6. Materials for rolling bearings

Due to various operating conditions and intricate aspects of deterioration phenomena, direct connections between mechanical characteristics and materials used for bearing manufacturing have been ascertained. Experimental studies proved that the following characteristics have to be considered, when appreciating the quality of bearing steels: rating life and contact fatigue loading, hardness at environment temperature and high temperatures, coefficient of expansion, tenacity, corrosion resistance and metallurgical conversion characteristics.

In case of normal applications and operating conditions, only the first two characteristics are of importance, the other being of importance only in case of bearings used for special applications.

Material behavior when being loaded at fatigue contact is difficult to be estimated due to the complexity of the factors involved while hardness can be estimated by classic methods.

These led to the selection of some steels, which are able to satisfy the main demands of normal and special operating conditions. The steels that meet the requirements for rings and rolling elements manufacturing are the following:

Chrome-alloy bearing steels

Steels with high carbon content (1%) and with chrome 1,5% have been chosen for bearing rings and rolling elements. Table 6.1 shows the chemical content of bearing steels used in Romania and also in Germany, U.S.A., Japan.

Case-hardening steels

Although case-hardening steels are not usually selected for bearing manufacturing, for certain applications they can be successfully used.

These steels are generally recommended for large-sized bearings and where bearings are operated under shock loads and vibrations.

Bearings manufactured of case-hardening steels are less liable to casual failure due to the ductile and soft core of these steels.

Table 6.2 shows the chemical content of the case-hardening bearing steels used in Romania and also in Germany, U.S.A., Japan.

Chemical content of bearing steels

Table 6.1

Country	Symbol	C	Si	Mn	P	S	Cr	Ni	Mo
		%							
Romania	**RUI 1V**	0,95–1,10	0,17–0,37	0,20–0,45	≤0,027	≤0,020	1,30–1,65	≤0,30	≤0,08
	RUI 2V	0,95–1,10	0,40–0,65	0,90–1,20	≤0,027	≤0,020	1,30–1,65	≤0,30	≤0,08
	RUI 3V	0,95–1,10	0,20–0,35	1,05–1,35	≤0,027	≤0,020	1,10–1,50	≤0,30	0,45–0,60
Germany	**105Cr4**	1,00–1,10	0,15–0,35	0,25–0,40	≤0,030	≤0,025	0,90–1,15	–	–
	100Cr6	0,90–1,05	0,15–0,35	0,25–0,40	≤0,025	≤0,025	1,40–1,65	–	–
	100CrMn6	0,90–1,05	0,50–0,70	1,00–1,20	≤0,025	≤0,020	1,40–1,65	–	–
USA	**E51100**	0,98–1,10	0,20–0,35	0,25–0,45	≤0,025	≤0,025	0,90–1,15	≤0,25	≤0,08
	E52100	0,98–1,10	0,20–0,35	0,25–0,45	≤0,025	≤0,025	1,30–1,60	≤0,25	≤0,08
	485Gr.4	0,98–1,10	0,20–0,35	1,05–1,35	≤0,025	≤0,025	1,90–1,40	≤0,25	0,45–0,65
Japan	**SUJ 2**	0,95–1,10	0,15–0,35	≤0,50	≤0,025	≤0,025	1,30–1,60	≤0,25	≤0,08
	SUJ 3	0,95–1,10	0,40–0,70	0,90–1,15	≤0,025	≤0,025	0,90–1,20	≤0,25	≤0,08

Chemical content of the case-hardening bearing steels

Table 6.2

Country	Symbol	C	Si	Mn	P	S	Cr	Ni	Mo
		%							
Romania	20MoCrNi06V	0,17–0,23	0,20–0,30	0,60–0,90	≤0,025	≤0,025	0,35–0,60	0,35–0,75	0,20–0,30
	13CrNi35V	0,09–0,13	0,17–0,37	0,30–0,60	≤0,025	≤0,025	1,25–1,65	3,25–3,75	–
	21MoMnCr12	0,18–0,24	0,17–0,37	0,80–1,20	≤0,025	≤0,025	1,00–1,40	–	0,20–0,30
	15Cr08Mo	0,12–0,18	0,17–0,37	0,40–0,70	≤0,025	≤0,025	0,70–1,00	–	0,08–0,15
Germany	16MnCr5	0,14–0,19	0,15–0,35	1,00–1,30	≤0,035	≤0,035	–	0,80–1,00	–
	20MnCr5	0,17–0,22	0,15–0,35	1,10–1,40	≤0,035	≤0,035	–	1,00–1,30	–
	15CrNi6	0,12–0,17	0,15–0,35	0,40–0,60	≤0,035	≤0,035	1,40–1,70	1,40–1,70	–
	18CrNi8	0,15–0,20	0,15–0,35	0,40–0,60	≤0,035	≤0,035	1,80–2,10	1,80–2,10	–
USA	5120H	0,17–0,23	0,15–0,30	0,60–1,00	≤0,025	≤0,025	–	0,60–1,00	–
	4118H	0,17–0,23	0,15–0,30	0,60–1,00	≤0,025	≤0,025	–	0,30–0,70	0,08–0,15
	8620H	0,17–0,23	0,15–0,30	0,60–0,95	≤0,025	≤0,025	0,35–0,75	0,35–0,65	0,15–0,25
	4320H	0,17–0,23	0,15–0,30	0,40–0,70	≤0,025	≤0,025	1,55–2,00	0,35–0,65	0,20–0,30
Japan	SCr420H	0,17–0,23	0,15–0,35	0,55–0,90	≤0,030	≤0,030	–	0,85–1,25	–
	SCM415H	0,12–0,18	0,15–0,35	0,55–0,90	≤0,030	≤0,030	–	0,85–1,25	0,15–0,35
	SCM420H	0,17–0,23	0,15–0,35	0,55–0,90	≤0,030	≤0,030	–	0,85–1,25	0,15–0,35
	SNCM220H	0,17–0,23	0,15–0,35	0,80–0,95	≤0,030	≤0,030	0,35–0,65	0,35–0,85	0,15–0,30
	SNCM420H	0,17–0,23	0,15–0,35	0,40–0,70	≤0,030	≤0,030	1,55–2,00	0,35–0,65	0,15–0,30

Heat treatment steels

For large sized-bearings of special design, with internal or external gearing, alloyed heat treatment steels are used.

Table 6.3 shows the chemical content of heat treatment bearing steels.

Bearing cages

Bearing cages are of great importance for bearing design.

The main purpose of the cage is to prevent immediate contact between two neighboring rolling elements and to guide them on raceways. Where bearings are of separable design, the cage also serves to retain the rolling elements when one bearing ring is removed during mounting and dismounting.

Considering the cage manufacturing technologies, they can be classified as follows:

- Pressed cages of steel sheet, low carbon content, for extra- deep drawing.
- Polyamide cages are used for some small and medium-sized bearings due to the following properties:
  - low density
  - high elasticity
  - low wear at sliding movement
  - low inertia moment

Heat-stabilized glass fibre reinforced polyamide 6.6 is the mostly used material. Maximum operating temperature for these cages must be of +120°C.

- Textolite cages, for high accuracy bearings, high speed operating.
- Machined cage of carbon steel, nodular cast iron and brass. These materials are generally used for cages of large-sized bearings.

Chemical content of the heat treatment bearing steels

Table 6.3

Country	Symbol	C	Si	Mn	P	S	Cr	Ni	Mo
		%							
Romania	41MoCr11	0,38–0,45	0,15–0,35	0,40–0,80	≤0,025	≤0,025	0,90–1,30	–	0,15–0,30
Germany	42CrMo4	0,42	0,25	0,65	≤0,035	≤0,035	1,05	–	0,20
USA	4140 (4142)	0,38–0,43	0,20–0,35	0,75–1,00	≤0,035	≤0,035	0,80–1,10	–	0,15–0,25
Japan	SCM4(H)	0,37–0,44	0,15–0,35	0,55–0,90	≤0,030	≤0,030	0,85–1,25	–	0,15–0,35