

Development of Analytical Methods for Free-MgO in Steelmaking Slag[†]

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Steelmaking slags have been widely used as aggregate for roadbeds and civil engineering. However, when used as aggregate, slag sometimes expands as a result of hydration, resulting in the evolution of cracks at the surface of roads. Because free magnesium oxide (free-MgO) as well as free calcium oxide in the slag are potential causes of this expansion, analytical methods to determine the free-MgO in slag for accurate evaluation of expansion are required. Based on a combination of chemical extraction and thermogravimetry (TG), an accurate method to determine the free-MgO in steelmaking slag was developed. In this method, the free-MgO and magnesium hydroxide ($Mg(OH)_2$) in the steelmaking slag are dissolved in an ethyleneglycol solution containing iodine and ethanol when heated. The amount of the magnesium species dissolved in the solution is determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES). The amount of ($Mg(OH)_2$) in the slag is determined separately by TG, and the result is then subtracted from that of the magnesium species dissolved in the ethyleneglycol to obtain the amount of free-MgO. The newly-established method enables determination of free-MgO in steelmaking slag at the 0.1 mass% level.

1. Introduction

Uvgn o cmkpi "unci." y jkej "ku" c" d{ rtqfwev" qh" vjg" uvgn" o cpwhcevwtkpi" rtqegu." ku" wugf" cu" c" eqpetvg" ci itgicvg." tqcfdgf" o cvgtkc." gve0" Tqcfdgf" o cvgtkc" o cfg" htqo" uvgn o cmkpi" unci" ku" wugf" dcugf" qp" cfsgwcvg" eqpukfgt/ cvkqp" qh" vjg" gzrcpukqp" qh" vjg" unci³⁻⁰ J { ftcvkqp" qh" htgg"

ecnekwo "qzkfg" *htgg/EcQ+. "htgg" o c i pgukwo "qzkfg" *htgg/ O i Q+. "gve0" kp" vjg" unci" ku" eqpukfgtgv" vq" dg" vjg" o ckp" ecwug" qh" vjku" gzrcpukqp^{4,5-0}

Kp" qtfgt" vq" wfgtuvcpf" vjg" gzrcpukqp" o gejcuko "qh" unci. "kv" ku" k o rqtvcv" vq" fgvgt o kpg" vjg" htgg/EcQ" cpf" htgg/ O i Q" kp" vjg" unci⁰ Vjg" cpcn{ vkecn" o gvjqf" d{ "gvj { ngpgin{ / eqn" *G I+ "gzvtcevkqp⁶⁶⁹⁺ ku" ykfgn{ "mpqyp" cu" c" fgvgt o kpc/ vkqp" o gvjqf" hqt" htgg/EcQ⁰ Cu" fgvgt o kpcvkqp" o gvjqfu" vjcv" fq" pqv" wug" e jg o kecn" gzvtcevkqp. " fgvgt o kpcvkqp" d{ " Z/tc{ " fkhhtcevkqp" *ZTF+...+ " ecnewncvkqp" htqo" kphtctgf" urgevtqueqr{ " chvgt" j { ftcvkqp" ykvj" jgcx{ " ycvgt³²⁺

Vjg⁴⁷ O i" P O T" urgevtqueqr{ " ku" pqv" c" i gpgtcn/ rwtrqug" o gvjqf. "cu" jki j" rghqt o cpeg" P O T" cr rctcvwu" ctg" pgegu/ uct{ "cpf" tgswtgu" c" nqpi" o gcuwtg o gpv" vk o g⁰ Vjg" o gvjqf" qh" ecnewncvkqp" htqo" kphtctgf" urgevtqueqr{ " chvgt" jgcx{ " ycvgt" j { ftcvkqp" cnuq" ncemu" rctcevkcnkv{ " ukpeg" O i Q" o wuv" dg" e jcpigf" eqo rnvgn{ " vq" O i *Q J +₄" d{ " j { ftcvkqp. " cpf" eqpukfgtcdng" vk o g" ku" tgswtg f0

Qp" vjg" qvgt" jcpf. " fgvgt o kpcvkqp" qh" EcQ" cpf" O i Q" wukpi" K₄/G I" uqnwvkqp" cpf" o gcuwtkpi" vjg" gnevtekcen" eqp/ fwevkv{ " dghqtg" cpf" chvgt" c f fkvkqp" jcu" dggp" tgrqtvf" cu" cp" cpcn{ vkecn" o gvjqf" hqt" EcQ" cpf" O i Q" kp" eg" o gpv" enkp/ mgt³⁶⁺⁰ Vjg" K₄/cneqjqn" fkuuqnwvkqp" o gvjqf" ku" mpqyp" cu" c" uvcpctf" o gvjqf" hqt" gzvtcevkqp" qh" qzkfgu" kp" uvgn^{37,38-0}

Htq o "vjg"cdqyg."cp"K₄/cneqjqn/G I "uqnwvkqp" ycu"eqpukf/ gtgf"vq"dg" c" rquukdng"uqnxgpv"htq"gzvtcevkqp"qh"htgg/O i Q" kp"unci⁰" J q y gxgt."vjgtg" ygtg"pq"ecugu"kp" y jkej"vjku"uqn/ xgpv" ycu"uvwfkfg" cu" cp" cpcn{vkecn" o gvjqf" htq" O i Q" kp" unci⁰"Vjgtghqtg."vjg"cwvjqtu"kpXgukicvfg"htcevkqpcn"fgvgt/ o kpcvkqp" qh" htgg/O i Q" kp" unci" d{ " e j g o k e c n" g z v t c e v k q p" w u k p i" c p" K₄/cneqjqn/G I " u q n w v k q p." c p f" f g v g t o k p g f" v j g" q r v k o w o" e q p f k v k q p u" h q t" f k u u q n w v k q p" q h" h t g g / O i Q" c p f" O i * Q J + 4" d { " w u k p i" u v c p f c t f" t g c i g p v u" c p f" c e v w c n" u n c i u⁰ " Y g" c n u q" h q w p f" v j c v" v j g t o q i t c x k o g v t k e" c p c n { u k u" e c p" d g" w u g f" k p" f g v g t o k p c v k q p" q h" O i * Q J + 4" v j c v" k u" f k u u q n x g f" v q i g v j g t" y k v j" O i Q⁰" V j k u" r c r g t" t g r q t v u" c" f g v g t o k p c v k q p" o g v j q f" h q t" h t g g / O i Q" k p" u n c i" y j k e j" y c u" f g x g n q r g f" d c u g f" q p" v j g" u v w f { " q w w n k p g f" c d q x g⁰

dcvj" cflwuvgf" vq" :207•E" cpf" jgcvgf" htq" 82" o kp" y j k n g" uvtktkpi" ykvj" c" uvtkgtl" Chvgt" jgcvkpi" htq" 82" o kp. "vjg" hncum" ku" eqqngf" vq" tqo" vg o rgt Òv_ "q" :2qqo" vg" Z

2. Experimental

2.1 Reagents and Sample Materials

2.1.1 Reagents

Vjg"O i Q" wugf"kp"vjku"uvwf{" ycu" c" jki j" rwtkv{ " tgc i g p v" o c p w h c e v w t g f" d { " M c p v q" E j g o k e c n" E q⁰." K p e⁰" V j g" O i * Q J + 4" y c u" c" j k i j" r w t k v { " t g c i g p v" o c p w h c e v w t g f" d { " M q l w p f q" E j g o k e c n" N c d q t c v q t { " E q⁰." N v f⁰" C u" C n" e q o r n g z" q z k f g u." U k" e q o r n g z" q z k f g u" c p f" H g" e q o r n g z" q z k f g u" h q t" w u g" k p" k p x g u k i c v k q p" q h" v j g" o g n v k p i" d g j c x k q t" q h" O i" q z k f g u." O i * C n Q₄₊₄." O i₄Uk₅Q₂ 7 J₄Q" c p f" O i H g₄Q₆" o c p / w h c e v w t g f" d { " Y c m q" R w t g" E j g o k e c n" K p f w u v t k u." N v f⁰" c p f" M q l w p f q" E j g o k e c n" N c d q t c v q t { " y g t g" w u g f⁰

2.1.2 Slags

Vjg"uygn o cmkpi" unci u" *Unci" C/F+ "ujqyp"kp" **Table 1** ygtg" wugf"kp"vjg"uvwf{" qh"htgg/O i Q" cpcn{uku⁰" Y jgp" wugf" kp" cpcn{uku." vjg" unci u" ygtg" etwujgf" kp" c f x c p e g" vq" 20297" o o" qt" u o c m n g t⁰

2.2 Experimental Method

2.2.1 Melting and determination method for MgO+Mg(OH)₂ in slag

C" 203" i" u c o r n g" q h" u n c i" e t w u j g f" v q" 20297" o o" q t" u o c m n g t" k u" y g k i j g f" k p" c" e q p k e c n" h n c u m" * 322" o l + " c p f" 39" o l" q h" g v j { n g p g i n { e q n" c p f" : " o l" q h" 47" o c u u " " K₄ g v j c p q n" e t g" c f f g f" v q" v j g" h n c u m⁰" V j g" h n c u m" k u" r n c e g f" k p" c" j q v" y c v g t"

*5+ "

i tcxk o gvtke" cpcn{uku" qh" vjg" uc o rng" chyt" G I " vtgcv o gpv"
Vjg" eqpv gpv" qh" htgg/O i Q" ku" qdvckpgf" htq o "vjg" fkhhtgpeg"
dgy ggp" vjg" v y q" tguwnvu0" Vjku" o gvjqf" gpcdngu" gxcnwcqpp"
qh" htgg/O i Q" kp" unc i0" kv" ku" rquukdng" vq" cr rn{" vjku" vgej/
pkswg" vq" uvwfkgu" qh" cikpi" vtgcv o gpv" eqpfkvkqpu." kpfgzgu"
qh" etkvgtk" hqt" lwf ikpi" vjcv" ujk r o gpv" qh" unc i" ku" rquukdng."
cpf"qvjgt" hkgnfu0

References

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