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Fine Production in Steelmaking Plants

Qing Liu[a,b], Bin Wang[a,b], Zhou Wang[a,b], Bao Wang[a,b], Feiming Xie[c], Jian Chang[c]

[a]State Key Laboratory of Advanced Metallurgy, University of Science and Technology Beijing, Beijing 100083, China
[b]School of Metallurgical and Ecological Engineering, University of Science and Technology Beijing, Beijing 100083, China
[c]Fangda Special Steel Science and Technology Co., Ltd., Nanchang, 330012, Jiangxi, China

Abstract

As the key component during steelmaking process, the production in steelmaking plants involves four stages in process: hot metal pretreatment, steelmaking, secondary metallurgy and continuous casting. This paper is to describe the fine production in steelmaking plants, which is elaborated from fine control of productive technology, fine configuration and reliable operation of process facilities, and fine control of production process. Meanwhile, recent research progress concerning fine production in steelmaking plants will be reviewed. The technology of fine production in steelmaking plants will be introduced combined with research cases on integration of process models and key techniques. Moreover, fine production in steelmaking plants is of great importance to the high-quality, high-efficiency, low-cost, and energy-saving production in steel manufacturing process.

Keywords: Steelmaking plants, Fine production, Hot metal pretreatment, Steelmaking, Continuous casting

1. Introduction

In recent years, with the vigorous development of Chinese industries such as aerospace, automotive, shipbuilding and facility manufacturing, metal materials, especially steel materials plays an important role in manufacturing industries. The national "'twelve • five' steel industry development plan" concisely proposes the requirements on steel industry in new situation: strengthen technological innovation, speed up technological progress, reduce production costs, improve product quality and optimize the product mix. Performance of iron and steel products should be developed toward the direction of the comprehensive performance, high dimensional accuracy, high surface quality and high level. The metallurgical production technology should be improved toward the direction of energy-saving, consumption-reducing, high-efficiency, low-consumption and environment-promoting. The fine

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metallurgical production process should be evaluated toward the precise, integrated, green and reusable direction. Nowadays, the disparity of the metallurgical industry between China and the steel power countries such as Japan, Germany, the United States, etc. is mainly embodied in fine control of productive technology (hereinafter denoted as "FCPT") of monomer process and coordinate operation of the whole process. Fine production in steelmaking plants not only contains FCPT of monomer process, but also contains fine configuration and reliable operation of process facilities (hereinafter denoted as "FCROPF"), and fine control of production process (hereinafter denoted as "FCPP"). Fine production in steelmaking plants could make the high-efficiency, low-cost and stable production achieved by proposing reasonably control requirements for raw materials, facilities, processes and management of various processes according to the product quality requirements proposed by clients, FCPT of monomer process, FCROPF, and FCPP. In the production of some steel products with high-cleanliness requirements, steel plants should not focus on cleanliness of steel only, the production with economical (proper and stable) cleanliness, high efficiency, low costs and stability of the product should also be sought based on the quality requirements of the clients. Fine production in steelmaking plants is the comprehensive embodiment of dynamic order, continuous compact and efficient coordination of production system, which has important significance for steel plants on saving energy, reducing consumption and improving the level of process control and automation.

Taking the steelmaking section (the important section in the steel manufacturing process) as an example, this paper mainly discusses fine production in steelmaking plants, and is elaborated from FCPT, FCROPF and FCPP. The structure of fine production in steelmaking plants is shown in Fig.1. Fine production in steelmaking plants is comprehensive development and performance of the ideas of function analysis of metallurgical processes, optimization and reorganization (from the angles of process, facility and technology) in steelmaking section. The fine production in steelmaking plants is another presentation of high-efficiency and low-cost clean steel "production platform".

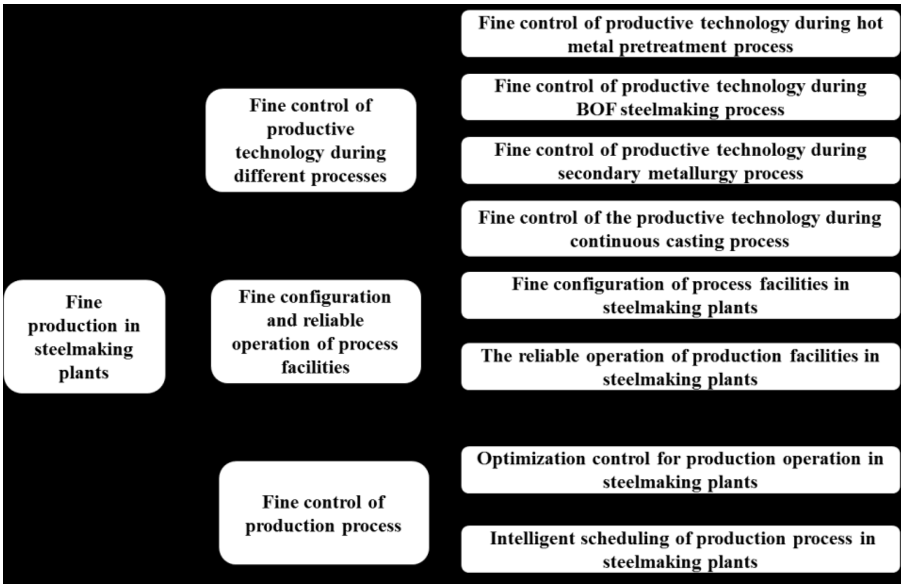

Fig. 1. The structure of fine production in steelmaking plants.

2. Fine control of productive technology during different processes

The production in steelmaking plants involves four processes: hot metal pretreatment, steelmaking, secondary refining and continuous casting, and each process play an important role in steel manufacture process. Due to the diversified function of each process, fine production in steelmaking plant is supposed to clarify the extent, optimized match and comprehensive integration of some functions in each process. Therefore, fine production in steelmaking plants aims to reasonably distribute the metallurgical function of each process and ensure each process complete the corresponding task based on the quality of products. Meanwhile, the idea of good management is permeated into the whole process. It is expected that the products of high quality could be stably produced within strict operation time, and the optimal utilization of resources could be achieved through FCPT. However, the excessive fine control of each process is not encouraged during fine production in steelmaking plants. This paper describes the FCPT, which is elaborated from the fine control of hot metal pretreatment, BOF(basic oxygen furnace) steelmaking, secondary metallurgy and continuous casting.

2.1. Fine control of productive technology during hot metal pretreatment process

With the fierce market competition, hot metal pretreatment is widely applied by various steelmaking plants which intend to produce high-quality, high-yield, high-efficiency and low-cost products. Hot metal pretreatment process is developed from the procedure which is initially designed to meet the demand of producing low sulfur or extremely low sulfur steel to an important procedure during ironmaking→steelmaking→solidification. Recently, a new process for desiliconization pretreatment, dephosphorization pretreatment, and desulphurization pretreatment of hot metal has been formed, especially when the technology of dedicated converter for desiliconization and dephosphorization is developed [1]. FCPT during hot metal pretreatment process needs to reasonably select the process mode (single desulfurization treatment or desiliconization, dephosphorization, desulphurization treatment) according to corresponding steel grade and the effect, costs, efficiency of the treatment. FCPT during hot metal pretreatment process would reduce the burden of BOF steelmaking process, and provide the conditions for the production of clean steel.

Generally speaking, desulphurization pretreatment of hot metal is applied by European and American steel plants, while desiliconization, dephosphorization and desulphurization treatment facilities of liquid steel are applied by most Japanese steel plants [2]. The new generation of steel plants in China mostly employs the technology of desiliconization, dephosphorization and desulphurization treatment of liquid steel in order to shorten production cycle of BOF steelmaking and fulfill the compact, high-efficiency and energy-saving production mode. Shougang Jingtang steel plants applied hot metal treatment (desulphurization in hot metal ladle, dedicated converter for desiliconization and dephosphorization) to clean steel production, which provided the conditions to large-scale, low-cost and quick-rhythm manufacture. With the process of desulphurization in hot metal ladle, desiliconization, dephosphorization, and desulphurization in dedicated converter, the removal processes of sulphur, phosphorus, carbon, oxygen and so on are obviously optimized. The production practices of Shougang Jingtang steel plants shows that the application of hot metal treatment process not only improved the production efficiency (the converter reduces 8 ~ 10 min per heat for decarburization), but also reduces the production costs (blast furnace could use the iron ore with high phosphorus content, manganese ore could be used in decarburization converter which reduced the amount of ferromanganese). Furthermore, hot metal treatment process is well adapted to high speed continuous casting of thin slab production.

2.2. Fine control of productive technology during hot metal pretreatment process

The BOF steelmaking process is the main approach for steelmaking process, and its corresponding technology such as long vessel campaign, combined blow and efficient operation greatly improves the quality of liquid steel [3]. FCPT during BOF steelmaking process intends to accurately control the content and temperature of molten steel through high efficient oxygen supply technology, long campaign combined blow technology, automation technology and advanced detection technology, which would lay the foundation for fine control of secondary metallurgy process.

Based on the introduction of foreign large-capacity converter steelmaking technology, Baosteel and WISCO have developed large-capacity converter steelmaking technologies with their own characteristics, and these technologies contains oxygen supply, slag forming, top and bottom combined blow, automatic control, etc.. Moreover, the economic indicators of converter steelmaking of these two steelmaking plants have reached international level with the application of these technologies [4].

Until now, numerous researches have been conducted on BOF end-point contents and temperature control [5-6]. Literature [5] established multiple linear regression model, BP neural network model and combined GA-BP neural network model for prediction of BOF end-point manganese content on the basis of actual production data from 80 ton BOF in Fangda special steel plants, and the hit rate of end-point manganese could approach 90% when predictive errors of the model are within ±0.03%. Meanwhile, the author developed the multi-level recursive regression model for prediction of BOF end-point phosphorus content, and the hit rate of the model is 73% when predictive errors of are within ±0.004%. Literature [6] proposed the process model for BOF steelmaking based on mixing degree of steel bath, and the verification of the model shows that it could greatly improve the hit rate of end-point carbon and temperature of molten steel when it is applied to the actual production. As it can be seen form Fig.2, the hit rate of end-point carbon is 80% when predictive errors of the model are within ±0.02%, while the hit rate of end-point temperature is 83% when predictive errors of the model are within ±20℃。Based on above analysis, the process model could provide a good reference for the smelting process of traditional small and middle converters. Literature [7] analyzed the factors that affect oxygen consumption during the basic oxygen furnace steelmaking process, and the integrated model for prediction of the oxygen blowing quantity was acquired based on statistical model and metallurgical process model. The test results show that the integrated model could provide an accurate prediction of oxygen blowing quantity (the average relative error of the integrated model is less than 1%). Fig.3 displays the verification of end-point carbon and temperature when the integrated model is applied to actual production, and it shows that the hit rate of end-point carbon and temperature of liquid steel is greatly improved with the help of the integrated model. The double hit rate of end-point carbon and temperature is more than 75% (when predictive errors of carbon are within ±0.03%, and predictive errors of temperature are within ±20℃), and the model could provide a relative good reference for actual production.

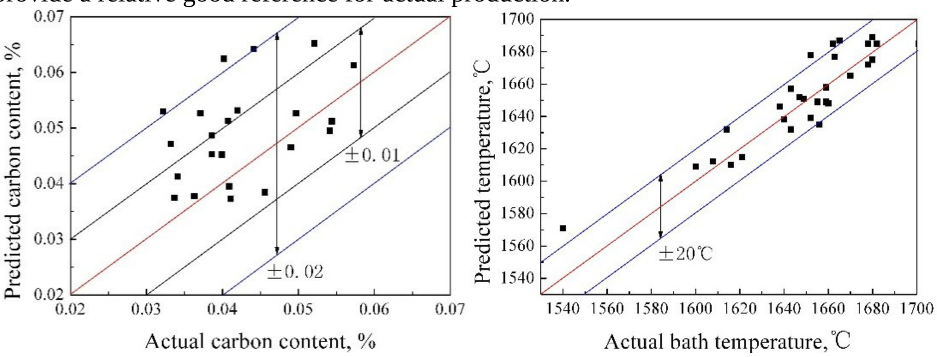

Fig.2 Verification of the process model for BOF process

2.3. Fine control of productive technology during secondary metallurgy process

Secondary metallurgy process appeared in the late 1930s-1940s, primarily used for the degassing treatment of few high-grade steel, and later it was applied to ordinary steel production in large quantities with the development of secondary metallurgy process equipped with different functions. Secondary metallurgy has developed into the key production process for meeting the requirements of cleanliness of the molten steel, precisely controlling the temperature and composition of molten steel, and effectively coordinating steelmaking and continuous casting production. There are a variety of secondary metallurgy processes, mainly including Ladle Furnace (LF) process, Vacuum Degassing (VD) process, Ruhrstahl-Heraeus (RH) process, Vacuum Oxygen Decarburization (VOD) process, Argon Oxygen Decarburization (AOD) process and Composition Adjustment by Sealed Argon Bubbling (CAS) process, etc. FCPT during secondary metallurgy process is supposed to select the appropriate secondary metallurgy process, according to the characteristics (sulfur content, oxygen content, inclusions, etc.) of different steel grades and the functions of different secondary metallurgy process facilities, and develop the corresponding process control technology. In addition, fine control of the productive technology during secondary metallurgy process should not only make the narrow control range of temperature and composition of molten steel during the refining process achieved, but also meet the requirements of cleanliness of molten steel, then provide raw materials for the continuous casting process.

For the purpose of improving the control level of the LF refining process, Shuyuan Xie [8] develops a set of process control models of ladle furnace, which combine with the specific control requirements of LF refining process in Baosteel on the basis of LF refining process and metallurgical mechanism, the models has been successfully applied to a 300t LF in NO.1 Steelmaking Plant of Baosteel. The application results show that the model has effectively improved the quality of the refining steel and reduced production costs. Aiming at the problem that the control of carbon content of the molten steel is inaccurate in RH refining process, Young-Geun PARK[9] builds a decarburization model of RH refining process using three-dimensional fluid dynamics software, which is used for real-time prediction of carbon content of the molten steel during RH decarburization process, and they take into sufficient consideration the behavior of the argon bubbles during RH decarburization process and the entire flow of the fluid in the modeling process.

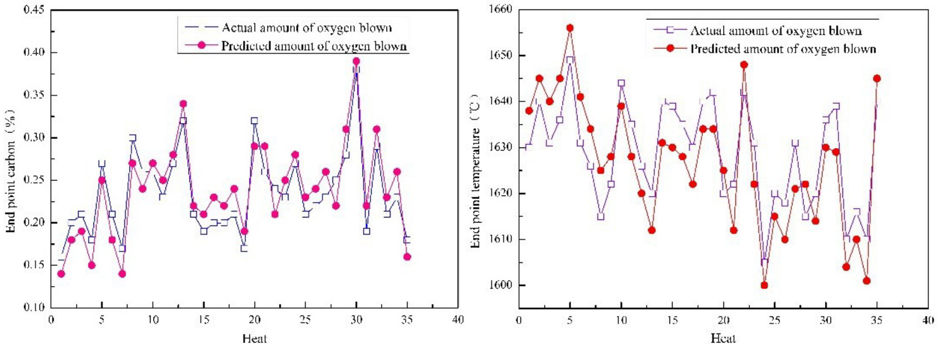

Fig.3 Verification of BOF end-point carbon and temperature

As to the problems that the end-point composition of molten steel was difficult to control and the consumption of alloy materials was instable in LF refining process, the authors have established the end-point prediction system of LF refining process, combining with chemical reaction principles, which could achieve the fine prediction of the refining endpoint composition in Fangda special steel plants, and it could increase the hit rate of LF refining end-point C, Si, Cr, Mn and V content of the prediction system to 97%, 90%, 95%, 88% and 95% respectively, when the predictive errors are within $\pm$0.02%,while value of the content of B is increased to 80% when the predictive errors are within $\pm$0.002%,besides the control level of LF refining endpoint composition of the molten steel is improved substantially, and this prediction system could also solve the problems of the improper judgment of the end-point content of C, Si, Cr, Mn, V and B, etc. in LF refining process for the operators, meanwhile it could provide a solution to fulfill the fine control of the end-point composition in LF refining process.

2.4. Fine control of the productive technology during continuous casting process

China is the world's first steel-producing countries, and the continuous casting ratio reaches at nearly 99%. Steelmaking and continuous casting overcapacity have highlighted the contradictions, so fine control directs the development of equipment of casting technology in the future [10]. The aim of fine control of continuous casting process is to achieve fine control of the quality of strands, by means of reasonably stable flow control in the tundish and mold, heat transfer as well as secondary cooling control optimization, applications of high-precision and high-level control technology in the continuous casting process and so on.

On the aspect of control optimization of solidification and heat transfer of slab, cooling water distribution, as for the common problems, such as cracks and centre segregation encounter in medium thickness slab casting, a fine control technology of solidification and cooling in continuous casting of steel is developed in the literature [11] by carrying out fundamental research and process research. It turns out to be an effective solution to quality problems of high cracks sensitivity strand in solidification and cooling process. A secondary cooling control model based on effective-speed and effective-superheat is developed by Zhichao Dou [12] to solve the problem of the frequent fluctuations of casting speed and temperature, which can lead to great fluctuations of slab surface temperature under secondary cooling control. This model has good adaptability to the variation of casting speed and superheat. This model can be operated simply and conveniently. This model could well control the surface temperature of slabs to meet the requirements of modern continuous casting production. The effects of nozzle arrangements on the slab cooling are analyzed in literature [13]. Through a nozzle cold performance test, the relationship between the spray overlap degree of adjacent nozzles and the uniformity of water distribution in the slab width direction is analyzed from three aspects, including the nozzle flow rate, injection height and hydraulic pressure. Based on the research results, an optimization scheme is put forward for the current secondary cooling system on slab caster II in the No. 3 steelmaking plant in Handan Iron and Steel Group Co., Ltd. As it turns out, the internal quality improves significantly, transverse corner cracks in slabs are almost eliminated, the centre segregation level is reduced to C 1.5 from B1.0, and the ratio of equated grains increases by 4.1%.

Aimed at the problems such as nonuniform cooling intensity in continuous casting process and lower quality pass of casting steel slabs, the author proposes a method of controlling the slab surface temperature at the straightening point. The air-cooled process receives feed forward compensation by adjusting the amount of water in every water-cooled section. Then the slab surface temperature at the straightening point could be guaranteed within the set target temperature range. So the slabs avoid being straightened in the brittle temperature range effectively. Thereby the probability of the occurrence of the slab cracks decreases to achieve the fine control of the strand quality.

During the process of steel production, there are corresponding process functions in hot metal pretreatment, steelmaking, secondary metallurgy and continuous casting process [14]. Hot metal pretreatment process, as the regulator of metallurgical load and quality, whose pretreatment method (single desulfurization treatment or desiliconization, dephosphorization, desulphurization treatment) could affect the metallurgical load during the converter smelting and have a direct significant impact on product quality. The main function of steelmaking process is fast decarburization, heating up and efficient dephosphorization. So the control of the steelmaking process will affect the composition and temperature of molten steel, which will be regulated and homogenized in the secondary metallurgy process, including controlling the morphology of inclusions and promoting the removal of inclusions. Therefore the control of secondary metallurgy is related to that whether molten steel to be casting, qualified in composition and temperature, can be obtained. Molten steel could be casted into qualified slabs in the process of continuous casting, reasonable control of which directly related to the quality of slabs. So the FCPP aims at combinatorial optimization of the above processes, forming a fine control technology of hot metal pretreatment - steelmaking - secondary metallurgy – continuous casting process. And it can provide a steady technical support for high-quality and high-efficiency production in steelmaking plants.

3. Fine configuration and reliable operation of process facilities

The modernization of metallurgical facilities supports the rapid development of Chinese steel industry. In turn, the development of steel industry also promotes the technical level of metallurgical facilities [15]. Fine configuration of process facilities is the important way for steelmaking plants to realize high-quality, high-efficiency production, and reliable operation of process facilities is the important guarantee for steelmaking plants to realize high-quality, high-efficiency production. Therefore, FCROPF is essential to realize fine manufacturing in steelmaking plants.

3.1. Fine configuration of process facilities in steelmaking plants

In recent years, with the change of market demands and the exploitation of high quality steels, the proportion of modernization and large-scale facilities for steelmaking-continuous casting production gradually increased in China. On the basis of ordinary pressure secondary metallurgy facilities such as LF, CAS and some other facilities with the function of blowing argon and stirring, some vacuum refining facilities such as RH, VD were equipped for the production of rolled strips, especially cold-rolled sheet in most of steel plants, which were able to improve steel cleanliness and enlarge the scale of high value-added steel products production. Therefore, fine configuration of process facilities in steelmaking plants is supposed to configure modern and large-scale production facilities, provide necessary facility conditions for high-quality, high-efficiency production to meet the demands of market and the exploitation of high performance steels.

Aim at the difficulty of quantitative evaluation for production process matching degree in steelmaking plants, literature [16] describes the concept of "equivalent cycle" and "matching degree between converters and casters" evaluation index. In order to realize the fine configuration of process facilities in steelmaking plants, intensive study has been made by the authors of literature [17] on the productivity and converter-caster matching of long products special steelmaking plants.

3.2. The reliable operation of production facilities in steelmaking plants

Modern steel production facilities are characterized by high degree of automation. So the reliable operation of production facilities plays decisive roles in the stability of product quality and the improvement of production efficiency. With the improvement of information technology, communication technology, sensor technology and signal processing technology, and the diversify of facility monitoring means, some large steel enterprises (such as Baosteel, WISCO) have widely used monitoring system for facility condition to ensure the reliable operation of the facilities for steel production process.

In the research field of facility operation reliability, literature [18] uses the reliability theory and method, applies reliability modeling and reliability analysis method of hybrid system in the actual production and operation of stainless steel billet caster, Ping Wu calculates the operation indicators for reliability of the stainless steel billet casters, and points out the weak links and the main existing problems in production operation of stainless steel billet casters. Moreover, the improvement measures and maintenance strategy to enhance the reliability of production operation are put forward, which lay the foundation for efficient and reliable operation of billet casters. Hui Dong [19] discusses the basic principle and method of metallurgical facility state on-line monitoring system, which are applied in JISCO production. Moreover, the real-time monitoring on operation status of each production facility is realized, which provides an effective method of judging operation reliability of production facilities.

Nowadays, there are fierce competitions in steel industry. The use of modern, large-scale production facility and the reliable operation of each production facility should be the important guarantee for steelmaking plants to improve market competitiveness. On one hand, the steelmaking plants provide the facility guarantee for high-quality, high-efficiency production by adopting advanced metallurgical facilities and strengthening the abilities of independent research and integration of metallurgical facilities. On the other hand, steelmaking plants adopt all kinds of facility condition monitoring measures to guarantee reliable operation of the production facilities, and then to make full use of the functions of facilities and improve the stability of product quality.

4. Fine control of production process

As an important part of automated production, the control technology for the production process in steelmaking plants has significant influence on steelmaking process control such as normalizing process operation, saving operation time, achieving optimum utilization of resources, etc. FCPP includes the optimization of operation control and the intelligent scheduling of production process. Among them, the optimization of operation control contains the operation optimization of ladles and cranes and the coordinate control of the production rhythm. The intelligent scheduling of production process, including building the planning and scheduling model that match the product process model, can be achieved by controlling the process model flexibility.

4.1. Optimization control for production operation in steelmaking plants

Steelmaking plant system is a vital subsystem in steel manufacturing process system. The complexity of the manufacturing process and the difficulty of process control are the most concentrated reflection of multidimensional mass flow control of steelmaking process. Therefore, the optimal control of steelmaking section is the key to system operation control in steel manufacturing process. The operation status of mass flow carriers in steel production process partly reflects the coordination and operation level of steelmaking-continuous casting production. As two representative mass flow carriers, the operation status of ladles and cranes are important manifestation of steel production efficiency. The optimal control of ladle operation process is the comprehensive integration and optimal control based on the process time analysis, temperature analysis, etc. in steelmaking-continuous casting production. The optimal control of ladle operation process is composed of operation process analysis, mathematical description of the time parameter, the calculation of number of operating ladle, the operation law of temperature decreasing, etc. The optimal control of crane operation process means the rational allocation of cranes with constraint conditions, such as crane running space, facility resource, etc. to fulfill manufacturing mass transporting tasks and ensure the orderly operation of production. The optimal control of crane operation process includes the process time analysis of the crane operation in steelmaking-continuous casting production, the match of cranes and multitasks, the optimization of the space conflict during crane operation and so on.

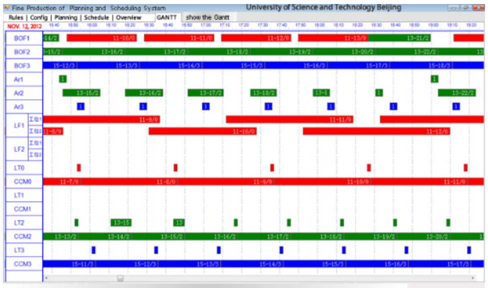

Fig. 4. GATT chart made by fine planning and scheduling system based on “furnace-caster matching”.

As to the aspect of optimal control for ladle operation process, the authors [20] have made a deep analysis and a systematic study with the theory of metallurgical process engineering. The control technology of ladle operation is formed, which contains process analysis of ladle operation, mathematical description of ladle running time, the calculation of ladle operation number, the temperature decreasing of ladle operation process, the frequency of ladle running and the optimization of operation process. It’s found that the number of running ladles decreases from 9 to 7, the tapping temperature reduces 38℃, and the production operation rhythm becomes more reasonable and operating efficiency is also improved when the technology is applied into actual production.

With respect to optimal control for crane operational process, a simulation model based on evolution rules to solve temporal and spatial constraints is proposed by Kai Chen [21]. The model’s objective is to guarantee execution of production plan in steelmaking plants. The matching between cranes and production tasks on working span is conducted to fulfill temporal constraints between multi-tasks and spatial constraints among multi-cranes. Simulation rules including task allocation, conflicts eliminating and task finishing are also proposed to dominate simulation process. This model could avoid difficulties of theoretical calculation for crane scheduling problem. Offline test in a steelmaking plant showed that it’s available to make a crane scheduling without conflicts between cranes and plans, which provids a guideline for production scheduling.

4.2. Intelligent scheduling of production process in steelmaking plants

Production planning is the center of production and management activities in steel plants. Making reasonable production plan is the fundamental guarantee to improve the economic efficiency of enterprises. Production scheduling, which is the decision-making process in manufacturing or service industries, means that in a given period of time, the available resources are allocated to the production task to optimize one or more scheduling indicators, and it is the execution of production plan. The core of intelligent scheduling of production process in steelmaking plants is to build a planning and scheduling model integrated with the production process model. Fig.4 is an intelligent scheduling schematic for the production process in steelmaking plants.

Since the research on flow shop scheduling problem of two machines proceeded by Johnson [22] in 1954, domestic and foreign scholars have conducted extensive research on intelligent scheduling problem. Xiuying Wang [23] applies the intelligent optimal setting control strategy into the production scheduling process of steelmaking plants to resolve the production scheduling problem for large-scale steelmaking plants. Through combining optimization scheduling method, expert system and case-based reasoning etc., the scheduling system which includes scheduling plan, online tracking and adjustment, human-computer interaction etc. is developed. The results shows that the time for plan-making within 20 heats by static scheduling subsystem is less than 15s, and the average response time of dynamic scheduling is less than 12s after the scheduling software is applied into actual production. These greatly shorten the time for plan-making, and reduced the work intensity for the scheduling operators, and improved work efficiency.

Shengping Yu [24] develops the hybrid intelligent scheduling method which includes rule-based expert systems, LP-based method with two stages and multi-layer fuzzy comprehensive evaluation for the production characteristic with multi-facility, multi-process and complex production types in steelmaking plants. The intelligent scheduling system is established by the hybrid intelligent scheduling method. Applied results show that the plan-making time and waiting time for molten steel are highly shortened, and the utilization ratio of facilities is raised. Significant economic benefits have been achieved.

For the problems in the process of production planning and scheduling, such as the production rhythm being affected by long-waiting-time during different processes, etc., fine production planning and scheduling system (hereinafter referred to as “FPPSS”) based on ‘furnace-caster matching’ is established in Fangda special steel plants by authors. Applied results show that the matching degree between furnaces and casters is improved by 60.5(55.6), and the increase amplitude is as high as 153% (125%). The average value of sequence casting heats for special steel increases from 13.5 to 15, and the average value of sequence casting heats for ordinary steel improves from 21 to 25. Compared with the production process without FPPSS, the total operation time of production scheduled by FPPSS is reduced by 5.5% (141min). The waiting time for molten steel in the production scheduled by FPPSS is 491min, far shorter than the one (1465min) in the production without FPPSS (reduced by 66%). Shortening of waiting time and unnecessary time of operation could reduce temperature decreasing of molten steel in steelmaking-continuous casting process, reduce energy consumption, save the cost of steelmaking, and achieve fine control of the production process.

In conclusion, fine control of the production process plays an important role in realizing ordered, coordinated, efficient and continuous production for steelmaking plants. Through optimizing control for the operation of mass flow carrier in production process, the level of coordination and operation for steelmaking production could be constantly improved. Through intelligent scheduling of production process, the plan-making time could be shorten, waiting time for molten steel could be reduced, and utilization ratio of manufacturing facilities could be increased. Fine production integration system of steelmaking plants should be built by the achievement for the integration of control model, production planning and scheduling model based on FCPT, FCROPF, and FCPP in steelmaking plants.

Conclusions

Based on the theory of metallurgical process engineering, fine configuration and operation of process facilities could be achieved. The integration application system of key technology and process could be established based on the consolidation of fine production technology including the fine control of hot metal pretreatment, BOF steelmaking, secondary metallurgy and continuous casting and the fine planning and scheduling in steelmaking plants. Thus, fine production technology in steelmaking plants is formed.

(1) Fine production in steelmaking plants is comprehensive development and performance of the ideas of metallurgical process function analysis, optimization and reorganization (from the angles of process, facility and technology) in steelmaking section. Fine production in steelmaking plants is another manifestation of high-efficiency and low-cost clean steel "production platform". Fine production in steelmaking plants has important significance for steelmaking plants on achieving high-quality, high-efficiency, low-costs, energy-saving production.

(2) Fine production in steelmaking plants could make the high-efficiency, low-cost and stable production achieved by proposing reasonably control standards for the raw materials, facilities, processes and management of various processes according to the product quality requirements of clients, FCPT for monomer process, FCROPF,

and fine control of the production process. Fine production in steelmaking plants is the comprehensive embodiment of dynamic order, continuous compactness and efficient coordination of production system.

(3) FCPT for each process in steelmaking plants aims to reasonably allocate metallurgical functions of each process and ensure each process complete the corresponding task based on the requirements of products quality. Meanwhile, the idea of good management is permeated into the whole process. It is expected that the products of high quality could be stably produced within strict operation time. However, the “excessive” FCPT for each process is not encouraged during fine production in steelmaking plants.

(4) FCROPF in steelmaking plants is supposed to equip modern and large-scale production facilities and provide necessary conditions for high-quality, high-efficiency production to meet the demands of market and the exploitation of high performance steel. Meanwhile, the process should be ensured to operate reliably based on various means of facility status monitoring. FCPP involves the optimal control of production operation and intelligent scheduling.

(5) With deepening of the idea of fine production in steelmaking plants, the concept of fine production could be applied to ironmaking and rolling process through the effective integration of modern information technology, and the manufacturing level of Chinese steel industry could be constantly promoted.

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