The European Proceedings of
Social and Behavioural Sciences
EpSBS

www.europeanproceedings.com
e-ISSN: 2357-1330

DOI: 10.15405/epsbs.2022.12.48

ISCKMC 2022
International Scientific Congress «KNOWLEDGE, MAN AND CIVILIZATION»

ACCOUNTING FOR INVENTORIES OF RUBBER PRODUCTION USING RADIO FREQUENCY IDENTIFICATION

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Abstract

The article presents the modeling of a digital passport per unit of manufactured products (rubber sleeve) to improve the efficiency of inventory accounting. The main ways of keeping records of inventory items in production are outlined. In the paper, accounting for material and technical values is determined on the basis of the batch method since the varietal method is not suitable due to a large number of manufacturers of the same rubber grade. This leads to an increase in the information base, and, as a result, to the complication of finding information for a particular formulation. The problem of identifying a specific batch of raw materials for the production of a rubber sleeve is defined. The use of barcoding and radio frequency identification as a means to obtain information for inventory accounting is presented. The advantages and disadvantages of each of the methods are revealed. The development of a digital passport model at the stage of receipt of inventory items at the warehouse and their transfer to the primary shop is described.

Keywords: Accounting, inventories, rubber production, radio frequency identification

https://doi.org/10.15405/epsbs.2022.12.48
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Selection and peer-review under responsibility of the Organizing Committee of the conference
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1. Introduction

Accounting for inventory items is carried out on the basis of primary documents (Article 9 of the Federal Law No. 129 of November 21, 1996). It must comply with all regulations. Inventory is a statistical indicator. It may include: inventories, work in progress, and the remaining finished goods (Pavlova & Shalaeva, 2017).

2. Problem Statement

In the production process of a rubber sleeve, each finished product unit includes batch units of various components, according to the formulation.

There are the following types of accounting:

Varietal method.

Accounting involves using cards of a varietal type: they record the presence of objects and their movement. The varietal method is used when the storage of inventory items is carried out by name and grade. This does not include the time of delivery of valuables and their cost. A separate inventory card is created for each item. One nomenclature differs from another in several indicators (Baydybekova, 2015).

The cards will be valid throughout the year. They must be registered in the relevant register. After that, individual numbers are affixed to the cards.

Batch method.

The batch method assumes an accounting procedure similar to the varietal method. The difference lies in the fact that each batch of inventory items is registered separately. About the batch method is written in paragraph 242 of the Instructions. It is used both in the warehouse and in the accounting department. It involves separate storage of each batch, each of which must have an appropriate transport document (Baydybekova, 2015).

3. Research Questions

In the paper, accounting for material and technical values is determined on the basis of the batch method since the varietal method is not suitable due to a large number of manufacturers of the same rubber grade. This leads to an increase in the information base, and, as a result, to the complication of finding information for a particular formulation.

4. Purpose of the Study

For accounting, it is necessary to identify products at individual production stages. The main methods of identification at the moment are:

- Identification in manual format. When materials or semi-finished products arrive at a warehouse or other production facility, the operator writes down the full details in the journal and brief information on the tag. As a rule, this identification method is not reliable, subject to the human factor, and not adapted to environmental conditions. All information is on paper and does not involve the use of digital storage platforms.

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- Identification by barcoding. When materials or semi-finished products arrive at a warehouse or other production facility, the operator records information in a journal and duplicates this information in a database. For further identification of products and materials, the operator prints out a barcode that is attached to the container. In the future, this barcode can be read semi-automatically using a portal or handheld scanner. Although this method simplifies the control of information flows in production, it also has drawbacks. The main shortcomings are the limited amount of information recorded in the barcode (up to 3072 bytes), and the impossibility of adding and rewriting information to the barcode itself (Halinouski, 2021).
- Identification using RFID. A common digital information database is established by analogy with the barcoding method. The major difference is the setting up of a separate database designed for the identification and subsequent accounting of materials for the manufacture of individual units of finished products, according to the formulation. It is also based on a reader and a tag; the main advantage is independence from environmental conditions and a large amount of data recorded and, most importantly, rewritten to a separate tag (Lim et al., 2021; Sharif et al., 2021b).

5. Research Methods

Thus, the paper aims to increase the efficiency of product accounting through the use of a system for automatic identification and traceability of materials and semi-finished products used for the manufacture of rubber products. To achieve this goal, it is necessary to solve the following tasks:

- Make an overview of existing tools for identifying production facilities.
- Review existing facility traceability tools.

Define a rubber consumption pattern based on a specific formulation.

6. Findings

The assembly of rubber sleeves belongs to the discrete type. Discrete manufacturing is a type of production in which the source material (raw material) undergoes more than one process interruption during processing into the initial product. This type also includes custom production, characterized by the fact that the enterprise manufactures various kinds of products that can be expressed in the number of pieces or divided into more or less small series. Each product or series of products can be distinguished according to its characteristics. Functionally, the production process of a rubber sleeve is divided into stages:

- Arrival at the warehouse of components (components of the rubber mixture / finished rubber bookmark; thread; wire; bandage, etc.);
- Preparation of components (filament/wire doubler winding, rubber calendering, mandrel manufacturing, bandage rewinding);
- Sleeve formation process;
- Vulcanization process;
- Unbandaging process;

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- The process of checking finished products by QCD engineer;
- Packaging of finished products;
- Transfer of finished products.

At each of these stages, accounting for inventory items is especially important. The accounting process begins with the identification of a specific material. Consider this process in the example of the arrival of rubber at the warehouse.

When rubber arrives at the warehouse, the basic information is taken from the manufacturer's documentation. The data is recorded in the production information system. Further, the data will be supplemented as the technological process progresses, that is, information about specific operations performed with a separate unit of material will be recorded. Thus, it is supposed to compile a digital product passport containing all information about the finished product.

When rubber arrives at the warehouse, the following operations are performed:

1. Weighing;

2. Posting in the accounting system of the enterprise;

3. Registration of a digital passport in the system of automatic identification and traceability and printing of a passport.

The participants in the operation are the loader and the storekeeper. Upon formulation of a batch of rubber compounds from the supplier, each pallet must be weighed on a scale. To do this, the loader moves the pallet to the scales. The storekeeper performs the function of posting the rubber compound in the accounting system of the enterprise and prints a passport for the rubber. After that, the rubber compound on the pallet will be determined for temporary storage at the warehouse.

Each individual finished product unit (rubber sleeve) has its formulation. The formulation accurately determines the amount of rubber, wire, bandage, and mandrel. The main problem is the conformity of rubber consumption according to the formulation. For this, a rubber posting system is implemented, which has fields according to Table 01.

Table 1. The structure of the database of the rubber posting system

Type of operation	Date and time of operation	Operator actions	Quantity, units
Coming			
From the manufacturer	xx.xx.xxxx 00:00	Weighing a lot of rubber on the scales Placing an RFID tag on a pallet	Lot weight
Remainder from production	xx.xx.xxxx 00:00	Weighing rubber on the scales Reading information from an RFID tag	Weight of part of a lot
Consumption			
Transfer to workshop No. X	xx.xx.xxxx 00:00	Recording the amount of transferred rubber Placing an RFID tag on a pallet	Lot weight

When transferring rubber to the workshop, a pallet with an RF tag installed on it is used. RFID is a common way to identify a particular material among its variety. RFID (Radio Frequency Identification) is a method of automatic identification of objects in which data is read or written using radio signals stored in so-called transponders, or RFID sensors (Alburaki et al., 2021; Sharif et al., 2021a; Sung & Hsiao, 2022). RFID tags are attached to any surface and work in extreme conditions: shock, vibration, bad weather; readers recognize objects through dirt, snow, and cardboard. In addition to identifying objects,

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this technology can be used directly to determine the location during the technological process of manufacturing a rubber sleeve (Andrade et al., 2021; Fraga-Lamas et al., 2021; Guo et al., 2021; Yu & Wang, 2021).

Thus, after a particular batch of rubber is transferred to the workshop from the warehouse, its location is determined by RF readers installed at the entrance and exit of each section. When a pallet arrives at the workshop, it is automatically recorded in the receipt database for the materials of the workshop. The structure of the information stored on the label is described in Table 02.

The changing field in the label is the “Mass of rubber” field. After consumption of a certain amount of rubber for the production of a defined metric area of a rubber sleeve, this parameter is reduced and rewritten to the database and the label. When the mass approaches zero, an alert is given to the operator. Based on this alert, the operator either puts the rest of the material in stock or requests an additional pallet of rubber from this batch. In the event of the end of the batch in the warehouse, rubber from another batch is used, and an additional entry is made in the database and the label. This solves the problem of identifying and accounting for rubber in production.

Table 2. Information on the rubber pallet label

Field name	Field description
Material ID	Unique identifier
Full name of the material	
Short name of the material	
Technical specifications / GOST	The name of Technical specifications / GOST by which the rubber compound is made
Shelf life of the rubber compound	Number of months
Group ID	
Unit ID	
Issue Unit ID	
ID batch	The unique ID of the batch
Mass of rubber	Mass of a batch of rubber

To automate the process of accounting for inventory items, it is proposed to use a computerized accounting system for materials in production, consisting of the following equipment.

The “brain” of the system is a programmable logic controller OVEN PLC200-01-CS. This programmable logic controller (PLC) reads information about the mass of rubber simultaneously from eight mass sensors, which makes it possible to obtain operational information on the reduction in the amount of rubber in a batch. A VESKOM RFM-02 reader is installed near the scales, broadcasting a radio signal. A transponder radio tag is placed on the weighted object, which, when it enters the reader's coverage area, transmits its identification number to the reader. The reader transmits data about the object that has appeared to the PLC via the RS-485 communication interface, where the final identification of the object is performed using the software.

7. Conclusion

Accounting for inventory items is one of the main tasks in modern production. The development and establishment of goals, tasks of accounting functions, the distribution of responsibilities, and the workflow scheme are the basis for organizing management accounting.

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The major problem is the accounting of rubber in the production of a rubber sleeve. To do this, an automatic identification and traceability system based on radio frequency technology is being implemented. The advantage is the ability to accurately determine a specific batch of rubber, both in the warehouse space and in the workshop space, through the transmission of radio signals. When rubber arrives at the warehouse and workshop, it is weighed, and the data is entered into the database and onto the label. When moving a pallet with a mark in space, information about the formulation/consumption of rubber is automatically updated (increase in the formulation in the workshop, which means an increase in the consumption in the warehouse). This allows keeping an operational record of the mass of rubber within the framework of the use of one batch for the production of a unit of rubber sleeve. When changing the batch, this information is also recorded in the database and the label.

Therefore, the system has the possibility of end-to-end viewing of the technological history in the context of batches of manufactured products, and the ability to keep records of inventory items in automatic mode by automatically reading and writing information to the radio tag. This information can be stored both in the enterprise database and in the label itself (ID). In general, the management system will solve the problems of operational accounting and control of material resources, and their movement in the intershop space, which will increase production efficiency.

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