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Data Mining in Quality Improvement

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ABSTRACTS

According to the example of Baosteel production, this paper introduces the way of using data mining technology -- SAS/EM to discover the rules that we don't know before and it can improve the quality of products and decrease the cost.

INTRODUCTION

Over a long period, Baosteel adopted the chemistry design of 'high manganese and low carbon' to produce the hot rolling plate used by welding pipe which steel grade is SP. In recent years as we communicated with other corporations, we found that the content of manganese of the same steel grade of other corporations is lower than ours, but its mechanical property is better than ours. The discovery attracted our attention. So we started to study the chemistry design and process of SP deeply.

INVESTIGATION

Elongation and tensile strength are important indices of the hot rolling plate. They will directly influence the customer's use. We investigated the elongation and tensile strength of SP produced in recent years. [**see Figure 1]**

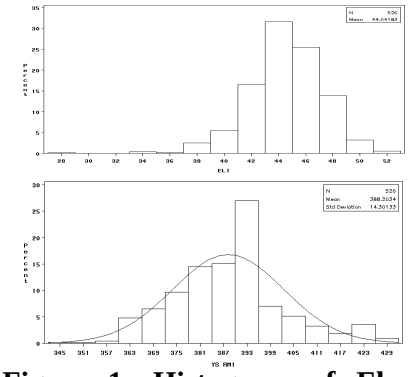


Figure 1: Histogram of Elongation and tensile strength

The figure shows that the average value of elongation is 44 and the average value of tensile strength is 388 Mpa. Although these values can satisfy the request of enterprise standard, they are lower than other corporation's product.

According to the condition we have mastered, we investigate the factor that would influence the mechanical property. The factor includes the content of carbon, manganese, phosphor, silicon, sulfur, after_rooling temperature, coil temperature. [**see Table 1**] We want to adjust the factor and improve the quality of steel plate.

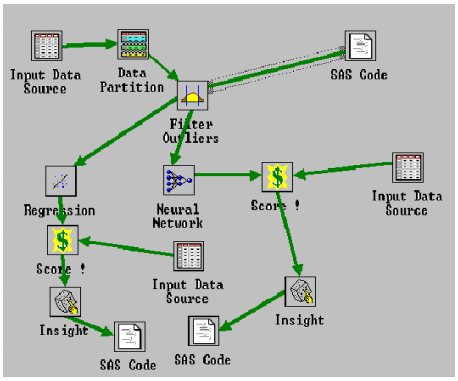
Table 1

Variable	Label	N	Mean	Std Dev	Minimum	Maximum
C_EL	C_EL	510	84.2294118	14.7405965	0	163.0000000
MN_EL	MN_EL	510	40.6784314	4.9100480	0	48.0000000
SI_EL	SI_EL	510	14.9372549	4.1843548	0	53.0000000
P_EL	P_EL	510	15.4156863	4.2863778	0	29.0000000
S_EL	S_EL	510	71.8882353	26.0597255	0	150.0000000
FT_AVER	FT_AVER	526	856.3517110	6.3530920	842.0000000	895.0000000
CT_AVER	CT_AVER	526	622.4904943	61.7079674	0	764.0000000

DATA MINING

We use SAS/EM to study our problem. SAS defines data mining as the process of selecting, exploring, modifying, and modeling large amounts of data to uncover previously unknown patterns in data for a business advantage. SAS/EM provides tools to facilitate the data mining process. A graphical user interface groups these tools by common data mining tasks: sample, explore, modify, model, and assess (SEMMA). According to the process of SEMMA provided by SAS/EM, we studied the data as described below. The process flow diagram is presented in figure 2.

Figure 2: The process flow diagram



1. *Data preliminaries:* We select the data of the common carbon steel produced by 1580 hot rolling plants from quality data warehouse. At this time we pay attention that the data should include several steel grade and the contents of carbon and manganese should vary at large scale.

2. *Designating the target variable:* We designate elongation and tensile strength as target variables. At the same time, we appoint the input variable and get rid of the irrelevant variables.

3. *Partition:* We split the data into three parts. 70% of the data are used for training, 20% of the data are used for validation and the rest of data are used for model testing.

4. *Building, training and validating regression model and neural network model.*

5. *Assessments and conclusion comparison:* We use a regression model and the neural network model. For both models, the accuracy is above 80%. The neural network model is better than the regression model.

6. *Selecting the model:* We select the neural network model as our final model to analyze the data.

ANALYSIS AND RESULTS

According to the result of the neural network model, we emphasize the study of the influence between the contents of carbon, manganese, coiling temperature and mechanical property. We discover that:

1. If the content of manganese increases, the value of elongation decreases and tensile strength increases; [**see Figure 3]**

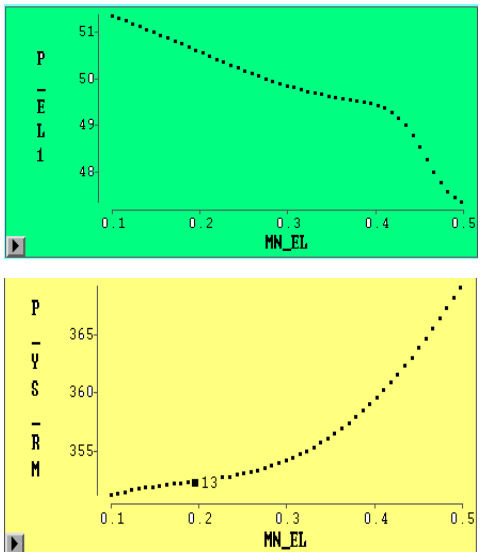


Figure 3: The relation between the content of manganese and mechanical property.

2. If the content of carbon increases, the value of elongation decreases and tensile strength increases; [**see Figure 4**]

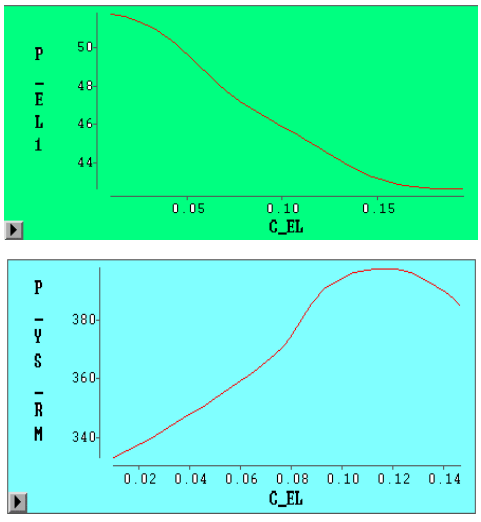


Figure 4: the relation between the content of carbon and mechanical properties

3. If the coiling temperature increases, the value of elongation increases and tensile strength decreases. [**see Figure 5**]

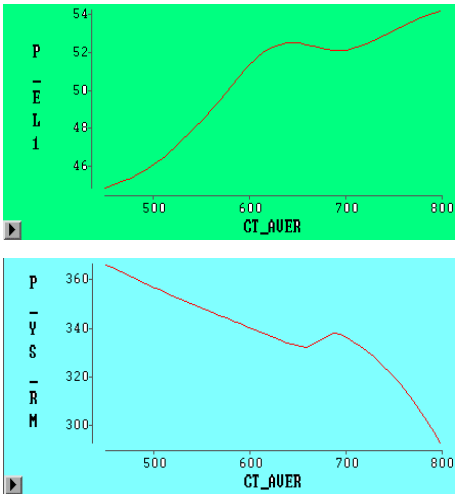


Figure 5: The relation between the coiling temperature and mechanical property

MEASURES AND EFFECTS

We discover that the content of manganese and carbon has the same influence upon the mechanical property, but the price of carbon is cheaper than manganese. So we decided to decrease the content of manganese and increase the content of carbon, then we adjust the coiling temperature. After a period of testing we get a production level that is better than the original SP. [**see Table 2**]

Table 2: The mechanical property compared new process and old process

mechanical property	new process	old process	standard
elongation	47	44	•35
tensile strength	385	390	•440

The more important outcome is the large decrease in the cost of the product. The cost of per ton is 7 RMB YUAN less than before and it will save 1.6 million RMB YUAN every year for our corporation.

CONCLUSION

With the coming of new information we can get millions of data. How to use data is an important thing that faces everyone. We should apply the data mining technology to more fields.

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