DILEMMAS OF STEELWORKS MACROLOGISTICS

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Abstract

The aim of steelworks macrologistics system to produce steel sheets is to create long-term conditions over the allocation of divisions and layout equipment (aggregates, machines, warehouses, manufacturing strategy), planning system and structure micrologistics system for the smoothest flow of material, maximum capacity utilization of production facilities, meet delivery dates these products of the required quality. Not suitable solution for macrologistics level creates on the micrologistics level situations with conflicting criteria of solution - dilemmas. The article deals with the analysis and solution of three selected logistics dilemmas in production of steel sheet.

Keywords: Micrologistics, logistic dilemma, material flows, metallurgy

1. INTRODUCTION

The manufacturing process of the steel company i.e. sinter production, iron and steel, slabs, black hot-rolled sheets and final range of packaging, construction, dynamo, automobile, cladding, galvanized, and tin plates, is among the manufacturing processes of a homogeneous type, whose characteristics in terms of logistics are, in particular [1], [2]:

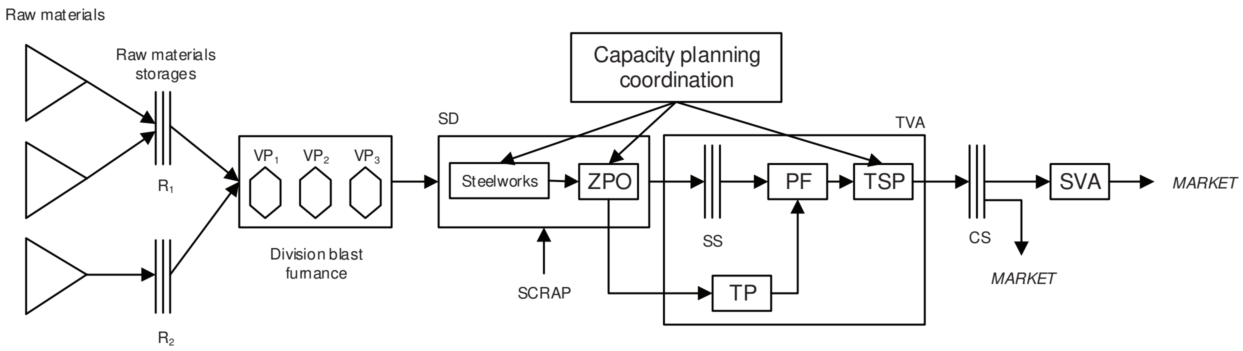
- Long production cycle (3 - 5 weeks).
- Continuous - discreet nature (the first part of the process - sinter production, iron and steel has a continuous character, the second part - cast slabs, rolled plate finalizing process have mostly discrete character).
- Big inertia i.e. management interventions in the management of material flow reflected a long delay [2], [3], [4].
- From the entry of raw materials into the production process to the final product is in motion and in-process consists, e.g. with annual production of around 4 million tons of metal, about 300 000 - 400 000 tons of materials and semi-finished products [1].

The article deals with a fundamental contradiction - logistics dilemmas of large production systems, which include the manufacture of steel sheet steelworks and possible solutions. Macrologistics dilemmas arise, for example, from layout of aggregates at the premises (distance of continuous casting aggregates from the hot rolling mill), defining priorities of conflicting criteria in operational plans (thermal jumps in push furnaces versus volume of hot charge), respectively. technological parameters of aggregates (adverse optimal dose for equipment for continuous casting of slabs and hot rolling mills). [1], [5], [9]

2. ANALYSIS OF THE PRODUCTION PROCESS OF STEEL SHEET - DEFINITION OF BASIC DILEMMAS

The dilemma is defined as: problem solving, in which you have to choose one of the conflicting criteria. This requires complex decisions and usually leads to compromise. [1]

Problems such strategic importance are encoded in the structure (layout) and strategic management of the production process of the steel plate. [6], [7], [8]



VP - Blast furnace	TP - Treatment plant of slabs
SD - Steelworks division	PF - Push furnaces
ZPO - Continue casting aggregates	TSP - Hot-wide-strip rolling mill
CS - Cold storage slabs	CS - Coins storage
TVA - Hot rolling mill division	SVA - Cold rolling mill division

Figure 1 Structure of the manufacturing process of the steel sheet

The manufacturing process begins with the division of the blast furnaces (see **Figure 1**), which carries out the production of sinter and pig iron on three blast furnaces (VP1, VP2, VP3) with each volume of about 2 000 m^3, which is transported in a blender and pans to Steelworks division (SD) with four oxygen converters, which from raw iron produces the desired range of steels. Steel in the ladle is transported to the two continuous casting of steel (ZPO I, ZPO II), with four casting equipment, which are cast slab thickness of 200 mm and width 780 - 1 540 mm. This part of the process in terms of material flow is continuous, without storage. [2]

Cast slabs are transported by railways to Hot rolling mill division (TVA) into Treatment plant of slabs (TP) and cold storage from where they introduce to push furnaces, respectively warm slabs, without storage directly for introducing in push furnaces. Push furnaces (PF1, PF2, PF3, PF4) heat the slabs to rolling temperature of 1 240 C°. The hot-wide-strip rolling mill (TSP) roll slabs by production schedule in the desired range a black plate. Rolled plates are winding to coins stored in Coins storage (CS) and tested for a defined quality. Part of the coils goes on sale, but the greater part is further processed into multiple lines of Cold rolling mill division (SVA), respectively they are cut into sheets. SVA finalize black sheets into galvanized, tin plate, plastic-dynamo sheets, respectively automotive sheets.

The analysis of production logistics revealed three basic dilemmas:

A. Control of the volume of material in the production process on a daily basis by the change the volume of the iron produced in the blast furnaces (VP1, VP2, VP3) or by in-process inventory to stock?

B. Coordination problems between dominant aggregates in this case between the equipment for slabs continuous casting (ZPO I, ZPO II) and hot wide-rolling mill TSP), conflicting requirements for optimum production batches.

C. Ensuring maximum volume batch hot slabs for push furnaces for heating the slabs before to rolling on the TSP and minimizing thermal jumps between slabs in push furnaces.

3. LOGISTICS DILEMMAS OF STEEL SHEETS PRODUCTION AND THEIR SOLUTIONS

3.1. Dilemma No. 1: Regulation of the amount of metal in the logistics flow

The necessary amount of metal each day varies from product ranges on the sheet TSP, from consumption to SVA final lines, sales of black metal, selling slabs etc.The control of metal amount is largely implemented at blast furnaces and in the range of 6 000 - 12 000 t / day and also partly by process inventories in cold storage of slabs, coils stock before mordant hall. The dilemma, however, in that the blast furnaces are aggregates of most inertia and the mode change e.g. from decreasing to increasing or vice versa or ineffective and complicated.

Figure 2 describes Transitional regimes of VP. When we want, for example in the N + 1 day significantly increase production to day N, we can carried out it on the blast furnace which is in the growth mode or stable production mode. Conversely, if the necessary reduced in the day N + 1 iron production at the blast furnace we can do it on the VP, where production declines respectively it was in the day N in stable production mode. It would be best not to change production volume of VP, but to produce a stable statistical averages amount of iron. Necessary regulation of pig iron and metal in the logistics flow regulates by the volume of stock in cold slab storage, field landfills of slabs, stock black rolls and interoperable to SVA. [10]

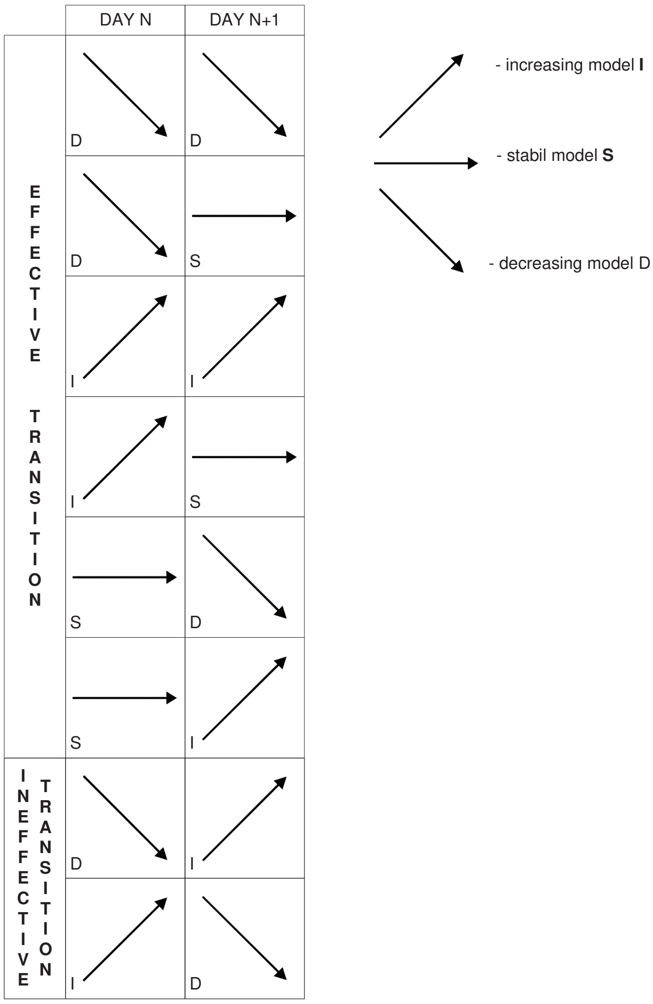


Figure 2 Effective and ineffective transitions of VP

3.2. Dilemma No. 2: Coordination of material flow between ZP and TSP

The difficulty lies in the principles of production technologies of continuous slabs casting on ZPO and rolling sheets on the TSP.

On the steelworks which include the ZPO is locally optimal in terms of waste minimization, staff motivation and productivity, to cast the greatest series of equally wide slab of the same quality. In this case are created minimum numbers so called transition slabs (see **Figure 3**) Transition slabs in terms of their width W1 and W2 arises when the difference W1 and W2 is greater than the shape tolerance. The cuneiform slab with unauthorized size need to be trimmed, or rendered into scrap, what is financial loss. Changing the casting width also reduces the casting speed. The more of smaller dose, the greater assumption of transition slab. The difference between the price of a tone of slab, which continues in the production process and price of a tone of scrap is multiple. Therefore, the aim of the ZPO is to cast the longest series of the same slab.

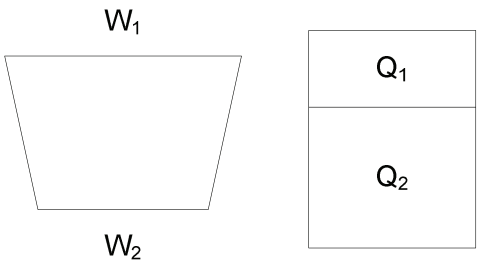


Figure 3 Transition slabs from the point of width and quality

As to the different qualities of successive doses of Q1 and Q2, either by the use of slabs for the engagement of a lower quality order, if possible, or is scrapped. The dilemma is that for TSP is optimal in view of the wear of the rolls, roll up the dose to 20 pieces of the same slabs, the maximum width slabs of approximately 40 pieces. For the production of larger doses of the ZPO, the remaining slabs are waiting for further processing, respectively another contract in a cold slab warehouse, which fits into some timetable and contract.

Cylinder wear of the TSP is solved by the exchange, which takes about 30 minutes, depending on the extent exchanges (small or large exchange), as in the production about 150 000 € / hour is a great financial loss and the goal is to flatten with the same cylinders most products. Cylinders after exchange must be abraded, heat treatment, which is also expensive and after a number of sanding, replace them with a new war.

Between losses on the ZPO in terms of inclusion transition slabs, costs of wear and tear, maintenance and purchase of new rolls is opposed relationship. This relationship is solved by compromise, by coordination of operational plans for ZPO and TSP, that the optimum number slabs in batches of the ZPO are about 40 pieces, of the same slab.

ZPO operative plan is formed such that the width of the successive slabs were lawfully wedge shape. On a cold storage slab ,have to create the necessary supply of slabs in terms of volume and range of products, but this reduces the amount of hot slabs committed to PF (direct sequence - dilemma No. 3).

3.3. Dilemma No. 3: Maximizing the volume of hot charge to PF

This dilemma results from the layout of the production process. ZPO I and ZPO II are far from the TSP, about 3 km. Slabs in continuous casting on ZPO have a temperature about 1 300 °C. Transport for the wagons to Treatment plant (TP) slabs, respectively to the Cold storage of slabs, thus the temperature drops to the temperature of the outside, respectively as "direct sequence" - with temperature to 150 - 400 °C for charge to PF. This saves energy for their heating and manufacturing costs. In terms of heating slabs in PF are undesirable thermal jumps, i.e. the difference between successive slabs more than 150 °C.

If the ZPO are cast doses over 20 pieces of the same slab, then part directly be introduced into the PF and the rest goes into Cold storage. It connected on the dilema No. 2 - the size of doses of casted slabs on ZPO, and coordination of operative plans for casting on ZPO and rolling on TSP. Dilemma is, that if we do not have heat jumps , e.g. in a sequence of slabs in one PF, to have of hot and cold slabs, leave to cool all slabs at ambient conditions, thus loos the costs of heating and vice versa, if undertake the more heat the slabs to PF naturally there is more thermal jumps, but we save on costs heating. The solution is a processing capacity planning a scheduling models for casting and rolling, so we found a cost trade-off between the two criteria.

4. CONCLUSION

Macrologistics decisions such as allocation, layout, organizational structure of management system, structure of production planning and scheduling system, creates an incentive framework, defined optimality criteria and restrictions that are difficult to tackle and overcome on the micrologistics level. Long-term and strategic impact on production costs. Their amendment requires large investments, so "good deal" is appropriate to seek to micrologistics level, particularly in effective model of capacity planning - coordination and scheduling and efficient design-process storage, as has been shown for solutions to dilemmas in the production of steel plates.

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