# METHODS FOR CHEMICAL ANALYSIS OF CAST IRON AND PIG IRON 

# PART 11 DETERMINATION OF TOTAL CARBON BY THE DIRECT COMBUSTION VOLUMETRIC METHOD (FOR CARBON 1.50 TO 4.50 PERCENT) 

[First Revision of IS 12308 (Part 11)]
ICS 77.080.10

| Methods of Chemical Analysis of Metals | Last date of comments |
| :--- | ---: |
| Sectional Committee, MTD 34 | $\mathbf{1 6 ~ M a r c h ~} \mathbf{2 0 2 3}$ |

Sectional Committee, MTD 34
16 March 2023

## FORWORD

This draft Indian Standard (Part 11) (First Revision) subject to its finalization, is to be adopted by the Bureau of Indian Standards on recommendation of the Methods of Chemical analysis of Metals Sectional Committee and approval of the Metallurgical Engineering Division Council.

Chemical analysis of cast iron and pig iron was covered in IS 228 : 1959 'Methods of chemical analysis of pig iron, cast iron and plain carbon and low alloy steels (revised)'. During its second revision it was decided that a comprehensive series should be prepared for chemical analysis of all type of steels and the other covering the chemical analysis of cast iron and pig iron. Accordingly IS 228 on revision was published in several parts covering chemical analysis of various steels only and a separate series of standards under IS 12308 is being published for chemical analysis of cast iron and pig iron.

This standard was first published in 1991 in different parts covering methods for chemical analysis of cast iron and pig iron. This standard (Part 11) covers determination of total carbon by the direct combustion volumetric method (for carbon 1.50 to 4.50 percent).

The other parts in the series are:
Part 1 Determination of total carbon by thermal conductivity method
Part 2 Determination of sulphur by iodimetric titration method
Part 3 Determination of manganese by periodate spectrophotometric method
Part 4 Determination of total carbon, graphitic carbon and combined carbon by gravimetric method
Part 5 Determination of phosphorus by Alkalimetric method (for phosphorus 0.01 to 0.50 percent)

Part 6 Determination of Silicon (for Silicon 0.1 to 6.0 percent )
Part 7 Determination of nickel by dimethylglyoxime (Gravimetric) method ( for nickel 0.5 to 36 percent )

Part 8 Determination of chromium by persulphate oxidation method ( for chromium 0.1 to 28 percent )

Part 9 Determination of molybdenum by thiocyanate (Spectrophotometric) method ( for molybdenum 0.1 to 1.0 percent )
Part 10 Determination of manganese (up to 7.0 percent ) by arsenite (Volumetric ) method
Part 12 Determination of copper by atomic absorption spectrometric method (for copper 0.01 to 0.5 percent)
Part 13 Determination of magnesium by atomic absorption spectrometric method (for magnesium upto 0.1 percent)
Part 14 Determination of titanium by hydrogen peroxide (Spectrophotometric) method (for titanium up to 0.25 percent)

This revision has been brought out to bring the standard in the latest style and format of the Indian Standards.

In reporting the result of a test or analysis made in accordance with this standard, is to be rounded off, it shall be done in accordance with IS 2:2022 'Rules for rounding off numerical values (second revision)'.

## Draft Indian Standard

## METHODS FOR CHEMICAL ANALYSIS OF CAST IRON AND PIG IRON

# PART 11 DETERMINATION OF TOTAL CARBON BY THE DIRECT COMBUSTION VOLUMETRIC METHOD (FOR CARBON 1.50 TO 4.50 PERCENT) 

( First Revision )

## 1 SCOPE

This standard (Part 11) describes the volumetric method for determination of carbon in the range of 1.50 to 4.50 percent in cast iron and pig iron.

## 2 REFERENCE

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

## IS No Title

IS 6226 (Part 1) : 1994 Recommendations for apparatus for chemicals analysis of metals Part 1 apparatus for determination of carbon by direct combustion (first revision)

## 3 SAMPLING

3.1 The sample shall be drawn as prescribed in the relevant Indian Standard.
3.2 The sample (3.1) shall be cleaned, by washing it thrice with AR grade ether or acetone, and finally drying in an air oven at $100 \pm 5^{\circ} \mathrm{C}$.

## 4 APPARATUS

The apparatus recommended in IS 6226 (Part 1) may be used.

## 5 DETERMINATION OF TOTAL CARBON

### 5.1 Outline of the Method

The sample is burnt in a current of oxygen in presence of a suitable flux, when all the carbon present is converted to carbon dioxide. After removal of sulphurous gases by suitable absorbents, the eat bun dioxide gas is collected in a specially jacketed burette along with excess of oxygen. The carbon dioxide is then absorbed in alkali. On passing excess of oxygen through the burette, the contraction in volume is read against a scale, calibrated directly in percentage of carbon.

### 5.2 Procedure

5.2.1 The apparatus should be tested for satisfactory working against standard samples of cast iron of appropriate values of carbon before use.
5.2.2 Weigh 1.000 g of test sample (see Note) in the form of small drillings or shavings in a preignited porcelain boat, which can withstand a temperature of $1250^{\circ} \mathrm{C}$. Spread 0.5 g of flux (for example, tin granules) over the sample. Introduce the boat into the hot combustion tube in the furnace, kept between 1150 to $1250^{\circ} \mathrm{C}$.

NOTE - Take 0.5 g of sample if the carbon content is more, than 4 percent.
5.2.3 Close the furnace inlet, allow the sample to heat for one or two minutes. Fill the burette with acidulated water or brine water coloured with methyl red. Regulate the flow of oxygen to 300-400 ml per minute, so that the level of liquid in the bulbed portion of the burette does not fall rapidly. After a minute or so the level of water in the burette begins to fall more rapidly, though the same rate of oxygen is maintained indicating completion of combustion.
5.2.4 Take readings, when the level reaches close to the zero graduation mark, after closing the bend way stopcock and equalizing the levels of burette and connected leveling bottle. Pass the collected and measured gas into absorbing bulb; till a constant reading is obtained. Record the burette reading. On the basis of one gram of sample taken for analysis, the burette is graduated to measure directly the percentage of carbon (see Note).

NOTE - It is always advisable to carry out duplicate determination.

### 5.2.5 Blank

Run a blank experiment with the same quantity of flux, without the sample and make the appropriate corrections.

### 5.2.6 Calculation

Carbon, percent by mass $=(A-B) \times F$
where
$A=$ burette reading after absorption of carbon dioxide in caustic potash with 1 g of sample;
$B=$ burette reading for the blank experiment, and
$F=$ correction factor for temperature and pressure (see Table 1)

### 5.2.7 Reproducibility

$\pm 0.03$ at 1.22 percent level
$\pm 0.06$ at 1.80 percent level
$\pm 0.07$ at 2.00 percent level
$\pm 0.10$ at 2.40 percent level
$\pm 0.15$ at 3.65 percent level

Table 1 Correction Factors
(Clause 5.2.6)

| Pressure, <br> $\mathbf{m m ~ H g}$Tempera-ture, ${ }^{\circ} \mathrm{C}$ | 730 | 732 | 734 | 736 | 738 | 740 | 742 | 744 | 746 | 748 | 750 | 752 | 754 | 756 | 758 | 760 | 762 | 764 | 766 | 768 | 770 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) |
| 15 | 0.964 | 0.967 | 0.970 | 0.972 | 0.975 | 0.978 | 0.980 | 0.983 | 0.986 | 0.988 | 0.991 | 0.994 | 0.996 | 0.999 | 1.002 | 1.005 | 1.007 | 1.010 | 1.013 | 1.015 | 1.018 |
| 16 | 0.960 | 0.926 | 0.965 | 0.968 | 0.970 | 0.973 | 0.976 | 0.978 | 0.981 | 0.984 | 0.987 | 0.989 | 0.992 | 0.995 | 0.997 | 1.000 | 1.003 | 1.005 | 1.008 | 1.011 | 1.013 |
| 17 | 0.955 | 0.958 | 0.961 | 0.963 | 0.966 | 0.969 | 0.971 | 0.974 | 0.977 | 0.979 | 0.982 | 0.985 | 0.987 | 0.990 | 0.993 | 0.995 | 0.998 | 1.001 | 1.003 | 1.006 | 1.009 |
| 18 | 0.951 | 0.953 | 0.956 | 0.959 | 0.961 | 0.964 | 0.967 | 0.969 | 0.972 | 0.975 | 0.977 | 0.980 | 0.983 | 0.985 | 0.988 | 0.991 | 0.993 | 0.996 | 0.999 | 1.001 | 1.004 |
| 19 | 0.946 | 0.949 | 0.952 | 0.954 | 0.957 | 0.959 | 0.962 | 0.965 | 0.967 | 0.970 | 0.973 | 0.975 | 0.970 | 0.981 | 0.983 | 0.906 | 0.909 | 0.990 | 0.994 | 0.996 | 0.999 |
| 20 | 0.942 | 0.944 | 0.947 | 0.950 | 0.952 | 0.955 | 0.957 | 0.960 | 0.963 | 0.965 | 0.968 | 0.971 | 0.973 | 0.976 | 0.978 | 0.981 | 0.984 | 0.986 | 0.989 | 0.992 | 0.994 |
| 21 | 0.937 | 0.940 | 0.942 | 0.945 | 0.947 | 0.950 | 0.953 | 0.955 | 0.958 | 0.961 | 0.963 | 0.966 | 0.968 | 0.971 | 0.974 | 0.976 | 0.979 | 0.982 | 0.984 | 0.987 | 0.990 |
| 22 | 0.932 | 0.935 | 0.937 | 0.940 | 0.943 | 0.945 | 0.948 | 0.950 | 0.953 | 0.956 | 0.958 | 0.961 | 0.964 | 0.966 | 0.969 | 0.972 | 0.974 | 0.977 | 0.979 | 0.982 | 0.985 |
| 23 | 0.927 | 0.930 | 0.933 | 0.935 | 0.938 | 0.940 | 0.943 | 0.946 | 0.948 | 0.951 | 0.954 | 0.956 | 0.959 | 0.961 | 0.964 | 0.967 | 0.969 | 0.972 | 0.974 | 0.977 | 0.980 |
| 24 | 0.922 | 0.925 | 0.928 | 0.930 | 0.933 | 0.936 | 0.938 | 0.941 | 0.943 | 0.946 | 0.949 | 0.951 | 0.954 | 0.956 | 0.959 | 0.962 | 0.964 | 0.967 | 0.967 | 0.972 | 0.975 |
| 25 | 0.918 | 0.920 | 0.923 | 0.925 | 0.928 | 0.931 | 0.933 | 0.936 | 0.938 | 0.941 | 0.944 | 0.946 | 0.949 | 0.951 | 0.954 | 0.957 | 0.959 | 0.962 | 0.964 | 0.967 | 0.970 |
| 26 | 0.913 | 0.915 | 0.918 | 0.920 | 0.923 | 0.926 | 0.920 | 0.931 | 0.933 | 0.936 | 0.939 | 0.941 | 0.944 | 0.946 | 0.949 | 0.952 | 0.951 | 0.957 | 0.959 | 0.962 | 0.964 |
| 27 | 0.908 | 0.910 | 0.913 | . 915 | 0.918 | 0.921 | 0.923 | 0926 | 0.928 | 0.931 | 0.934 | 0.936 | 0.939 | 0.941 | 0.944 | 0.946 | 0.949 | 0.952 | 0.954 | 0.957 | 0.959 |
| 28 | 0.903 | 0.905 | 0.908 | 0.910 | 0.913 | 0.916 | 0.918 | 0.921 | 0.923 | 0.926 | 0.928 | 0.931 | 0.934 | 0.936 | 0.939 | 0.941 | 0.944 | 0.946 | 0.949 | 0.952 | 0.954 |
| 29 | 0.897 | 0.900 | 0.903 | 0.905 | 0.908 | 0.910 | 0.913 | 0.915 | 0.918 | 0.920 | 0.923 | 0.926 | 0.928 | 0.931 | 0.933 | 0.936 | 0.938 | 0.941 | 0.944 | 0.946 | 0.949 |
| 30 | 0.892 | 0.895 | 0.897 | 0.900 | 0.902 | 0.905 | 0.908 | 0.910 | 0.913 | 0.915 | 0.918 | 0.920 | 0.923 | 0.925 | 0.928 | 0.930 | 0.933 | 0.936 | 0.938 | 0.941 | 0.943 |
| 31 | 0.887 | 0.889 | 0.892 | 0.894 | 0.997 | 0.900 | 0.902 | 0.905 | 0.907 | 0.910 | 0.912 | 0.915 | 0.917 | 0.920 | 0.900 | 0.925 | 0.917 | 0.930 | 0.933 | 0.935 | 0.938 |
| 32 | 0.882 | 0.884 | 0.886 | 0.889 | 0.892 | 0.894 | 0.897 | 0.899 | 0.902 | 0.904 | 0.907 | 0.909 | 0.912 | 0.914 | 0.917 | 0.920 | 0.912 | 0.925 | 0.927 | 0.930 | 0.932 |
| 33 | 0.876 | 0.878 | 0.881 | 0.884 | 0.886 | 0.889 | 0.891 | 0.894 | 0.896 | 0.899 | 0.901 | 0.904 | 0.906 | 0.909 | 0.911 | 0.914 | 0.906 | 0.917 | 0.922 | 0.924 | 0.927 |
| 34 | 0.870 | 0.873 | 0.875 | 0.878 | 0.880 | 0.883 | 0.886 | 0.888 | 0.891 | 0.893 | 0.896 | 0.898 | 0.901 | 10903 | 0.906 | 0.908 | 0.901 | 0.913 | 0.916 | 0.918 | 0.921 |
| 35 | 0.865 | 0.867 | 0.870 | 0.872 | 0.875 | 0.877 | 0.880 | 0.882 | 0.885 | 0887 | 0.890 | 0.892 | 0.895 | 0.897 | 0.900 | 0.902 | 0.905 | 0.907 | 0.910 | 0.912 | 0.915 |

Table 1
(Concluded)

| Pressure, <br> $\mathbf{m m ~ H g}$ <br> Tempera- <br> ture, ${ }^{\circ} \mathrm{C}$ | 730 | 732 | 734 | 736 | 738 | 740 | 742 | 744 | 746 | 748 | 750 | 752 | 754 | 756 | 758 | 760 | 762 | 764 | 766 | 768 | 770 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) |
| 36 | 0.859 | 0.861 | 0.864 | 0.866 | 0.869 | 0.871 | 0.874 | 0.876 | 0.879 | 0.882 | 0.884 | 0.886 | 0.889 | 0.892 | 0.894 | 0.896 | 0.899 | 0.902 | 0.904 | 0.906 | 0.909 |
| 37 | 0.853 | 0.856 | 0.858 | 0.860 | 0.863 | 0.866 | 0.868 | 0.870 | 0.873 | 0.876 | 0.878 | 0.880 | 0.883 | 0.886 | 0.888 | 0.890 | 0.893 | 0.869 | 0.898 | 0.900 | 0.903 |
| 38 | 0.847 | 0.850 | 0.852 | 0.854 | 0.857 | 0.859 | 0.862 | 0.864 | 0.867 | 0.869 | 0.872 | 0.874 | 0.877 | 0.879 | 0.882 | 0.884 | 0.887 | 0.889 | 0.982 | 0.894 | 0.897 |
| 39 | 0.841 | 0.843 | 0.846 | 0.848 | 0.851 | 0.853 | 0.856 | 0.858 | 0.861 | 0.863 | 0.866 | 0.868 | 0.871 | 0.873 | 0.876 | 0.878 | 0.881 | 0.883 | 0.886 | 0.888 | 0.890 |
| 40 | 0.835 | 0.837 | 0.840 | 0.842 | 0.844 | 0.847 | 0.850 | 0.852 | 0.854 | 0.857 | 0.859 | 0.862 | 0.864 | 0.867 | 0.869 | 0.872 | 0.874 | 0.877 | 0.879 | 0.882 | 0.884 |
| 41 | 0.828 | 0.831 | 0.833 | 0.836 | 0.838 | 0.841 | 0.843 | 0.846 | 0.848 | 0.850 | 0.853 | 0.855 | 0.858 | 0.860 | 0.863 | 0.865 | 0.868 | 0.870 | 0.873 | 0.875 | 0.878 |
| 42 | 0.822 | 0.824 | 0.827 | 0.829 | 0.832 | 0.834 | 0.836 | 0.839 | 0.841 | 0.844 | 0.846 | 0.849 | 0.851 | 0.854 | 0.856 | 0.859 | 0.861 | 0.864 | 0.866 | 0.868 | 0.870 |
| 43 | 0.815 | 0.818 | 0.820 | 0.822 | 0.825 | 0.827 | 0.830 | 0.832 | 0.835 | 0.837 | 0.840 | 0.842 | 0.844 | 0.847 | 0.849 | 0.852 | 0.854 | 0.857 | 0.859 | 0.862 | 0.864 |
| 44 | 0.808 | 0.811 | 0.813 | 0.816 | 0.818 | 0.820 | 0.823 | 0.825 | 0.828 | 0.830 | 0.833 | 0.835 | 0.838 | 0.842 | 0.842 | 0.845 | 0.847 | 0.850 | 0.852 | 0.855 | 0.857 |
| 45 | 0.801 | 0.804 | 0.806 | 0.809 | 0.811 | 0.814 | 0.816 | 0.818 | 0.821 | 0.823 | 0.826 | 0.828 | 0.830 | 0.833 | 0.835 | 0.838 | 0.840 | 0.843 | 0.845 | 0.848 | 0.850 |

