SERIAL PRODUCTION PLANNING IN METALLURGIC OPERATIONS USING THE SAP S/4 HANA INFORMATION SYSTEM

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Abstract

One of the types of production employed at metallurgical plants is serial production. Serial production is applied for products that have steady demand, are homogeneous and can be delivered to more customers. This type of production is commonly referred to as "warehouse manufacturing", where the business further addresses the allocation of available quantities between existing sales orders. This article describes the specifics of metallurgical serial production and methods that can be used to control it. Additionally, it proposes the possibilities of automating this process using the S/4 HANA version of a modern SAP information system.

Keywords: Planning in Serial Production; SAP S/4 HANA; Stochastic Dynamic Models

1. INTRODUCTION

Serial production is a typical type of mass production in a metallurgical plant. Its features are that it is the repeated production of products with the same properties that can be delivered to different customers. Unlike for custom production, it is possible to use a production management method in the warehouse and methods of allocating the available quantity to sales orders. Nowadays, there are many proven methods from which an enterprise can choose the one that best suits its specific requirements. These requirements include, above all, the flexibility of production, shipping and the quality of customer service on the one hand and the minimization of production, warehousing and shipping costs on the other. The goal of the business is to automate and digitize the entire process of planning as much as possible, in order to speed it up, avoid errors and reduce human resources requirements. For this purpose, it is possible to choose from a wide range of information systems and information technologies. In this article, we will focus mainly on the SAP information system, which in its latest version of S / 4 HANA allows using a number of planning tools.

2. PLANNING METHODS IN SERIAL PRODUCTION

The goal of every business is to optimize its costs. In the case of the production process, these are mainly the costs of the actual production, storage of raw materials, semi-finished products and products, and shipping costs. On the other hand, a company tries to provide its services in the highest standard, in particular, short lead times, flexibility of deliveries and meeting the promised delivery dates [1].

Several models can be used to determine a suitable performance level, where the enterprise is not unnecessarily holding a large inventory, but is able to react to customer requirements in a timely manne [2].

The basic model is the EOQ (Economic Order Quantity) model and Camp's formula, which can be used if the demand is continuous and does not change over time. "EOQ is an amount that minimizes the cost balance between the ordering and storage costs" [3]. This model, which is primarily used to find the appropriate size of the ordered quantity of inventory, can be transformed for production planning purposes, where we are looking for an appropriate production batch size that optimizes production costs and storage costs for finished products. These production batches are then repeated in a given interval, which is given by the shipping volume.

$$Q = \sqrt{\frac{2 \cdot D \cdot F}{a \cdot K}} \quad (1)$$

where:

Q - optimum production batch (optimum order quantity)
D - anticipated annual shipping (estimated annual consumption)
F - Costs associated with preparation of the production batch (ordering costs)
a - Coefficient for annual inventory carrying costs as a % of the value of the product (coefficient for annual costs for holding inventory as a % of the material cost)
K - production costs for one unit (procurement costs for 1 unit)

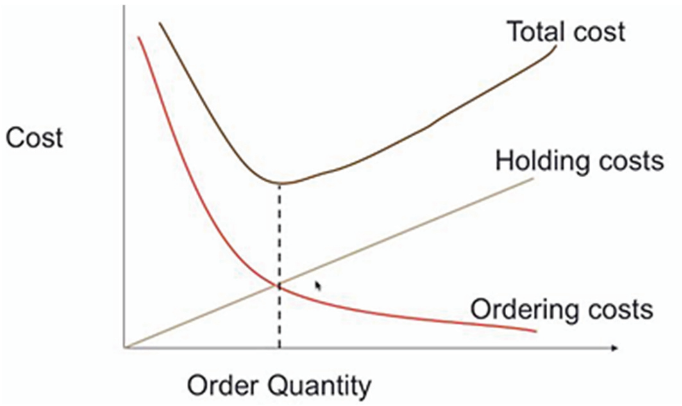

Figure 1 EOQ model

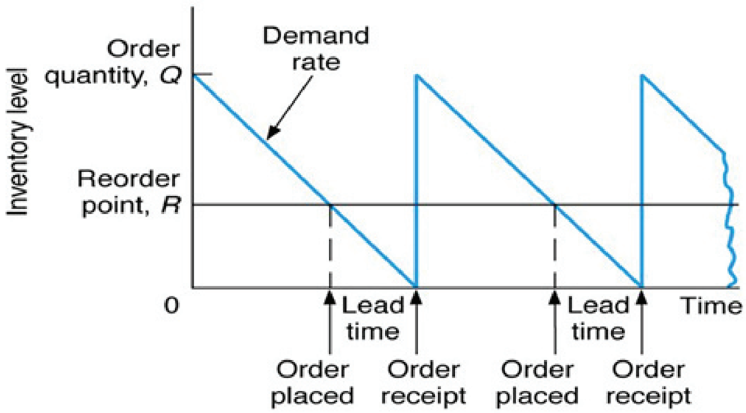

Figure 2 Development of the status of inventory when using the EOQ model

This model can be expanded with using minimum inventory quantities, which we want to have in stock, always available.

If no regular shipping plan for finished products is available, it is possible to use **stochastic dynamic models: Fixed Production Quantity, Fixed Production Interval, and Target Inventory Level.**

2.1. The Fixed Production Quantity (FPQ) model

The Fixed Production Quantity (FPQ) model should be used if, from a cost and organizational perspective, it is appropriate to always produce the same amount of products (e.g. in a metallurgical plant, the production batch is determined by the capacity of the furnace to heat the input material). The time between production batches is then flexible. A new production batch will be scheduled when the stock value of the product drops below the selected level. This level of inventory should be determined by the time needed for the production of the new batch and the average delivery quantity for the given period. In the model example, a production batch of 40 tons will be scheduled at the moment when the inventory status of finished products will drop to 12 tons. The disadvantage of this model is that in the event of a lower-than-average demand, more finished products will be produced than are needed [4].

$$\mathrm{s} = \mathrm{Tp} \cdot \mathrm{Qe} + \mathrm{Qs} = 2 \cdot 1 + 2 = 4\ \mathrm{tons} \tag{2}$$

where:

s - Inventory level initiating production
Q - Production batch = 40 tons
Tp - Production prep time = 2 days
Qe - Average daily shipping = 1 ton
Qs - Insurance inventory (back up) = 2 tons

The following illustration shows an example of the FPQ model.

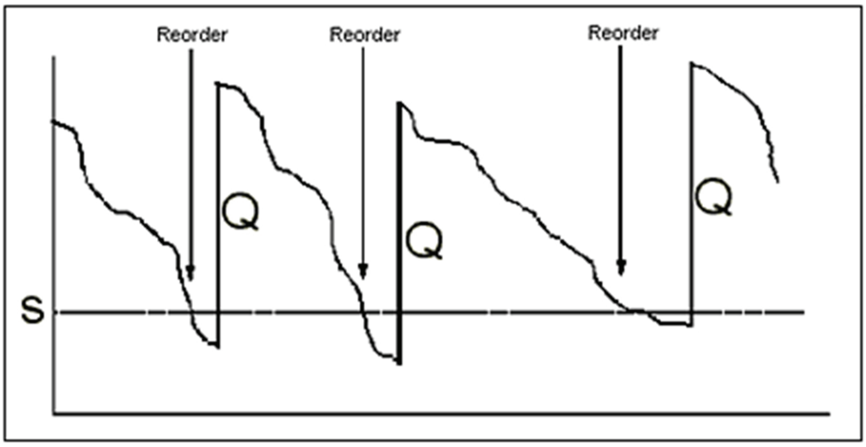

Figure 3 Example of FPQ model

2.2. The Fixed Production Interval (FPI)

The Fixed Production Interval (FPI) model should be used if we want to repeat the production of the product within a given fixed interval and the production batch size can be flexible. In a metallurgic plant, this might be, for example, a fixed monthly campaign schedule, where the size of individual campaigns is adjusted based on the current state of inventory of finished products. In this case, it is necessary to determine the target stock of the product in question and the batch size is calculated. The disadvantage of this model is that very small production batches can be planned, which increases the average cost of the product.

$$S = Ti \cdot Qe + Qs = 9 \cdot 2 + 2 = 20\ tons \tag{3}$$

$$Q = S - Qc = 20 - 2 = 18\ tons \tag{4}$$

where:

Q - Production batch
S - Target inventory level
Qc - Current inventory level = 2 tons
Ti - Interval between two production batches = 9 days

Qe - Average daily shipment = 2 tons

Qs - Back-up inventory = 2 tons

The following illustration shows an example of the FPI model.

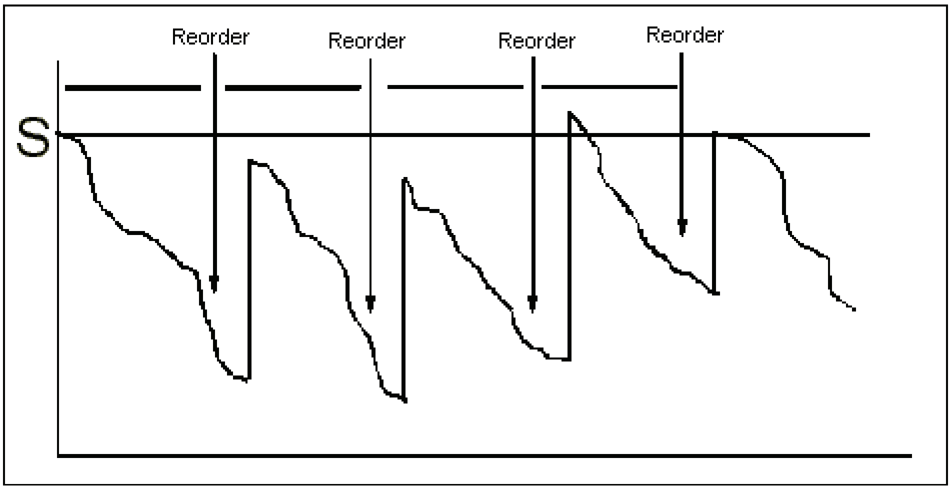

Figure 4 Example of FPI model

2.3. The Target Inventory Level model (TIL)

The Target Inventory Level model (TIL) works with a variable production batch and with a flexible production interval. As with the FPQ model, the company sets the amount at which the production will be scheduled. It further sets the target quantity for replenishment of the warehouse status similarly to the FPI model, except that it does not use a fixed interval but a minimum interval between two production batches. The actual production quantity itself is then adjusted to the current inventory (the production batch can be flexible). The advantage of this model is that production takes place only if it is needed and the production batch is adjusted to the optimal level of replenishment. By choosing an appropriate minimum interval between two production batches, we optimize storage costs versus preparation costs for the production batch. A longer minimum interval will increase the target amount of inventory, and therefore even storage costs, but will reduce the number of production batches.

$$s = Tp \cdot Qe + Qs = 2 \cdot 1 + 2 = 4\ tons \quad (5)$$

$$S = Tm \cdot Qe + Qs = 4 \cdot 2 + 2 = 10\ tons \quad (6)$$

$$Q = S - Qc = 10 - 2 = 8\ tons \quad (7)$$

where:

Tm - minimum interval between two production batches = 4 days

This minimum interval can be calculated using the Camp formula:

$$Tm = Q/d \quad (8)$$

$$Tm = 8/2 = 4\ days \quad (9)$$

where:

Q - Optimum production batch calculated using Camp's formula, for example, 8 tonsD - Average daily shipments = 2 tons

The following illustration shows an example of the TIL model.

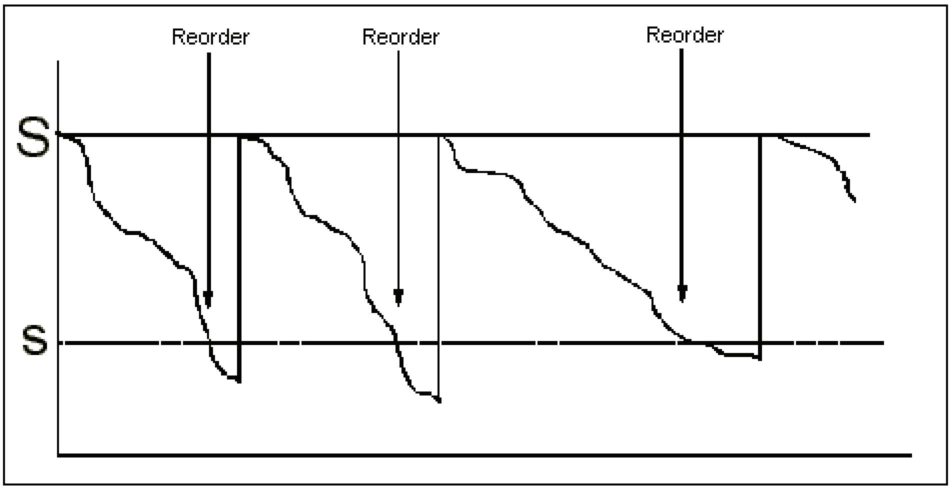

Figure 5 Example of the TIL model

3. USING THE SAP S/4 HANA INFORMATION SYSTEM TO PLAN SERIAL PRODUCTION

For production planning in the SAP S / 4 HANA information system, and in its earlier versions, it is possible to use the Material Resource Planning (MRP) process. In the latest version, there are several new ways to influence this process to increase overall system performance.

In case of serial production, this will involve the Make to Stock (MTS) planning mode. In this mode, the system plans production of individual products in accordance with the set rules. Production is driven by demand, which is represented by individual sales orders that are registered in the system with each having its required quantity and date of fulfilment. Based on such requirements, SAP finds the available quantity of the finished products in the finished products warehouse and plans production for the missing quantity in such a way as to meet the required delivery date [5].

Planned production = Total demand - existing inventory + planned shipping + back-up inventory

Date of production commencement =

= Planned delivery date - shipping time - time of preparation for shipping - time of production

By the desired production start date, the system then checks the availability of the input material and, if needed, orders it.

Individual products are represented here by material numbers (materials). Each such material then has a set of parameters that can affect the automatic MRP process.

The user may choose a **minimum inventory**, which the system will try to maintain for cases of unexpected events (fluctuations in demand, production malfunctions, shortage of input material, etc.) This quantity is then added to the requested quantity.

The material can also be assigned a **calendar** that determines when it is possible to produce the given material. This allows us to fix a firm plan of production of individual materials, e.g. material will be produced once a month.

Another option is to determine the fixed or minimum **size of the production batch** for the material in question. This prevents us from planning production batches that are too small, which would be economically disadvantageous.

Similarly, materials for input can be configured, wherein we determine their minimum stock, delivery schedule and fixed or minimum order quantities.

Typically, production consists of several production steps and each of these manufacturing steps is represented by a separate material - a semi-finished product.

The Bill of Material (BOM) then defines what materials are needed to produce the given product.

Based on the final product requirements, the MRP process then calculates the need for individual semi-finished products and input raw materials, and tries to plan production for each of these or potentially issue a materials order, according to the set parameters. The result of this planning is either confirmation of delivery date or non-confirmation if production cannot be completed in time [6].

The settings for minimum inventory, production interval, or production batch size must then be set outside the system, for example, by the methods listed in the first part of this article.

4. CONCLUSION

Planning serial production in a metallurgical plant uses the principles of Make to Stock (MTS) planning. In the event of stable demand, we can use the Economical Order Quantity and the Camp Formula adapted for the needs of production planning. In the case of variable demand, the Fixed Production Quantity, the Fixed Production Interval or the Target Volume of Inventory models can be used, depending on the needs of the enterprise. The Fixed Production Quantity model should be used when it is technologically necessary or advantageous to produce a fixed-size production batch. A disadvantage of this model may be higher costs of storing surplus inventory. The Fixed Production Interval method is appropriate when the enterprise has a fixed production plan for individual products or campaigns that is repeated on a regular basis. The production batch size is then adjusted to the current state of the inventory and replenished to the desired level. One disadvantage of this model may be lower flexibility in the event of an increase in demand where the products may not be available on time (it is necessary to wait for production of the next batch). The Target Inventory Volume model uses a flexible production interval and batch quantity for replenishing to the optimum level of inventory of finished products. Production is then ordered when the state of finished products for the given product drops to a set level, to ensure that demand is met until new production is completed.

Based on the results of these optimization methods, it is possible to set up an ERP information system such as SAP S / 4 HANA. Here, for each finished product or semi-finished product represented by the material number, it is possible to set the required minimum stock, the production schedule and the fixed or minimum size of the production batch. Using the MRP process, the information system then plans the individual production batches, based on these parameters, with the aim of fulfilling business orders in the required time. For a metallurgical enterprise, this usually involves hundreds of h products and their semi-finished versions, which must be planned thus. Without using the information system, this would be a very lengthy process. In the case of SAP S / 4 HANA, the high computational and database performance of the MRP, makes it also possible to launch the planning process on demand (in earlier versions the MRP process was run once a day during a low user activity period in the system).

ACKNOWLEDGEMENTS

The work was supported by the specific university research of the Ministry of Education, Youth and Sports of the Czech Republic No. SP 2018/107.

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