UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON 25, D.C.

National Bureau of Standards Certificate of Analyses

Standard Sample 153A

Cobalt—Molybdenum—Tungsten Steel

ANALYST	C	Mn	P	S		Si	Cu	Ni	Cr	V	Mo	W	Co	N	
	Direct combustion	Persulfate-Arsenite	Photometric	Gravimetric (direct oxidation and final precipitation after reduction of iron)	Combustion Iodate titration	Perchloric acid dehydration	Photometric	Weighed as nickel dimethylglyoxime	$FeSO_4$–$KMnO_4$ titration	HNO_3 oxidation, potentiometric titration				Distillation-titration	
1	0.903	[a,b]0.190	[c,d]0.021	0.008	[e]0.006	[f]0.274	[g]0.091	0.174	[h]3.72	2.08	[i]8.85	[j]1.79	[k]8.44	[l]0.022	
2	.905	.199	[m].026		.007	[n].273	.098	[o].158	[h]3.75	2.06	[p]8.86 [i]8.83	[p,q]1.76	[r]8.47 [k]8.53	.024	
3	.904								[h]3.73	2.06	[s]8.84 [p]8.82	[t]1.75	[u]8.48		
4	.908								[h]3.75	2.07	[p]8.85	[t]1.73	[u]8.47		
5	.907	[v].181	[w].023	.007	.009	.269	[x].091	[o].178	[y]3.76	[z]2.02	[p]8.86	[t]1.74	[u]8.41	.028	
6	.898	[a']. 178	[w].020	.007	[a'].006	.265	[g].095	[o,a'].167	3.69	2.08	[p]8.82	[t]1.74	[k]8.49	.022	
7	.907	[b',a'].192	[w].024		[c',a'].008	.286	[x].098	[p].168	[y]3.72	[a']2.07	[p]8.87	[t]1.76	[r]8.44	.025	
8	[d'].90	[b'].206	[e'].024	.006	.006	.262	[f'].089	.172	[h]3.72	2.05	8.91	[j]1.79	[k]8.42	.024	
9	.89	[b'].19	[e'].022		.008	[g'].265	[h'].092	.16	[y]3.71	2.10	[p]8.85	[j]1.83	[k]8.50		
10	.903	[i'].196	[e'].024		[j',a'].007	.267	[k',a'].101	.168	3.69	[l']2.04	[i]8.88	[j]1.73	[k]8.48		
Average	0.902	0.192	0.023	0.007	0.007	0.270	0.094	0.168	3.72	2.06	8.85	1.76	8.47	0.024	
General average	0.902	0.192	0.023	0.007		0.270	0.094	0.168	3.72	2.06	8.85	1.76	8.47	0.024	

[a] Chromium separated by hydrolytic precipitation with $NaHCO_3$. Persulfate oxidation-arsenite titration.
[b] Potentiometric titration.
[c] Molybdenum-blue photometric method. See J. Research NBS **26**, 405 (1941) RP 1386.
[d] Same value obtained by the molybdate-$Mg_2P_2O_7$ method.
[e] 1-g sample burned in oxygen at 1,425° C, and sulfur dioxide absorbed in starch-iodide solution. Iodine liberated from iodide by titration, during the combustion, with standard KIO_3 solution. Titer based on 93 percent of the theoretical factor.
[f] Double dehydration with intervening filtration.
[g] Diethyldithiocarbamate photometric method. See J. Research NBS **47**, 380 (1951) RP 2265.
[h] Persulfate oxidation and potentiometric titration with ferrous ammonium sulfate.
[i] α-benzoinoxime method. See BS J. Research **9**, 1 (1932) RP 453.
[j] Tungsten precipitated by acid digestion and cinchonine. Ignited WO_3, corrected for silicon, iron, chromium, vanadium and molybdenum.
[k] Zinc oxide-α nitroso β naphthol gravimetric method.
[l] Sulfuric acid digestion for 3 hr of a 0.5-g sample. See J. Research NBS **43**, 201 (1949) RP 2021.
[m] Ammonium phosphovanadate photometric method. Color complex extracted into iso-amyl alcohol.
[n] Sulfuric acid dehydration.
[o] Dimethylglyoxime precipitate titrated with cyanide.
[p] Photometric method.
[q] Same value obtained by cinchonine gravimetric method.
[r] Cobalt oxidized to trivalent state with potassium ferricyanide and the excess ferricyanide titrated potentiometrically with cobaltous nitrate.
[s] H_2S–MoO_3 gravimetric method.
[t] Hydroquinone photometric method.
[u] Cobalt chloride-photometric method.
[v] KIO_4-photometric method.
[w] Molybdenum-blue photometric method.
[x] Diethyldithiocarbamate photometric method.
[y] Perchloric acid oxidation.
[z] $HClO_4$ oxidation. Chromium and vanadium titrated with ferrous sulfate, and vanadium titrated with $KMnO_4$ after addition of K_2HPO_4.
[a'] Titrating solution standardized by the use of a standard steel.
[b'] Chromium separated with ZnO.
[c'] Combustion gases absorbed in NaOH–H_2O_2. Solution titrated with H_2SO_4.
[d'] Gasometric method.
[e'] Alkali-molybdate method.
[f'] Neocuproine photometric method.
[g'] Nitric-hydrochloric acid dehydration.
[h'] Copper-ammonia complex photometric method.
[i'] Chromium volatilized as CrO_2Cl_2.
[j'] Combustion gases absorbed in neutral H_2O_2. Solution titrated with NaOH.
[k'] CuS precipitated with $Na_2S_2O_3$. Precipitate ignited, dissolved and titrated with KI–$Na_2S_2O_3$.
[l'] $FeSO_4$–$(NH_4)_2S_2O_8$–$KMnO_4$ method.

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