). On the other hand, R$ 3 / barrel will be saved, referring to the variable costs of the Naphtha Hydrotreatment Unit, and R$ 4 / barrel related to the variable costs of the Catalytic Reform Unit. Thus, for each barrel of naphtha sold, the refinery will no longer earn R$ 13.00. Therefore, the proposed sale of naphtha is not advantageous.

In the case of Cracked Naphtha, the refinery will give up the same R$ 20 (gasoline price minus the price of naphtha). On the other hand, R$ 5 / barrel will be saved, referring to the variable costs of the Cracked Naphtha Hydrodesulfurization Unit. Thus, with each barrel of cracked naphtha sold, the refinery will no longer earn R$ 15.00. Therefore, the proposed sale of cracked naphtha is not advantageous either.

Question 7

Considering that the expected additional cost per barrel of diesel produced will be R$ 32, in the case of the requirement to reframe the sulfur emission, for the current production of 7,280 thousand barrels of diesel per month, there will be an additional cost corresponding to R$ 233 million per month, thus incompatible with the refinery's result of around R$ 221 million per month. The refinery should position itself in the sense that this type of requirement will only be economically feasible when the additional cost is transferred to the sales price of diesel.

Question 8

Tables 20 and 21 present the sales prices and the unit costs determined, respectively, using the physical units and net realizable value methods, and the unit profits of each product produced at Refinaria Fluminense S.A.

Table 20
Unit income per product verified based on physical units method

Product	Volume (barrels)	Price (R$/barrel)	Cost/Expense (R$/barrel)	Income (R$/barrel)
LPG	655,000	R$ 58.00	R$ 209.24	-R$ 151.24
Gasoline	2,535,000	R$ 270.00	R$ 212.21	R$ 57.79
Diesel	7,280,000	R$ 236.70	R$ 206.96	R$ 29.74
AVK	470,000	R$ 228.00	R$ 206.96	R$ 21.04
Fuel Oil	800,000	R$ 160.00	R$ 228.57	-R$ 68.57
Coke	760,000	R$ 2.70	R$ 0.07	R$ 2.63
Total Refinery	12,500,000	R$ 214.63	R$ 196.95	R$ 17.68

Source: the authors, 2016.

Table 21
Unit income per product verified based on net realizable value method

Product	Volume (barrels)	Price (R$/barrel)	Cost/Expense (R$/barrel)	Income (R$/barrel)
LPG	655,000	R$ 58.00	R$ 53.21	R$ 4.79
Gasoline	2,535,000	R$ 270.00	R$ 248.30	R$ 21.70
Diesel	7,280,000	R$ 236.70	R$ 216.79	R$ 19.91
AVK	470,000	R$ 228.00	R$ 216.79	R$ 11.21
Fuel Oil	800,000	R$ 160.00	R$ 146.76	R$ 13.24
Coke	760,000	R$ 2.70	R$ 0.07	R$ 2.63
Total Refinery	12,500,000	R$ 214.63	R$ 196.95	R$ 17.68

Source: the authors, 2016.

As all derivatives produced in December 2016 were sold, the two joint cost distribution methods lead to the same total income for the refinery (see Tables 8 and 19). The costs and income per product obtained with the two methods are different though (see Tables 20 and 21).

The main advantage of the physical units method is that it is easy to understand, deploy and use. But eventually, it can generate distorted information, like in the case of LPG and Fuel Oil. It is possible to demonstrate that if the refinery fails to produce and sell these products, its total revenue will drop more than the costs it will eliminate, reducing its profitability, which indicates that both products are profitable. Nevertheless, the physical units method imputes to these products costs higher than the revenues they generate, unduly suggesting that they are deficient (see Table 20).

The student's choice of one of the methods proposed in questions 3 and 4 is free, with no correct or appropriate answer, aiming that, after the elaboration of all the calculations and analyses, (s)he is able to perceive, from his/her own experience in developing the case, the advantages and disadvantages of the methods applied and able to form an opinion and defend his/her point of view.

The main advantage of the net realizable value method is that it takes into account the sales price of the products in the distribution of the joint costs and, consequently, ensures that if all the products are profitable in group, all products individually will also be. It should be noted, however, that in this case, the profit margins of the different products will be different when the costs of the specific processes are different. Compared specifically with the physical units method, the net realizable value method fails to be more complex and laborious. This is evident from the calculations made to answer questions 3 and 4 of this case.

The information obtained through the physical units and net realizable value methods, because they do not reflect the contributions of the production factors to obtain each of the product, do not represent the costs of the products and therefore do not present useful financial information in accordance with CPC 00 (R1). But as a result of the allocation of all production costs to all products, this information meets the accounting standards and can be used in the preparation of the financial statements. The only restrictions are that, having chosen a method, the accountants use it consistently and declare it in the explanatory notes.

Question 9

After answering and analyzing the eight questions in the case, the students should be able to recognize three relevant aspects in relation to the accounting information available in the companies that perform decomposition or analysis operations. The first is the paradoxical nature of information about the costs of individual products. Without them, there is no way to prepare the financial statements. As this information results from necessarily arbitrary allocations, they do not reliably represent the production costs of the products. This indicates that not all information disclosed in the financial statements is useful under CPC 00 (R1).

The second aspect is that the nature of decomposition operations obliges companies to manufacture all products, or not to manufacture any of them. Therefore, the decision to carry out the operation should be based on the comparison of the total revenue obtained from the sale of all products with the costs of producing them. The way individual profits are distributed is irrelevant. This was duly evidenced by the costs determined by the physical units of production method. In two cases, they exceeded revenues from product sales, but neither of the two deficit products could be eliminated without diminishing the total profit of the Refinaria Fluminense S.A.

Finally, the third aspect is that, in the decisions to further process individual products after the splitoff point, the costs of the joint process are irrelevant because they are already being incurred. What we want to know is whether the additional processing will offer profit. This can be verified by comparing incremental income (income from the sale of the product after specific processing minus income from the sale of the product as it is at the splitoff point) with the total incremental cost (the cost of the specific processing to be performed).