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Knowledge-Base-System for forging mold and die material selection

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Abstract

In recent years, the production value of Taiwanese mold and die industries have reached to a high peak in 1998, in amount of NT 604 hundred million dollars. But in recent years production value are going down year by year, till year of 2001 the production value have down to NT 394 hundred million dollars. Its main reason might be the major product were following in medium and low price category, the high accuracy and high cost mold and die still rely on import aboard.

Therefore how to made the related technical database system on various field to provide the industry user to promote industries competition ability in mold and die is really urgent matter at this moment.

In this research, we will offer how to apply the Visual Basic program language to edit a set of more perfect database system of mold and die material selection. At the present time, we have constructed complete Knowledge-Base-System of intelligence for forging mold and die material, the most related data from the existed data, the others are through our additional experimental results.

By using this system by the user can got the related and need data easily, we hope it will reduce designing time and cost for mold and die.

Keyword: Mold material; Knowledge-Base-System

1. Purpose of this study

During forging process, the mold and die must contact with the high working piece, and also accept the impact force at the same time, the operation environment of forging mold and die were not only in high temperature, some degree of vibration and severe wear simultaneously, so in order to extend the die life to choose the suitable material is apparently important. The choice of the forging mold and die is generally affect by following factors:

(1) The shape, size and weight.
(2) The chemical composition.
(3) The working temperature.
(4) The categories of forging equipment.(hammer forging or press forging)
(5) The amount of tolerance and bevel angle.
(6) The cost .

According to the above reason, we will in accordance with material property, manufacturing terms, heat treatment process, surface coating treatment and etc. carry on Knowledge-Base-System of Intelligence for forging mold and die material for the convenience of the user to reduce the damage of forging mold and die.

This research with some data of mold and die material that often use, we collect some data from the existed data. If it is not enough, we have done some experiments to get the necessary data. Therefore according to the need of users, we construct a set of perfect Knowledge-Base-Systems.

According to the above reason, the purpose of this research is:

1. Make the systematical Knowledge-Base-System of Intelligence for forging mold and die material.
2. To promote a convenient material selection system for mold and die designer or production engineer to reduce operation cost.

2. The content of this system

According to the need of the users, we made the construction of Knowledge-Base-System of Intelligence for forging mold and die material as shown in Fig. 2-1.

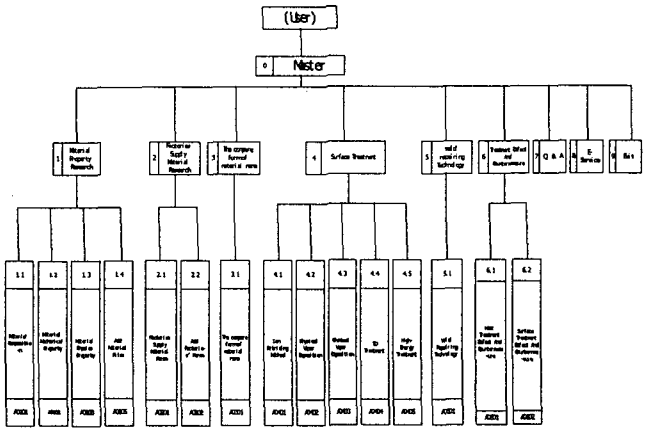

Fig.2-1. The content of Knowledge-Base-System of Intelligence for forging mold and die material

This knowledge base system is to adopt the documentary checking method which will included such as Job Description and operating Manuals and etc. Because those documents are to organize to record of the activity data, it also work as the medium of information transmit. We can use the various form of table of this system to be the reference standard of the existed system.

But generally speaking, by documents only that can't express the operation of the system completely, so still need the supplementary other method to carry on the more complete analysis.

The most method we use are through customer interview.

The form pattern and the content of data table of the mechanical properties system were shown in table 2-1 and table 2-2. The design flow chart of the Knowledge-Base-System was shown in Fig. 2-3. Base on the collect data, we take into the integration, analysis, and then design the searching flow chart of the material mechanical properties was shown in Fig. 2-2. The table 2-3 shows the processing of the searching of the descriptive form for the mechanical properties.

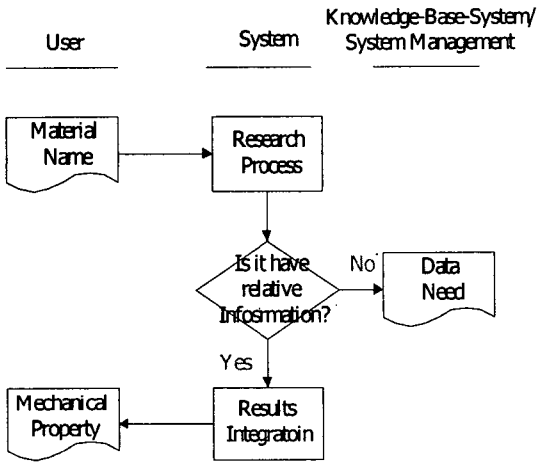

Fig. 2-2. The flowing chart of material mechanical property searching

Table 2-1 The format form of the mechanical properties

Material Serial Number	A	
Material Name	B	
Mechanical Property		**Remarks**
Hardness	C (HRC)	
Impact Value	D (J/cm^2)	
Tensile Strength	E (N/m^2)	
Yield Strength	F (N/m^2)	
Elongation Rate	G(%)	

Table 2-2 The data vocabulary of format form of mechanical property

Number	Column Name	length/ Appearance	key	Rule/Format/Scope /formula	Examples
A	Material Number	6N	U		000001
B	Material Name	10C	A		SKD11
C	Hardness	5N	H		58 (HRC)
D	Impact Value	5N	I		17 (J/cm^2)
E	Tensile Strength	5N	T		490 ($\mathbf{N/m^2}$)
F	Yield Strength	5N	Y		580 ($\mathbf{N/m^2}$)
G	Elongation	5N	E		10 (%)

Table 2-3 The descriptive searching form of the mechanical property

Activity	**The search for mechanical property**
Procedure and Rules	After user input the material name on this system, it will carry on searching and checking the mechanical property and related data in the database. If there is data, it will carry on the results compilation processing; if there is no data, it will notify the Knowledge-Base-System to carry on the data of complement.
Data input/Source	Material Name/User
Data output/Destination	Mechanical property / Data for user need /Knowledge-Base-System
Limits and Remarks	

The mechanical property is consist of five attributes that include elongation rate, tensile strength, hardness, impact value and yield strength of material in system. We use the chart to explain the attributed relation as shown in Fig. 2-3.

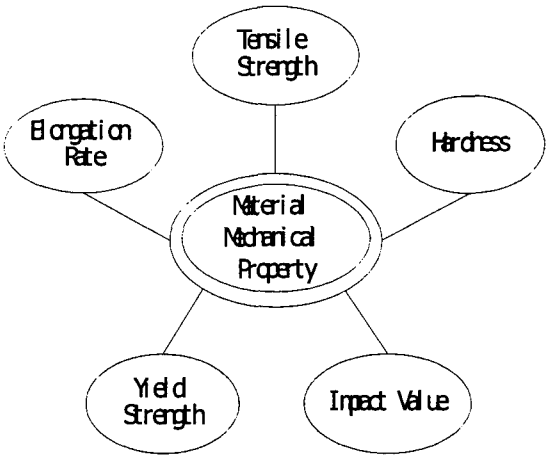

Fig. 2-3. The attributed diagram of material mechanical property in this system

2.1. The flow chart of the system construction

In order to let users friendly, a lot of technical data is gradually to use the type of the Knowledge-Base- System, in order to make the software interface to meet user's usage. We construct the flowing chart that we have taken various consideration to design the system as shown in Fig.2-4.

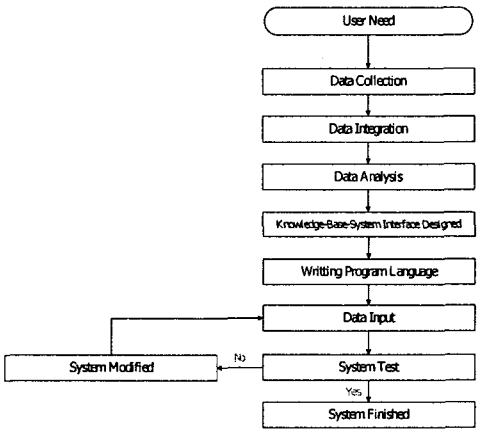

Fig. 2-4. The flowing chart of the system construction

2.2. The choice and introduce of Knowledge-Base-System of Intelligence for forging mold and die material

This system is Knowledge-Base-System of Intelligence for forging mold and die system, we only choose five kinds of die material in this study such as (SKD11, SKD61, SKH51, SKT4, SNCM439) which is commonly used are in Taiwan industry.

We will explain as the following:

1. SKD11 (tool steel high metal alloy) For high efficiency cutting tool.

   (1) Tool Industry: punch, Immediate roller for cold rolling.
   (2) Wire Cutting Industry: mould.
   (3) Steel Tube Industry: rolling cutter, shaping wheel.
   (4) Screw Industry: screw wheel, screw mould, drawing die.

The engineering diagram of heat treatment of SKD11 as shown in Fig. 2-5. The heat treatment procedure of SKD11 as shown in table 2-4. The material composition of SKD11 as shown in table 2-5.

Table 2-4 The heat treatment procedure of SKD11

Heating Method / Thickness	Salt Bath	Electrical Furnace	Heating in box
< 5	5~8 minutes	Each 25mm thickness 20~30minutes	Each 25mm thickness 30~45minutes
<10	8~10 minutes		
<20	10~15 minutes		
<30	15~20 minutes		
<50	20~25 minutes		
<100	30~40 minutes		
>100	----------	Each 25mm thickness 10~20minutes	

Table 2-5 The material composition of SKD11

Composition	Content (%)	Composition	Content (%)
C	1.40~1.60	S	0.030max
Si	0.4max	Cr	11.0~13.0
Mn	0.60max	Mo	0.80~1.20
P	0.030max	V	0.20~0.50

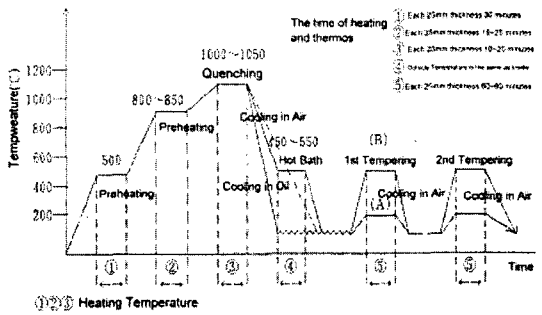

Fig. 2-5. The engineering diagram of heat treatment of SKD11 [12]

2. SKD61 (of mold and die steel of hot working)

For highly stressed hot work tools:

(1) Extrusion Industry: die and container for extrusion.

(2) Forging Industry: Forming die.

(3) Die for die-casting.

(4) Tool for manufacture of screw, nut.

The material composition of SKD61 as shown in table 2-6. The engineering diagram of heat treatment as shown in Fig. 2-6. The function diagram for tempering as shown in Fig. 2-7.

Table 2-6 The material composition of SKD61

Composition	Content (%)
C	0.35~0.42
Si	0.80~1.20
Mn	0.50max
P	0.030max
S	0.030max
Cr	4.50~5.50
Mo	1.00~1.50
V	0.80~1.20

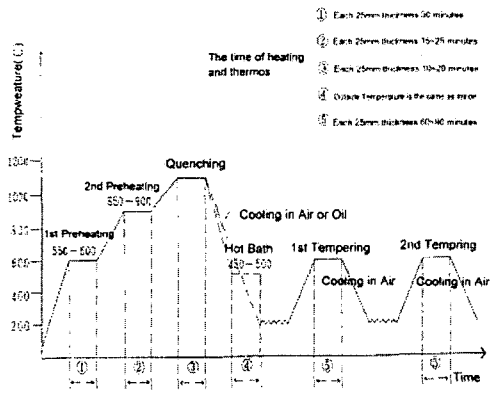

Fig. 2-6. The engineering diagram of heat treatment [12]

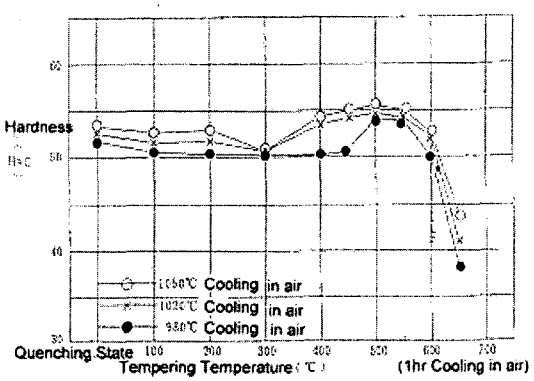

Fig. 2-7. The function curve diagram for tempering [12]

3. SKH9

For tools with high shock and impact resistance as well as high torsion stress.

(1) Tooling Industry: end mill, drill, punch, tap, reamer.

(2) Forging Industry: forging mould, press mould.

(3) Molding Industry: mould, screw mould.

The material composition of SKH9 as shown in table 2-7. The engineering diagram of heat treatment of SKH9 as shown in Fig.2-8. and Fig. 2-9 shows the relative diagram of tempering and hardness for SKH9.

Table 2-7 The material composition of SKH9

Composition	Content (%)	Composition	Content (%)
C	0.80~0.90	Cr	3.80~4.50
Si	0.4max	Mo	4.50~5.50
Mn	0.40max	W	5.50~6.70
P	0.030max	V	1.60~2.20
S	0.030max		

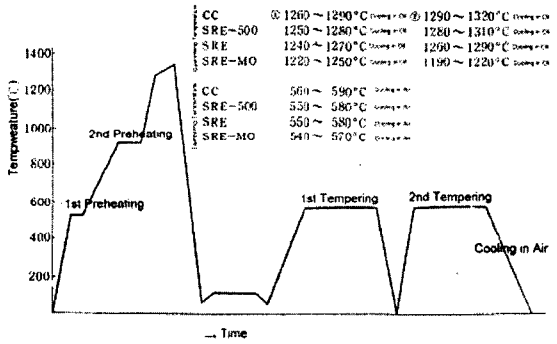

Fig.2-8. The engineering diagram of heat treatment ofSKH9 [11]

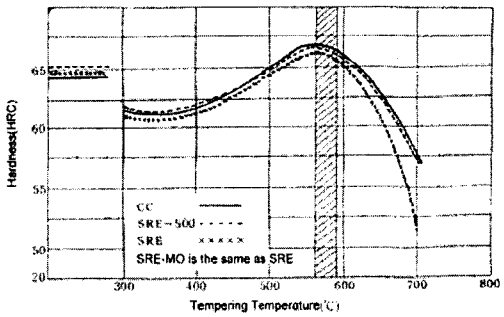

Fig.2-9. The relative diagram of tempering and hardness for SKH9

4. SKT4 (mold and die steel of hot working)

For all metal-cutting tools for roughing or finishing, such as twist drills, all kinds of milling cutters, screw taps, screw dies, broaches, reamers, countersinks, thread chasers, segments for circular saws, shaping tools and woodworking tools. Also highly suitable for cold-forming tools, such as cold extrusion rams and die, as well as cutting and precision cutting tools, plastic moulds with elevated wear resistance and screws. The material composition of SKT4 as shown in table 2-8. The relative diagram of quenching, tempering and hardness for SKT4 as shown in Fig. 2-9. and Fig. 2-10 shows the mechanical properties of SKT4 in the normal temperature.

Table 2-8 The material composition of SKT4

Composition	Content (%)
C	0.50~0.60
Si	0.35max
Mn	0.60~1.00
Ni	1.30~2.00
Cr	0.70~1.00
Mo	0.20~0.50

Table 2-9 The heat treatment terms of SKT4

The temperature of the heat treatment (℃)			Forging temperature(℃)
Annealing	Quenching	Tempering	
680~700 Cooling Slowly	(1) 830~870 Cooling in Oil (2) 870~900 Cooling in Air	450~650	1100~850

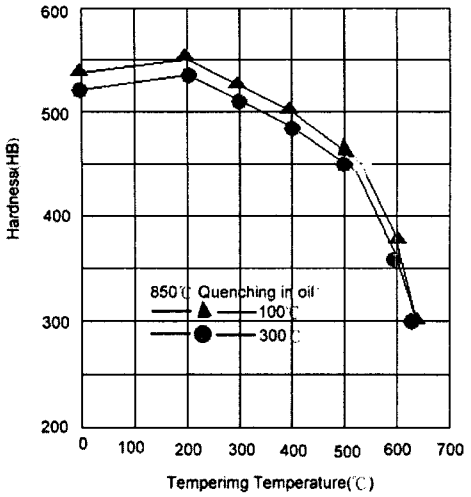

Fig. 2-9. The relative diagram of quenching, tempering and hardness for SKT4

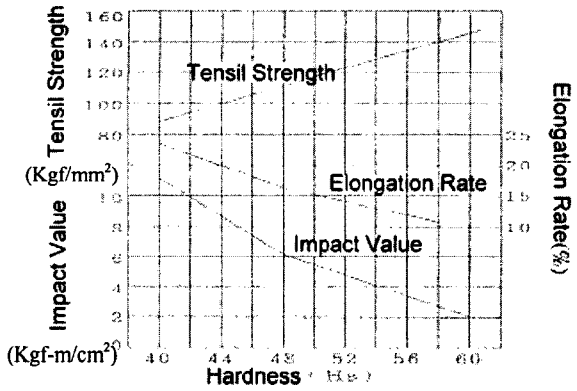

Fig. 2-10. The mechanical properties of SKT4 in the normal temperature

5. SNCM439

The steel material of SNCM439 is used for stalk, song stalk, wheel gear, piston, car spare parts, motorcycle spare parts, every kind of machine importance spare parts, strong power screw, nut and etc. The material composition of SNCM439 as shown in table 2-10. The heat treatment terms of SNCM439 as shown in table 2-11.

Table 2-10 The material composition of SNCM439

Composition	Content (%)	Composition	Content (%)
C	0.36~0.43	S	<0.030
Si	0.15~0.35	Ni	1.60~2.00
Mn	0.60~0.90	Cr	0.60~1.00
P	<0.030	Mo	0.15~0.30

Table 2-11 The heat treatment terms of SNCM439 [12]

The temperature of the heat treatment (℃)			Metamorphosis Abnormality point(℃)		
Annealing	Quenching	Tempering	Ac	Ar	Ms
(1) 820 Thermal Annealing (2) 670 Soft Annealing	820～870 Cooling in Oil	580～680 Cooling in Air	730 ～ 775	710 ～ 655	285

2.3. Introducing of the interface of the Knowledge-Base-System

The Knowledge-Base-System of Intelligence for forging mold and die material, the main chart is used to the PhotoImpact7.0 painting software to design the covering. In the diagram of the main chart, we make hyperlink function on style of calligraphy of Precision Mold and Die Research Center of National Kaohsiung First University of Science and Technology, enter our center system and search something that about the technical data and least information of mold and die material as shown in Fig. 2-11.

We divide into several level for different users, we also designed the users' login interface specially by star mark in password, we also adopt special treatment for safety protection as shown in Fig. 2-12.

By this system, the user can also input the forging mold and die material name to search its property, heat treatment methods and its metallurgical microstructure and etc. The way of the searching is to adopt the way of the benefit dialog box, establishing the interface of the more ease searching to carry on the way of the database search were shown in Fig. 2-13 and Fig. 2-14.

The user also can search through our Knowledge-Base-System to search the address of contact, telephone, products and etc. as shown in Fig.2-15.

Fig. 2-11. The covering of the main system

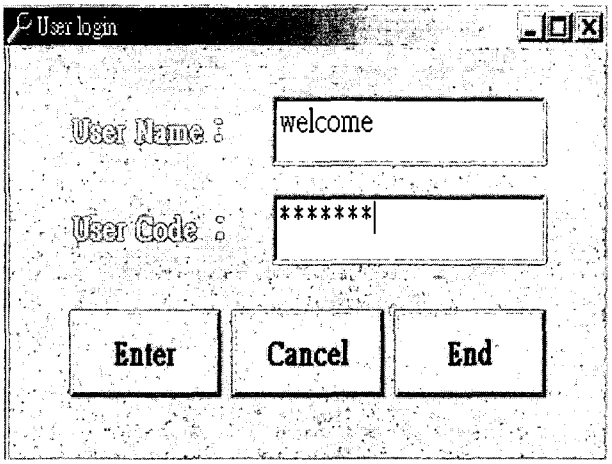

Fig. 2-12. The interface of user login

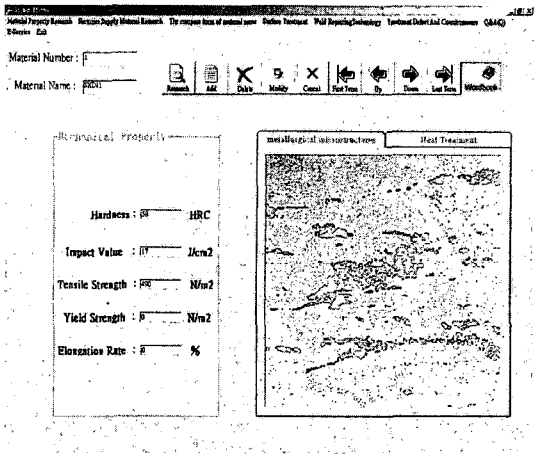

Fig. 2-13. The searching interface of mechanical properties

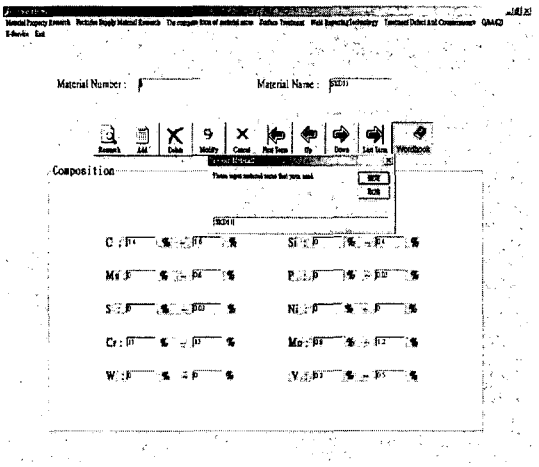

Fig. 2-14. The dialog box to carry on

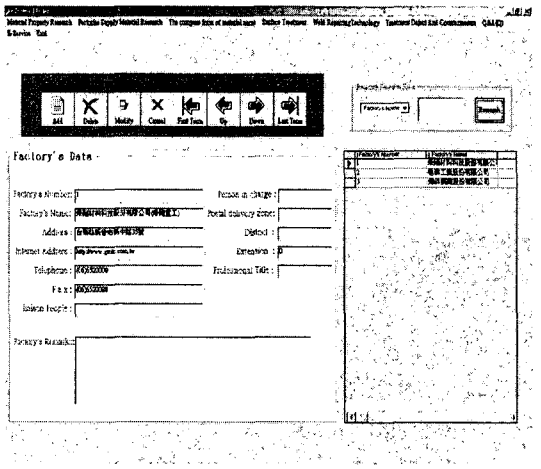

Fig. 2-15. The main business of forging mold and die material

3. Conclusion

By construct the Knowledge-Base-System of Intelligence for forging mold and die material selection in order to reduce designing time, this Knowledge-Base-System also have following functions:

1. Systematized database system.
2. Interacted database system.
3. Meet for Knowledge-Management trend.
4. Meet for Internet tendency.
5. Database-system disk is carried easily.

This system can not only provide the mold and die designer the necessary technical data. The software also can maintain easily and system have good extension, we sure the system will have the help to the business enterprise.

4. Future Development

In this system, the Knowledge-Base-System is by means of forging mold and die material as the topic. In the future, we will increase the Knowledge-Base-System of pressing, plastics injection and die casting. We will connect to internet, and make it to on-line system. When users get to the internet and he will get the necessary information from our system.

For future development, we will collect more data of mold and die material, and construct a interface in which the user just only input the question, and then you will get the appropriate answer with it.

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