



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS G 1211-4 : 2011
(JISF)

**Iron and steel—Determination of
carbon content—Part 4: Infrared
absorption method after combustion
in a furnace with preheating or peak
separating**

ICS 77.040.30;77.080.01

Reference number : JIS G 1211-4 : 2011 (E)

PROTECTED BY COPYRIGHT

Date of Establishment: 2011-03-22

Date of Public Notice in Official Gazette: 2011-03-22

Investigated by: Japanese Industrial Standards Committee
Standards Board
Technical Committee on Iron and Steel

JIS G 1211-4:2011, First English edition published in 2012-12

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2012

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED FY COPYRIGHT

Contents

	Page
Introduction	1
1 Scope	1
2 Normative references	1
3 General matters	2
4 Summary	2
5 Type of carbon removal method adhered or adsorbed on surface	2
6 Reagents	3
7 Implements and materials	4
8 Apparatus	6
9 Test portion	6
10 Operation	6
10.1 Selection of determination operation condition	6
10.2 Preparatory operation	7
10.3 Determination operation	8
10.4 Confirmation of determination operation	9
11 Blank test	9
12 Preparation of working curve	10
12.1 Preparation of working curve when applying waveform separating method	10
12.2 Preparation of working curve when applying preheating method	11
13 Calculation	13
14 Tolerances	13
Annex JA (informative) Comparison table between JIS and corresponding International Standard	14

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by the Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Consequently, **JIS G 1211:1995** has been withdrawn and partially replaced with this Standard.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public or utility model right. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public or the utility model right.

JIS G 1211 series consists of the following 5 parts under the general title “*Iron and steel—Determination of carbon content*”:

Part 1: Combustion gravimetric method

Part 2: Gas volumetric method after combustion

Part 3: Infrared absorption method after combustion

Part 4: Infrared absorption method after combustion in a furnace with preheating or peak separating

Part 5: Determination of non-combined carbon

Iron and steel—Determination of carbon content—Part 4: Infrared absorption method after combustion in a furnace with preheating or peak separating

Introduction

This Japanese Industrial Standard has been prepared so that, concerning Annex 5 of **JIS G 1211**: 1995, the determination method is specified over again so as to be the removal of carbon adhered and adsorbed on surface—combustion—infrared absorption method, and the tolerance calculation formula is reviewed.

The specification in this Standard had been proposed onto **ISO/TC17** (Steel and iron)/**SC1** (Methods of determination of chemical composition). Among the determination methods, the preheating—high frequency induction heating combustion method was published as the first edition of **ISO 15349-2** in 1999; however the waveform separating and preheating—electric resistance furnace heating combustion method was not adopted as **ISO** Standard and limited to the publish of Technical Report because of the insufficiency of laboratories participating in the international cooperative experiment. Consequently, the relation between this Standard and **ISO** Standard becomes MOD where **ISO 15349-2** only is the corresponding International Standard.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the removal of carbon adhered and adsorbed on surface—combustion—infrared absorption method among the determination methods of carbon content of iron and steel. This method is applicable to the determination of carbon content (mass fraction) in iron and steel in the range of 0.000 3 % or over to and including 0.010 %.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows:

ISO 15349-2:1999 *Unalloyed steel—Determination of low carbon content—Part 2: Infrared absorption method after combustion in an induction furnace (with preheating)* (MOD)

The symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 1201 *Iron and steel—General rules for analytical methods*

JIS K 0050 *General rules for chemical analysis*

JIS Z 2615 *General rules for determination of carbon in metallic materials*

JIS Z 8402-6 *Accuracy (trueness and precision) of measurement methods and results—Part 6: Use in practice of accuracy values*

3 General matters

General matters common to the determination method shall be in accordance with **JIS G 1201**.

4 Summary

The sample is heated at a high temperature in a current of oxygen, all carbon is oxidized to carbon dioxide, sent to an infrared absorption detector together with oxygen, the infrared absorption amount by only carbon in sample is measured according to the waveform separating method (waveform separating method), or the sample where a very small amount of carbon compound adhered or adsorbed on surface is removed beforehand by heating, is heated to a high temperature, the carbon in sample is oxidized to carbon dioxide, sent to an infrared absorption detector together with oxygen, and an infrared absorption amount by carbon dioxide is measured (preheating method).

5 Type of carbon removal method adhered or adsorbed on surface

The carbon removal method adhered or adsorbed on the surface shall be either of the following.

- a) **Waveform separating method** The obtaining method in which the waveform pattern obtained by developing the measured strength of carbon dioxide on time base is analyzed and the signal strength of carbon dioxide generated by oxidation according to carbon in sample only is measured. For the waveform separating method, a tubular electrical resistance furnace is used.

NOTE : When the strength of carbon dioxide is measured continuously by developing the gas generated by oxidization on time base, the specific waveform pattern is obtained depending on the generation source of carbon dioxide. When a normal steel sample is burnt by using a tubular electrical resistance furnace, firstly the peak caused by the carbon dioxide in atmosphere involved at the time of inserting the sample in furnace, secondly the peak caused by the carbon dioxide generated from the carbon adhered or adsorbed on the surface of sample, and finally the peak caused by the carbon dioxide generated by the combustion of carbon in sample are obtained. According to this, when respective waveforms of waveform pattern are analyzed beforehand, the strength of signal caused by the carbon dioxide generated by the oxidization of carbon in sample only can be measured.

- b) **Preheating method** The method in which the sample weighed out is preheated at prescribed temperature beforehand and the carbon adhered or adsorbed on the surface of sample is removed. For the furnace used for the combustion of preheated

sample, there are the two types such as a tubular electrical resistance furnace, and a high-frequency induction furnace, and the determination procedures slightly differ depending on the furnace to be used.

NOTE : Even if the steel sample is cleaned with an appropriate organic solvent (see **5.2** of **JIS G 1201**), it is difficult to remove the trace amount of carbon adhered or adsorbed on the surface of sample, and it influences the determination of not more than 0.010 % in carbon content (mass fraction). However, the carbon adhered or adsorbed on the surface of sample is oxidized at the lower temperature than the carbon in sample, therefore the both can be separated by setting an appropriate temperature.

6 Reagents

6.1 Water free from carbon dioxide

Water free from carbon dioxide shall be prepared immediately before the use according to either of the following.

- a) Boil water for 30 min by heating, cool it down to the room temperature as introducing oxygen (**6.2**), and furthermore introduce oxygen (**6.2**) for 15 min.
- b) In accordance with **E.2** of **JIS K 0050**.

6.2 Oxygen

That of 99.5 % or more in volume fraction.

An oxidation catalyst [copper (II) oxide or platinum] tube heated to a temperature at 450 °C or higher shall be used in front of the purifying unit (**7.6**), when the presence of organic contaminants is suspected in the oxygen.

6.3 Iron

That of high purity and of low carbon content (mass fraction) known of not more than 0.000 3 %, from which carbon adhered or adsorbed on the surface is removed.

6.4 Magnesium perchlorate [$\text{Mg}(\text{ClO}_4)_2$]

That for the analysis of element whose particle size is 0.7 mm to 1.2 mm.

6.5 Sodium carbonate

That (99.9 % or more in mass fraction) dried at about 150 °C to 200 °C for about 1 h and cooled in a desiccator not coated with grease, etc. before use.

6.6 Accelerator

For the accelerator used for the tubular electrical resistance furnace, copper or tin is preferable. For the accelerator used for the high-frequency induction furnace, an equivalent amount mixture of tungsten and tin or copper is preferable.

As the accelerator reduces the blank test value, it is preferable to treat it as the following.