

Study on the damage mechanism of high chromia refractory in the slag tapping hole of commercial entrained-flow gasifier

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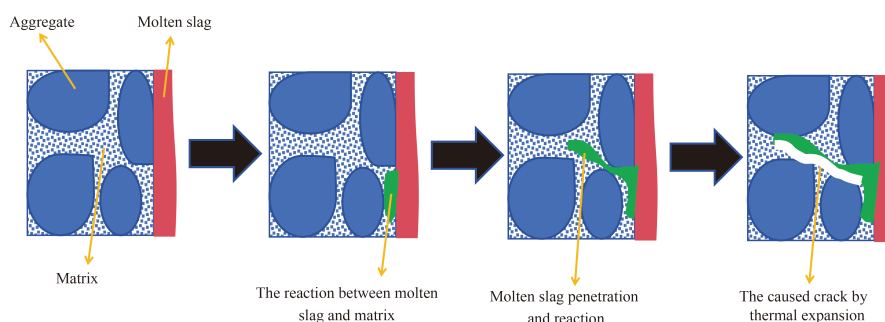
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Abstract: The service life of refractory brick in the slag tapping hole of gasifiers is a significant concern for long-term and stable operation. This study examined the damage mechanism of high chromia refractory of four commercial coal-water slurry gasifiers

with their corresponding gasification coal samples and the corroded refractory bricks in the slag tapping hole of the gasifier. The slag characteristic, including crystallization and viscosity-temperature of four gasification coal samples were analyzed. The results revealed that the low viscosity slag could lead to more severe damage to refractory bricks. Given the risk of slag crystallization, it is recommended to establish a safe slag tapping temperature range should be set as t_{ICT} (initial crystallization temperature) $- t_{2.5}$ when t_{ICT} is higher than t_{25} . Upon examining interior morphology of these corroded refractory bricks, some cracks were observed within them. The chemical composition of molten slag was analyzed using SEM-EDS. However, XRD results found no spinel containing zirconium in these cracks. This suggests that the emergence of these cracks are mainly attributed to the molten slag penetration and the subsequent reaction with the refractory material. The difference in thermal expansion between the newly formed substances and refractory material is critical in forming these cracks. Furthermore, SEM-EDS analysis was also conducted on the slag-aggregate and the slag-matrix interface. The results reveal that the reduction in Cr_2O_3 content is the earliest characteristic of damage in high chromia refractories. A proposed damage mechanism of refractory brick suggests that the matrix and aggregate of high chromia refractory are initially compromised because of the reduced Cr_2O_3 content. Subsequently, the molten slag penetrates the interior of the refractory brick, forming new substances, leading to damage caused by the difference in thermal expansion between the new substances and the refractory brick. Understanding and preventing the reduction of Cr_2O_3 content is vital to prolonging the service life of refractory brick in the slag tapping hole of the gasifier based on this damage mechanism.

Key words: gasification; high chromia refractory; slag; damage mechanism; corrosion



Entrained-flow gasification is considered one of the most efficient and environmentally benign processes, converting mixtures of carbon-based materials like coal, biomass, and petroleum coke into syngas^[1–2]. Entrained-flow gasifiers are

categorized into refractory brick walls and water-cooling membrane wall based on the lining of the gasifier chamber^[3–4]. Refractory brick lining gasifier exhibits low radial heat flux and a high conversion efficiency due to its

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excellent thermal insulation performance^[5–6]. However, the service life of refractory brick is a bottleneck for long-term and stable operation of the gasifier^[3], particularly for refractory bricks located in the slag tapping hole of the gasifier. The service life of refractory bricks varies significantly across different areas within a gasifier. In commercial gasifiers, the refractory brick service life in the slag tapping hole is approximately half that of the straight section^[5,7].

Many researchers have explored the damage mechanism of refractory bricks by the experimental method under simulated gasification conditions, focusing on the corrosion effect of different types of slag^[8–14]. Kaneko et al.^[15] studied the corrosion mechanism of various slags (coal slag and petroleum coke slag) on 90%Cr₂O₃-10%Al₂O₃ refractory material, which showed that the chromium spinel layers hindered the slag from penetrating the porous microstructure of the refractory, thus limiting infiltration. Kwong et al.^[16] reported that iron oxide in the melting furnace slag preferentially reacts with chromium oxide to form iron chromium spinel, which the continuous growth of FeCr₂O₄ in a limited space resulted in the flaking of fine particles on the surface of refractory materials. Chen et al.^[17] examined the corrosion characteristics of Cr₂O₃-Al₂O₃-ZrO₂ refractory brick in a coal-water slurry gasifier, and the result showed the formation of an isolation layer primarily composed of (Mg, Fe²⁺)(Cr, Fe)₂O₄ complex spinel effectively inhibited the infiltration of key corrosive components in the slag (Fe_xO, MgO). Additionally, Cai et al.^[18–19] studied the corrosion properties of acidic and alkaline slag on various refractory materials, and founded that a (Mg, Fe)(Al, Cr)₂O₄ spinel solution formed in the reaction layer, resulting in a densification of the matrix structure. ZrO₂ in the matrix dissolved directly into the molten slag and forming a ZrO₂-free region that reduced the thermal shock resistance of refractory bricks.

The research mentioned above suggests that the damage mechanism of refractory bricks is highly complex, influenced by factors such as temperature fluctuation, slag characteristics, and the properties of the refractory material. However, most of the research on the damage mechanism of refractory bricks were carried out by the experimental method and focus only to the surface corrosion of refractory bricks. Therefore, the precise nature of the damage mechanism of refractory bricks remains unclear. This study selected four commercial coal-water slurry gasifiers as the focus. The four gasification coal samples and their corresponding to refractory bricks from the slag tapping hole of the gasifier were collected to investigate the damage

characteristic of refractory bricks. By combining the slag characteristic and the analysis of corroded refractory brick with an understanding of slag characteristics, this study aims to gain insight into the damage mechanism and ultimately improve the service life of refractory brick of the gasifier.

1 Experimental

1.1 Sample preparation

Gasification coal samples (No.1[#]–4[#]) from each gasifier and the corresponding corroded refractory bricks from the slag tapping hole were collected. The coal ash was prepared at 815 °C in a muffle furnace according to GB/T 1574—2007 standards. The chemical compositions of ash were analyzed using X-ray fluorescence (XRF) (Bruker S8 Tiger, Germany), and are presented in Table 1.

The data in Table 1 reveals that the acidic characteristic (SiO₂, Al₂O₃ and TiO₂) is more pronounced than the alkaline characteristic (Fe₂O₃, CaO, MgO, K₂O and Na₂O) across all samples, which indicate that coal with acidic/alkaline ratio greater than one is more suitable for coal water slurry gasification. Upon comparison, it is notable that the iron oxide content is relatively higher in coal samples 3[#] and 4[#], while the 4[#] coal sample content of CaO is the highest.

1.2 Analysis of coal samples and corroded refractory bricks

The viscosity of coal ash was measured using a Theta high-temperature rotating viscometer (Theta Industries, Inc., USA) with molybdenum rotors and crucibles. The measurement process was detailed in the report by Cao et al.^[20]. The crystallization process of molten slag was monitored by using the single hot thermocouple technique (SHTT), as reported by Lu et al.^[21]. The microstructure of the corroded refractory brick in the slag tapping hole was longitudinally cut and analyzed using a Scanning Electron Microscope (SEM) with X-ray Energy Dispersive Spectroscopy (EDS). Mineralogical analysis was performed using an X-ray powder diffract meter (BRUKER D8, Germany), equipped with Cu K α radiation (40 kV, 40 mA). The powder samples were mounted on a sample glass and scanned with a step size of 0.02° over a 2 θ range of 0.2°–120°.

Table 1 Ash chemical compositions of 1[#]–4[#] coal samples

Sample	Content w/%									
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	SO ₃	K ₂ O	Na ₂ O	TiO ₂	P ₂ O ₅
1 [#]	47.47	16.55	8.99	14.89	1.42	4.44	1.58	1.97	0.74	0.06
2 [#]	48.93	16.87	8.10	14.81	0.98	4.38	1.58	1.79	0.72	0.04
3 [#]	39.16	16.57	15.02	13.06	3.76	6.05	0.75	2.86	0.72	0.14
4 [#]	36.91	15.30	13.90	22.97	2.47	3.51	1.00	0.75	0.71	0.05

1.3 Thermodynamic equilibrium calculations

Equilib-module in FactSage (version 8.3) was used for calculating phase distribution under a reducing atmosphere ($\text{CO}/\text{CO}_2 = 60:40$, volume fraction) from 1300 to 1000 °C via 20 °C. The FactPS and FToxid databases were used for these calculations.

2 Results and discussion

2.1 Slag characteristic analysis

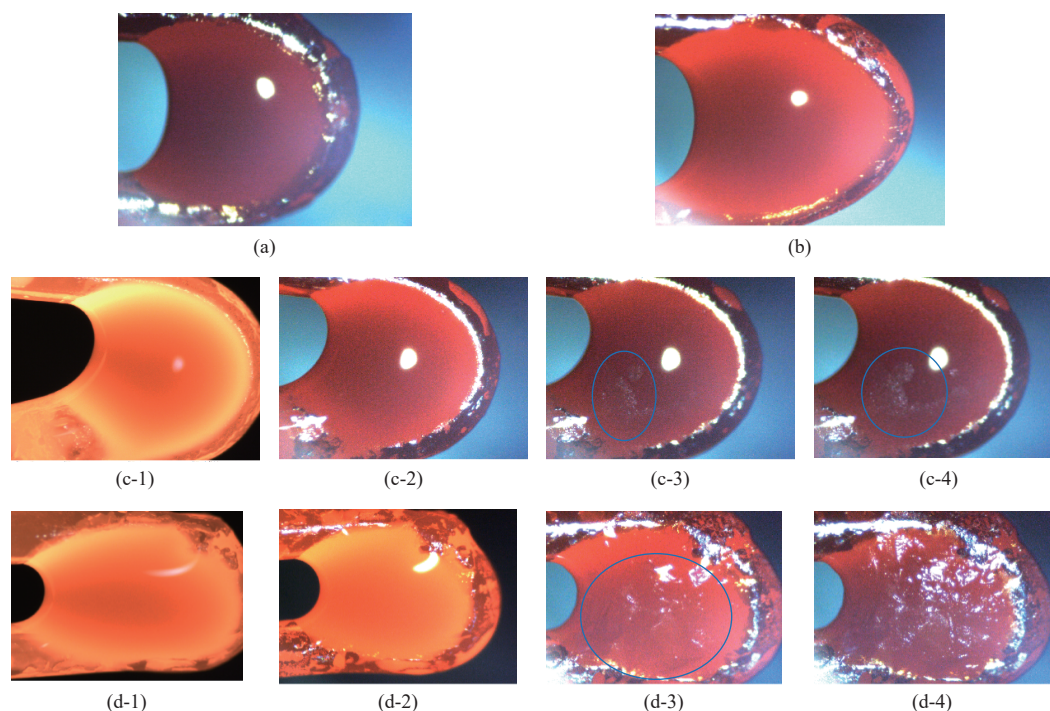
The crystallization behavior of slag is vital for efficient operation of gasifier and for preventing refractory brick corrosion. Typically, the operation temperature of the gasifier should exceed the slag crystallization temperature to ensure smooth slag tapping. To analyze the slag crystallization characteristics of four coal samples used in gasification, the SHTT method was used to measure their crystallization behavior, and the results are illustrated in Figure 1.

Figure 1 reveals that both 1[#] and 2[#] coal samples did not exhibit crystallization behavior even at 1000 °C. However, crystallization behavior was observed for 3[#] and 4[#] coal samples (as shown by the blue circle in the (c-3), (c-4) and (d-3) of Figure 1). In the crystallization process of 4[#] coal sample, crystallization accelerated as the temperature decreased, and quickly spread over the molten slag surface. The t_{ICT} (initial crystallization temperature) of 3[#] and 4[#] coal

samples observed by the SHTT were 1044 and 1174 °C, respectively. Additionally, the phase distribution of four gasification coal samples at thermodynamic equilibrium conditions under a weak reducing atmosphere was calculated by using the FactSage software packages 8.3 and is presented in Figure 2.

Figure 2 reveals that the thermodynamic liquid phase temperature of the 1[#]–4[#] coal samples are 1245.6, 1267.0, 1196.8 and 1198.8 °C, respectively. As the temperature decreases, crystalline formations appear in the molten slag. The initial crystallization phase for 1[#]–3[#] coal samples are anorthite and gehlenite for 4[#] coal sample. The difference in the crystallization phases for the 4[#] coal sample compared to the others may be because of the high calcium content and the low crystallization activation energy of gehlenite^[22]. As the temperature decreases further, different types crystallization are formed in each coal sample. However, according to Figure 1, the crystallization process of the 1[#] and 2[#] coal samples was not observed. It can be observed from Figure 2 that the slope of the liquidus line for 1[#] and 2[#] coal samples is smaller than that of 3[#] and 4[#] coal samples, indicating the need for a larger thermodynamic driving force for crystallization. This may explain why the crystallization process of the 1[#] and 2[#] coal samples was not observed. The viscosity-temperature curves of different slags were also measured and depicted in Figure 3.

Figure 3 reveals that the 1[#] and 2[#] coal samples exhibited the behavior of a glassy slag, whereas 3[#] and 4[#] coal samples have behavior typical of crystalline slag.



(a): the molten slag surface morphology of 1[#] coal sample at 1000 °C; (b): the molten slag surface morphology of 2[#] coal sample at 1000 °C; (c-1)–(c-4): crystallization process of 3[#] coal sample; (d-1)–(d-4): crystallization process of 4[#] coal sample.

Fig. 1 Slag crystallization process of four coal samples

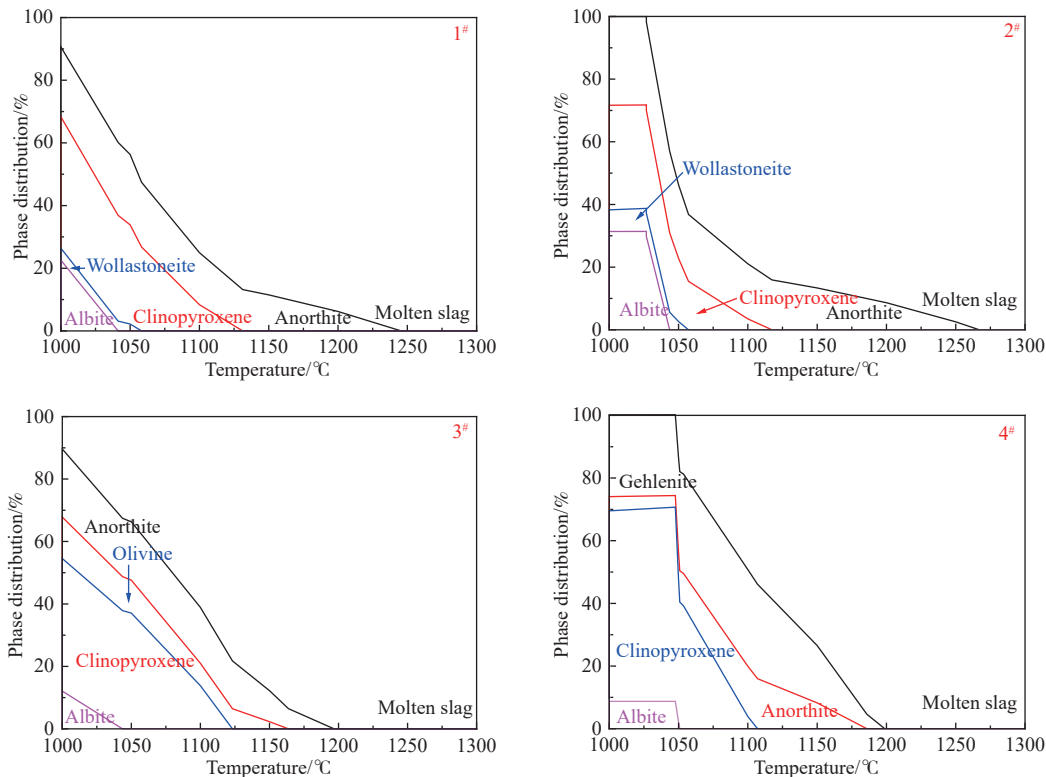


Fig. 2 Thermodynamic equilibrium calculation of 1[#]–4[#] coal samples

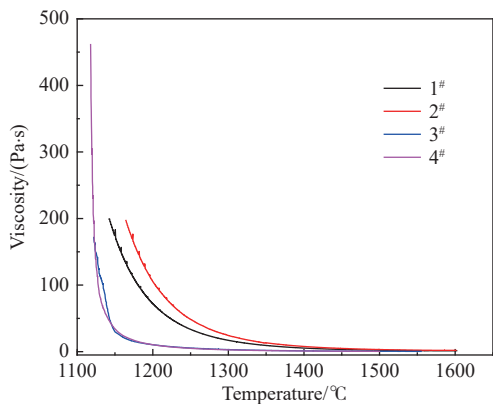


Fig. 3 Viscosity-temperature curves of different slags

Furthermore, the range of slag tapping temperature range is a vital parameter for selecting gasification feedstock to ensure smooth tapping, and the ideal viscosity range of slag is 2.5–25 Pa·s^[21]. Table 2 displays the corresponding temperature range of 2.5–25 Pa·s and t_{ICT} for 1[#]–4[#] coal samples.

Table 2 reveals that the t_{ICT} of 4[#] coal sample surpasses that of t_{25} , whereas the t_{ICT} of 3[#] coal sample is lower than that of t_{25} . In the context of a commercial gasifier, even if the slag is in a flowable, the slag crystallization poses a significant risk to the operation of a gasifier state. Therefore, it is recommended to establish the safe slag tapping temperature range should be set as t_{ICT} – $t_{2.5}$ when t_{ICT} exceeds t_{25} . Furthermore, the temperatures of 3[#] and 4[#] coal samples at which the slag viscosity was 2.5 Pa·s are excessively low, this may intensify the corrosion of high chromia refractory more serious because of the temperature

fluctuation in the gasifier. Figure 4 presents the slag distribution of 2[#] and 4[#] coal samples in the inner wall of the gasifier. It is clear that the slag distribution for the 2[#] coal sample is uniform, while there is almost no slag for 4[#] coal sample in the inner wall of the gasifier, with the chrome green being prominently visible. This phenomenon is primarily attributed to the low viscosity of the molten slag.

Table 2 The corresponding temperature range of 2.5–25 Pa·s and t_{ICT} for 1[#]–4[#] coal samples

sample	t_{ICT} / °C	$t_{2.5}$ / °C	t_{25} / °C
1 [#]	—	1482.2	1270.9
2 [#]	—	1534.6	1297.8
3 [#]	1044.0	1322.0	1156.3
4 [#]	1174.0	1307.3	1159.3

Note: $t_{2.5}$ and t_{25} are the temperature at which the slag viscosities were 2.5 and 25 Pa·s, respectively.

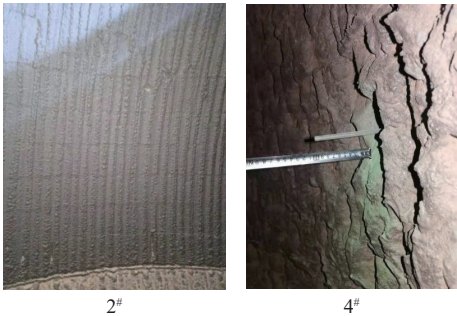


Fig. 4 The slag distribution of 2[#] and 4[#] coal samples in the inner wall of the gasifier

2.2 Morphology of corroded refractory bricks

The corroded high chromia refractory bricks in the slag tapping hole of four commercial coal-water slurry gasifiers were obtained, each corresponding to a different coal sample used as gasification feedstock (1[#]–4[#]). These corroded high chromia refractory bricks were cut longitudinally and marked as 1[#]–4[#] brick. The morphology of these corroded bricks were shown in Figure 5.

Figure 5 reveals that some cracks occurred in the interior of all corroded refractory bricks, particularly for bricks 1[#] and 4[#], where the width of the crack is larger. The poor flow characteristic of crystallization slag causes severe penetration and corrosion due to prolonged residence time of molten slag on the surface of refractory brick. To further investigate the cause of the crack formation, these cracks in the 3[#] and 4[#] refractory bricks were examined, and their microstructures were analyzed by SEM-EDS. Figure 6(a) and (b) depict the microstructure of the crack internal surface of the 3[#] refractory brick, Figure 6(c) and (d) are the microstructure of the crack internal surface of 4[#] refractory brick.

In Figure 6(a), (b), the surface of refractory material appeared muddy and some trip-shaped crystals were found in the cracks. An analysis of the trip-shaped crystal and the area in Figure 6(a) using EDS. The results are shown in Table 3. It is evident from Table 3 that the chemical composition of slag was found in the cracks, and the trip-shaped crystal mainly comprise Fe and P elements. In the case of the crack in the 4[#] refractory brick, significant fragments and dendritic substances were observed in Figure 6(c) and (d), respectively. These were also analyzed

using EDS and the results are presented in Table 3. Similarly, the chemical composition of slag was also found in the crack of 4[#] refractory brick. According to the EDS analysis, the dendritic substance mainly comprised Ca and P elements. This may be related to the high calcium content in the 4[#] coal sample. Additionally, the XRD analysis was conducted to determine the substance in the crack, and the results are illustrated in Figure 7 and Figure 8.

Figure 7 and Figure 8 revealed that the substances in the crack of 3[#] refractory brick were similar to that in the crack of 4[#] refractory brick and both containing $(Al,Cr)_2O_3$, $Ba(PO_3)_2$, Cr_2O_3 , $(Cr,Fe)_2O_4$, Fe, $KAlSi_3O_8$, ZrO_2 . The presence of $Ca_3Si_2O_7$ in the crack of the 4[#] refractory brick indicated the high calcium content in the coal sample.

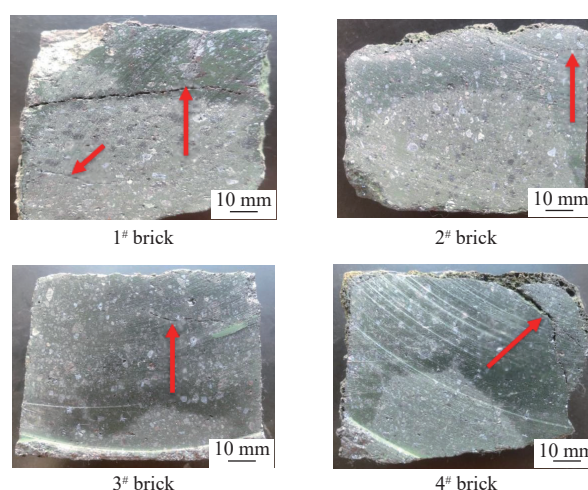


Fig. 5 Morphology of different corroded refractory bricks

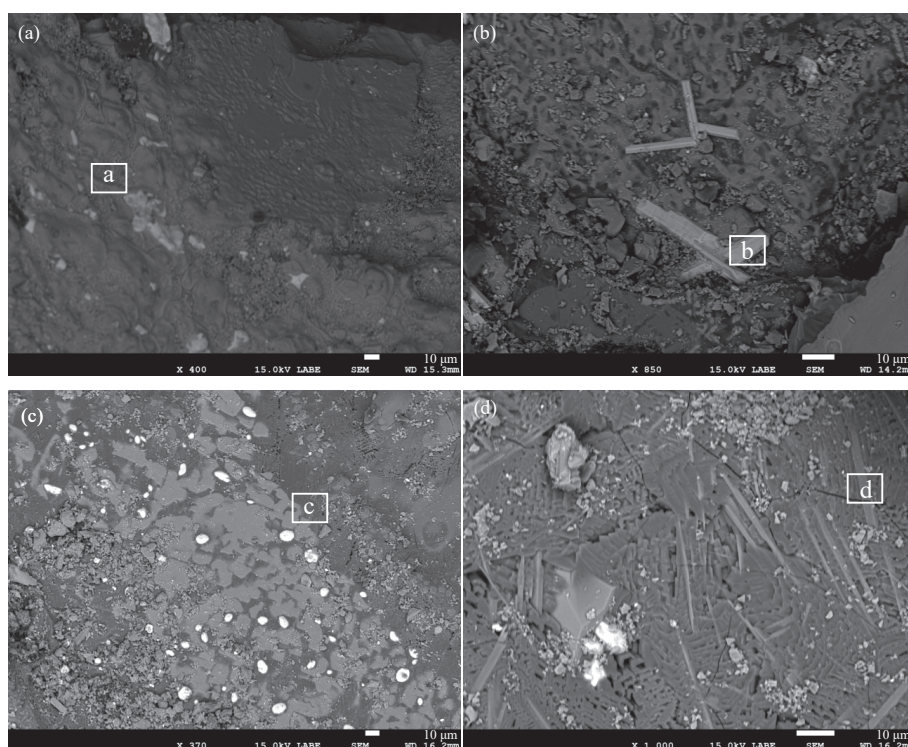
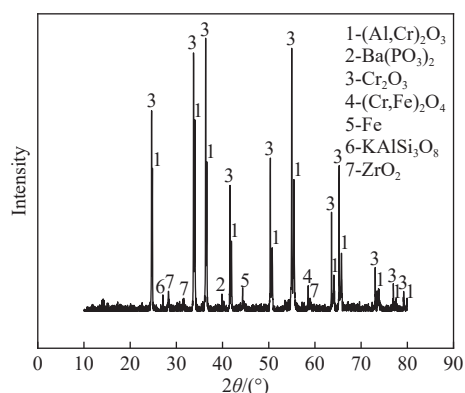
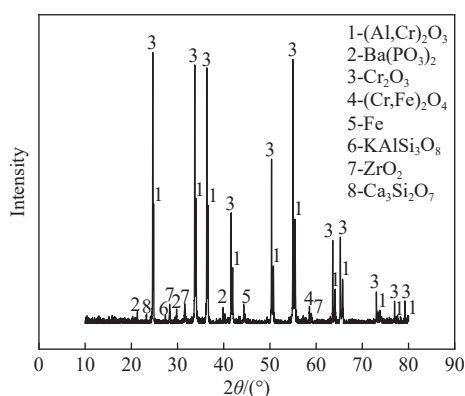


Fig. 6 Crack microstructures of 3[#] ((a)+(b)) and 4[#] ((c)+(d)) refractory bricks

Table 3 Chemical composition of 3[#] and 4[#] refractory bricks crack

w/%	O	Si	Al	Fe	Ca	Ba	P	Na	K	Cr	Zr
a	33.02	0.97	3.24	0.63	1.66	—	1.12	0.49	—	53.41	5.46
b	32.64	—	—	48.19	0.19	0.13	12.49	—	—	3.16	3.33
c	42.53	17.86	14.71	0.61	8.97	—	—	7.27	1.11	1.37	5.57
d	37.68	4.56	1.51	0.66	40.12	—	9.58	0.35	—	2.20	3.95


 Fig. 7 XRD analysis of 3[#] refractory brick

 Fig. 8 XRD analysis of 4[#] refractory brick

Based on the identified substances, it can be concluded that a reaction occurred between chromium oxides in refractory brick and Fe oxides and Al oxides in molten slag. However, the absence of zirconium-containing spinel in these cracks, as confirmed by XRD, indicates that the thermal shock resistance of the cracks remains unchanged^[23]. The results suggest that the formation of these cracks is mainly attributable to molten slag penetration and the ensuing reaction with the refractory material. The new substance formed by reaction, such as Fe, has a higher linear expansion coefficient ($1.22 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}$) than Cr_2O_3 ($9.6 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$). The difference in thermal expansion between the newly formed substances resulting from the reaction and the refractory material is a vital factor in forming these cracks.

2.3 Analysis of the interface between molten slag and refractory brick

Refractories typically comprise multiple phases,

including aggregate and matrix^[24]. In the case of high chromia refractory bricks, the aggregate consists of Cr_2O_3 , while the matrix composition comprises ZrO_2 , Al_2O_3 and Cr_2O_3 . Since the interface between molten slag and refractory brick is the primary reaction region, the microstructure of the slag-aggregate interface and the slag-matrix interface were analyzed using SEM-EDS. Figure 9 presents the micrographs of the slag-aggregate interface for corroded 1[#]–4[#] refractory bricks.

Figure 9 reveals that the slag layer and the aggregate are separated by the slag-aggregate interface (see red dashed line in the figure). The chemical composition of slag near the slag-aggregate interface was analyzed using EDS and the results are presented in Table 4.

The analyses in Table 4 show the presence of Cr_2O_3 and ZrO_2 in the chemical composition of slag near the slag-aggregate interface. However, EDS analysis indicates that the chemical composition of aggregate near the slag-aggregate interface remains unchanged. This suggests that the corrosion of slag on refractory bricks is mainly due to the chemical reaction and/or dissolution of slag on refractory material. Furthermore, other phenomenon like slag permeation and residual carbon, were observed in the 1[#] brick and 3[#] brick as shown in Figure 9. These phenomena may be related to the operation temperature of the gasifier, with higher temperature corresponding to higher probability of slag permeation and lower residual carbon. The average gasification operation temperature is $1350 \text{ } ^\circ\text{C}$ for 1[#] brick and $1250 \text{ } ^\circ\text{C}$ for 3[#] brick. The observed slag permeation in the aggregate indicates a significant chemical reaction and/or dissolution between slag and Cr_2O_3 . Figure 10 presents the micrographs of the slag-matrix interface for the 1[#]–4[#] refractory bricks.

Figure 10 reveals that the interface between slag and matrix appears relatively clear and residual carbon was observed in the 3[#] brick. The EDS analysis revealed that the white particles in the matrix consist of 100% ZrO_2 . Furthermore, the chemical composition in the slag layer and matrix near the slag-matrix interface was analyzed using EDS and results are presented in Table 5.

Table 5 reveals that the presence of Cr_2O_3 and ZrO_2 in the slag layer was observed, and their chemical composition was also found in the matrix. These findings indicate a chemical reaction between slag and matrix. Furthermore, the relatively high content of Fe_2O_3 in the matrix suggests that iron oxide from slag has permeated into the matrix and reacted with Cr_2O_3 in a reducing atmosphere to form a spinel solution^[18]. Typically, the Cr_2O_3 content in the matrix of the initial high chromia refractory brick is around 76%.

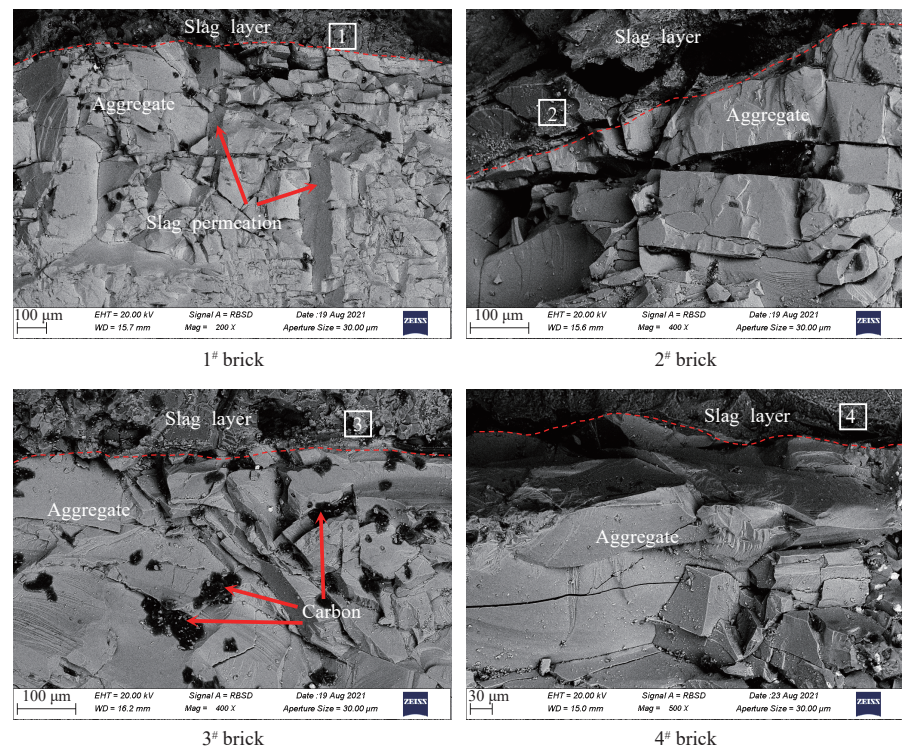


Fig. 9 Microstructure analysis of the slag-aggregate interface for 1[#]–4[#] corroded refractory bricks

Table 4 Chemical composition of slag near the slag-aggregate interface

No.	Content w/%									
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	TiO ₂	Cr ₂ O ₃	ZrO ₂
1	37.85	17.52	13.27	12.51	1.46	2.37	7.14	0.58	5.65	1.67
2	34.58	19.23	2.47	16.5	0.07	3.55	5.66	0.24	17.05	0.65
3	37.56	8.00	9.01	35.96	3.36	0.16	3.11	0	1.18	1.66
4	45.66	16.79	12.04	17.53	1.76	1.33	0.94	1.21	1.31	1.41

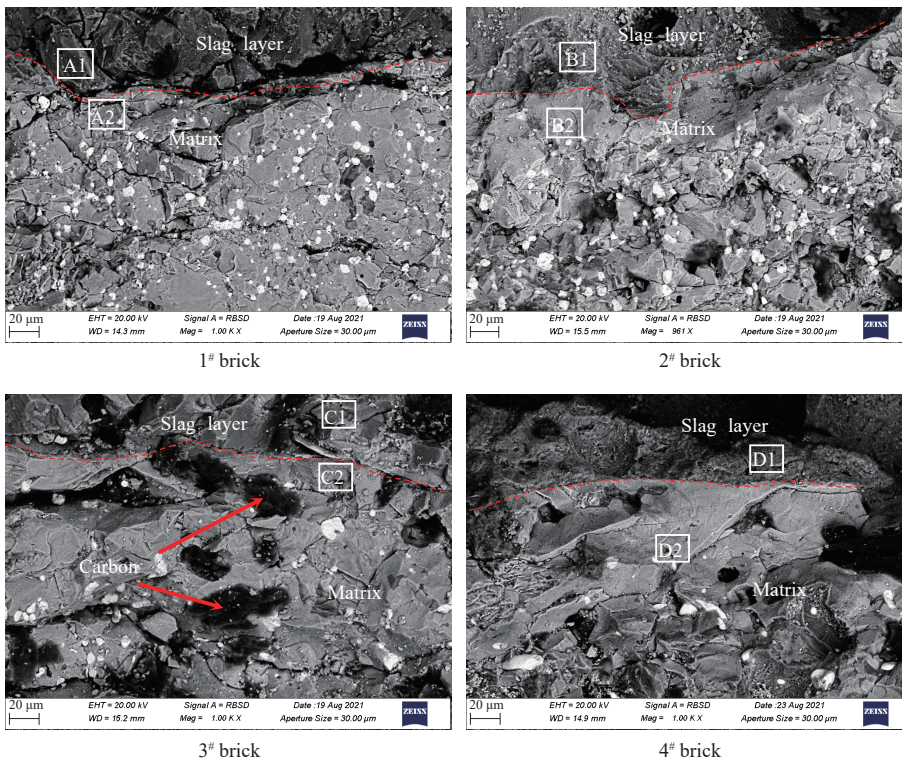


Fig. 10 Microstructure analysis of the slag-matrix interface for 1[#]–4[#] corroded refractory bricks

Table 5 Chemical composition in the slag layer and matrix near the slag-matrix interface for 1[#]–4[#] refractory bricks

No.	Content w/%									
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	K ₂ O	Na ₂ O	TiO ₂	Cr ₂ O ₃	ZrO ₂
A1	37.12	15.47	10.46	21.36	7.39	0.12	0.6	0.93	5.46	1.1
A2	0.27	8.05	18.64	0.72	6.66	0.09	0.29	0	55.77	9.52
B1	44.7	16.07	3.92	14.57	0.86	1.34	2.59	0.84	12.91	2.21
B2	0.88	10.47	26.97	0.48	4.44	0.08	0.55	0.22	55.9	0
C1	32.72	7.66	15.83	28.03	2.7	0.15	7.49	0.42	2.75	2.26
C2	0.86	9.4	9.92	0.79	1.62	0.33	8.07	0.33	62.36	6.32
D1	45.46	16.02	12.17	13.87	2.35	2.76	1.69	0.84	2.62	2.19
D2	5.15	9.81	17.19	1.52	3.5	0.35	0.88	0.08	59.18	2.35

However, in Table 5, a noticeable decrease in the Cr₂O₃ content in the matrix compared to the initial high chromia brick is evident. After analyzing the slag-aggregate interface and the slag-matrix interface, it became evident that the reduction of Cr₂O₃ content is the initial sign of high chromia refractory damage. Figure 11 shows the schematic of high chromia refractory damage mechanism.

As shown in Figure 11, the damage mechanism of refractory brick in the slag tapping hole of the gasifier suggests that the matrix and aggregate of high chromia

refractory are primarily affected due to the reduction of Cr₂O₃ content. This allows the slag penetrates the interior of the refractory brick and form new substances, ultimately resulting in damage caused by difference in thermal expansion between the new substances and the refractory brick. It is imperative to focus on preventing the reduction of Cr₂O₃ content to improve the service life of refractory brick in the slag tapping hole of the gasifier. It is crucial to dedicate more effort to this area in the future.

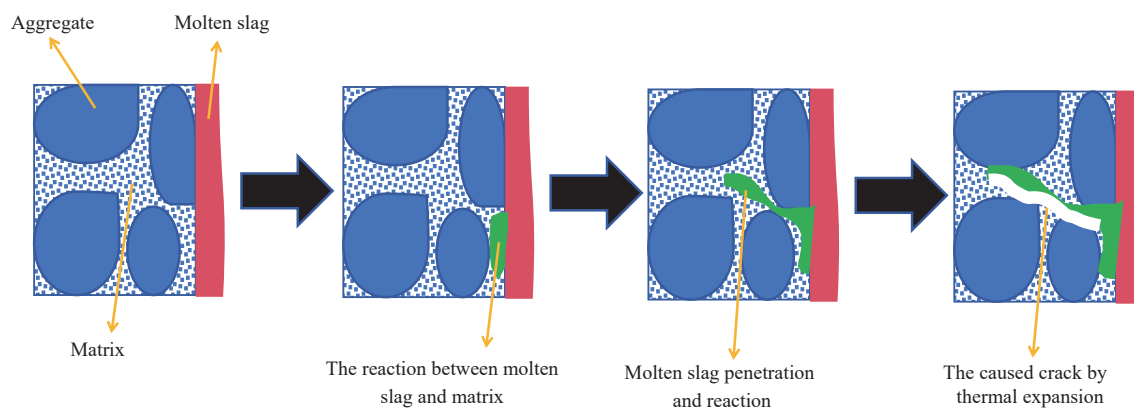


Fig. 11 The schematic of high chromia refractory damage mechanism

3 Conclusion

This study examined the damage mechanism of high chromia refractory in four commercial coal-water slurry gasifiers. Coal samples used for gasification and the corroded refractory bricks in the slag tapping hole of the gasifier were analyzed to understand the damage mechanism. The slag characteristic of coal samples, including crystallization and viscosity-temperature of four gasification coal samples were investigated. The interior morphology of the corroded refractory bricks and the interface between slag and refractory brick were analyzed. The main conclusions were as follows:

The low-viscosity slag causes more severe damage to refractory bricks, suggesting that the safe slag tapping temperature range should be set as $t_{ICT}-t_{2.5}$ when t_{ICT} is higher than t_{25} .

Cracks were observed in the interior of all corroded refractory bricks, primarily due to the molten slag

penetration and the reaction between molten slag and refractory material. The difference in thermal expansion between the new substances formed by the reaction and refractory material plays a vital role in these crack formations.

The reduction of Cr₂O₃ content is the earliest characteristic of high chromia refractory damage, as shown by the slag-aggregate and slag-matrix interface analysis results. Early detection or prevention of this reduction is vital to further damage.

Declaration of Competing Interest

The authors declare no conflict of interest.

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工业气流床气化炉渣口高铬砖损毁机理研究

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摘要: 气化炉渣口砖寿命是影响气化炉长周期稳定运行的关键。通过对四台工业水煤浆气化炉损毁的渣口砖和其对应

的气化煤特性进行分析,研究了气化炉渣口砖的损毁机理。对四种气化煤样品的炉渣特性,包括结晶和黏温的研究表明,低黏度炉渣会对耐火砖造成更严重的损坏。基于炉渣结晶的风险考虑,建议当 T_{ICT} (初始结晶温度) 高于 T_{25} 时,应将 T_{ICT} — T_{25} 设定为安全排渣的温度范围。而对所有侵蚀耐火砖的内部形态分析均发现了裂缝,采用 SEM-EDS 和 XRD 对损毁渣口砖剖面裂缝形态分析结果表明,渣口砖内部裂缝出现的原因主要是熔渣的渗透并与耐火材料反应生成新物质,由于该新物质与耐火材料热膨胀的差异导致裂缝的产生。通过对渣-骨料界面和渣-基质界面的分析结果表明,耐火材料中铬含量的减少是耐火砖被损毁的初始特征。基于此提出一种耐火砖损毁机理,即由于 Cr_2O_3 含量降低,高铬耐火材料的基质和骨料首先会遭到破坏,熔渣会渗透到耐火砖内部与耐火材料反应形成新的物质。由于新物质与耐火砖之间的热膨胀差异从而导致耐火砖内部开裂损毁。因此,理解和如何阻止耐火砖中铬含量的减少是延长耐火砖寿命的关键手段。

关键词: 气化炉; 高铬砖; 渣口; 熔渣; 损毁

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