Department of Commerce and Labor

Bureau of Standards

Certificate of Analyses

OF

STANDARD SAMPLE No. 30

CHROME-VANADIUM STEEL

CASTING FURNISHED BY BETHLEHEM STEEL CO., SOUTH BETHLEHEM, PA.

ANALYST.	CARBON.		SILICON.		PHOSPHORUS.				SULPHUR.			MANGANESE.		CHROMIUM.	VANADIUM.	NICKEL.	COPPER.	MOLYBDENUM.
	DIRECT COMBUSTION.	SOLUTION AND COMBUSTION.	BROWN METHOD.	OTHER METHODS.	ALKALI-MOLYBDATE.	MOLYBDATE REDUCTION.	WEIGHING PHOS. PHO-MOLYBDATE.	AS $Mg_2P_2O_7$ AFTER ACETATE SEPARATION.	OXIDATION.	EVOLUTION (KI-Iodine).	OTHER METHODS.	FORD (Weighing as $Mn_2P_2O_7$).	OTHER METHODS.					
1	.377	.376	------	.111	------	------	------	.042	.029	------	.027[1]	------	.530	1.34	.204	.104	.055	------
2	.376	------	------	.126	------	------	------	.036[2]	.029	------	.028[1]	------	.550 .560	1.34 1.35	.207	.091	.074	.008
3	.373	------	------	.110	------	------	------	.034	.028	------	------	------	.557	1.37 1.34	.204	.100	.070	------
4	.385	------	------	.122	.045	------	------	.044	.027	.027	------	------	.556[3]	1.33[3]	.216[3]	.150 .120	.068	------
5	.366	.366	.115	.112	------	------	------	.041	.030	------	.032[4]	------	.565	1.33	.218	.120	.064	------
6	.350	------	.122	------	.037	------	------	------	------	.030	------	.555	------	1.37	.185	------	------	------
7	------	.374	------	.104	------	------	.048	------	------	.029	------	------	.540	1.35	.220	------	------	------
8	------	.370	------	.110	------	------	.047	------	.029	------	------	.576	------	1.35	.206	.110	.082	------
9	.360	------	------	.112	.046	------	------	------	------	.030	------	------	.600	1.38	.215	.120	.080	------
10	.376	.384	------	.121 .117	.045	------	------	------	------	.028	------	------	.586	1.37	.224 .217	.140	.080	------
11	.385	------	.107	------	------	.046	------	------	------	.028[5]	------	------	.578	1.35	.194	------	------	------
Av	.372*	.374	.115	.114	.043	.046	.047	.039	.029	.029	.029	.565	.562	1.35	.21	.117	.07	.008
Gen. Av	.373		.114		.043				.029			.563		1.35	.21	.117	.07	.008

[1] Evolution—H_2O_2—$BaSO_4$.
[2] Fe and Cr removed by electrolysis before precipitating.
[3] Mean by three methods.
[4] Meineke's method.
[5] Absorption in zinc chloride solution.

***In view of the results of certain chemists, especially those of the Midvale Steel Co., supported by tests made at the Bureau of Standards, it seems not improbable that even the highest results reported for carbon in this steel are slightly below the truth. The matter is under investigation.**

INDEX TO ANALYSTS

1. J. R. Cain, Bureau of Standards.
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3. Wm. H. Keen, Washington Steel and Ordnance Co., Washington, D. C.
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5. E. A. Loos, Carpenter Steel Co., Reading, Pa.
6. J. Lloyd Uhler, Union Steel Casting Co., Philadelphia, Pa.
7. J. L. Harvey, Carnegie Steel Co., Homestead, Pa.
8. W. D. Brown, Carnegie Steel Co., Duquesne, Pa.
9. C. M. Johnson, The Crucible Steel Co. of America, Park Works, Pittsburgh, Pa.
10. George M. Berry, Halcomb Steel Co., Syracuse, N. Y.
11. H. J. Force and C. Schoen, Delaware, Lackawanna & Western R. R., Scranton, Pa.

S. W. STRATTON,
Director.

Washington, D. C.

June 20, 1912.

The methods used for determining special and certain other constituents are indicated below, in so far as they are not shown by the table. In most cases the values given in the table are the means of two or more determinations. This is particularly true of those made at the Bureau of Standards. The numbers designating analysts correspond to those in the "Index to Analysts."

1. CHROMIUM

1. Cain's method (Bur. Stand. Tech. Paper No. 6; J. Ind. Eng. Chem., **4**, 17, 1912). Solution in HCl without oxidation, precipitation by $BaCO_3$, fusion with Na_2CO_3 and KNO_3, etc., precipitation as $PbCrO_4$ and final titration with $FeSO_4$ or $FeSO_4$ and $K_2Cr_2O_7$. 2. Like 1 for the value 1.34, using, however, H_2SO_4 instead of HCl and MgO instead of $BaCO_3$; for 1.35 the ether and NaOH separations, finishing as in Cain's method. 3. McKenna's method for the value 1.34; gravimetrically after ether and NaOH separations for 1.37. 4. Cain's method as by 1, 1.33; new volumetric method not yet published, 1.33; Barba's method, 1.34. 5. Cain's method as by 1. 6. Method not reported. 7. McKenna's method. 8. Fusion with Na_2O_2 and titration after separation from vanadium (see Blair, J. Am. Chem. Soc., **30**, 1229). 9 and 10. See Johnson, "Analysis of Special Steels, etc.," 1909, pp. 8, 9, 10, 32, 33. 11. Barba's method.

2. VANADIUM

1. Cain's method (Bur. Stand. Bull., Vol. 8, Reprint No. 161; J. Ind. Eng. Chem., **3**, 476, 1911). Solution in H_2SO_4 or HCl without oxidation, precipitation with $CdCO_3$, removal of excess cadmium by H_2S, of iron and chromium by electrolysis with Hg cathode in H_2SO_4 solution, and titration with $KMnO_4$. 2. Precipitate formed by MgO without oxidation of iron dissolved in HNO_3, poured into NaOH to remove sesquioxides, vanadium precipitated by $HgNO_3$ and finally titrated by $KMnO_4$ in sulphate solution. 3. Sodium hydroxide separation after ether extraction of iron, precipitation of vanadium with $HgNO_3$. 4. Campagne's method, correcting for chromium, 0.203; special Midvale electrolytic method, 0.221; Cain's method as in 1, 0.223. 5. Cain's method. 6. Method published in pamphlet of American Vanadium Co. 7. Method not reported. 8. Campagne's method. 9. See Johnson, "Analysis of Special Steels, etc.," 1909, pp. 8, 9, 10, 32, 33. 10. Johnson's method as by 9 for the value 0.217; ether and NaOH separations, precipitation by $HgNO_3$, fusion with Na_2CO_3, reduction with SO_2 and titration with $KMnO_4$ for 0.224. 11. See Blair, "Chemical Analysis of Iron," 7th ed., p. 209.

3. MANGANESE

1. Cain's method (J. Ind. Eng. Chem., **3**, 630, 1911). Precipitation of chromium by $CdCO_3$ from the sulphuric acid solution of the steel and treatment of the filtrate by the bismuthate method. 2. Like 1 for the value 0.55, using, however, MgO instead of $CdCO_3$; for 0.56, ether separation of iron, followed by ZnO precipitation and determination of manganese in the filtrate by the bismuthate method. 3. Ford-Williams precipitation, followed by bismuthate determination. 4. Bismuthate method for the value 0.556; modified bismuthate for 0.561; Cain's method (see 1 above) for 0.551. 5. Cain's method. 7. Ford precipitation, followed by persulphate color determination. 9. See Johnson, "Analysis of Special Steels, etc.," 1909, pp. 180–182. 10. Like 9. 11. Persulphate oxidation and titration against As_2O_3.

4. COPPER, NICKEL, MOLYBDENUM

Determined by Bureau of Standards analysts as described in Bur. Stand. Circular No. 14. To give in sufficient detail the methods used by other analysts would require more space than the importance of the determinations seems to warrant.