The Thickness Effect of Exothermic Sleeve Made From Rice Husk on Its Performance as A Riser in Steel Casting

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The Thickness Effect of Exothermic Sleeve Made From Rice Husk on Its Performance as A Riser in Steel Casting

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ABSTRACT

Exothermic sleeves are useful to be applied in the steel foundry for minimizing the size of the riser and increasing its efficiency. This paper describes the effect of the thickness of the exothermic sleeves made of rice husk and the modulus of the riser to the feeding efficiency of riser for the casting of metal. The series of thermal analysis of carbon steel (GS20Mn5) under the conditions of various thicknesses of exothermic sleeve at the same modulus and various geometry modulus of the riser at the same thickness of sleeve were carried out. Direct Thermal analysis of the cooling rate of the riser was conducted for the temperature during the cooling down to the solidus temperature were conducted. Based on the cooling curves, Modulus Extension Factors as an indicator of the effectiveness of the exothermic sleeves were determined and compared. By comparing the cooling rates, it was found that a 25 mm thick sleeve produced the highest MEF value (1.90) for the riser modulus of 1.6 cm and a solidification time of 285 seconds. Riser modulus of 1cm produces MEF value of

1.90, which is higher than the modulus of 1.6 cm and 3 cm at the sleeve thickness of 15mm

Key words : Casting of metal, Exothermic sleeves, modulus the riser, Rice husk,

1. INTRODUCTION

1.1 Feeding

The main problem in the steel foundry industry is the low yield of casting products (under 50% on average) since riser is to be used to compensate for the relatively large shrinkage of around 7% [1]. During the solidification process of liquid metal in the mold, shrinkage may occur in the product due to temperature changes. The liquid metal becomes solid by experiencing three stages of shrinkage, namely liquid shrinkage, crystal shrinkage, and solid shrinkage (solid shrinkage) [2]. Hardin et al. said that increasing the efficiency and modulus of the riser can be done by increasing the solidification time [3], which is understood as the cooling time between pouring temperature and solidification temperature. A sleeve is a material that covers the liquid in the riser and provides longer solidification time so as to provide a liquid supply for the purpose of feeding.

1.2 Potential of rice husk as a sleeve

Based on how it works, the exothermic sleeve must be made of a material that is easily flammable or has exothermic properties when exposed to metal liquid. Materials that have these properties are carbonaceous materials and thermite materials [4]. Carbonaceous materials are organic materials with a very high amount of carbon content. While thermite materials are flammable materials that release an amount of heat in a short time. Based on this, Idamayanti et al. [5] conducted research on the substitution material of exothermic sleeve using rice husk material. This material has a calorific value of 15.3 kJ / gram, which is higher than that of a typical exothermic sleeve with a value of 11.35 kJ / gram [5]. Exothermic rice husk sleeve is able to extend the solidification rate from

215 to 454 seconds. The modulus extension factor (MEF) obtained from exothermic rice husk is

1.69. This value meets the minimum requirement of MEF

value based on Indian Standard IS 15865: 2009, which is 1.60 [6]. Idamayanti [60] et al [61] [5] showed that the Modulus Extension Factor (MEF) value of the rice husk sleeve was still below the MEF value of the primarily produced exothermic sleeve

Rice husk is an abundant amount of biomass in an agrarian country. Biomass itself is a kind of material derived from living things that can be [62] renewed in a relatively short time [7]. As biomass, rice husk has a huge hydrocarbon content of around 44%, as shown in Table 1 [8]. The hydrocarbon content can furthermore be used as fuel to provide the required heat. The higher the carbon content of a material, the more energy (heat) the material can produce. Rice husk has a fuel value of around 3000-3600 Kcal/kg, Fuel [63] value is the number of calories that is produced by the material.

This level of fuel value enables rice husk to be defined [64] as exothermic material [9]. The refractory nature of rice husks

depends [65] on their alkaline oxide content. But [66] normally [67] it [68] can withstand temperatures up to 1600°C. Rice husks are porous and lightweight, with a bulk density of around 210-300 kg / m3 [9].

Table 1 :[69] Elemental Test Results on Rice Husk [8]

LOI

Element, % s

Carbon

(organic)

N

Fe

Al

Mg

Si

K

38.69

0.67

0.0055

0.0070

0.051

6.82

0.36

1.3 Thermophysical calculation

According to Joseph Black[70] theory, if there is a mixing of two substances, the amount of heat released by the substance with higher temperature is equal to the amount of heat received by the substance with lower temperature [10]. Since casting processes to deal with higher temperatures, the amount of the heat energy produced is proportional to the mass of the sleeve and its[71] specific heat.[72] Differences in the[73] size of the sleeve caused dissimilarity subsequently in the mass of liquid metal, which at the end will affect the amount of energy received by the sleeve itself. This will also affect the cooling/solidification rate that occurs in the casting process. The cooling rate is defined as the function of heat absorbed or released by objects against other surrounding objects that have differences in temperature with time [11]. The greater heat received by the sleeve will affect the duration of the cooling process.

The geometry modulus of the riser, as well as of casting, is used to determine the location of the riser in the casting design. Modulus is a function of the solidification rate of an object and is defined as the volume (V) of the object divided by the area of the heat releasing section (A). When the modulus of the object is getting bigger, more liquid metal is available so that the cooling/solidification process takes longer. Based on this, the greater the modulus, the slower the cooling [12]. According to its thermal properties, the sleeve is divided into 3 types: exothermic, insulating, and exothermic-insulating sleeve [2].

Sleeve thickness is one of the factors that greatly affect the performance of the sleeve. The use of sleeves with a thickness of 15% of the diameter of the riser and the use of hot toppings on the top of riser produce a flat shrinkage form [12]. The increased efficiency of the riser is caused by the slowing down of the cooling rate due to the higher thickness of the sleeve.

1.4 Characterization

Modulus extension factor (MEF) is the ratio of the geometrical modulus of the sand riser and the geometric modulus of the sleeved riser [6] so that the sleeved riser is considered[114] to have the same modulus as the sand riser modulus. The thickness and modulus of the exothermic sleeve have a great[115] influence on the MEF value of the sleeve, which is normally[116] assessed based on the solidification rate of the riser [6].[117]

Therefore this[118] research was[119] conducted[120] by[121] [122] measuring and[123] analyzing the solidification rate of the riser sleeve[124] and calculating MEF at various modulus and thickness.[125] The effects of these on the thermophysical properties of the exotherm sleeves are then to be observed.[126]

1.5 Research aim

377 This study is aimed[127] to analyze the effect of different modulus and thickness on the thermophysical properties of the rice husk exothermic sleeve and to produce a rice husk exothermic sleeve that meets[128] the sleeve standard specifications of the Indian standard [6].[129]

2. 2. DESIGN OF EXPERIMENT

2.1 Sleeve material and casting material

Sleeve in this study has a composition of 60 mesh rice husk as much as[130] 89%, 11% of polyvinyl acetate as a binder, and methanol as much as 180% of the amount of polyvinyl acetate.[131] Methanol is used[132] as thinner[133] for the polyvinyl acetate. When methanol is mixed[134] with polyvinyl acetate, this polymer will stabilize and form a surfactant, which act[135] as an active substance on the surface of the solution, so that it will adsorb strongly at the liquid and air interface [13].[136] The material used in this study is GS30Mn5.

2.2 Sleeve shape and dimension

This study uses a tubular sleeve with 3 [137] modulus variations, which are [138] 1 cm, 1.6 cm, and 3 cm, with a height and diameter ratio of [139] 1: 1. Based on the [140] [141] IS 15865:2009 [6], the riser diameter (D) is five times the modulus (M). Then the diameter of the sleeve for MEF testing is 50mm, 80mm, and

150mm.

To determine the effect of the thickness of the exthermic [143] sleeve on the riser, an experiment with two variations of thickness of 15 mm and 25 mm on a riser with a modulus of [142]

1.6 cm was also carried out (Figure 1).

Figure 1: The exothermic sleeve of modulus 1.6 with 2 [144] a thickness of 15mm and 25 mm

2.3 Casting

The liquid GS 30 Mn 5 steel was poured [145] at a temperature of

1600oC ± 20oC into the alcaly [146] phenolic mold. Prior to [147] the pouring exothermic sleeves were inserted into the mold. To ensure uniform [148] condition of each trial gating system, as shown in Figure 2, is used. Rice husk is compacted to produce the desired tubular shape [149] and dimension with [150] [151] a constant bulk density of 0.60195 gr.cm-3.

To determine the solidus temperature of the material, [152] the Fe-Fe 33C phase diagram is used [153]. Since GS30Mn5 steel material is classified [154] as low alloy steel, a carbon equivalent (CE) value is applied[155] in the phase diagram instead of just carbon content.[156] Following is the formula determining the[157] value of CE [16].

Figure 2 :[158] Gating system of casting

2.4 Characterization

To analyze the results of this study,[159,160] calculation of modulus extension factor (MEF) and Feeding Safety Margin (FSM) is used.[161]

A. Determination of Modulus Extension Factor (MEF) Modulus extension factor (MEF) is the effective ratio of the sand riser and riser sleeve. MEF values are determined[162] by comparing the modulus of the sleeved riser with the modulus of the sand riser by using the solidification rate [6, 12].[163] If a riser with an exothermic sleeve that has a geometry modulus of A cm demonstrates the same cooling rate as a sand riser that has a geometry modulus of B cm, then MEF is determined as the B / A ratio.[164] MEF value is calculated[165] by comparing the solidification rate[166] on[167] the riser[168] sleeve[169] and[170] sand[171] riser[172] as[173] [174,175] described in the Indian Standard.

Simplified[176] procedure to determine the MEF value, as suggested by Ignaszak and Prunier, was conducted [14]. The first step is to measure the solidification rate of the rice husk riser sleeve. Temperature measurement is carried out in the range between the pouring temperature and solidus temperature of the material[177] so[178] that the[179] delay time of the solidification can be observed[180]. The temperature detection and measurement were carried out directly on the riser sleeve by using a data logger and thermocouple type R. The measurement position shown in Figure 3 refers to William's research [15].

The solidification rate of the sand riser is obtained through a casting simulation using the SolidCast 8.2.5 application, whereby the data of temperatures was retrieved[181] from the thermocouples, which was positioned[182] as shown in Figure 3.[183]

Figure 3 :[184] Measuring temperature at the riser

Based on the composition of the material that has been determined bu[185] applying Optical Emission Spectrometry (OES), the CE value of 0.69% was obtained[186]. According to Fe-Fe3C[187] diagram and the formula derived by Miettinen and Howe, the liquidus temperature is therefore 1490°C, and solidus temperature is 1400°C [17].

B. Feeding efficiency of a plate casting (plate test) Volumetric feed[188] efficiency of[189] [190] a[191] sleeve is defined[192] [193,194] as[195] the[196] percentage of maximum feed metal transferred to the casting during its solidification at the same level of feed safety margin as found in a sand riser of given dimensions mounted on the same casting. The feed efficiency is obtained[197] by calculating the percentage of feed metal supplied to the casting relative to a sand riser [6].[198]

Feed safety margin (FSM) is the safe limit for liquid supply from a riser to casting. FSM is measured based on the distance between the lowest shrink surface of a riser to the bottom of the riser.[199] FSM value is determined[200] by applying a cube test [6].

3. RESULTS AND DISCUSSION

3.1 Determination Modulus Extension Factor (MEF)

MEF values were obtained[201] by analyzing the solidification/cooling rate of the sleeved riser and sand riser. The following are the MEF values on various thickness and modulus.

A. Determination Modulus Extension Factor (MEF) at various thickness

The solidification rate test was carried out on various thicknesses of the sleeve[2] on the riser with a diameter of 80 mm (modulus 1.6 cm). The cooling rate of GS30Mn5 steel was also observed[203] for the sleeve thickness of 15 mm and 25 mm. Figure 4 confirms that the thickness of the sleeve affects the cooling rate of the metal, where the sleeve with a thickness[204,205]

of[206,207] 25 mm has a temperature retarding time longer than a sleeve with a thickness of 15 mm and a sand riser.

The considered working area of a riser is above the solidus line. Therefore the determination of the riser modulus is done by measuring the solidification time of the material up to its solidus point.[208]

The heat produced by each sleeve is determined[209] by its mass and can be calculated[210] as follows[211]

Table 2 and Figure 4. Temperature retarding time of riser sleeve up to solidus point. Show the difference in holding time up to the solidus point (freezing time) for each variation. A

sleeve with a thickness of 25 mm has the largest [212] working area note : of 285 seconds, a sleeve with a thickness of 15 mm 188 seconds, and a sand riser of 21 seconds.

Both types of the sleeve [213] have a much larger working area compared to the sand riser, which proves that sleeved [214] riser [215]

▯

Q = Heat (Joule)

m = Mass of sleeve (kg)

c = Specific heat of rice husk

(Joule/Kg.K) = 1690,71 J/Kg [18]

ΔT = Temperature difference (oC)

can [216] perform longer feeding time and more supply of fluid than a sand riser [12].

Figure 4 described the cooling rates of the sand riser [217], riser sleeve with a thickness of 15 mm and 25 mm. Riser sleeves with a thickness of 15 mm indicate a considerably constant temperature during the cooling process at the temperature of

1460 ° C for up to 120 seconds. Riser sleeve with a thickness of 25 mm experiences a significant increase in temperature from the pouring temperature to a temperature of 1610 ° C, and then[218] it will be followed by a constant decrease starting from 120th second. The graph shows[219] that the heat[220] rate is proportional to the change in temperature with time. It can be seen[221] that riser[222] sleeve with a thickness of 15 mm has a lower cooling rate compared to[223] riser[224] sleeve with a thickness of 25 mm by 1/5 times. 15 mm riser can be considered as slightly better at releasing heat compared to the 25 mm riser. The amount of heat supply is very influential on the temperature of the material. The variation of thickness causes, therefore, a change of[225] the cooling rate of GS30Mn5. Sleeve[226] with a thickness of 25 mm has a mass of 450 grams, and a sleeve thick 15 has a mass of 235 grams.

Figure 4 :[227] Temperature retarding time of riser sleeve up to solidius point

Table 2 :[228] Ratio sleeve mass to mass of liquid metal

No.	Type of Riser	Solidification time
1	Sand riser	21 seconds
2	Riser with 15mm thick sleeve	190 seconds
3	Riser with 25mm thick sleeve	285 seconds

Based on the above calculations, the amount of heat produced by a sleeve of 25 mm thick is 159,77 J while[229] a sleeve of 15 mm thick produces only 23,84 J.[230] The temperature of GS30Mn5 steel in the sleeved riser with a sleeve thickness of 25 has a higher increase compared to[231] the sleeved riser with a sleeve thickness of 15 mm. During the cooling process of the GS30Mn5, which is[232] wrapped[233] with[234] a 25 mm thick sleeve[236,237] receives a very large[238] amount of heat energy so that the cooling process will be longer though the relatively similar heat rate. MEF is obtained[239,240] from[241] the[242] ratio of[243] the[244] solidification rate[245] between the sleeved riser and sand riser. Table 3 presents the sand riser solidification time data,[246] as resulted from the SolidCast 8.2.5 software simulation.

No.

Diameter (mm)

Modulus (cm)

Solidication[247] time (s)

1

80

1.6

21

2

136

2.72

163

3

140

2.8

196

4

152

3.04

255

5

156

3.12

271

6

160

3.2

317

The solidification time required for the material to reach the solidus temperature by the 15 mm thick sleeve (196 seconds) is relatively similar to those of the 140 mm sand riser (190 seconds). Since the riser of 25 mm thick sleeve is associated with a greater[248] supply of heat compared to a riser with 15 mm thick sleeve,[249] in the[250] term of[251] solidification time,[252] it is[253] only comparable with a sand riser of 152 mm diameter (Table 4).

Table 3 :[254] Solidification time of sand riser

Table 4 :[255] Solidification time of riser with 15 mm thick sleeve, the sand riser of 140 mm diameter, riser with 125 mm thick sleeve
and sand riser of 156 mm diameter

No.

Riser Type

Mod ulus

Solidication time (s)

1

Riser with 15mm sleeve

1.6

190 seconds

2

Sand riser 140mm diameter

2.8

196 seconds

3

Riser with 25mm sleeve

1.6

285 seconds

4

Sand riser 152mm diameter

3.04

280 seconds

Based on the comparison of the solidification time of the two risers, the MEF values of the 15 mm thick sleeve and 25 mm thick sleeve are as follows [256]

consequently [257] have longer solidification [258] time [12] due to a more significant mass of liquid.

As previously discussed, MEF [259] of a riser sleeve with a modulus of 1.6 cm (diameter 80) is 1.75. The MEF value is obtained [260] from the ratio of the sleeve solidification rate to the sand riser solidification rate. [261] Table 5 presents the sand riser solidification times resulted from the SolidCast 8.2.5 software simulation.

No.

Diameter

(mm)

Modulus (cm)

Solidication[262] time

(s)

1

90

1.8

39

2

95

1.9

50

3

240

4.8

408

4

244

4.88

431

Table 5 :[263] Solidification time of sand riser

For the purpose of[264] a comparative study[265] Idamayanti et al. has conducted MEF testing on the Kalminex sleeve riser used in POLMAN[266] Bandung [5]. Based on his research, the Kalminex sleeve riser has a MEF of 1.77. Figure 5 shows that a riser wrapped with a 15 mm thick rice husk sleeve generates a MEF value of 1.75, which is[267] slightly below the MEF value of[268] Kalminex[269] sleeve (1.77). The riser with a rice husk sleeve of 25 mm thick generates a MEF value of 190, respectively. This[270] proves that the increasing thickness of the sleeve can expand the MEF value since it produces a higher amount of heat to compensate for the decreasing temperature during the solidification process.[271]

Figure 5 :[272] MEF value of sleeves

B. Modulus Extension Factor (MEF) fo various modulus

The solidification rate test was carried out[273] on three types of sleeved risers with a variation of modulus, which was 1 cm,

1.6 cm, and 3 cm with the same sleeve thickness of 15 mm. Riser sleeve with a diameter of 50 mm (modulus 1 cm), 80 mm (modulus 1.6 cm) and[274] 150 mm (modulus 3 cm) has a solidification time in the following sequence: 48 seconds, 190 seconds and[275] 434 seconds. Riser sleeves with larger modulus

Table 6 :[276] Retarding time of sleeved riser modulus 1 cm dan sand riser 95 mm

N

o.

Riser Type

Modulus

Retarding

Time

1

Sleeved Riser modulus

1cm

1.0 cm

48 seconds

2

Sand riser 95mm

1.9 cm

50 seconds

3

Sleeved riser modulus

3cm

3 cm

434 seconds

4

Sand riser 244 mm

4.88 cm

431 seconds

The solidification rate lines of the sleeved riser with a geometry modulus of 1 cm and the sand riser with a diameter of 95 mm intersect the solidus temperature line at almost the same time. Likewise, the solidification rate lines of the sleeved riser with a modulus of 3 cm intersect the solidus temperature line at almost the same time as the solidification rate line of the sand riser with a diameter of 244 mm. Based on these, the MEF value of the sleeved riser with a modulus of

1 cm is 1.9, and the sleeved riser of the modulus 3 cm is 1.63.

MEF values of rice husk sleeved riser in various modulus exceed the minimum MEF value, as stated in the Indian Standard, which is 1.60 [16]. At the same sleeve thickness, increasing the modulus of the riser decreases the MEF value. A higher modulus can be understood as an increase in the liquid mass, which means that the amount of heat to be supplied is also increasing. However, the MEF value continues to decline. This is caused by the amount of liquid that needs to be supplied by the sleeve, where the greater the geometric modulus of the sleeve, the greater the amount of liquid that needs to be supplied . So the ratio between the weight of the sleeve and the weight of the liquid becomes smaller, as shown in Table 7.

Table 7 : Ratio sleeve mass to mass of liquid metal

No.

Riser

Type

Diamet er

Mass of

Sleeve (S)

Mass of liquid metal

Ratio

S/G

1

Modulu [303]

s 1cm

50 mm

113 gram

0.77 kg

0.14

2

Modulu [304]

80 mm

235 gram

3.14 kg

0.07

3

Modulu[305]

s 3cm

150 mm

699 gram

20.68 kg

0.03

s 1.6cm

As shown in Table 7 that the same sleeve thickness of 15 mm creates a less mass ratio of rice husk and liquid metal for higher modulus. The amount of rice husk mass that is aimed[306] to supply liquid metal with exothermic heat per kilogram of the liquid becomes smaller. The increasing modulus of riser causes, therefore, a decrease in MEF value subsequently.

C. Morphology of solidification curve of the sleeved riser The morphology of the solidification rate[307] comes out mainly in two types.[308] The characteristics of these[310 311][312] graphs[313] show the[314][315] reaction or phenomenon that occurs in the riser during the solidification and cooling process.[309]

(a)

(b)

Figure 6 : Solidification and cooling curves of rice husk sleeved riser

The first graphical characteristics, as shown in Figure 6(a), are formed during the cooling process of the rice husk sleeves with a diameter of the riser of 80 and 150 and a sleeve thickness of 15 mm. It describes that there are three different working areas. Suharto [7] explains that rice husks may experience two times exothermic reactions, namely the pyrolysis reaction and the oxidation reaction [7]. Area 1 is the area where the first exothermic reaction occurs, which is the pyrolysis reaction. Pyrolysis combustion reaction may occur

even in the absence of oxygen from the adjacent environment because rice husks already have oxygen as a constituent element itself . This reaction causes the cooling rate to be slower than without the sleeve. Area 2 After the pyrolysis reaction occurs, a few moments later, an oxidation reaction or combustion takes place.[333] At this stage, a reaction occurs between biomass, charcoal, and pyrolysis products. This reaction is[334] exothermic so as to[335] produce adequate heat and cause a temperature surge, as shown in the graph. Area 3 is where all of the reaction has completely[336] finished so that at this stage, only a consistent temperature decrease occurs.

The second type of cooling curve is shown[337] in Figure 6(b). This graph is remarked with just two working areas. Area 1 on the riser with[339] a[340] sleeve thickness of 25 mm does[341] not indicate[342] clearly[343] the occurrence of two reactions. There is a combustion process in area[344] 1, whereas, according to Suharto [7], rice husks experience two exothermic reactions. This[345] is caused by the thickness of the
379 burning sleeve so that the pyrolysis and oxidation reactions do not occur at the same time[346]. The pyrolysis reaction takes place[347] gradually and alternately with the oxidation reaction causing a rise in temperature[348] simultaneously and significantly, as shown in the graph. In area 2, the exothermic reaction is completed[349]. Some applications and integration[350] can[351] be[352] considered[353] for[354] further[355] exploration [19] [20].

4. CONCLUSION

The thicker the sleeve at the same geometry modulus of the riser, the more heat is produced during the burning of the sleeve[356], and the solidification time becomes longer. Sleeve with a thickness of 25 mm, the longest solidification time of

285 seconds. Increasing the geometry modulus of the rice husk sleeved riser at the same sleeve thickness will decrease the MEF value of the riser since the

amount of heat to be supplied gets intensified. [357] By applying various thicknesses, the rice husk sleeve produces the highest MEF value at a sleeve thickness of 25 mm with a MEF value of 1.90. The rice husk sleeve that produces the highest MEF value is a sleeve with a modulus of 1 cm with a MEF value of 1.90, while risers with higher geometry modulus at the same sleeve thickness of 25 mm produce lower MEF value.

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1.	Exothermic sleeves	Improper formatting	Correctness
2.	~~sleeves are~~ → sleeves are	Improper formatting	Correctness
3.	~~are useful~~ → are useful	Improper formatting	Correctness
4.	~~useful to~~ → useful to	Improper formatting	Correctness
5.	~~to be~~ → to be	Improper formatting	Correctness
6.	~~be applied~~ → be applied	Improper formatting	Correctness
7.	~~applied in~~ → applied in	Improper formatting	Correctness
8.	~~in the~~ → in the	Improper formatting	Correctness
9.	~~the steel~~ → the steel	Improper formatting	Correctness
10.		Intricate text	Clarity
11.	~~to~~ → on	Wrong or missing prepositions	Correctness
12.	the riser	Determiner use (a/an/the/this, etc.)	Correctness
13.		Intricate text	Clarity
14.	~~series of~~	Wordy sentences	Clarity
15.	the exothermic	Determiner use (a/an/the/this, etc.)	Correctness
16.	~~riser at~~ → riser at	Improper formatting	Correctness
17.	~~were~~ → was	Faulty subject-verb agreement	Correctness
18.	*were carried out*	Passive voice misuse	Clarity
19.		Intricate text	Clarity
20.	exothermic sleeves' effectiveness	Wordy sentences	Clarity

21.	*was found*	Passive voice misuse	Clarity
22.	~~Key words~~ → Keywords	Confused words	Correctness
23.	words :	Improper formatting	Correctness
24.	*be used*	Passive voice misuse	Clarity
25.		Intricate text	Clarity
26.	solidification process	Improper formatting	Correctness
27.	shrinkage stages	Wordy sentences	Clarity
28.	~~solid~~ → definite, concrete, substantial, stable	Word choice	Engagement
29.	~~solid~~ → definite, concrete, substantial, stable	Word choice	Engagement
30.	~~and modulus~~ → and modulus	Improper formatting	Correctness
31.	~~modulus of~~ → modulus of	Improper formatting	Correctness
32.	~~of the~~ → of the	Improper formatting	Correctness
33.	~~the riser~~ → the riser	Improper formatting	Correctness
34.	~~riser can~~ → riser can	Improper formatting	Correctness
35.	~~can be~~ → can be	Improper formatting	Correctness
36.	~~increasing the~~ → increasing the	Improper formatting	Correctness
37.	solidification time	Improper formatting	Correctness
38.	~~which is~~ → which is	Improper formatting	Correctness
39.	*is understood*	Passive voice misuse	Clarity
40.		Intricate text	Clarity

41.	~~the riser~~ → the riser	Improper formatting	Correctness
42.	~~riser and~~ → riser and	Improper formatting	Correctness
43.	~~and provides~~ → and provides	Improper formatting	Correctness
44.	provides longer	Improper formatting	Correctness
45.	a longer	Determiner use (a/an/the/this, etc.)	Correctness
46.	longer solidification	Improper formatting	Correctness
47.	solidification time	Improper formatting	Correctness
48.	~~time so~~ → time so	Improper formatting	Correctness
49.	~~so as to~~ → to	Wordy sentences	Clarity
50.	~~the purpose of~~	Wordy sentences	Clarity
51.	*be made*	Passive voice misuse	Clarity
52.	~~heat in~~ → heat in	Improper formatting	Correctness
53.	~~in a~~ → in a	Improper formatting	Correctness
54.	~~short time~~ → short time	Improper formatting	Correctness
55.	researched	Wordy sentences	Clarity
56.	exothermic sleeve substitution	Wordy sentences	Clarity
57.	~~sleeve~~ → sleeves	Incorrect noun number	Correctness
58.	~~value of~~	Wordy sentences	Clarity
59.	~~is able to~~ → can	Wordy sentences	Clarity
60.	~~Idamayanti~~ → Damayanti	Misspelled words	Correctness

61.	~~et al~~ → et al.	Comma misuse within clauses	Correctness
62.	~~that can be~~	Wordy sentences	Clarity
63.	~~, Fuel~~ → ; fuel, . Fuel	Punctuation in compound/complex sentences	Correctness
64.	*be defined*	Passive voice misuse	Clarity
65.	~~depends~~ → Depends	Improper formatting	Correctness
66.	~~But~~ → However,, Nevertheless,	Inappropriate colloquialisms	Delivery
67.	normally,	Punctuation in compound/complex sentences	Correctness
68.	~~normally it~~ → it usually	Word choice	Engagement
69.	1 :	Improper formatting	Correctness
70.	~~Black~~ → Black's	Incorrect noun number	Correctness
71.	~~and its~~ → and its	Improper formatting	Correctness
72.		Intricate text	Clarity
73.	~~in the~~ → in the	Improper formatting	Correctness
74.	*by the sleeve*	Misplaced words or phrases	Correctness
75.		Intricate text	Clarity
76.	*This*	Intricate text	Clarity
77.	*is defined*	Passive voice misuse	Clarity
78.	~~against other~~ → against other	Improper formatting	Correctness
79.	other surrounding	Improper formatting	Correctness
80.	surrounding objects	Improper formatting	Correctness

81.	~~that have~~ → that have	Improper formatting	Correctness
82.	~~that have~~ → with	Wordy sentences	Clarity
83.	~~differences in~~ → differences in	Improper formatting	Correctness
84.	~~greater~~ → more significant, more excellent, more incredible, more tremendous	Word choice	Engagement
85.	*The geometry modulus of the riser, as well as of casting, is used to determine the location of the riser in the casting design.*	Intricate text	Clarity
86.	~~used to~~ → used to	Improper formatting	Correctness
87.	~~to determine~~ → to determine	Improper formatting	Correctness
88.	~~location of~~ → location of	Improper formatting	Correctness
89.	~~riser in~~ → riser in	Improper formatting	Correctness
90.	*is defined*	Passive voice misuse	Clarity
91.	*Modulus is a function of the solidification rate of an object and is defined as the volume (V) of the object divided by the area of the heat releasing section (A).*	Intricate text	Clarity
92.	the object's modulus	Wordy sentences	Clarity
93.	*is divided*	Passive voice misuse	Clarity
94.	~~divided into~~ → divided into	Improper formatting	Correctness
95.	~~3~~ → three	Improper formatting	Correctness
96.	~~greatly~~ → significantly	Word choice	Engagement
97.	riser's diameter	Wordy sentences	Clarity

98.	the riser	Determiner use (a/an/the/this, etc.)	Correctness
99.		Intricate text	Clarity
100.	Modulus extension	Improper formatting	Correctness
101.	extension factor	Improper formatting	Correctness
102.	~~is the~~ → is the	Improper formatting	Correctness
103.	~~the ratio~~ → the ratio	Improper formatting	Correctness
104.	~~ratio of~~ → ratio of	Improper formatting	Correctness
105.	~~of the~~ → of the	Improper formatting	Correctness
106.	geometrical modulus	Improper formatting	Correctness
107.	~~modulus of~~ → modulus of	Improper formatting	Correctness
108.	~~of the~~ → of the	Improper formatting	Correctness
109.	~~the sand~~ → the sand	Improper formatting	Correctness
110.	sandriser's geometrical modulus	Wordy sentences	Clarity
111.	~~sand riser~~ → sand riser	Improper formatting	Correctness
112.	~~riser and~~ → riser and	Improper formatting	Correctness
113.	~~and the~~ → and the	Improper formatting	Correctness
114.	*is considered*	Passive voice misuse	Clarity
115.	~~great~~ → significant	Word choice	Engagement
116.	~~is normally~~ → is typically, is usually, usually is	Word choice	Engagement
117.		Intricate text	Clarity

118.	~~Therefore this~~ → Therefore this	Improper formatting	Correctness
119.	~~this research~~ → this research	Improper formatting	Correctness
120.	~~research was~~ → research was	Improper formatting	Correctness
121.	~~was conducted~~ → was conducted	Improper formatting	Correctness
122.	~~conducted by~~ → conducted by	Improper formatting	Correctness
123.	~~measuring and~~ → measuring and	Improper formatting	Correctness
124.	riser sleeve's solidification rate	Wordy sentences	Clarity
125.	~~thickness~~ → thicknesses	Incorrect noun number	Correctness
126.	*be observed*	Passive voice misuse	Clarity
127.	*is aimed*	Passive voice misuse	Clarity
128.	~~that meets~~ → that meets	Improper formatting	Correctness
129.		Intricate text	Clarity
130.	~~much as~~ → much as	Improper formatting	Correctness
131.	*Sleeve in this study has a composition of 60 mesh rice husk as much as 89%, 11% of polyvinyl acetate as a binder, and methanol as much as 180% of the amount of polyvinyl acetate.*	Intricate text	Clarity
132.	*is used*	Passive voice misuse	Clarity
133.	a thinner	Determiner use (a/an/the/this, etc.)	Correctness
134.	*is mixed*	Passive voice misuse	Clarity
135.	~~act~~ → acts	Faulty subject-verb agreement	Correctness

136.		Intricate text	Clarity
137.	~~3~~ → three	Improper formatting	Correctness
138.	~~, which are~~ → :	Wordy sentences	Clarity
139.	~~ratio of~~ → ratio of	Improper formatting	Correctness
140.	~~Based on~~ → Based on	Improper formatting	Correctness
141.	~~on the~~ → on the	Improper formatting	Correctness
142.	*To determine the effect of the thickness of the exthermic sleeve on the riser, an experiment with two variations of thickness of 15 mm and 25 mm on a riser with a modulus of*	Intricate text	Clarity
143.	~~exthermic~~ → exothermic	Misspelled words	Correctness
144.	~~2~~ → two	Improper formatting	Correctness
145.	*was poured*	Passive voice misuse	Clarity
146.	~~alcaly~~ → ally	Misspelled words	Correctness
147.	~~Prior to~~ → Before	Wordy sentences	Clarity
148.	the uniform	Determiner use (a/an/the/this, etc.)	Correctness
149.	~~tubular shape~~ → tubular shape	Improper formatting	Correctness
150.	~~dimension with~~ → dimension with	Improper formatting	Correctness
151.	~~with a~~ → with a	Improper formatting	Correctness
152.	*To determine the solidus temperature of the material*	Misplaced words or phrases	Correctness
153.	*is used*	Passive voice misuse	Clarity

154.	*is classified*	Passive voice misuse	Clarity
155.	*is applied*	Passive voice misuse	Clarity
156.	~~carbon content~~ → carbon content	Improper formatting	Correctness
157.	determining the	Improper formatting	Correctness
158.	2 :	Improper formatting	Correctness
159.	*To analyze the results of this study*	Misplaced words or phrases	Correctness
160.	this study's results	Wordy sentences	Clarity
161.	*is used*	Passive voice misuse	Clarity
162.	*are determined*	Passive voice misuse	Clarity
163.	*A. Determination of Modulus Extension Factor (MEF) Modulus extension factor (MEF) is the effective ratio of the sand riser and riser sleeve. MEF values are determined by comparing the modulus of the sleeved riser with the modulus of the sand riser by using the solidification rate [6, 12].*	Hard-to-read text	Clarity
164.		Hard-to-read text	Clarity
165.	*is calculated*	Passive voice misuse	Clarity
166.	solidification rate	Improper formatting	Correctness
167.	~~rate on~~ → rate on	Improper formatting	Correctness
168.	~~on the~~ → on the	Improper formatting	Correctness
169.	~~the riser~~ → the riser	Improper formatting	Correctness
170.	~~riser sleeve~~ → riser sleeve	Improper formatting	Correctness
171.	~~sleeve and~~ → sleeve and	Improper formatting	Correctness

172.	~~and sand~~ → and sand	Improper formatting	Correctness
173.	~~sand riser~~ → sand riser	Improper formatting	Correctness
174.	~~riser as~~ → riser as	Improper formatting	Correctness
175.	~~as~~	Wordy sentences	Clarity
176.	A simplified	Determiner use (a/an/the/this, etc.)	Correctness
177.	~~the material~~ → the material	Improper formatting	Correctness
178.	~~material so~~ → material so	Improper formatting	Correctness
179.	~~that the~~ → that the	Improper formatting	Correctness
180.	*be observed*	Passive voice misuse	Clarity
181.	*was retrieved*	Passive voice misuse	Clarity
182.	*was positioned*	Passive voice misuse	Clarity
183.		Intricate text	Clarity
184.	3 :	Improper formatting	Correctness
185.	~~bu~~ → by	Confused words	Correctness
186.	*was obtained*	Passive voice misuse	Clarity
187.	the Fe-Fe3C	Determiner use (a/an/the/this, etc.)	Correctness
188.	Volumetric feed	Improper formatting	Correctness
189.	feed efficiency	Improper formatting	Correctness
190.	~~efficiency of~~ → efficiency of	Improper formatting	Correctness
191.	~~of a~~ → of a	Improper formatting	Correctness

192.	~~sleeve is~~ → sleeve is	Improper formatting	Correctness
193.	~~is defined~~ → is defined	Improper formatting	Correctness
194.	*is defined*	Passive voice misuse	Clarity
195.	~~defined as~~ → defined as	Improper formatting	Correctness
196.	~~as the~~ → as the	Improper formatting	Correctness
197.	*is obtained*	Passive voice misuse	Clarity
198.	*B. Feeding efficiency of a plate casting (plate test) Volumetric feed efficiency of a sleeve is defined as the percentage of maximum feed metal transferred to the casting during its solidification at the same level of feed safety margin as found in a sand riser of given dimensions mounte...*	Hard-to-read text	Clarity
199.	*FSM is measured based on the distance between the lowest shrink surface of a riser to the bottom of the riser.*	Intricate text	Clarity
200.	*is determined*	Passive voice misuse	Clarity
201.	*were obtained*	Passive voice misuse	Clarity
202.	sleeve thicknesses	Wordy sentences	Clarity
203.	*was also observed*	Passive voice misuse	Clarity
204.	*Figure 4 confirms that the thickness of the sleeve affects the cooling rate of the metal, where the sleeve with a thickness*	Intricate text	Clarity
205.	thickness.	Closing punctuation	Correctness
206.	~~of~~ → Of	Improper formatting	Correctness

207.	~~of~~	Wordy sentences	Clarity
208.		Intricate text	Clarity
209.	*is determined*	Passive voice misuse	Clarity
210.	*be calculated*	Passive voice misuse	Clarity
211.	follows.	Closing punctuation	Correctness
212.	~~largest~~ → most extensive, most considerable	Word choice	Engagement
213.	~~the~~ sleeve	Determiner use (a/an/the/this, etc.)	Correctness
214.	the sleeved	Determiner use (a/an/the/this, etc.)	Correctness
215.	riser.	Closing punctuation	Correctness
216.	~~can~~ → Can	Improper formatting	Correctness
217.	sand riser's cooling rates	Wordy sentences	Clarity
218.	~~, and then~~ → . Then	Hard-to-read text	Clarity
219.	~~graph shows~~ → graph shows	Improper formatting	Correctness
220.	~~heat~~ → heart	Confused words	Correctness
221.	*be seen*	Passive voice misuse	Clarity
222.	the riser	Determiner use (a/an/the/this, etc.)	Correctness
223.	~~compared to~~ → than	Wordy sentences	Clarity
224.	the riser	Determiner use (a/an/the/this, etc.)	Correctness
225.	~~of~~ → in	Wrong or missing prepositions	Correctness

226.	A sleeve	Determiner use (a/an/the/this, etc.)	Correctness
227.	4 :	Improper formatting	Correctness
228.	2 :	Improper formatting	Correctness
229.	, while	Punctuation in compound/complex sentences	Correctness
230.		Intricate text	Clarity
231.	~~compared to~~ → than	Wordy sentences	Clarity
232.	~~which is~~ → which is	Improper formatting	Correctness
233.	*is wrapped*	Passive voice misuse	Clarity
234.	~~wrapped with~~ → wrapped with	Improper formatting	Correctness
235.	~~with a~~ → with a	Improper formatting	Correctness
236.	~~thick sleeve~~ → thick sleeve	Improper formatting	Correctness
237.	sleeve,	Punctuation in compound/complex sentences	Correctness
238.	~~a very large~~ → a huge, a considerable, a tremendous, a substantial	Word choice	Engagement
239.	~~is obtained~~ → is obtained	Improper formatting	Correctness
240.	*is obtained*	Passive voice misuse	Clarity
241.	~~obtained from~~ → obtained from	Improper formatting	Correctness
242.	~~from the~~ → from the	Improper formatting	Correctness
243.	~~the ratio~~ → the ratio	Improper formatting	Correctness
244.	~~ratio of~~ → ratio of	Improper formatting	Correctness

245.	solidification rate	Improper formatting	Correctness
246.	*sand riser solidification time data*	Intricate text	Clarity
247.	~~Solidication~~ → Solidification	Misspelled words	Correctness
248.	~~greater~~ → more generous, more excellent	Word choice	Engagement
249.	~~thick sleeve~~ → thick sleeve	Improper formatting	Correctness
250.	~~in the~~ → in the	Improper formatting	Correctness
251.	~~term of~~ → term of	Improper formatting	Correctness
252.	solidification time	Improper formatting	Correctness
253.	~~it is~~ → it is	Improper formatting	Correctness
254.	3 :	Improper formatting	Correctness
255.	4 :	Improper formatting	Correctness
256.	follows.	Closing punctuation	Correctness
257.	~~consequently~~ → Consequently	Improper formatting	Correctness
258.	longer solidification	Improper formatting	Correctness
259.	the MEF	Determiner use (a/an/the/this, etc.)	Correctness
260.	*is obtained*	Passive voice misuse	Clarity
261.		Intricate text	Clarity
262.	~~Solidication~~ → Solidification	Misspelled words	Correctness
263.	5 :	Improper formatting	Correctness
264.	~~the purpose of~~	Wordy sentences	Clarity

265.	study,	Comma misuse within clauses	Correctness
266.	~~POLMAN~~ → Polman	Confused words	Correctness
267.	~~which is~~ → which is	Improper formatting	Correctness
268.	~~value of~~ → value of	Improper formatting	Correctness
269.	the Kalminex	Determiner use (a/an/the/this, etc.)	Correctness
270.	*This*	Intricate text	Clarity
271.		Intricate text	Clarity
272.	5 :	Improper formatting	Correctness
273.	*was carried out*	Passive voice misuse	Clarity
274.	, and	Comma misuse within clauses	Correctness
275.	, and	Comma misuse within clauses	Correctness
276.	6 :	Improper formatting	Correctness
277.	~~same time~~ → same time	Improper formatting	Correctness
278.	the solidification	Improper formatting	Correctness
279.	solidification rate	Improper formatting	Correctness
280.	~~rate lines~~ → rate lines	Improper formatting	Correctness
281.	~~lines of~~ → lines of	Improper formatting	Correctness
282.	~~of the~~ → of the	Improper formatting	Correctness
283.	simultaneously	Wordy sentences	Clarity
284.	*be understood*	Passive voice misuse	Clarity

285.	~~liquid mass~~ → liquid mass	Improper formatting	Correctness
286.	~~which means~~ → which means	Improper formatting	Correctness
287.	~~that the~~ → that the	Improper formatting	Correctness
288.	~~amount of~~ → amount of	Improper formatting	Correctness
289.	~~heat to~~ → heat to	Improper formatting	Correctness
290.	~~supplied is~~ → supplied is	Improper formatting	Correctness
291.	~~is also~~ → is also	Improper formatting	Correctness
292.	~~is also increasing~~ → increases	Wordy sentences	Clarity
293.	also increasing	Improper formatting	Correctness
294.	*This is caused by the amount of liquid that needs to be supplied by the sleeve, where the greater the geometric modulus of the sleeve, the greater the amount of liquid that needs to be supplied.*	Intricate text	Clarity
295.	*This*	Intricate text	Clarity
296.	*is caused*	Passive voice misuse	Clarity
297.	~~greater~~ → more significant, more generous, more fantastic	Word choice	Engagement
298.	~~that needs~~ → that needs	Improper formatting	Correctness
299.	*be supplied*	Passive voice misuse	Clarity
300.	*So the ratio between the weight of the sleeve and the weight of the liquid becomes smaller, as shown in Table 7.*	Intricate text	Clarity
301.	~~between the~~ → between the	Improper formatting	Correctness

302.	7 :	Improper formatting	Correctness
303.	~~Modulu~~ → Module	Misspelled words	Correctness
304.	~~Modulu~~ → Module	Misspelled words	Correctness
305.	~~Modulu~~ → Module	Misspelled words	Correctness
306.	*is aimed*	Passive voice misuse	Clarity
307.	solidification rate's morphology	Wordy sentences	Clarity
308.	~~two types~~ → two types	Improper formatting	Correctness
309.	*The characteristics of these graphs show the reaction or phenomenon that occurs in the riser during the solidification and cooling process.*	Intricate text	Clarity
310.	The characteristics	Improper formatting	Correctness
311.	characteristics of	Improper formatting	Correctness
312.	~~of these~~ → of these	Improper formatting	Correctness
313.	~~these graphs~~ → these graphs	Improper formatting	Correctness
314.	~~graphs show~~ → graphs show	Improper formatting	Correctness
315.	~~show the~~ → show the	Improper formatting	Correctness
316.	6 :	Improper formatting	Correctness
317.	~~with a~~ → with a	Improper formatting	Correctness
318.	~~diameter of~~ → diameter of	Improper formatting	Correctness
319.	~~riser of~~ → riser of	Improper formatting	Correctness
320.	~~and a~~ → and a	Improper formatting	Correctness

321.		Intricate text	Clarity
322.	~~working areas~~ → working areas	Improper formatting	Correctness
323.	~~explains that~~ → explains that	Improper formatting	Correctness
324.	~~that rice~~ → that rice	Improper formatting	Correctness
325.	~~husks may~~ → husks may	Improper formatting	Correctness
326.	occur.	Closing punctuation	Correctness
327.	~~even~~ → Even	Improper formatting	Correctness
328.	~~element itself~~ → element itself	Improper formatting	Correctness
329.		Intricate text	Clarity
330.	reaction causes	Improper formatting	Correctness
331.	~~slower than~~ → slower than	Improper formatting	Correctness
332.	~~than without~~ → than without	Improper formatting	Correctness
333.		Intricate text	Clarity
334.	~~reaction is~~ → reaction is	Improper formatting	Correctness
335.	~~so as to~~ → to	Wordy sentences	Clarity
336.	~~completely~~	Wordy sentences	Clarity
337.	*is shown*	Passive voice misuse	Clarity
338.	*is remarked*	Passive voice misuse	Clarity
339.	~~riser with~~ → riser with	Improper formatting	Correctness
340.	~~with a~~ → with a	Improper formatting	Correctness
341.	~~mm does~~ → mm does	Improper formatting	Correctness

342.	~~not indicate~~ → not indicate	Improper formatting	Correctness
343.	~~clearly~~	Wordy sentences	Clarity
344.	~~in area~~ → in area	Improper formatting	Correctness
345.	*This*	Intricate text	Clarity
346.	~~at the same time~~ → simultaneously	Wordy sentences	Clarity
347.	~~takes place~~ → occurs	Wordy sentences	Clarity
348.	temperature rise	Wordy sentences	Clarity
349.	*is completed*	Passive voice misuse	Clarity
350.	and integration	Improper formatting	Correctness
351.	integration can	Improper formatting	Correctness
352.	~~can be~~ → can be	Improper formatting	Correctness
353.	*be considered*	Passive voice misuse	Clarity
354.	~~considered for~~ → considered for	Improper formatting	Correctness
355.	~~for further~~ → for further	Improper formatting	Correctness
356.	sleeve's burning	Wordy sentences	Clarity
357.		Intricate text	Clarity
358.	~~to~~	Wrong or missing prepositions	Correctness
359.	facilities.	Closing punctuation	Correctness
360.	, and	Comma misuse within clauses	Correctness
361.	~~sleeve type~~ → sleeve-type	Misspelled words	Correctness
362.	of	Wrong or missing prepositions	Correctness

	~~on~~ →		
363.		Intricate text	Clarity
364.	~~Procedure to~~ → Procedure to	Improper formatting	Correctness
365.	~~exo~~ → Exo	Misspelled words	Correctness
366.	~~effective~~ → useful, practical	Word choice	Engagement
367.	thermophysical properties	Improper formatting	Correctness
368.	~~properties for~~ → properties for	Improper formatting	Correctness
369.	~~for simulation~~ → for simulation	Improper formatting	Correctness
370.	~~simulation and~~ → simulation and	Improper formatting	Correctness
371.	~~performanc~~ → performance	Misspelled words	Correctness
372.	a thermodynamic	Determiner use (a/an/the/this, etc.)	Correctness
373.	the thermal	Determiner use (a/an/the/this, etc.)	Correctness
374.	rice husk's thermal response	Wordy sentences	Clarity
375.	*International Journal of Emerging Trends in Engineering Research*	International Journal of Emerging Trends in Engineering ... https://www.rootindexing.com/journal/international-journal-of-emerging-trends-in-engineering-research--2/	Originality
376.	*During the solidification process of liquid metal in the mold,*	Formation of shrinkage cavity and porosity in valve casting https://www.zhycasting.com/formation-of-shrinkage-cavity-and-porosity-in-valve-casting/	Originality
377.	*This study is aimed to analyze the effect of*	Determinants of Income of Poor Women-Headed Households in ...	Originality

		http://jp.feb.unsoed.ac.id/index.php/eko-regional/article/view/1152	
378.	*the amount of heat to be supplied is*	Renewal of the heating system [Tender documents : T27409799]	Originality
379.	*reactions do not occur at the same time.*	Photosynthesis Practice Multiple Choice NEL https://studylib.net/doc/6674107/photosynthesis-practice-multiple-choice-nel	Originality
380.	*Analysis on chemical and physical properties of bio-oil pyrolyzed from rice husk,*	Analysis on chemical and physical properties of bio-oil ... https://www.sciencedirect.com/science/article/pii/S0165237008000302	Originality
381.	*https://doi.org/10.1016/j.jaap.2008.03.*	Analysis on chemical and physical properties of bio-oil ... https://www.sciencedirect.com/science/article/pii/S0165237008000302	Originality