

## Design and implementation of production scheduling system based on genetic algorithm

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### Abstract

The planning and scheduling of petroleum production have the difficulties in complex constraints, being prone to put off the delivery date and hard to explore the optimal solution, etc. In light of these, we put forward a design scheme for production planning and scheduling system structure and function. In it the improved batch decision-making and batch scheduling strategy is chosen to establish the planning and scheduling model, the genetic algorithm is employed to solve the production scheduling plan. Based on a manufacturing execution system designed and implemented for a petroleum enterprise, we study the execution situation of the production planning and scheduling system, and carry out simulative calculation and outcomes comparison using different order data and various plan formulation approaches. It is verified that the solution of the modified batch decision-making and batch scheduling model is able to save production time, reduce the times of equipment scheduling, and reduce the times of delay in delivery. It can feasibly improve the production efficiency of the enterprises by using the model to guide the production of petroleum.

### Keywords

Production scheduling, Production planning, Genetic algorithm

### 1. Introduction

In today's society, the fierce competition in the manufacturing industry, effective scheduling has become a necessary prerequisite for the survival of enterprises in the market. Especially in the petroleum enterprise, production scheduling as the internal management of enterprises as a key part, plays a pivotal role in the production and operating activities of the enterprises, production scheduling management and control method for the existing problems urgently to be solved. Enterprises must fulfill their commitment to customers, as scheduled delivery, otherwise it will cause a significant loss of reputation, and even lose customers, lose the market. However, whether the production task can be successfully completed depends largely on whether the scheduling scheme is superior, so production scheduling plays a key role in the process of production management of petroleum enterprises. Petroleum enterprises should be in strengthening the control of dispatching, sound enterprise production scheduling system of the premise, to improve the economic efficiency of enterprises as a fundamental goal, to the production and operating plans of enterprises as the fundamental basis, reasonable organization petroleum enterprise's production and operating activities, make enterprises producing and operating the whole process through coordination and balance to achieve cohesion with the effect.

Study on the production scheduling can be divided into two aspects of the scheduling model is established and an algorithm for the design, the core content and focus of research on production scheduling problem is a scheduling method and scheduling method basically can be attributed to four types: Based on operational research, based on Simulation Based on artificial intelligent scheduling method and heuristic scheduling method. Among the many methods, genetic algorithm is the most active research in production scheduling. Genetic algorithm was proposed by Professor J.Holland in 1975 by Michigan University of the United States. Inspired by biological evolution in nature, genetic

algorithm is introduced into the concept of reproduction, selection, crossover, mutation and competition in the process of biological evolution. This paper mainly for based on genetic algorithm of production scheduling system design and implementation is discussed, the existing production scheduling system and the actual production have decoupled, affecting the improvement of production efficiency, the actual production process there are many constraints, so more to increase the complexity of the production scheduling system. Due to the complexity of the scheduling problem, the efficiency of scheduling algorithm in some existing production scheduling systems needs to be improved. In order to improve the efficiency of production scheduling system in scheduling algorithm, through a combination of petroleum enterprise's actual production characteristics and constraints, this paper proposes a more reasonable optimal scheduling algorithm, in production scheduling system establishment of process improved batch scheduling and group decision model, design and implement the a production scheduling system based on the hybrid algorithm, use genetic algorithm to solve the model, derived from the models of the production scheduling plan is efficient and executable.

## 2. Problem description and system design

### 2.1 Problem description

Production scheduling is actually execute the command of the production manager, especially to the dispatcher at night is the supreme commander, the dispatcher where something where. Oil storage plant undertakes unloading crude oil, product oil blending and transfer task, with sophisticated technology and equipment, advanced technology, with technology and different complex, various equipment, high temperature and high pressure, inflammable, explosive, toxic and harmful substances, high degree of automation, continuous production, and other characteristics. Production scheduling is enterprise production command center, is responsible for organizing the crude oil into the factory loading and unloading, product oil blending, transferring, coordination property, convergence of various professional, optimize production, to enterprise's production operation plays a crucial role. There is considerable authority in organizing and directing production. If there are two sets of the normal operation of the pump in the production of the posts, all of a sudden a breakdown may cause to the oil refinery problems, if not timely processing, may cause paralysis of refinery unit production. At this time, if production scheduling no authority, immediately arrange for another machine pump to replace the work, and instructed the workshop immediately repair the pump, is bound to upset the whole plant running order. Therefore, production scheduling in manufacturing enterprises accounted for a position can not be replaced.

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In the process of enterprise production is full of interference factors, such as emergency orders of the join, equipment failure, the raw material is not in place, when in the face of such events plan

adjustment, actual production with the scheduling needs time to play a role. Production scheduling is not only to ensure the timely scheduling of raw materials in place, but also to take into account the full use of equipment and process. In the face of a large number of production scheduling problem with artificial scheduling scheduling in contrast, reasonable and efficient production scheduling system, to improve petroleum enterprise modern management level, reduce product cost and enhance the competitiveness of enterprises is essential. Figure 1 shows the production scheduling process of petroleum enterprises.

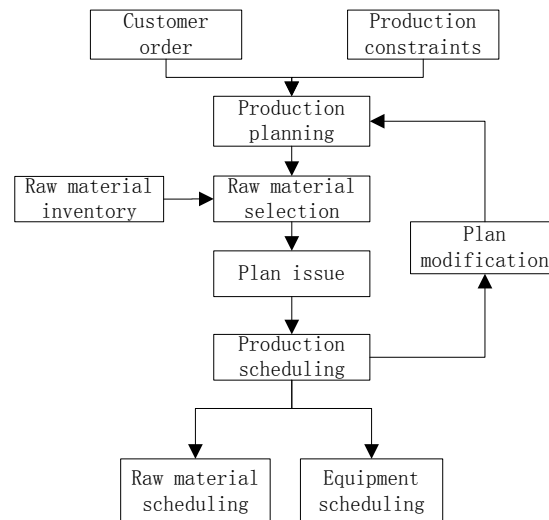


Fig. 1 Production scheduling process

## 2.2 System design

Has the scheduling management organization, command, control, coordination of the functions, the establishment of reasonable scheduling management system, the production and business activities of the various elements and all links organically organized, according to determine the production and operating plans of organizational work, production and business activities effectively. At the same time, in the process of production and operation, the ready to collect information and grasp the progress and situation, timely and effectively deal with various problems. At the same time, in organizing the implementation of the production and business activities of effective communication, to enable all kinds of personnel in accordance with the production and operation of the target coordinate with. Production management system in the process of management, the dynamic balance is the law, coordination is to maintain dynamic balance, so as to ensure smooth flow of production management system internal links, ensure all of the production and operation of part of synchronous operation. This is the central role of scheduling. The basic task of the production scheduling is to organize the daily production activities according to the requirements of the production plan. It can be seen that the production planning is the main basis for the production scheduling, and the main task of production scheduling is to organize and implement the production plan by means of scheduling. However in the narrow level of production scheduling management refers to the petroleum enterprise production scheduling management technology management work, its fundamental content also refers to production scheduling for the orderly operation and production and management to understand the dynamic, master, control, and processing for the key parts of the enterprise internal control and between departments coordination with.

In the system design, considering the practical, reliability and maintainability of the software, the special nature of the oil industry is specially added. Starting from the actual production characteristics of oil enterprises, taking into account the general nature of the industry to avoid waste caused by repeated development of the same industry. The production scheduling system uses B/S mode, which can greatly simplify the load of the client computer, reduce the workload of system upgrade and maintenance, in order to reduce the overall cost of the system. The function module of production scheduling system is shown in Figure 2.

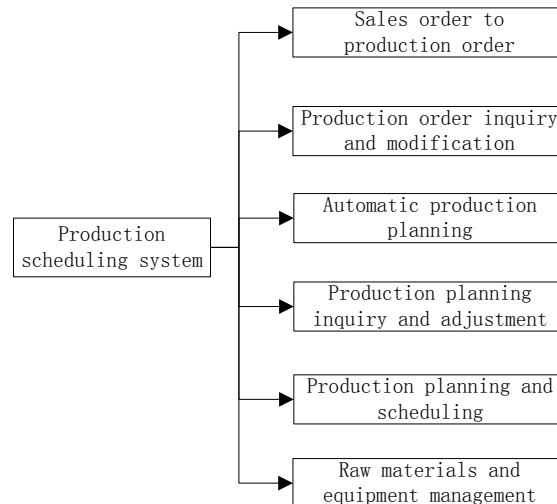


Fig. 2 Function module

### 3. Research of production scheduling system based on genetic algorithm

#### 3.1 Establishment of model

Petroleum enterprise production scheduling needs of different specifications and delivery needs under the orders of the group, it is necessary to ensure not to delay in delivery time, but also minimize the inventory backlog; in production line, how to schedule the use of various production processes equipment, maximize the use all the equipment capacity and taking into account the equipment maintenance. Planning should be prepared to minimize the total production time to ensure that the real cost reduction. Firstly, the parameters and variables in the mathematical model are explained:

$n$ —Total order;

$x_{ij}$ —The  $j$  order is not split and the production is 1 after the  $I$  order, otherwise 0;

$t_{ij}$ — $i$  orders after the production of  $J$  time, and  $j$  orders not split;

$m$ — $j$  order split into  $M$  parts production;

$y_{ij}$ —When the  $j$  part of the  $k$  order is produced after the  $I$  order, it is 1, otherwise 0;

$t_{ijk}$ —Production of  $J$  orders after  $I$  orders part  $k$ ;

$t$ —The sum of the time of equipment maintenance;

$T_j$ —Delivery time;

$\tau_s$ —Current system time;

$g_t$ —The weight of the product stored in the finished products;

$G_c$ —Maximum inventory.

In the mathematical model of the problem, the objective function is:

$$J = \min \sum_{i=1}^n \sum_{j=1}^n t_{ij} x_{ij} + \sum_{i=1}^n \sum_{j=1}^n \sum_{k=1}^m t_{ijk} y_{ij}$$

$i, j = 1, 2, \dots, n, k = 1, 2, \dots, m$

Constraint conditions are:

$$t_{ij} + \sum_{k=1}^m t_{ijk} + t \leq T_j - \tau_s$$

$$\sum_{j=1}^n x_{ij} + y_{ij} = 1, x_{ij} \geq 0, y_{ij} \geq 0$$

$$\sum g_t \leq G_c$$

### 3.2 Solving model

Genetic algorithm is a simulation of biological genetic and evolutionary processes in the natural environment and the formation of a probability search algorithm, but its search is not a simple randomly, but rather a repeated use breeding and selection operation of iterative optimization algorithm. Genetic algorithm by the evaluation of chromosomes or individuals and the role of chromosomes and genes, as far as possible to use the information available to guide the follow-up search, as far as possible to improve the quality of the individual. It uses the group search technology, through the selection, crossover, mutation and so on a series of genetic operations, so that the group gradually evolved to contain or close to the state of the optimal solution. Compared to other algorithms, genetic algorithm and genetic algorithm is relatively simple, the algorithm for full spatial parallel search, which can improve the efficiency and not easy to fall into local minima.

Due to the combination of the production scheduling problem and the process constraints, the coding method needs special design. Due to the presence of complex production constraints. In the following code: every genes on each chromosome represents a unit of production, the production unit may is the production orders, may also be part of a production order split, chromosome length for all production units total, said  $\{O_{ij}\}_m$  that M production unit,  $O_{ij}$  said I denotes the production order J part of gene fragments. The specific implementation steps of the genetic algorithm are as follows:

Step 1 model initialization. In the initial time of the algorithm, the model transformation and the constraint processing are carried out, according to the process of production process initialization and related parameters initialization model, and the relevant constraints are applied.

Step 2 initialize the population. To encode a production order, each individual contains a gene that indicates an order, a resolution, and an identity. The number of the population was 50, 100 of the initial individuals were randomly generated, and 50 individuals were selected as the initial population by calculating their fitness values.

Step 3 to find the optimal solution of each combination. Due to the uncertainty of the order quantity in the production planning, the calculation is simplified, and the objective function in the model is transformed into the fitness function directly. The objective function is to minimize the problem, and the fitness function is set:

$$fit(h) = \begin{cases} c_{\max} - J(h), & c_{\max} \geq J(h) \\ 0, & c_{\max} < J(h) \end{cases}$$

Where  $J(H)$  for the purpose of the first  $h$  individual function values, in accordance with the general production orders of the number of hours of production estimates  $c_{\max}$  value 100.

Step 4 genetic manipulation. Selection operation is compatible with the method of proportion of the roulette wheel selection method, and in order to avoid the roulette selection method is easy to cause premature convergence and search for sensitive issues, in the use of conditional optimal reservation strategy for auxiliary. For the crossover operation, an improved single point crossover algorithm and a partial mapping algorithm are proposed, which are designed by the Reeves for scheduling problems. In order to meet the actual needs of the production planning and scheduling, to ensure that the order of the uniqueness, the modified one point crossover process after the traditional single point crossover operation, also need to the non commutative positional gene transformation operations. For the mutation operation, using the SHIFT mutation algorithm proposed by Reeves, it has been proved to be one of the most efficient algorithms in the genetic algorithm for scheduling problem. Shift mutation algorithm the basic idea: choose two different positions in individual chromosomes randomly, and then reverse arrangement gene between these two positions.

Repeat steps 5 steps 3 and 4 steps until it reaches a predetermined number of iterations and termination, and output corresponding to the last individual optimal solution of the problem.

#### 4. Conclusion

Scheduling of the pipeline dynamic balance is the basic law, coordination is to maintain the dynamic balance of effective measures, to ensure that all aspects of the enterprise production and management system of orderly, smooth, ensure the part of all production and management do synchronous operation. This is the production scheduling management play out the center of the role of. The basic task of production scheduling management in oil enterprises is to organize the daily production activities of enterprises according to the basic requirements of the production plan. Thus, the fundamental basis of the core of enterprise production is the production scheduling work, through the functions of the dispatching management, using management means to specific tissues, the core task of the enterprise production planning and production scheduling management. Petroleum enterprises in the production scheduling management with the main function of the organization, command, control and coordination, establish a scientific and reasonable production scheduling management system, can well combine the petroleum enterprises in production and business activities of the various different elements and each link, according to have clear production and management planning and carry out the work of the organization, enterprise production and operating activities effectively.

In this paper, we study a production scheduling system based on genetic algorithm, the function modules of the system scheduling with reference to the theory of group decision-making and batch scheduling and ordering, to split the order sorting can be improved decision-making and batch and batch scheduling model, and problems about the actual oil enterprises production planning and scheduling system is solved and improved new model in such problems in the obtained solution has excellent efficiency, energy saving, so the preparation of a scheduling scheme can greatly reduce the cost of production of hot-rolled steel enterprises. And in order is the management of petroleum enterprises can survival and sustainable development of the key security, in the production of petroleum enterprises with more advanced production planning and scheduling system can effectively strengthen the security work, promote the development of the petroleum enterprises.

#### Acknowledgements

This research is supported by these projects: The Yangtze Youth Fund(No. 2015cqn53); The Yangtze University Students' Innovation and Entrepreneurship Training Program Project(No. 2014024 )

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