


---

---

इस्पात के रासायनिक विश्लेषण की पद्धति

भाग 4 ग्रेविमेट्रिक विधि द्वारा कुल कार्बन का  
निर्धारण (कार्बन  $\geq 0.1$  प्रतिशत के लिए 

( चौथा पुनरीक्षण )

**Method for Chemical Analysis of  
Steels**

**Part 4 Determination of Total Carbon  
by Gravimetric Method  
(for Carbon  $\geq 0.1$  Percent)**

( Fourth Revision )

ICS 77.080.20

© BIS 2024



भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002

MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG

NEW DELHI - 110002

[www.bis.gov.in](http://www.bis.gov.in) [www.standardsbis.in](http://www.standardsbis.in)

October 2024

Price Group 4

## FOREWORD

This Indian Standard (Part 4) (Fourth Revision) was adopted by the Bureau of Indian Standards after the draft finalized by the Methods of Chemical Analysis of Metals Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1952 and subsequently revised in 1959, 1974 and 1987, covered the chemical analysis of plain carbon and low alloy steels, along with pig iron and cast iron. It was revised again to make it comprehensive in respect of steel analysis and to exclude pig iron and cast iron which were being covered in separate standards. During its second revision the standard has been split up in several parts.

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

This part covers method for determination of total carbon content of plain carbon, low alloy and high alloy steels of 0.1 percent and above by the gravimetric method. The other parts of this series are:

- Part 1 Determination of carbon by volumetric method (for carbon 0.05 to 2.50 percent)
- Part 2 Determination of manganese in plain-carbon and low alloy steels by arsenite method
- Part 3 Determination of phosphorus by alkalimetric method
- Part 5 Determination of nickel by dimethyl glyoxime (gravimetric) method (for nickel  $\geq 0.1$  percent)
- Part 6 Determination of chromium by persulphate oxidation method (for chromium  $\geq 0.1$  percent)
- Part 7 Determination of molybdenum by alpha-benzoinoxime method (for molybdenum  $> 1$  percent and not containing tungsten)
- Part 8 Determination of silicon by gravimetric method (for silicon 0.05 to 5.00 percent)
- Part 9 Determination of sulphur by evolution method (for sulphur 0.01 to 0.25 percent)
- Part 10 Determination of molybdenum by thiocyanate (photometric) method in low and high alloy steels (for molybdenum 0.01 to 1.5 percent)
- Part 11 Determination of total silicon by reduced molybdosilicate spectrophotometric method in carbon steels and low alloy steels (for silicon 0.01 to 0.05 percent)
- Part 12 Determination of manganese by periodate spectrophotometric method in plain carbon, low alloy and high alloy steels (for manganese 0.01 to 5.0 percent)
- Part 13 Determination of arsenic
- Part 14 Determination of carbon by thermal conductivity method (for carbon 0.005 to 2.000 percent)
- Part 15 Determination of copper by thiosulphate iodide method (for copper 0.05 to 5 percent)
- Part 16 Determination of tungsten by spectrophotometric method (for tungsten 0.1 to 2 percent)
- Part 17 Determination of nitrogen by thermal conductivity method (for nitrogen up to 0.04 percent)
- Part 18 Determination of oxygen by instrumental method (for oxygen 0.01 to 0.100 0 percent)
- Part 19 Determination of nitrogen by steam distillation method (for nitrogen 0.002 to 0.50 percent)
- Part 20 Determination of total carbon and sulfur content — Infrared absorption method after combustion in an induction furnace (routine method)
- Part 21 Determination of copper by spectrometric method (for copper 0.02 to 0.5 percent)
- Part 22 Determination of total hydrogen in steel by thermal conductivity method (hydrogen 0.1 ppm to 50 ppm)

*(Continued on third cover)*

*Indian Standard***METHOD FOR CHEMICAL ANALYSIS OF STEELS****PART 4 DETERMINATION OF TOTAL CARBON BY GRAVIMETRIC METHOD (FOR CARBON  $\geq$  0.1 PERCENT)***( Fourth Revision )***1 SCOPE**

This standard (Part 4) covers the method for determination of total carbon content of plain carbon, low alloy and high alloy steels of 0.1 percent and above by the gravimetric method.

**2 REFERENCES**

This standard given below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated was 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 edition of this standard:

<i>IS No</i>	<i>Title</i>
IS 6226 (Part 1) : 1994	Recommendations of apparatus for chemical analysis of metals: Part 1 Apparatus for determination of carbon by direct combustion ( <i>first revision</i> )

**3 OUTLINE OF THE METHOD**

The sample is burnt in a stream of purified oxygen and the carbon dioxide formed is absorbed, after purification, in suitable absorbent and determined.

**4 REAGENTS**

**4.1 Oxygen (O<sub>2</sub>)** — 99.5 percent minimum

**4.2 Accarite or Soda Lime** — 0.80 mm to 2.00 mm

**4.3 Magnesium Perchlorate** — Mg (ClO<sub>4</sub>)<sub>2</sub>, 0.80 mm to 2.00 mm

**4.4 Boat/Crucible**

Boat/crucible of precise dimension for accommodating in the resistance and induction furnace.

Pre-ignite the boats/crucibles in air or oxygen in a furnace for an hour at 1 100 °C and store in a desiccator and check for consistency of the blank values.

**4.5 Flux/Accelerator** — low carbon copper, red lead (pre-ignited at 550 °C), tin and iron of low carbon content.

**5 APPARATUS**

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

**5.2** Instead of the resistance furnace, an induction furnace may also be used.

**6 SAMPLING**

**6.1** The sample shall be drawn as prescribed in the relevant Indian Standards.

**6.2** The sample is to be cleaned with analytical grade ether and acetone, dried in an air oven at 100 °C  $\pm$  5 °C.

**7 PROCEDURE**

**7.1** Assemble the apparatus. Switch on the furnace, if it is a resistance furnace, and allow it to attain a temperature of 1 050 °C (*see Note*), all the while passing oxygen through the apparatus so that it bubbles freely at the exit end of the train. Disconnect the absorption bulb, keep in a desiccator till it attains room temperature and take the initial weight. Repeat the operation till a constant weight is obtained.

NOTE — For high chromium and high nickel steel, the temperature of 1 250 °C is recommended for complete combustion.

**7.2** Weigh to the nearest 0.001 g, 2.0 g to 3.0 g of the test sample. Transfer to the pre-ignited combustion boat covered at the bottom with a thin layer of calcined alumina. Spread the sample evenly over the top of the alumina and cover it with 2.0 g to 3.0 g of the flux. Introduce the boat slowly in the hot zone of the combustion tube.

To access Indian Standards click on the link below:

[https://www.services.bis.gov.in/php/BIS\\_2.0/bisconnect/knowyourstandards/Indian\\_standards/isdetails/](https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/knowyourstandards/Indian_standards/isdetails/)

**7.3** In the case of induction heating, weigh to the nearest 0.001 g, 0.9 g to 1.1 g of the sample and transfer to a pre-ignited crucible. Add an equal quantity of the flux. Place the crucible in position on the pedestal post of the furnace, raise to the combustion position and lock the system. Pass oxygen through the system and ignite the sample.

**7.4** Maintain a rapid flow of oxygen (800 ml/min to 1 000 ml/min) throughout the combustion, then reduce to 400 ml to 500 ml per minute and maintain it for another 6 min to 8 min in order to sweep out the carbon dioxide.

**7.5** Remove the absorption bulb and weigh it after keeping it in desiccator till it attains room temperature. The increase in weight of the bulb represents the carbon dioxide.

**7.6** Remove the boat or crucible and examine for any incomplete combustion. If the sample is not thoroughly fused, repeat the determination with a fresh sample.

#### **7.7 Blank**

Charge a pre-ignited boat or crucible, as the case may be, with the same amount of flux used in the

determination and follow the procedure as in [7.2](#) to [7.5](#).

### **8 CALCULATION**

**8.1** Calculate the total carbon content of the sample as follows:

$$\text{Carbon, percent} = \frac{A - B}{C} \times 27.29$$

where

*A* = increase in mass, in g, of the absorption bulb due to carbon dioxide from the sample;

*B* = increase in mass, in g, of the absorption bulb due to carbon dioxide from the blank determination; and

*C* = mass, in g, of the sample taken.

### **9 ACCURACY**

The accuracy of the method is  $\pm 0.01$  percent for carbon the range of 0.1 percent to 0.75 percent and  $\pm 0.02$  percent for carbon above 0.75 percent.

## ANNEX A

*(Foreword)*

## COMMITTEE COMPOSITION

Methods of Chemical Analysis of Metals Sectional Committee, MTD 34

<i>Organization</i>	<i>Representative(s)</i>
CSIR - National Metallurgical Laboratory, Jamshedpur Arcelor Mittal Nippon Steel, Mumbai	DR SANCHITA CHAKRAVARTY ( <i>Chairperson</i> ) SHRI MANOJ GUPTA SHRI KIRIT TAILOR ( <i>Alternate</i> )
Bhabha Atomic Research Centre, Mumbai	MS SANJUKTA A. KUMAR SHRI M. V. RANA ( <i>Alternate</i> )
CSIR - National Metallurgical Laboratory, Jamshedpur	DR ASHOK K. MOHANTY ( <i>Alternate</i> )
Defence Metallurgical Research Laboratory, Ministry of Defence, Hyderabad	SHRI S. S. KALYAN KAMAL
Directorate General of Quality Assurance, Ministry of Defence, New Delhi	SHRI A. MITRA SHRI D. KARTIKEY ( <i>Alternate</i> )
Geological Survey of India, New Delhi	SHRI NITIN PURUSHOTTAM SHRIMATI SANJUKTA DEY PAL ( <i>Alternate</i> )
Hindalco Industries Limited, Mumbai	SHRI KRISHANU MAHAPATRA SHRI ASHUTOSH ACHARYA ( <i>Alternate</i> )
Indian Metals and Ferro Alloys Limited, Bhubaneswar	SHRI DINESH KUMAR MOHANTY
Jawaharlal Nehru Aluminium Research Development and Design Centre, Nagpur	DR UPENDRA SINGH
JSW Steel Limited, Mumbai	SHRI KOTRABASAVARAJU SHRI MARULASIDDESHA U. M. ( <i>Alternate</i> )
National Aluminium Company Limited, Bhubaneswar	SHRIMATI SUKLA NANDI SHRI DEBANANDA BHATTACHARYYA ( <i>Alternate</i> )
National Test House, Kolkata	DR RAJEEV KUMAR UPADHYAY SHRI AKBAR H. ( <i>Alternate</i> )
Shriram Institute for Industrial Research, Delhi	DR LAXMI RAWAT SHRI PUNEET KAPOOR ( <i>Alternate</i> )
Steel Authority of India Limited - Salem Steel Plant, Salem	SHRI L. SIVAKUMAR SHRI VIVEKANANDHAN G. ( <i>Alternate</i> )
Tata Steel Limited, Kolkata	SHRI DR JATIN MOHAPATRA DR RAVIKRISHNA CHATTI ( <i>Alternate</i> )
BIS Directorate General	SHRI SANJIV MAINI, SCIENTIST 'F'/SENIOR DIRECTOR AND HEAD (METALLURGICAL ENGINEERING) [REPRESENTING DIRECTOR GENERAL ( <i>Ex-officio</i> )]

*Member Secretary*

SHRI ASHISH PRABHAKAR WAKLE  
SCIENTIST 'C'/DEPUTY DIRECTOR  
(METALLURGICAL ENGINEERING), BIS



(Continued from second cover)

- Part 23 Determination of total nitrogen in steel by optical emission spectrometer (nitrogen 0.002 to 1.0 percent)
- Part 24 Determination of nitrogen in steel by inert gas fusion — Thermal conductivity method (nitrogen 0.001 to 0.2 percent)

The composition of the Committee responsible for formulation of this standard is given in [Annex A](#).

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*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

## Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 2016* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

### Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Head (Publication & Sales), BIS.

### Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-[www.bis.gov.in](http://www.bis.gov.in) or [www.standardsbis.in](http://www.standardsbis.in).

This Indian Standard has been developed from Doc No.: MTD 34 (21385).

### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

## BUREAU OF INDIAN STANDARDS

### Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones: 2323 0131, 2323 3375, 2323 9402

Website: [www.bis.gov.in](http://www.bis.gov.in)

### Regional Offices:

Central : 601/A, Konnectus Tower -1, 6<sup>th</sup> Floor,  
DMRC Building, Bhavbhuti Marg, New  
Delhi 110002

Telephones

{ 2323 7617

Eastern : 8<sup>th</sup> Floor, Plot No 7/7 & 7/8, CP Block, Sector V,  
Salt Lake, Kolkata, West Bengal 700091

{ 2367 0012  
2320 9474

Northern : Plot No. 4-A, Sector 27-B, Madhya Marg,  
Chandigarh 160019

{ 265 9930

Southern : C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113

{ 2254 1442  
2254 1216

Western : Manakalya, 5<sup>th</sup> Floor/MTNL CETTM, Technology Street, Hiranandani Gardens, Powai  
Mumbai 400076

{ 25700030  
25702715

**Branches :** AHMEDABAD, BENGALURU, BHOPAL, BHUBANESHWAR, CHANDIGARH, CHENNAI, COIMBATORE, DEHRADUN, DELHI, FARIDABAD, GHAZIABAD, GUWAHATI, HARYANA (CHANDIGARH), HUBLI, HYDERABAD, JAIPUR, JAMMU, JAMSHEDPUR, KOCHI, KOLKATA, LUCKNOW, MADURAI, MUMBAI, NAGPUR, NOIDA, PARWANOO, PATNA, PUNE, RAIPUR, RAJKOT, SURAT, VIJAYAWADA.