SLOVENSKI STANDARD
SIST ISO/TR 7517:1998

01-februar-1998

Koks - Primerjava razliļ nih preskusov za oceno fizikalne trdnosti

Coke -- Comparison of different tests used to assess the physical strength

Coke -- Comparaison des différents essais pratiques pour déterminer la cohésion

Ta slovenski standard je istoveten z: ISO/TR 7517:1983

ICS:

75.160.10	Trda goriva	Solid fuels

SIST ISO/TR 7517:1998 **en**

TECHNICAL REPORT 7517

Published 1983-12-15

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Coke — Comparison of different tests used to assess the physical strength

Coke — Comparaison des différents essais pratiques pour déterminer la cohésion

0 Introduction

In the course of its work, the subcommittee ISO/TC 27/SC 3, *Coke*, received a considerable amount of experimental and other information relating the principal drum tests used in the assessment of the physical strength of coke and also the relevant strength indices. This Technical Report presents this information in a concise form.

1 Scope and field of application

This Technical Report describes the principal drum tests used to assess the physical strength of coke. These tests involve rotation of the coke in drums of different dimensions for different durations, and lead to the production of different indices. Additionally the available experimental evidence relating the various strength indices has been consulted. Such evidence relates the principal as well as secondary indices; in this Technical Report, all available statistical relationships between the principal strength indices have been listed and where possible illustrated graphically.

2 Definitions and symbols

For the purpose of this Report, the following definitions and symbols apply.

2.1 Drums

2.1.1 ISO drum : The drum described and defined in ISO 556[1], and used in the determination of Micum and Irsid indices. The dimensions given are those of the half-drum specified in that International Standard.

2.1.2 JIS drum : The drum described and defined in JIS K 2151-1972[2] and used in the determination of drum strength indices.

2.1.3 ASTM drum : The drum described and defined in ASTM D 3402-81[3] and used in the determination of hardness factor and stability factor.

2.2 Indices

2.2.1 Micum index, M_{40} : The percentage of the test sample, originally of particle size + 60 mm, remaining on or over a 40 mm aperture test sieve after 100 revolutions in the ISO drum.

2.2.2 Micum index, M_{10} : The percentage of the test sample, originally of particle size + 60 mm, passing a 10 mm aperture test sieve after 100 revolutions in the ISO drum. A loss in mass may be added, and this index is thus the complement to 100 of the percentage of the test sample remaining on or over the 10 mm aperture test sieve.

UDC 662.749.2 : 539.41 Ref. No. : ISO/TR 7517-1983 (E)

Descriptors : coal, tests, physical tests, physical properties, cohesion, cohesion number, test equipments, drums.

Printed in Switzerland

Price based on 14 pages

2.2.3 Irsid index, I_{20} : The percentage of the test sample, originally of particle size + 20 mm, remaining on or over a 20 mm aperture test sieve after 500 revolutions in the ISO drum.

2.2.4 Irsid index, I_{10} : A similar index to the Micum index M_{10}, but taken from the percentage of the test sample, originally of particle size + 20 mm, passing a 10 mm aperture test sieve after 500 revolutions in the ISO drum.

2.2.5 stability factor, S : The percentage of the test sample remaining on or over a 25 mm aperture test sieve after 1 400 revolutions in the ASTM drum.

2.2.6 hardness factor, H : The percentage of the test sample remaining on or over a 6,3 mm aperture test sieve after 1 400 revolutions in the ASTM drum.

2.2.7 JIS drum index, DI_{15}^{30} : The percentage of the test sample remaining on or over a 15 mm aperture test sieve after 30 revolutions in the JIS drum.

2.2.8 JIS drum index, DI_{15}^{150} : The percentage of the test sample remaining on or over a 15 mm aperture test sieve after 150 revolutions in the JIS drum.

3 Methods of test

The physical dimensions of the drums and the detailed procedures adopted are given in full in the national and International Standards to which reference has been made.

However, for convenience in this Technical Report, the main dimensional and procedural features of the various tests have been given in table 1. It is emphasised that this table gives only a summary of the relevant information, and the appropriate standard should be consulted for fuller details.

4 Relationships between indices

The available relationships between the principal strength indices are given in the form of statistical regression lines. In most cases this is the limit to which the evidence can be presented, because the full experimental data are not given in the documents to which reference has been made. In some instances a correlation coefficient has been quoted and this further information is given in this Technical Report.

For the purpose of graphical representation, a few of the equations have been inverted in order to effect a change of base. This operation can introduce a small uncertainty, because the regression of x upon y is not necessarily the same as the regression of y upon x. It is not considered that, in this context, the difference will be large, but the situation should be noted.

In the case of every relationship noted, the source of the information is given : the number given to each equation is the number of the appropriate source given in the Bibliography.

A summary of those pairs of indices between which relationships are noted is given in table 2.

Table 1 — Characteristics of drum tests

Method		ASTM	ISO (half-drum)		JIS	
Drum dimensions						
Internal diameter	mm	914	1 000		1 500	
Internal radius, r	mm	457	500		750	
Internal length, L	mm	457	500		1 500	
Lifting flights						
Number		2	4		6	
Depth of face	mm	51	100		250	
Depth of transverse support, t	mm	51	63		small	
Test sample						
Mass	lb	22				
	kg	10	25		10	
Lump size	in	2-3				
	mm		> 20		> 50	
Sieve type		square hole	round hole		square hole	
Moisture	%	1,0 max.	< 3,0		3	
Rotation						
Angular velocity	rev/min	24	25		15	
			Micum	Irsid	JIS K 2151-1960	JIS K 2151-1972
No. of revolutions		1 400	100	500	30	150
Strength indices		Stability factor	M_{40}	I_{20}	DI^{30}_{15}	DI^{150}_{15}
		= % > 1 in (25 mm)	= % > 40 mm	= % > 20 mm	Crushing strength = % > 15	Crushing strength = % > 15 mm
		Hardness factor	M_{10}	I_{10}		
		= % > 1/4 in (6,3 mm)	= % < 10 mm	= % < 10 mm		

Table 2 — Summary of pairs of indices between which relationships are noted

	I_{10}	I_{20}	DI^{30}_{15}	DI^{150}_{15}	S	H
M_{10}	x		x	x	x	x
M_{40}		x	x	x	x	
DI^{30}_{15}					x	
DI^{150}_{15}	x				x	

The relationships are presented in the following order :

a) Micum M_{40} and ASTM stability factor, S

b) Micum M_{40} and JIS $DI\,^{30}_{15}$

c) Micum M_{40} and JIS $DI\,^{150}_{15}$

d) Irsid I_{20} and Micum M_{40}

e) Irsid I_{10} and Micum M_{10}

f) Micum M_{10} and ASTM hardness factor, H

g) ASTM stability factor, S and Micum M_{10}

h) Micum M_{10} and JIS $DI\,^{30}_{15}$

j) Micum M_{10} and JIS $DI\,^{150}_{15}$

k) JIS $DI\,^{30}_{15}$ and ASTM stability factor, S

m) Irsid I_{10} and JIS $DI\,^{150}_{15}$

n) JIS $DI\,^{150}_{15}$ and ASTM stability factor, S

p) Mixed equations

a) **Micum M_{40} and ASTM S** (see figure 1)

i) $M_{40} = 1{,}24\,S + 17{,}8$ [4]

ii) $S = M_{40} - 20{,}1$ [5]
($r = 0{,}983$)

Equivalent inverted form
$M_{40} = S + 20{,}1$

iii) $M_{40} = 0{,}532\,S + 45{,}0$ [6]
(95 % limits $\pm$ 5,5)

iv) $S = 1{,}1\,M_{40} - 28{,}8$ [7]

Equivalent inverted form
$M_{40} = 0{,}90\,S + 26{,}18$

v) $M_{40} = 0{,}31\,S + 57{,}73$ [8]

vi) $M_{40} = 0{,}825\,S + 30{,}9$ [9]

vii) $M_{40} = 1{,}095\,S + 15{,}2$ [10]

viii) $M_{40} = 0{,}883\,S + 25{,}94$ [10]

ix) $M_{40} = 0{,}633\,S + 40{,}68$ [10]

x) $M_{40} = 0{,}3083\,S + 61{,}349$ [10]

b) **Micum M_{40} and JIS $DI\,^{30}_{15}$** (see figure 2)

i) $M_{40} = 3{,}15\,DI\,^{30}_{15} - 217{,}4$ [11]
($n = 30$, $r = 0{,}702$)

ii) $DI_{15}^{30} = 70{,}07 + 0{,}30\,M_{40}$ [12]
$(n = 90,\ r = 0{,}81)$

Equivalent inverted form

$M_{40} = 3{,}33\,DI_{15}^{30} - 233{,}57$

iii) $DI_{15}^{30} = 17{,}14\,(M_{40})^{0{,}39}$ [5]
$(r = 0{,}532)$

iv) $M_{40} = 1{,}85\,DI_{15}^{30} - 96{,}08$ [8]

v) One unqualified relationship has been added to the figure, taken from document N 85 [15]

c) **Micum M_{40} and JIS DI_{15}^{150}** (see figure 3)

i) $DI_{15}^{150} = 0{,}68\,M_{40} + 26{,}07$ [12]
$(n = 29,\ r = 0{,}90)$

Equivalent inverted form

$M_{40} = 1{,}47\,DI_{15}^{150} - 38{,}34$

ii) $M_{40} = 0{,}24\,DI_{15}^{150} + 55{,}18$ [8]

d) **Irsid I_{20} and Micum M_{40}** (see figure 4)

i) $I_{20} = 62{,}2 + 0{,}22\,M_{40}$ [13]
$(r = 0{,}60)$

ii) $I_{20} = 58{,}8 + 0{,}25\,M_{40}$ [13]
$(r = 0{,}57)$

iii) $I_{20} = 12{,}77 + 0{,}74\,M_{40}$ [16]
$(n = 70,\ r = 0{,}925,\ s = 1{,}775)$

e) **Irsid I_{10} and Micum M_{10}** (see figure 5)

i) $I_{10} = 8{,}1 + 1{,}80\,M_{10}$ [13]
$(r = 0{,}90)$

ii) $I_{10} = 5{,}2 + 2{,}24\,M_{10}$ [13]
$(r = 0{,}78)$

iii) $I_{10} = 16{,}43 + 1{,}09\,M_{10}$ [16]
$(n = 70,\ r = 0{,}936,\ s = 1{,}464)$

f) **Micum M_{10} and ASTM hardness factor, H** (see figure 6)

i) $M_{10} = 33{,}7 - 0{,}376\,H$ [9]
$(r = 0{,}853)$

ii) $H = 68{,}6 - 0{,}287\,M_{10}$ [5]
$(r = 0{,}504)$

Equivalent inverted form

$M_{10} = 239{,}0 - 3{,}48\,H$

g) **ASTM stability factor, S and Micum M_{10}** (see figure 7)

$S = -2{,}62\, M_{10} + 73{,}9$ [5]
($r = -0{,}801$)

h) **Micum M_{10} and JIS $DI\,^{30}_{15}$** (see figure 8)

i) $M_{10} = 62{,}97 - 0{,}58\, DI\,^{30}_{15}$ [8]

ii) $M_{10} = 102{,}0 - 0{,}99\, DI\,^{30}_{15}$ [11]
($n = 30$, $r = 0{,}487$)

iii) $DI\,^{30}_{15} = -1{,}54\, M_{10} + 103$ [5]
($r = -0{,}691$)

Equivalent inverted form

$M_{10} = 66{,}88 - 0{,}65\, DI\,^{30}_{15}$

iv) $DI\,^{30}_{15} = 102{,}38 - 0{,}97\, M_{10}$ [12]
($n = 90$, $r = 0{,}68$)

Equivalent inverted form

$M_{10} = 105{,}55 - 1{,}03\, DI\,^{30}_{15}$

v) One unqualified relationship has been added to the figure, taken from document N 85 [15]

j) **Micum M_{10} and JIS $DI\,^{150}_{15}$** (see figure 9)

i) $M_{10} = 14{,}56 - 0{,}07\, DI\,^{150}_{15}$ [12]
($n = 29$, $r = 0{,}64$)

ii) $DI\,^{150}_{15} = 102{,}19 - 2{,}37\, M_{10}$ [8]
($n = 29$, $r = 0{,}64$)

Equivalent inverted form

$M_{40} = 42{,}76 - 0{,}418\, DI\,^{150}_{15}$

k) **JIS $DI\,^{30}_{15}$ and ASTM stability factor, S** (see figure 10)

i) $DI\,^{30}_{15} = 56{,}0\,(S)^{0,14}$ [5]
($r = 0{,}968$)

ii) $DI\,^{30}_{15} = 42{,}0\,(S)^{0,198}$ [8]

iii) $DI\,^{30}_{15} = 60{,}21 + 1{,}13\, S - 0{,}009\,46\,(S)^2$ [14]
($n = 182$, $r = 0{,}84$)

m) **Irsid I_{10} and JIS $DI\,^{150}_{15}$** (see figure 11)

$I_{10} = 120{,}35 - 1{,}19\, DI\,^{150}_{15}$ [15]

(derived relationship from curve given)

n) **JIS DI^{150}_{15} and ASTM stability factor, S** (see figure 12)

$$DI^{150}_{15} = 38{,}32 + 1{,}25\,S - 0{,}008\,17\,S^2 \qquad [14]$$

(n = 161, r = 0,90)

p) **Mixed equations**

i) $$DI^{30}_{15} = 78{,}800 + 0{,}243\,M_{40} - 0{,}481\,M_{10} \qquad [12]$$

(n = 90, r = 0,87)

ii) $$DI^{150}_{15} = 39{,}052 + 0{,}605\,M_{10} - 0{,}666\,M_{10} \qquad [12]$$

(n = 29, r = 0,92)

5 Interpretation

In this Technical Report, a total of 40 relationships have been noted between the principal strength indices currently in use. Each has been derived from the statistical analysis of substantial experimental data, but each is only directly applicable to the specific conditions of sampling and testing employed in that exercise, and all relationships are subject to some degree of error or uncertainty.

The data are intended to give guidance to those desirous of seeking such relationships between coke strength parameters. They also indicate how further relationships may be derived from direct experimental evidence which are appropriate to specific conditions of the degree of coke stabilization and the point at which samples are taken. Where producers and consumers of coke are involved, an appreciation of the extent of coke degradation which occurs between the two points of sampling is necessary.

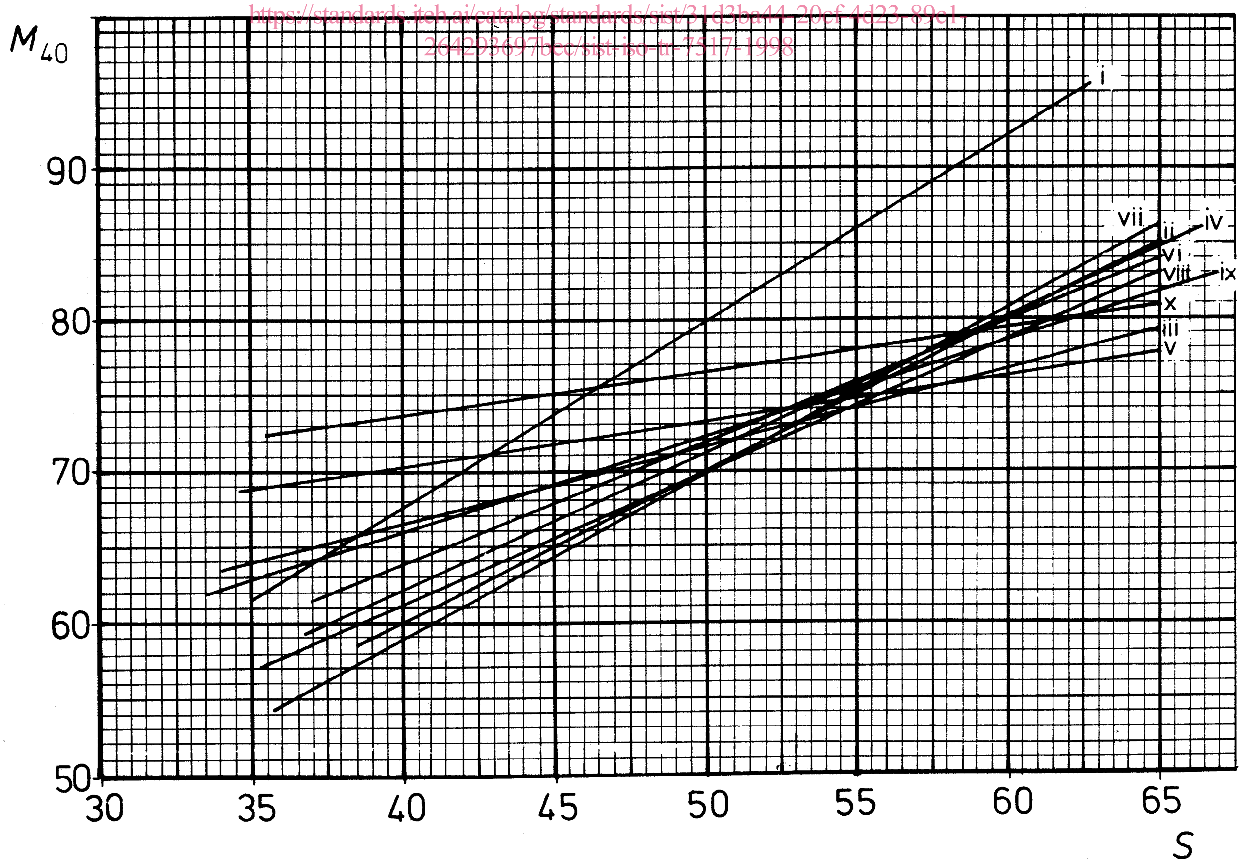

Figure 1 — Relationships between M_{40} and S