2010 2nd International Conference on Information and Multimedia Technology (ICIMT 2010)
IPCSIT vol. 42 (2012) © (2012) IACSIT Press, Singapore
DOI: 10.7763/IPCSIT.2012.V42.15

Analysis on Production Processe Optimization of Small-Mddle Float Glass Manufacturer

-Shenmu Float Glass Manufacturer in Shaanxi Province as an Example

Jing Yang [1,2] and Yingwen Pan[1]

[1] Management School, Xi'an Polytechnic University

[2] School of Business Administration, Xi'an University of Technology, Xi'an, Shannxi,China

e-mail: yjwp@163.com, panyingwen@163.com

Abstract—A float glass manufacturer in Shaanxi Province as an example, two aspects current situation of production process are analyzed, the time organization of the production process and time - cost analysis of procedure, and on this basis, we optimize the production process from these two aspects. Through the production process optimization manufacturing cycle of float glass is reduced and manufacturing costs are decreased. This gives small and medium float glass manufacturer a good inspiration in the management of the production schedule.

Keywords-optimization of the production process; time organization of the production process; time-cost optimization; production cycle

1. Introduction

Rapid growth of glass production in China recent years , more than 300 large, medium and small flat glass enterprises have been built, Of which the vast majority of small and medium enterprises. End of 2009, China has built and put into operation more than 210 float glass production lines, annual output of flat glass has reached 582 million weight cases, the highest in the world [1]. But compared with developed countries, many of the float lines in technology, production management, there is still a gap and some problems, Such as long production cycle, higher production costs and slow cash flow, etc. This shows that these enterprises need to further optimize the production process. Therefore in this paper, a small float glass enterprise of Shaanxi Province will be example to be analyzed.

2. Status of the production process of a certain float glass enterprise in Shaanxi

Shaanxi ShenMu Float Glass Co., Ltd is private enterprise, with a production line, daily melting capacity of 450 tons, main production types: flat glass, tempered glass, tinted glass.

2.1 Feasibility andOperability of theProduction Process Optimization

The following conditions and environment of Shaanxi

Shenmu Float Glass Co. Ltd. determines its feasibility and operability of the optimization of the production processes:

- Without any change in company's business direction, the implementation of process optimization do not damage on the company's mature production technology, and only continuously improve on the basis of the original production technology.

- No major changes in production process and production technology, the stability of production help the process optimization smoothly.
- The company employee composition tends to younger, who has strong ability to accept new things and ideas, this decrease resistance of optimization.

In the following paragraph, we will analysis the status of product process from two aspects: time organization, time-cost.

2.2 Time Organization Status of Production Process

There are average 3 batches of production every day, and each batch of production is about 2400 weight boxes.The whole process is with the operation of man-machine form, and time organization of the entire production process is in the way of sequence moving. The production process and the processing time for each stage are shown in Figure 1.

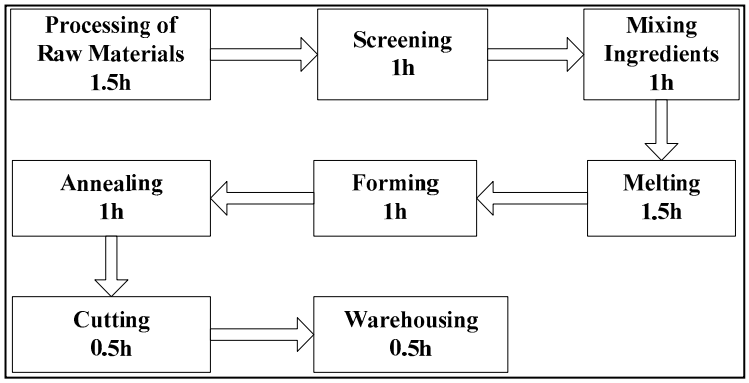

Figure 1. Production process of float glass and the processing time

Figure 1 shows that the production time required for each batch of glass is about 8 hours (from raw materials to finished products storage). While compared with the industry average of 6 or 7 hours, the company's production cycle is longer.

The analysis shows that the main reason leading to longer production cycle are: (1)The way of time organization in the production process is sequence moving, resulting in long production cycle;(2) Plant layout unreasonable cause long route transportation of materials.

2.3 Time –Cost status of Production Processes

The network planning technique in time and cost analysis shows that, the total cost is also at the lowest point when time limit is optimal. Thus duration and cost optimization of production schedule can be carried out simultaneously.The optimization of time - cost is to achieve the best economic returns in meeting the production cycle processes required in the circumstances. In this paper analysis on time – cost is to at the lowest cost of shortening the production cycle. Table Ⅰ shows each process time and associated costs of the production process (including reclaiming including).

TABLE I. PROCESS TIME AND ASSOCIATED COSTS

Production procedure	Operation time (Hour)		Direct costs (Yuan)	
	t_B^a	t_A^b	c_B^c	c_A^d
Taking Materials	0.5	0.4	25	35
Crushing	0.5	0.4	20	0.5
Grinding	1	0.8	20	30
Screening	1	0.8	40	50
Mixing	1	0.9	40	45
Melting	1.5	1.4	80	100
Forming	1	0.9	70	90

Annealing	1	0.8	95	105
Cutting	0.5	0.4	35	50
Warehousing	0.5	0.3	45	60

Indirect costs：65Yuan/H

a. The normal duration of a single process, b. The minimum duration of a single process,

c. The normal cost of a single process, d. the cost of a single process when minimum duration

According to the company's float glass manufacturing process the logical relationship between processes is listed in the Table Ⅱ. In Table Ⅱ English letters are listed instead of the name of each process, and then the logical relationships between the various processes are given.

TABLE II. LOGICAL RELATIONSHIPS BETWEEN THE VARIOUS PROCESSES

Production procedure	**Letters**	**preceding activity**
Taking Materials	A	/
Crushing	B	A
Grinding	C	A B
Screening	D	C
Mixing	E	A D
Melting	F	E
Forming	G	F
Annealing	H	G
cutting	I	H
warehousing	J	I

The optimization of production process will be analyzed from two aspects mentioned above.

3. Optimization of the production process

3.1 Time Organizational Optimization of theProduction Process

In order to improve production efficiency and reduce production costs, the company should optimize the time organization of the production process. This paper argues that parallel-serial movement should be used to organize the production process. Because the parallel-serial movement can not only shorten the production cycle, but also maintain continuity of production processes [2]. Specific optimization is as follows:

The formula of the parallel-serial movement:

$$T_{ps} = n\sum_{i=1}^{m} t_i - (n-1)\sum_{i=1}^{m} t_{is} \qquad \text{Equation (1)}$$

T_{ps} : Production cycle of the parallel-serial movement,

n : Batch processing,

m : Number of processes,

t_i : Single procedure of the i process,

t_{is} : Single working hours of the shorter in the two adjacent processes.

The datum in Figure 1 is calculated into the equation (1), the result shows in follows.

$$T_{ps}=3\cdot(1.5+1+1+1.5+1+1+0.5+0.5)-(3-1)\cdot(1+1+1+1+1+0.5+0.5)$$

$$=24-12=12 \text{ (hours)}$$

Optimization process and the results shown in Figure2

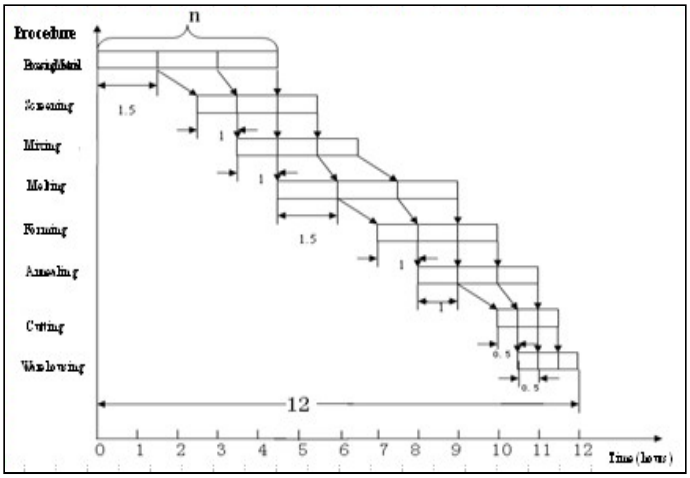

Figure 2. Sketch map of the parallel-serial movement

In the way of serial movement, in a day production cycle of three batches is 24 hours, after optimization of the parallel-serial movement the production cycle is only 12 hours, shorter 12 hours than previous. And equipment and workers of each process can be up and running, these can effectively reduce the waste of time, equipment and human. This greatly decrease production cycle, reduces production costs and improve productivity.

Combined with calculation results, the optimal specific recommendations related to the time organization are as follows:

- The way of time organization of production process changes from previous sequence movement into the parallel-serial movement.
- Strengthen management, and strengthen the concept of time in workshop manager's mind, and arouse the initiatives of them. In this regard, companies should establish a training system to train workshop managers about concept of time and management of knowledge, and establish incentive and reward systems to improve the initiative of all workers.
- Reasonably adjust the layout of the plant to shorten materials transportation routes, reduce the transit time of goods in process.
- Introduction of advanced material transport means in some processes, fully realize the automatic control of transport of goods in process to increase the transport efficiency. For example: introduction of electrically-driven conveyor belts in the processing of raw materials, screening, mixing and warehousing for full realization of the whole process of automation, finally increasing production efficiency.

3.2 Time- Cost Optimization of Production Processes

According to the actual situation of Float Glass Co., Ltd. Shaanxi Shenmu, we optimize the time-cost of glass production process in order to achieve reasonable configuration between the time and cost, and to further optimize allocation of resources [3].

1) Drawing the NetworkDiagram

First, according to various logical relationships between processes listed in Table Ⅱ and the normal process time in Table Ⅰ, the network diagram of float glass production schedule is drawn out(Figure 3).

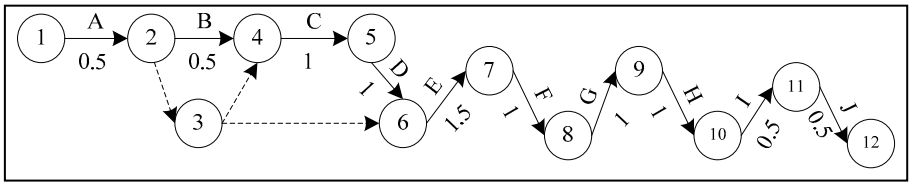

Figure 3. Network diagram of glass production schedule

2) Calculating the Nodes Time Parameters

According to the network diagram drawn in Figure 3 and the calculation method of network diagram nodes time parameters, the earliest start time (ET) and the latest start time (LT) of each node is calculated out and marked on the network diagram of specifically expressed in Figure 4.

In Figure 4 "□"denotes the earliest start time of node, while "△"denotes the latest start time of node.

3) Calculating the Total Float Time and Finding the Key Operating Procedures and Critical Path

According to Figure 4 the total float time of each process is calculated out and listed in Table Ⅲ. The process whose total float time is ZERO is key operating procedures [4]. From the total float time listed in Table Ⅲ, the key operating procedures are in following: Taking materials, Crushing, Grinding, Screening, Mixing, Melting, Forming, Annealing, Cutting and Warehousing. So the only one critical path is consists of these key operating procedures.

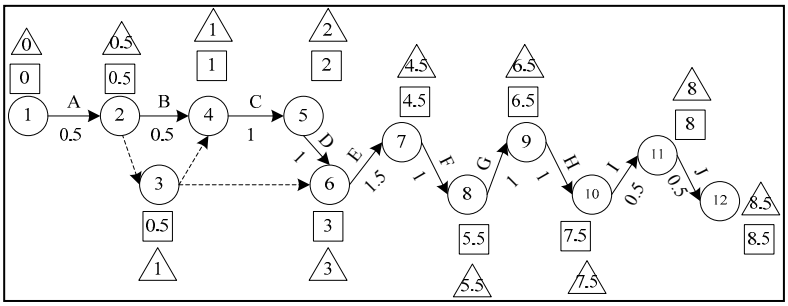

Figure 4. Nodes time parameters of network diagram

TABLE III. THE TOTAL FLOAT TIME OF EACH PROCESS

Production procedure	**Letters**	**Process time (hours)**	**Total float time**
Taking Materials	A	0.5	0
Crushing	B	0.5	0
Grinding	C	1	0
Screening	D	1	0
Mixing	E	1.5	0
Melting	F	1	0
Forming	G	1	0
Annealing	H	1	0
Cutting	I	0.5	0
Warehousing	J	0.5	0

4) Calculating the Cost Rate in Time-Cost optimization

The basic idea of time - cost optimization is: First, from the relationship between the process duration and cost of the process, identify the process with the ratio of shortening duration to increases of direct costs is the smallest(cost rate is smallest), and shorten its duration, and then considering the influence of indirect costs decrease with the duration of shortening respectively calculate direct and indirect costs of different duration, finally you can find the optimal duration of the lowest cost [5].

Therefore the key problem of time - cost optimization is to calculate the cost rate of key operating procedures by equation (2).

$$e=\frac{CA-CB}{tB-tA} \qquad \text{Equation (2)}$$

e: the cost rate of procedure.

The datum in Table Ⅰ is calculated into the equation (2), to calculate the cost rate of each key operating procedure, and the result shows in Table Ⅳ.

TABLE IV. THE COST RATE OF EACH PROCEDURE

Production procedure	**Operation time(Hour)**		**Direct costs (Yuan)**		**e**
	t_B^a	t_A^b	c_B^c	c_A^d	
Taking Materials	0.5	0.4	25	35	100

Crushing	0.5	0.4	20	0.5	100
Grinding	1	0.8	20	30	50
Screening	1	0.8	40	50	50
Mixing	1	0.9	40	45	50
Melting	1.5	1.4	80	100	150
Forming	1	0.9	70	90	200
Annealing	1	0.8	95	105	50
Cutting	0.5	0.4	35	50	150
Warehousing	0.5	0.3	45	60	75

Indirect costs：65Yuan/H

From the datum in Table Ⅳ,under normal circumstances the total number of direct production cost of one batch glass is:

25+30+20+40+40+80+70+95+35+45=475**(Yuan)**

While the total cost of production is the sum of direct costs and indirect costs, so the total cost of production is:

475+65×8.5=1027.5**(Yuan)**

From the datum in Table Ⅳ, the processes of crushing, screening, mixing and annealing is the lowest cost rates, all is 50, less than indirect costs of 65 Yuan / hour. So the time of the four processes should be compressed. The specific suggestion of compression and calculation as follows:

- Crushing process is compressed 0.2 hours, the total cost after compressed:
  1027.5-65×0.2+50×0.2=1024.5**(Yuan)**
- Screening process is compressed 0.2 hours, the total cost after compressed:
  1024.5－65×0.2+50×0.2=1021.5**(Yuan)**
- Mixing process is compressed 0.1 hours, the total cost after compressed:
  1021.5－65×0.1+50×0**.1=1020 (Yuan)**
- Annealing process is compressed 0.2 hours, the total cost after compressed:
  1020－65×0.2+50×0.2=1017 **(Yuan)**

After the four processes of compression, optimization completed, the result of optimization is: production cycle of each batch glass is 0.7 hours shorter than before, and the total cost is reduced from 1027.5 Yuan to 1,017 Yuan. Optimization not only reduces the cost of production but also improve productivity [6].

4. Conclusions and summarizations

The process optimization results of Shaanxi Province Float Glass Co., Ltd. Shenmu are as follows:

- About the time organization of production process, the company's production cycle saved 12 hours each batch of float glass, moreover the allocation of human and machine is reasonable so that production efficiency is greatly improved and production costs is greatly reduced.
- About the time - cost, application of network optimization to compress period and lower production costs. By optimized, the total duration of the production of glass batch shortened by 0.7 hours to reduce the total cost of the 1027.5 Yuan to 1,017 Yuan, thus reducing production costs.

In short, optimization of production process can improve production efficiency, decrease production costs, and reduce production waste of the phenomenon.

5. Acknowledgment

The authors appreciate the suggestions of associate professorYingwen Pan, and participants at Management School, Xi'an Polytechnic University, Xi'an, China.

6. References

[1] "The development of float glass industry(2008-2009)", http://report.ecdms.com/jianzhufangchan/fufaboliyefazhanzhuangkuang.html.

[2] Tong Xin shun , Production and Operations Management ,Nanjing University Press:Nanjing,pp232-250,2007(in Chinese).

[3] Yi Ping, Li Jianjun and Xiong He gen, “Study and Development of the Optimal Management of Production Process for Mould Companies”, Journal of WUT(Information & Management Engineering) , Vol. 28, No.1, pp.57-61, 2006(in Chinese).

[4] Mei Hong, “Optimization- Based Production Scheduling and its Application”, Journal of Hangzhou Dianzi University, Vol. 25,No. 5,pp.68-71, Oct. 2005(in Chinese).

[5] Chen Xinde, Wu Zhong, Production and Operations Management , Tsinghua University Press:Beijing,pp217-221,2005(in Chinese).

[6] T Holczinger, J Romero and L Puiganer. “Scheduling o f Multipurpo se Batch Processes with Multiple Batches of the Products” .Hungarian Journal of Industrial Chemistry Beszprem, Vol.30, NO. 4, pp. 305- 312. Apr.2002.