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Rice Husk Waste as an Exothermic Material for a Riser Sleeve for Steel Casting

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Abstract. This research examines the suitability of rice husk waste as an exothermic material for a riser sleeve for use in steel casting production.[1] Exothermic sleeves are used in the steel casting process to compensate for shrinkage of the steel during solidification. Commonly, the exothermic sleeve consists of fuel materials, fillers, and binders. Rice husk waste has potential[2] for use as a fuel material in the exothermic sleeve due to its high calorific value. For this study, rice husk waste was ground to gain a particle size of 60 mesh and then mixed with organic binders of 12wt%, 15wt%, and 18wt%. A H-sleeve[3] was then formed by hand pressing, followed by drying. A series of quantitative

tests were carried[4] out to analyze the performance of the rice husk as an exothermic material.[5] These include measurement[6] of modulus extension factor (MEF) and the cooling rate of the steel casting within the liquidus-solidus temperature range. The test results show that the rice husk sleeve mixed with 12wt% of binder extended the solidification time from 273 seconds to up to 511 seconds within the desired temperature range. Furthermore, the best MEF of 1.69 was achieved[7] using the rice husk riser sleeve. This[8] meets the standard MEF value of an exothermic sleeve.

Keywords: Exothermic sleeve; Modulus extension factor; Rice husk; Riser sleeve; Steel casting

Introduction

Exothermic riser sleeves are feeding aids used in steel casting to prevent the molten steel from shrinking during solidification. They perform better than silica sand risers (conventional risers) in increasing feeding efficiency and minimizing the riser size (Brown, 2000; Miki, 2002).[9] One riser sleeve manufacturer reports that the use of an exothermic riser sleeve can enhance the casting yield by 74.47–91.80% (Schäfer, 2011). According to many references (Auderheide et al., 1999; Miki, 2002; Schäfer, 2011), exothermic riser sleeves consist of fuels (i.e., oxidizable metals or exothermic materials), fillers (i.e., sand or metal oxides), and binders (i.e., resin or water glass). In order for[10] an exothermic riser sleeve to produce a high casting yield, certain[11] parameters must be considered, such as the heat resistance of the fuel material in the exothermic sleeve, which should readily ignite at 600oC (Williams et al., 2015; Dafiqurrohman et al., 2016); the density of the exothermic sleeve, which should be low as porosity produces higher insulation

(Miki, 2002); and the ash content after the material is burned[12] (Rao, 2013). These properties are required to keep the retardation of temperature fall during steel

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solidification[14]. In our previous studies (Idamayanti et al., 2015; Purwadi et al., 2016), we investigated an exothermic riser sleeve manufactured from aluminium[15] slag and red mud waste. The results of these studies confirmed that the synergy of these materials resulted in excellent characteristics due to their exothermic and insulating behavior.

However, our previous studies revealed several problems, including limited raw materials and a complicated sleeve fabrication process. To solve these problems[16], substitute materials were studied based on their thermal properties. One study reported on an experiment in which[17] rice husk was used as the primary material to produce a top riser sleeve to prevent heat loss from the mold (Rao, 2013). This[18] showed the potential of rice husk for use in a riser sleeve. Currently, rice husk is not widely used[19] in the foundry industry, despite its abundance as biomass waste in Indonesia (Gibran et al., 2018)[20]. It is a source

of renewable energy and, due to its high calorific value (Lim et al., 2012), is promising as an exothermic material. Thus, this study aimed to utilize rice husk waste as a material for an exothermic riser sleeve. Rice husk has a remarkably higher heating value (15.84 MJ/kg) (Lim et al., 2012) than commercial exothermic sleeves (250–850 kJ/kg) (Williams et al., 2015). Burned rice husk produces combustion residues that contain SiO2 (91.42%), K2O (3.71%), CaO (3.21%), Al2O3 (0.78%), and small amounts of other metal oxides (Maiti et al., 2006), all of which can act as insulators. As well as being affordable and having slow oxidation properties, rice husk is one of the carbonaceous materials with anti-piping characteristics (Rao, 2013). Based on previous studies, it can be concluded [21] that rice husk is a potential material for exothermic sleeves with its excellent physical properties (Maiti et al., 2006), effective [22] insulating potential due to the amorphous structure of residual silica, and the high porosity of its ash residues (Wang et al., 2016a); (Tiwari and Pradhan, 2017). [23] It is easy to form into briquettes with a low binder of 2–4% (Maiti et al., 2006) and is an eco-friendly product with very low emissions (Unrean et al., 2018).
Hence, this research focuses on the use of [24] rice husk waste as an exothermic material for a riser sleeve in steel casting. Its suitability as a riser sleeve was determined quantitatively by testing the modulus extension factor (MEF) and measuring the cooling rate to observe the thermal behavior of the rice husk sleeve. [25] Furthermore, the simulation was calculated [26] to predict its feeding efficiency in steel casting. The physical properties of the rice husk sleeve, such as its bulk density and compressive strength, were also investigated.

Methods

Materials

The rice husk sleeve was formed[27] by mixing rice husk waste, collected from a local rice mill, with acetate polymer, which is[28] an organic binder made of technical grade material. To identify the performance of the rice husk sleeve in the feeding system, GX60Cr15, a high[29] alloy steel, was selected. An elemental[30] analysis of the GX60Cr15 alloy was conducted[31] using an optical emission spectrometer (OES, research grade[32] ARL 4360). The results are shown[33] in Table 1. The rice husk particles were prepared by milling and sieving to reduce and homogenize the size of the rice husk feedstock to within a range of 40 to 60 mesh.[34] The higher heat value (HHV) of rice husk waste and a commercial sleeve (KALMINEX 2000) were measured using a bomb calorimeter and are shown[35] in Table 2.

Table 1 Elemental analysis of GX60Cr15

Elements	%
C	0.638
Cr	14.925
Mn	0.618
Si	1.018
Mo	0.125

Ni

2.588

V

0.060

P

0.025

Fe

balance

Table 2 Higher heat value (HHV) of materials

Materials

HHV (MJ/kg)

Rice husk

15.3

KALMINEX 2000

11.3

Fabrication of Rice Husk Sleeve

The rice husk was mixed homogeneously with various amount[36] of organic binder: 12%wt, 15%wt, and 18%wt. The mixture was molded and compacted by manual (hand) pressing to form a cylinder sleeve (H-sleeve type), as shown in Figure 1.

Figure 1 Rice husk sleeve

The sleeve dimensions used for the observation were 80 mm in diameter,[37] 15 mm in thickness, and 80 mm in height, with the modulus of the sleeve set accordingly to 1.38 cm.[38] The last step was to dry the sleeve[39] at 110oC for 1 hour.

Rice Husk Sleeve Characterizations

Characterizations were performed[40] to identify the quality of the sleeve. Several characteristics of the rice husk sleeve were determined by referring to the standard specifications of IS 15865:2009 (The Foundry and Steel Castings Sectional Committee, 2009).

Compressive strength

The compressive strength of a sleeve should be 5.0 kg/cm2 or higher. The whole sleeve was tested in compression mode until it fractured. The compressive strength was obtained by dividing the highest[41] load of the sleeve by its average cross-sectional area. The compressive strength not only indicates the sleeve's resistance against the compressive[42] load,[43] but also other properties associated with this load type, such as formability and stability during storage. The compressive strength was also used[44] to determine the minimum binder content.

Bulk density

The bulk density of the sleeve was obtained by dividing the weight of the sleeve[4] by its volume. The bulk density of the rice husk sleeve was in the range of 0.3–0.4 g/cm3. The degree of porosity, which is related to the bulk density of the sleeve,[46] increases its insulation.

Cooling rate measurement

A thermocouple was installed in the center of the sleeve and attached to a data logger, which recorded the cooling temperature for 30 minutes.[47] The experimental layout is illustrated [48] in Figure 2. The data recording was carried [49] out during the liquid state of the material ranging, from the pouring temperature to the liquidus temperature of GX60Cr15 (1340oC), which was then established [50] as a working temperature range of the sleeve.

The solidification temperature of GX60Cr15 casting was measured for both the rice husk sleeve and the sand riser, while the KALMINEX sleeve was used [51] as a reference sleeve.

(a)

(b)

Figure 2 The layout for temperature measurement: (a) cross-section view; (b) top view

Modulus extension factor (MEF)

The ratio of a sand riser modulus to the sleeve modulus at the same retardation time is expressed [52] as the MEF. The recommended MEF values by size are shown [5] in Table 3 (The Foundry and Steel Castings Sectional Committee, 2009).

Table 3 The MEF criteria of a sleeve

Minimum MEF

Exothermic

and insulating sleeves

Insulating sleeve

Up to 150 mm [54] diameter [37]

1.60

1.45

160 to 225 mm[55] diameter

1.45

1.30

250 to 300 mm[56] diameter

1.40

1.30

325 to 400 mm[57] diameter

1.30

1.20

425 to 500 mm[58] diameter

1.30

1.20

525 mm and above

1.30

1.20

Results and Discussion

Rice Husk as the Main Material of the Sleeve

Table 2 shows that the rice husk released heat energy to up to 15.3 MJ/kg. When the rice husk was applied[59] as a riser sleeve, it resembled a pyrolysis reaction which burned at

250–600oC (Wang et al., 2016a). The reaction continued while the molten steel (approximately 1500oC) was poured, which led to the release of a considerable amount of heat and a subsequent extension of the solidification time.[60] The first stage of the exothermic reaction in common[61,62] biomass is hemicellulose decomposition, which released 40–280 kJ/kg of energy (Bates et al., 2013). The pyrolysis of rice husk, represented by the reaction scheme in Equation 1, is a thermochemical decomposition in which biomass organics are heated[63] at high temperatures in the absence of oxygen and, therefore, decompose into solid[64] carbon and volatile matter (Wang et al., 2016b; Quispe et al., 2017).

Rice husk à solid residue + volatile and gas (Said et al., 2014) (1)

The temperature of the pyrolysis process influences the pyrolysis product. At 1200oC or higher, the mass fraction of pyrolysis gas (volatile matter) is higher than that of rice husk char and tar (Wang et al., 2016b). Xinyu Wang et al. concluded that pyrolysis gas is mostly released[65] within 6 minutes (Wang et al., 2016b). The higher the temperature, the more gas is produced. Furthermore, CH4 and CO gases are predominantly formed[66] when rice husk sleeve is in direct contact with molten steel at 1500oC.
Furthermore, a[67] previous study reported the measurement of the heat released during rice husk degradation (pyrolysis) using differential scanning calorimetry (Said et al., 2014). The results showed that there are[68] several steps or zones in the pyrolysis of rice husk, namely the decomposition zone, the drying zone, the devolatilizing[69] zone, and the char degradation zone. In the drying zone, the amount of heat absorbed by moisture is 161.5 kJ/kg, which is[70] known as the endothermic process. In the devolatilizing[71] zone[72], the released energy is 4437 kJ/kg, and in the char degradation zone, the energy absorbed is 313 kJ/kg (Said et al., 2014). The total energy involved in the pyrolysis of rice husk is determined[73] as enthalpy decomposition energy (which is confirmed[74] as the

heating value).[75] The mechanism of thermal degradation of rice husk has been thoroughly investigated and proves[76] that rice husk has significant potential for use as the primary material in exothermic sleeves with a heat value that is higher than that of commercial sleeves.[77]

Characterization of the Rice Husk Sleeve

Compression strength

Based on IS 15865:2009, the compression strength should be 5.0 kg/cm2 or higher and, for that purpose, is controlled by adjusting the binder content. This study uses acetate polymer binder to bind the rice husk particles in various mass fractions of 12wt%, 15wt%, and 18wt%. As[78] Figure 3 shows, the rice husk sleeve had a compression strength of 6.67 kg/cm2, 11.02 kg/cm2, and 16.26 kg/cm2, respectively. Subsequently, the rice husk sleeve was formed[79] using a binder content of 12wt%, 15wt%, and 18wt%. The higher the binder content, the better the formability of the sleeve.

Figure 3 The compressive strength of the rice husk sleeve

Thermal Behavior of the Rice Husk Sleeve

The effectiveness of an exothermic sleeve is determined[80] by the duration necessary for the sleeve[81] to retard the solidification of the steel in the riser. Furthermore, heat[82] released by the exothermic reaction can delay the formation of a solid shell in the early stages of steel solidification (Midea et al., 2007). The burning of the sleeve involves several stages[83] take: ignition, combustion, time to reach maximum temperature, and insulation.

The temperature of the GX60Cr15 casting was measured over 30 minutes. As shown in Figure 4, the ideal temperature range of rice husk sleeve was determined[84] as 1340oC (liquidus temperature) or above.

Liquidus temperature

Figure 4 Cooling rate of GX60Cr15 solidification using the rice husk sleeve expressed as a function of binder content

The rice husk sleeve performed best with a binder content of 12%wt as it maintained the temperature of molten metal above 1340oC for up to 511 seconds. The binder content of 15%wt and 18%wt kept the molten steel above liquidus temperature for 409 seconds and 237 seconds, respectively. These results indicate that the binder content has a significant influence on temperature retardation as shown it determines the amount of rice[85]

husk[86] ash that forms after the burning process, which contributes to the insulating effect. The lower the binder content of a sleeve, the more rice husk ash formed. The characteristics of rice husk ash include good[87] refractoriness (which depends primarily on its alkali oxides content), high porosity, light weight[88] and[89] bulkiness (Kapur, 1980). The porosity of the rice husk sleeve enhances its insulating capability (Kaviany, 1995) to prevent heat loss and prolong the solidification time, as illustrated in Figure 5. This[90] is because the porosity of the sleeve is related to its compression strength. For example, a compression[91] strength of 16 kg/cm2 resulted from a porosity[92] of 68% (Kapur, 1980).

Figure 5 Illustration of porous silica net formation as a result of burning the rice husk sleeve

Table 4 The modulus of sand riser and sleeve in relation to[93] retardation time

Sand riser Dimensions Diameter[37] (⌀) mm,

Height (H) mm

Volume (mm3) Heat releasing

area (mm2)

Modulus, cm

Retardation time, s

Modulus extension factor (MEF)

= sand/sleeve

⌀80 mm, H 80 mm

444 / 32.2

1.38

215

⌀90 mm, H 90 mm

625 / 40.5

1.54

278

⌀100 mm, H 100 mm

867 / 50.4

1.72

342

ø110 mm 110 mm

1.164 / 61.3

1.90

409

ø130 mm 120 mm

1.592 / 755

2.1

436

ø140 mm, 140 mm

2.155 / 923

2.33

454

ø140 mm, 150 mm

2.474 / 1.013

2.44

527

Rice husk sleeve binder 12%wt

443.677 / 32.2

1.38

511

2.33/1.38 = 1.69

Rice husk sleeve binder 15%wt

443.677 / 32.2

1.38

409

1.90 /1.38 =1.46

Rice husk sleeve binder 18%wt

443.677 / 32.2

1.38

237

1.54 / 1.38 = 1.12

KALMINEX 2000

443.677 / 32.2

1.38

579

2.44 / 1.38 = 1.77

The performance of an exothermic sleeve is also quantified [94] by measuring the MEF, which represents the increase in the modulus of the riser (Rao, 2013). The higher the MEF value, the smaller the dimensions of the sleeve. The MEF calculation is presented [95] in Table 4, where the standard modulus of a sand riser is determined [96] as 1.38. As Figure 6 demonstrates, the binder content influenced the MEF results. A binder content of 12wt %, 15wt%,[97] and 18wt% produced MEF values of 1.12, 1.38, and 1.69, respectively. With a binder content of 12wt%, the rice husk sleeve has an MEF[98] value close to that of a commercial sleeve[99] (KALMINEX 2000) and can, therefore,[100] be classified[10] as an exothermic sleeve.

Figure 6 Modulus extension factor of the sleeves

The feeding efficiency of the rice husk sleeve can be simulated[102] by taking a binder content of 12wt% and an MEF[103] value of 1.69 and following the calculation steps in Equations 2 to 4 below (The Foundry and Steel Castings Sectional Committee, 2009).

Modulus of the sleeve (Ms) = (D x H) / (D+4H) (2)

Equivalent modulus of the sand riser (Msr) = MEFsleeve Ms (3)

Feeding efficiency of rice husk sleeve = (Vsr / Vs) x100% (4)

First, the modulus of the sleeve (Ms) is calculated[104] using Equation 2, where D (diameter)[37] is 8 cm, and H (height) is 8 cm. The Ms obtained is 1.6 cm and the[105] Msr[106] is 2.704 cm. The real volume of the sand riser (Vsr) is 1940 cm3 and[107] the volume[108] of the sleeve (Vs) is 401.92 cm3. Assuming that the sand riser efficiency is 14%, the molten steel supplies 271.60 cm3. Thus, the feeding efficiency of the rice husk sleeve based on the previous equations is 67.58%. Therefore, by using the rice husk sleeve as a riser, the feeding efficiency can be increased to 67.58%.

Conclusions

Rice husk waste has significant potential for use as a material for a riser sleeve feeding system in steel casting. The MEF calculation generates an MEF[109] value of

1.69, based on which the rice husk sleeve can be classified[110] as an exothermic sleeve. With a binder content of 12wt%, the rice husk sleeve had good formability, a sufficient[111] compressive strength of 6.9 kg/cm2, and excellent temperature retardation of[112] during GX60Cr15 solidification.[113] The solidification time of molten metal in the rice husk sleeve can be extended[114] to 511 seconds, which is[115] higher than that of the sand riser (215 seconds). Furthermore, the feeding efficiency of the rice husk sleeve can be increased[116] to approximately 67.58%. In terms of compliance, the main characteristics of the rice husk sleeve comply with the standard specifications of IS 15865:2009 for an exothermic sleeve.[117] Hence, the rice husk sleeve is

recommended[118] for use in a feeding system for steel casting, where it has the potential to replace existing commercial exothermic sleeves and enhance the value of rice husk waste.

Acknowledgments

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1.		Intricate Text	Clarity
2.	the potential	Determiner Use (a/an/the/this, etc.)	Correctness
3.	~~A H-sleeve~~ → An H-sleeve	Determiner Use (a/an/the/this, etc.)	Correctness
4.	*were carried*	Passive Voice Misuse	Clarity
5.		Intricate Text	Clarity
6.	the measurement	Determiner Use (a/an/the/this, etc.)	Correctness
7.	*was achieved*	Passive Voice Misuse	Clarity
8.	*This*	Intricate Text	Clarity
9.		Intricate Text	Clarity
10.	~~In order for~~ → For	Wordy Sentences	Clarity
11.	~~certain~~ → specific	Word Choice	Engagement
12.	*is burned*	Passive Voice Misuse	Clarity
13.	~~Idamayanti~~ → Damayanti	Misspelled Words	Correctness
14.	~~solidification~~ → Solidification	Improper Formatting	Correctness
15.	~~aluminium~~ → aluminum	Mixed Dialects of English	Correctness
16.	*To solve these problems*	Misplaced Words or Phrases	Correctness
17.	~~in which~~ → where	Wordy Sentences	Clarity
18.	*This*	Intricate Text	Clarity
19.	*is not widely used*	Passive Voice Misuse	Clarity

20.		Intricate Text	Clarity
21.	*be concluded*	Passive Voice Misuse	Clarity
22.	~~effective~~ → productive	Word Choice	Engagement
23.	*Based on previous studies, it can be concluded that rice husk is a potential material for exothermic sleeves with its excellent physical properties (Maiti et al., 2006), effective insulating potential due to the amorphous structure of residual silica, and the high porosity of its ash residues (Wang...*	Hard-to-read text	Clarity
24.	~~the use of~~	Wordy Sentences	Clarity
25.		Intricate Text	Clarity
26.	*was calculated*	Passive Voice Misuse	Clarity
27.	*was formed*	Passive Voice Misuse	Clarity
28.	~~which is~~	Wordy Sentences	Clarity
29.	~~a~~ high	Determiner Use (a/an/the/this, etc.)	Correctness
30.	~~An~~ elemental	Determiner Use (a/an/the/this, etc.)	Correctness
31.	*was conducted*	Passive Voice Misuse	Clarity
32.	~~research grade~~ → research-grade	Misspelled Words	Correctness
33.	*are shown*	Passive Voice Misuse	Clarity
34.		Intricate Text	Clarity
35.	*are shown*	Passive Voice Misuse	Clarity

36.	~~amount~~ → amounts	Incorrect Noun Number	Correctness
37.	*diameter; Diameter*	Text Inconsistencies	Correctness
38.		Intricate Text	Clarity
39.	~~sleeve~~ → jacket	Word Choice	Engagement
40.	*were performed*	Passive Voice Misuse	Clarity
41.	~~highest~~ → most top	Word Choice	Engagement
42.	compressive.	Closing Punctuation	Correctness
43.	~~load~~ → Load	Improper Formatting	Correctness
44.	*was also used*	Passive Voice Misuse	Clarity
45.	~~sleeve~~ → jacket, envelope	Word Choice	Engagement
46.	~~sleeve~~ → jacket, envelope	Word Choice	Engagement
47.	*A thermocouple was installed in the center of the sleeve and attached to a data logger, which recorded the cooling temperature for 30 minutes.*	Wordy Sentences	Clarity
48.	*is illustrated*	Passive Voice Misuse	Clarity
49.	*was carried*	Passive Voice Misuse	Clarity
50.	*was then established*	Passive Voice Misuse	Clarity
51.	*was used*	Passive Voice Misuse	Clarity
52.	*is expressed*	Passive Voice Misuse	Clarity
53.	*are shown*	Passive Voice Misuse	Clarity
54.	mm in	Wrong or Missing Prepositions	Correctness
55.	mm in	Wrong or Missing Prepositions	Correctness

56.	mm in	Wrong or Missing Prepositions	Correctness
57.	mm in	Wrong or Missing Prepositions	Correctness
58.	mm in	Wrong or Missing Prepositions	Correctness
59.	*was applied*	Passive Voice Misuse	Clarity
60.	*The reaction continued while the molten steel (approximately 1500oC) was poured, which led to the release of a considerable amount of heat and a subsequent extension of the solidification time.*	Wordy Sentences	Clarity
61.	~~common~~ → conventional, collective	Word Choice	Engagement
62.	~~common~~ → traditional	Word Choice	Engagement
63.	*are heated*	Passive Voice Misuse	Clarity
64.	~~solid~~ → stable	Word Choice	Engagement
65.	*is mostly released*	Passive Voice Misuse	Clarity
66.	*are predominantly formed*	Passive Voice Misuse	Clarity
67.	~~Furthermore, a~~ → A	Wordy Sentences	Clarity
68.	~~that there are~~	Wordy Sentences	Clarity
69.	*devolatilizing*	Unknown Words	Correctness
70.	~~which is~~	Wordy Sentences	Clarity
71.	*devolatilizing*	Unknown Words	Correctness
72.	~~zone~~ → region, area	Word Choice	Engagement
73.	*is determined*	Passive Voice Misuse	Clarity

74.	*is confirmed*	Passive Voice Misuse	Clarity
75.		Intricate Text	Clarity
76.	~~and proves~~ → . It proves	Hard-to-read text	Clarity
77.	~~sleeves~~ → envelopes	Word Choice	Engagement
78.	~~As~~	Wordy Sentences	Clarity
79.	*was formed*	Passive Voice Misuse	Clarity
80.	*is determined*	Passive Voice Misuse	Clarity
81.	~~sleeve~~ → jacket, envelope	Word Choice	Engagement
82.	the heat	Determiner Use (a/an/the/this, etc.)	Correctness
83.	~~stages~~ → steps	Word Choice	Engagement
84.	*was determined*	Passive Voice Misuse	Clarity
85.	rice.	Closing Punctuation	Correctness
86.	~~husk~~ → Husk	Improper Formatting	Correctness
87.	~~good~~ → excellent	Word Choice	Engagement
88.	~~light weight~~ → lightweight	Confused Words	Correctness
89.	, and	Comma Misuse within Clauses	Correctness
90.	*This*	Intricate Text	Clarity
91.	~~a~~ compression	Determiner Use (a/an/the/this, etc.)	Correctness
92.	~~a~~ porosity	Determiner Use (a/an/the/this, etc.)	Correctness

93.	~~in relation to~~ → about, to, with, concerning	Wordy Sentences	Clarity
94.	*is also quantified*	Passive Voice Misuse	Clarity
95.	*is presented*	Passive Voice Misuse	Clarity
96.	*is determined*	Passive Voice Misuse	Clarity
97.	%,	Comma Misuse within Clauses	Correctness
98.	~~an MEF~~ → a MEF	Determiner Use (a/an/the/this, etc.)	Correctness
99.	~~sleeve~~ → jacket	Word Choice	Engagement
100.	~~, therefore,~~	Wordy Sentences	Clarity
101.	*be classified*	Passive Voice Misuse	Clarity
102.	*be simulated*	Passive Voice Misuse	Clarity
103.	~~an MEF~~ → a MEF	Determiner Use (a/an/the/this, etc.)	Correctness
104.	*is calculated*	Passive Voice Misuse	Clarity
105.	, and	Punctuation in Compound/Complex Sentences	Correctness
106.	~~the~~ Msr	Determiner Use (a/an/the/this, etc.)	Correctness
107.	, and	Punctuation in Compound/Complex Sentences	Correctness
108.	~~volume~~ → size, amount, bulk, capacity	Word Choice	Engagement
109.	~~an MEF~~ → a MEF	Determiner Use (a/an/the/this, etc.)	Correctness

110.	*be classified*	Passive Voice Misuse	Clarity
111.	~~a~~ sufficient	Determiner Use (a/an/the/this, etc.)	Correctness
112.	~~of~~	Wrong or Missing Prepositions	Correctness
113.	*With a binder content of 12wt%, the rice husk sleeve had good formability, a sufficient compressive strength of 6.9 kg/cm2, and excellent temperature retardation of during GX60Cr15 solidification.*	Hard-to-read text	Clarity
114.	*be extended*	Passive Voice Misuse	Clarity
115.	~~which is~~	Wordy Sentences	Clarity
116.	*be increased*	Passive Voice Misuse	Clarity
117.		Intricate Text	Clarity
118.	~~recommended~~ → Recommended	Improper Formatting	Correctness
119.	~~Auderheide~~ → Aufderheide	Misspelled Words	Correctness
120.	~~an~~ → and	Confused Words	Correctness
121.	~~Kaviany~~ → Kaveny	Misspelled Words	Correctness
122.	~~Unrean~~ → Unreal, Unread	Misspelled Words	Correctness
123.	*A Review on Utilisation of Biomass from Rice Industry as a Source of Renewable Energy.*	A review on utilisation of biomass from rice industry as a ... https://www.sciencedirect.com/science/article/pii/S1364032112001451	Originality
124.	*Energy Potential from Rice Husk through Direct Combustion and Fast Pyrolysis: A Review.*	Energy potential from rice husk through direct combustion ... https://www.sciencedirect.com/science/article/pii/S0956053X1630	Originality

		5517	
125.	*Energy and Exergy Analysis of Rice Husk High-temperature Pyrolysis.*	Energy and exergy analysis of rice husk high-temperature ... https://www.sciencedirect.com/science/article/abs/pii/S0360319916328853	Originality
126.	*Characterization of the Thermophysical Properties of Riser Sleeve Materials and Analysis of Riser Sleeve Performance.*	5.9 Characterization of the Thermophysical Properties of ... http://user.engineering.uiowa.edu/~becker/documents.dir/SFSA/2015-5.9%20Sleeves.pdf	Originality