D. MALINDŽÁK, P. KAČMÁRY, B. ZATWARNICKA-MADURA, D. ZIMON

ISSN 0543-5846
METABK 56(1-2) 219-222 (2017)
UDC – UDK 669.2/.8.15:669.715:621.747:621.794:62.002.086.5=111

THE CONTINUAL CHEMICAL CHANGING ASPECTS IN METALLURGY PRODUCTION SCHEDULING

Received – Prispjelo: 2016-04-30
Accepted – Prihvaćeno: 2016-08-10
Preliminary Note – Prethodno priopćenje

Due to keeping the continuous changes of the chemical composition of alloys in the sequence of manufactured products it is required to apply a specific approach at creation of models of production scheduling. The production schedule is created for the workplace continuous process at first, and then the following production schedules of work are derived for another workplaces. The model was implemented in the company RS Slovakia s.r.o.

Key words: metallurgical production, aluminium casting, continual chemical transition, models of production, continual-discrete process

INTRODUCTION

The RS Slovakia s.r.o. is a daughter company of German Rosenberg-Ventilatoren Gmbh. The company produces rotors and stators respectively components of motors for production of industrial air-conditioning systems. [1] The manufacturing process has the character of combination of the machinery and metallurgy process, the continuous-discrete production, i.e. the aluminium (Al) alloys production and casting at the injection moulding presses has a continuous character, which requires synchronization of moulding at section PP3 and melting at induction furnace PP2. [2] Contrariwise, previous operations – cutting, welding and riveting – PP1 have a discrete character as well as the following process – machining at PP4 and finishing at PP5 work discreetly (Figure 1). [1, 3, 4] Therefore, the procedure of production schedules preparation is not done according the PULL nor PUSH systems, which are usual. But it uses the idea of applying the OPT (Optimized Production Technology), which are considered the continuous processes PP2 and PP3 in this case. [1, 5]

METHODOLOGY OF PRODUCTION SCHEDULING MODEL CREATION

The sequence of Al alloys production at the injection moulding presses is given by the chemical transitions matrix (Figure 2), which defines from which Al alloy to which is possible transition without cleaning process at presses and furnace.

The same is applied to the induction furnace, which produces these alloys [6]. When the direct transition is

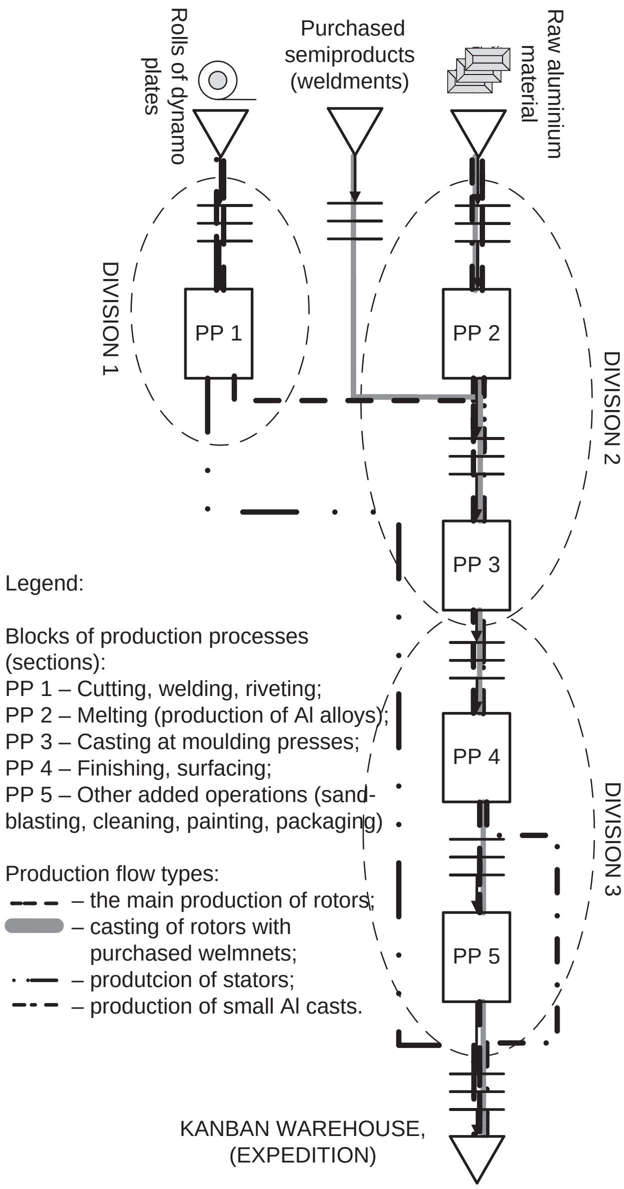

Figure 1 The manufacturing process – the block diagram [1]

D. Malindžák, P. Kačmáry, TU Košice, Faculty BERG, Košice, Slovakia
B. Zatwarnicka-Madura, D. Zimon, Rzeszow University of Technology, Faculty of Management, Rzeszów, Poland

	DIN 226	DIN 231	DIN 230	D 106	S 106	D 165
DIN 226	Y	Y	N	Y	Y	Y
DIN 231	Y	Y	N	Y	Y	Y
DIN 230	Y	Y	Y	Y	Y	Y
D 106	N	N	N	Y	Y	Y
S 106	N	N	N	Y	Y	Y
D 165	N	N	N	Y	Y	Y

N – (NO) transition is not possible without cleaning process
Y – (YES) transition is possible without cleaning process

Figure 2 Transition matrix of Al alloys chemical composition

not allowed ("N" in Figure 2) it is necessary to clean out injection moulding presses and prepare flushing melting for the furnace before the production of next product, what is economically disadvantageous and also the production capacities of furnace are lost. Therefore, the strategy of scheduling (i.e. creation of the weekly production plans for days and shifts to the particular devices with specific quantities and sequences of processed products) is based on the idea to optimally organize the sequence of production at injection moulding presses and induction furnaces first (sections PP3 and PP2) and then to deduce the production schedules for the sections PP1, PP4 and PP5 (see the algorithm at Figure 3).

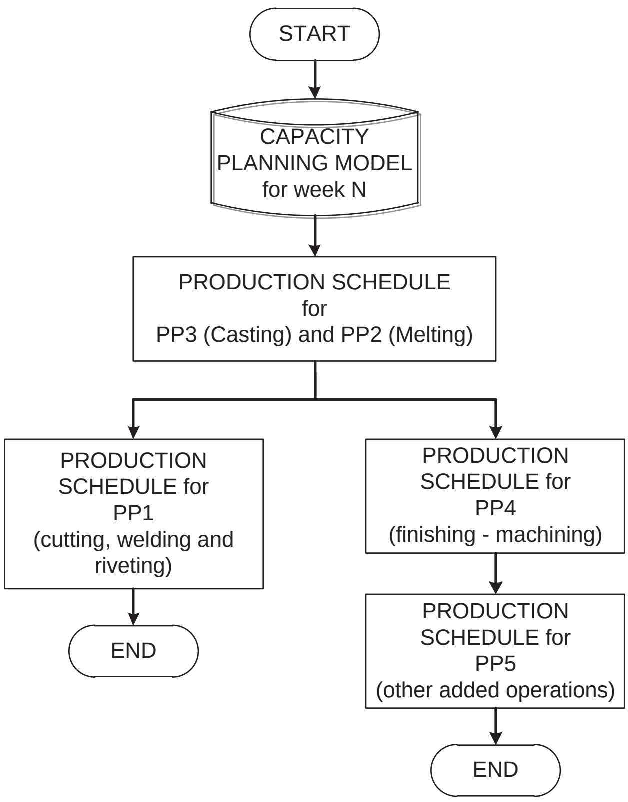

Figure 3 The suggested sequence of production scheduling

PRODUCTION SCHEDULES MODELS CREATION

The planning process begins in actual week *"N"* by setting the capacity plan of week *"N+2"* i.e. two weeks ahead for the division 2 (PP2 and PP3 together) and it is called CPP-DIV2 for N+2. The planning system is realized by a "close" principle, it means that one normal order is in one division only at one week. The division 2 is the second in order of the manufacturing process, but because of its continual character as well as continual chemical transition is the first in the sequence of planning process. Then it is deduced capacity plan for division 1 for week N+1 (CPP-DIV1 for N+1) and also CPP-DIV3 for N+3 from the above mentioned capacity plan CPP-DIV2 for N+2.

The production scheduling model for the sections PP2 and PP3 (division 2)

It starts at the section PP2 (moulding) – model for casting and melting of Al alloys. There are five injection moulding presses at the section PP2 and section PP3 has one induction furnace. The procedure is as followed:

1. Cumulated orders are sorted by the chemical composition, according to the number of products and the possibility of transition by the transition matrix (Figure 2).
2. Decomposition of orders to items required a maximum two doses for the presses (it is approximately one melt form the induction furnace approx. 400 kg).
3. Selection of the order with the latest produced alloy and assigning it to the press – the main technology for the product, the second dose, if it exists, is assigned to an alternate technology. (Each product has the main and an alternate casting (moulding) technology).
4. If there is another product with the same alloy then this is assigned to the main technology, if the main technology is not occupied. The process is repeated from the step 3.
5. If there is not another product with the same alloy, another product with different alloy is assigned. The alloy is chosen according the best chemical transition to not occupied injection press before (in step 3 and 4).
6. This is cyclically repeated until all products are assigned from the capacity plan of division 2 for week N+2 (CPP-DIV2 for N+2). [7]
7. It is reduced the capacity of an injection press about the required operational time of the order at assigning the product (order) to a press. If all the capacity is reserved (not enough) and there is not another order to use the rest of the capacity, then this press is not more loaded.
8. Following this sequence of assigning it is calculated the schedule of melts and the order of supplies of appropriate alloys to particular presses.

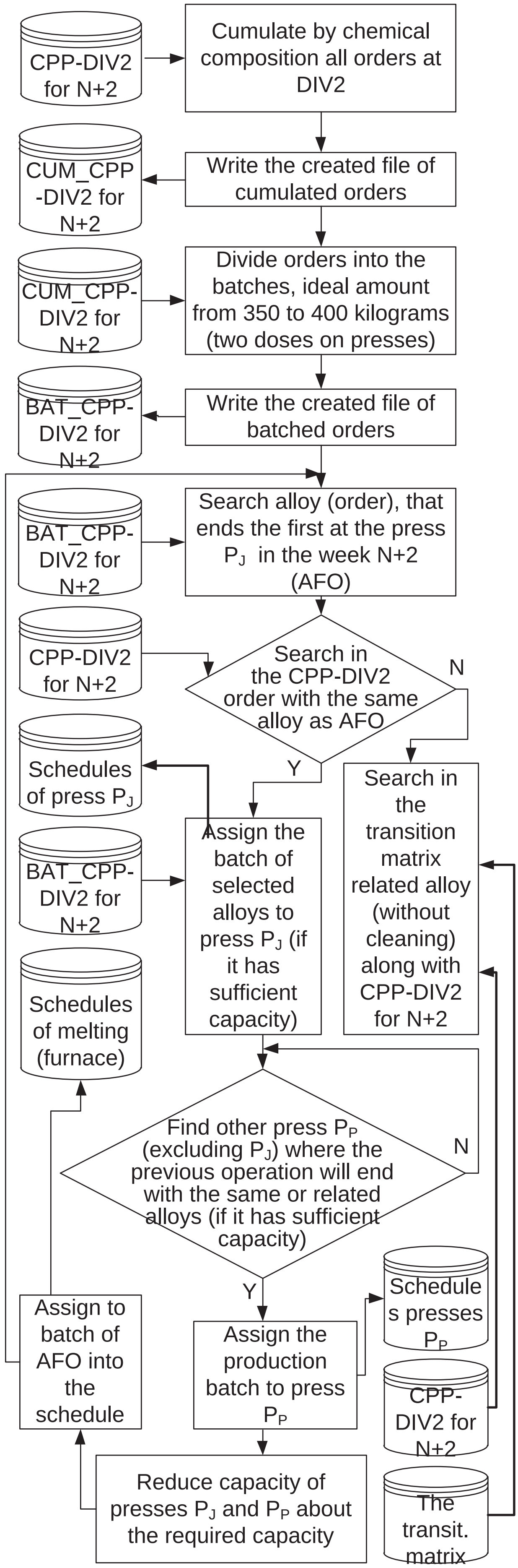

Figure 4 Algorithm of the model of production scheduling creation at the section 2

9. There are created orders sequences (and number of products), for the particular injection presses of which it is calculated daily and shift plans. [1, 2]

The production scheduling model for the section PP1 (division 1)

Orders casted in week N+2 are produced in the section PP1 in week N+1. Based on the capacity plan for the week N+2 for the division 2 the order of cutting to cutting presses L1 and L2 (there are two cutting presses) are determined as follows:

1. The volume of cumulated orders is divided into the form of family products (FP) and individual orders for approximately two equal volumes.
2. The cutting press CP1 cuts large-size parts for riveting workplace R1 – it is more specialized workplace for large-dimension stators and for welding workstation W1.
3. The cutting press CP2 cuts small-dimension parts for riveting workplace R2 and welding workplace W2.

Cutting order is determined by FP (family product) and by width of steel plate – from the widest to the thinnest. Riveting order is not important, because it is the last operation. Welding order is derived from the order of casting (schedules of presses). [8, 9]

The production scheduling model for the sections PP4 a PP5 (division 3)

Orders casted in week N+2 are processed in the sections PP4 and PP5 in week N+3. The section PP4 consists of five Computer Numerical Control (CNC) machining centres CNC1 to CNC5. The cumulated products will be divided as follows:

1. CNC1 and CNC2 process various castings by the main technology centres and balanced utilisation of CNC1 and CNC2 capacity.
2. CNC3 processes small rotors (about 1/3 of the weekly volume).
3. CNC4 processes middle-sized rotors (about 1/3 of the weekly volume).
4. CNC5 processes large rotors (about 1/3 of the weekly volume).

General rule at CNC machines to process orders: from the smallest dimensions to the largest in even week and from the largest dimensions to the smallest in odd weeks. This minimizes the number of transitions i.e. setting time. Sometimes there are processed products with the earliest due date first (to have enough time for finishing at the section PP5).

The order of processing at the section PP5 is done by the principle of FIFO (first in – first out). [10, 11]

CONCLUSION

The paper describes the specific case of creating the production scheduling model when the dominant operation, according the cost, is the operation of the smooth chemical composition change, which reflects also the order of processed products. Similarly, as it is in the bottleneck theory, there is also applied specific approach to create the schedule for this dominant operation and other schedules are derived from the working place schedule with the continuous production flow character. These models were successfully applied in company RS Slovakia s.r.o. [6, 8].

REFERENCES

[1] D. Malindžák, P. Kačmáry, A. A. Moussttfa, Models for Capacity Planning in the Condition for SMEs Connected to Supply Chain Management, Carpathian Logistics Congress, Tanger, Ostrava, 2012, p 1-8.

[2] J. C. Johnson, D. F. Wood, Contemporary logistics, sixth ed., Prentice Hall, Upper Saddle River, 1996, p 15-24.

[3] I. Mamuzić, F. Trebuňa, F. Šimčák, M. Buršák, J. Tomčík, Investigation of reasons and possibility of parameters elimination influencing cracking of leaf springs on continuous casting machine, Metalurgija 46 (2007) 4, p 267-271.

[4] M. Straka, Layout of production facilities in company Alumin s.r.o., Transport and Logistics International Journal 12 (2012) 23, p 1-6.

[5] D. Blazevic, M. Ikonic, T. Mikac, Algorithm for prevention of molten steel sticking on to mold in continuous casting process, Metalurgija 47 (2008) 1, p 47-50.

[6] A. Pawliczek, R. Kozel, Š. Vilamová, K. Janovská, On the strategic planning, innovation activities and economic performance of industrial companies, Acta Montanistica Slovaca 20 (2015) 1, p 16-25.

[7] P. Futáš, I. Jelč, I. Vasková, G. Fedorko, V. Molnár, P. Kačmáry, The GIST of thermal stresses of cast iron castings, Manufacturing Technology 13 (2013) 2, p 173-178.

[8] R. Lenort, R. Klepek, A. Samolejová, Heuristic Algorithm for Planning and Schedulling of Forged Pieces Heat Treatment, Metalurgija 51 (2012) 2, p 225-228.

[9] J. Šaderová, P. Bindzár Using a model to approach the process of loading and unloading of mining output at a quarry, Gospodarka Surowcami Mineralnymi 30 (2014) 4, p 97-112.

[10] M. Malindžáková, Significance Evaluation of Environmental Aspects, Communications 13 (2011) 3, p 48-51.

[11] J. Spišák, J. Lišuch, A. Roháčová, Technological logistics - Tool of optimalization of heat treatment processes of raw materials, Metal, Brno, 2011, p 1169-1176.

Note: The English Language translation was done by Ing. Ladislav Pivka, PhD., Kosice, Slovakia