Development of Small Scale Low Cost Insulating Riser Sleeves from Scraps and by Products of an Existing Foundry Industry

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Abstract— Riser sleeves are used to avoid defective casting caused by the shrinking of the molten metal due to solidifying after being cast in a mold. Riser sleeve whether insulating or exothermic or both are manufactured over the world by using different kinds of materials. But the costing associated with the riser sleeves is high and it increases the overall casting cost of a particular foundry industry. There are lots of scarp materials and by-products in an existing foundry industry that can be used as the constituent of riser sleeves. The overall costing of the sleeves will be very low if it is possible to use these scarps and by products to produce low scale sleeves. This paper deals with the process and parameters of manufacturing very low cost insulating riser sleeves by utilizing the scraps and by-products of an existing foundry industry.

Keywords: Foundry, riser sleeve, insulation, binder, slurry, Sodium Silicate

I. INTRODUCTION

Most metals are less dense in liquid condition than as solid and during solidification of casting; the less dense liquid portion creates shrinkage inside the cast body. Risers or feeders are used to prevent this shrinkage by providing molten metal to the casting during solidification. Riser size is based on the modulus of the casting as well as the capacity of riser to feed metals. But, traditional riser costs a lot of metal, poor casting yield and large contact area with the main casting body leading high fettling cost. In order to prevent these drawbacks, riser sleeves are being used over the past half century.

Riser sleeves are well established tool all over the world to minimize the costing associated with the foundry. It is estimated that in the year of 2013, about 80% of all steel castings are produced using riser sleeves, and the U.S. Steel casting industry alone spends about $38 million per year on riser sleeves [1]. A number of types of riser sleeve have been developed over the years to improve riser efficiency by controlling heat loss from the riser or by providing an additional heat source to the metal in the riser. An insulating riser sleeve supports the riser to keep the temperature for a long period while an exothermic sleeve utilizes Thermit reaction to provide a heat generating source [2]. One method of manufacturing exothermic and heat insulating sleeves are by mixing aluminum particles, iron oxide particles and refractory materials such as silica sand, olivine sand and alumina, thereafter bonding them together with a binder such as water glass, or resin [2]. One common method of manufacturing insulating sleeves is the use of insulating materials mixed with a binder, perhaps a greensand mix with the slurry or oil and starch [3]. Compositional analysis by XRF of a common insulating riser sleeves shows the presence of large amount of Silica content as SiO_2 as the main constituent along with Al_2O_3 as the second main element. Along these two constituents, FeO is also found which provide some heat source using Thermit reaction. No matter what are the components or manufacturing process of the sleeves, the associated costing of the sleeves increases the overall cost of a particular foundry.

This work aims to the development of very low cost insulating riser sleeves using the by-products and scraps found in an existing foundry industry. Walton Hi-Tech Industries Limited, Gazipur, Bangladesh has been running a non-ferrous foundry section under the department of Metallurgy over the past few years. The foundry section includes pattern making unit, moulding unit using green sand molding, melting unit and machining unit and CO_2 process. Pattern making unit making wood patterns, produces a lot of wood saw dust and molding unit while washing sands produce certain amount of slurry. On the other hand, the aluminium dross in the melting unit produces ash containing about 50-75% Alumina (Al_2O_3) [4] and certain amount of FeO. Apart from all of these things, we have an abundant access of rice husk ash (RHA). As RHA is very rich in SiO_2 [5, 6], it was also used as a constituent of the sleeves made. All these constituents were mixed in different composition and amount with the binder- Sodium Silicate (Na_2SiO_3). CO_2 was used to strengthen the sleeve structures. Then the sleeves were baked for 1hour under a temperature of 150^oC and used in the casting. The experimental procedure and results are described in the following article.

II. EXPERIMENTAL PROCEDURE

Four types of insulating sleeves were made comprising following composition.

Table I: Composition of the experimental insulating riser sleeves

Sleeve No	Component	Amount (gm)
1	Rice Hush Ash (RSA)	22
	Aluminium Ash (AA)	44
	Wood Saw Dust (WSD)	500

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	Sodium Silicate (Na_2SiO_3)	468
2	Aluminium Ash (AA)	42
	Wood Saw Dust (WSD)	340
	Slurry (S)	67
	Sodium Silicate (Na_2SiO_3)	181
3	Wood Saw Dust (WSD)	400
	Slurry (S)	265
	Sodium Silicate (Na_2SiO_3)	295
4	Wood Saw Dust (WSD)	400
	Dry Sand (DS)	250
	Sodium Silicate (Na_2SiO_3)	310

Table II: Ratio of the Constituents

Sleeve Number	Constituents	Ratio
Sleeve 1	RSA:AA:WSD:SS	1:2:23:21
Sleeve 2	AA:WSD:S:SS	1:8:1.5:4
Sleeve 3	WSD:S:SS	1.5:1:1.1
Sleeve 4	WSD:DS:SS	1.6:1:1.5

All the constituents were then mixed and pressed in a die manually. Resulting sleeves had the following dimension

Outer diameter = 150mm
Inner diameter = 105mm
Height =140mm
Thickness = 22mm (approximate)

Fig. 1: One of the Riser Sleeves made in the experiment

The sleeves were then experimented in a CO_2 process mold. There were 5 riser sleeves in the mold including the 4 experimental sleeves and one sleeve from **Foseco**, named ***kalmin 100plus***. It is also an insulating sleeve and the dimension of this sleeve is below

Outer Top diameter = 142mm
Inner Top diameter = 110mm
Outer Bottom diameter = 148mm
Inner Bottom diameter = 116mm
Height =150mm
Thickness = 16mm

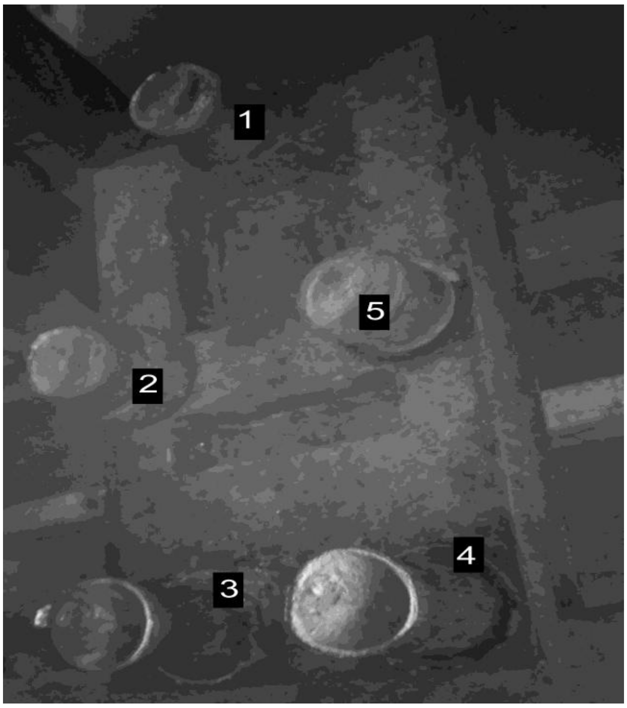

Fig. 2: Position of the riser in the cast body

The metal used was A356 grade aluminium. Temperature of the molten metal inside the sleeves was measured using a K-type thermocouple. The efficiency of the sleeves was then observed comparing with Kalmin 100 plus insulating sleeve. Then the conclusion of the experiment is to be drawn and one method of manufacturing sleeves will be established.

III. RESULTS

The temperature of the molten metal of Aluminium A356 inside the insulating rise sleeves was measured with K-type thermocouple against time. The values of temperature are listed below.

	Temperature (^oC) of the molten metal inside sleeves				
Time (s)	**Sleeve 1**	**Sleev e 2**	**Sleeve 3**	**Sleeve 4**	**Kalmin 100plus**
0	616	616	617	617	616
300	575	585	582	581	602
600	527	548	550	525	585
900	496	523	527	497	577
1200	465	495	503	471	557
1500	432	473	481	453	550
1800	407	458	465	435	529
2100	371	437	448	417	503
2400	344	422	431	398	482
2700	329	403	418	374	465
3000	314	389	402	358	449

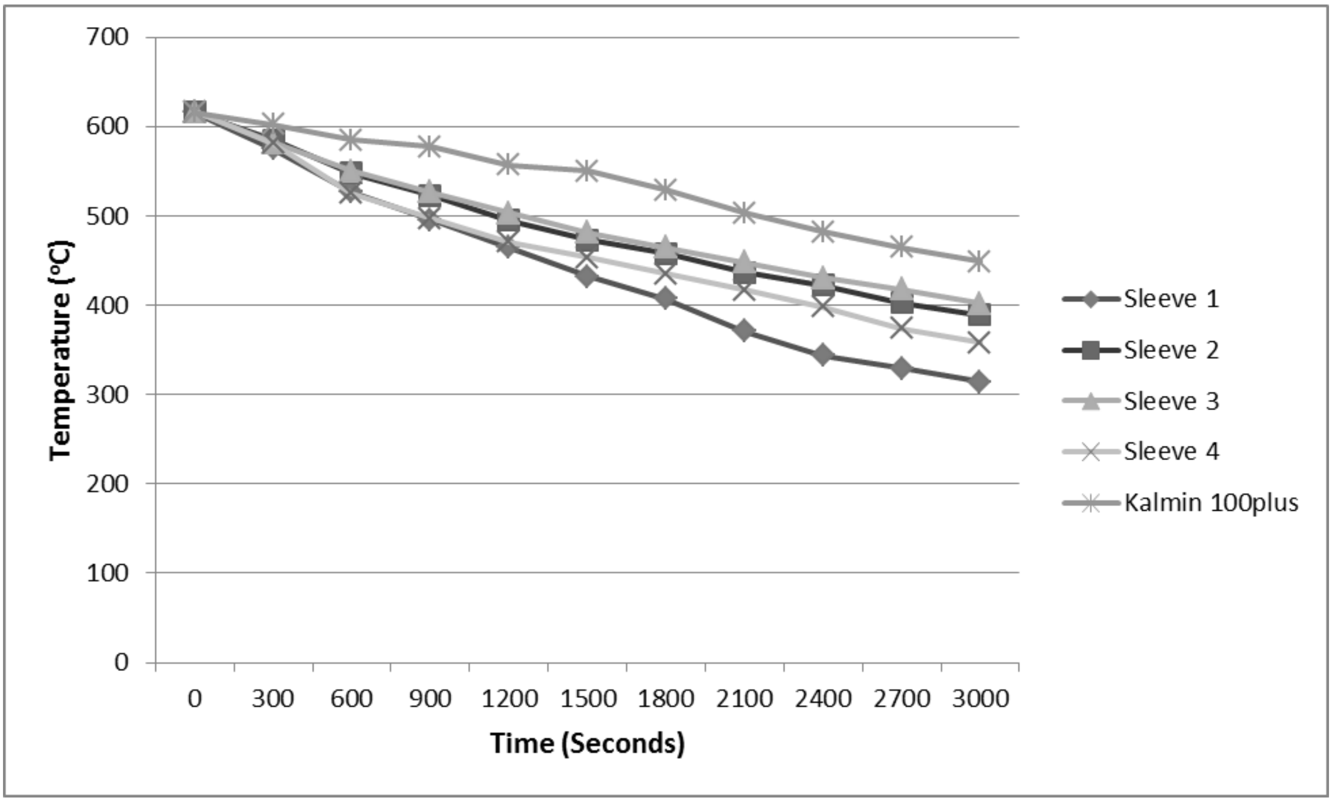

Fig. 3: Temp. of the molten metal inside the riser sleeves VS time graph

IV. DISCUSSION

From the graph we can come to a summary that sleeve number 3 provides the nearest values near Kalmin 100 plus insulating sleeve implementing it can be used as an alternative to commercial sleeves.

From the composition of sleeve 3, we can see it was made by mixing saw dust along with slurry, both bonded with Sodium Silicate. Slurry provides a lot of SiO_2 and perhaps it is the main source for the good insulating properties. Again, sleeve no 2 provides almost as the same result as sleeve no 3 as it also contains good amount of slurry. So, it may be possible to get some good aspects from this kind of sleeve also. But, Sleeve no 1 shows a lot of differentiation from the kalmin 100 plus sleeve values. There was no slurry in sleeve no 1, but a certain amount of Rice Husk Ash. As SiO_2 covers the major part of insulating riser sleeves, perhaps increasing the amount of RSA will lead to better insulating properties. Last of all, poor result of sleeve no 4 may be attributed to the fact that, dry sand could not mix well with the wood saw dust bonded by Sodium Silicate and CO_2. As the heat raised up from the molten metal, dry sand started peeling off resulting poor insulating property.

V. CONCLUSION

From the above discussion, it can be concluded that riser sleeve composed of Wood Saw Dust and Slurry in the ratio of 1.5:1 bonded with Sodium Silicate and CO_2 (Sodium Silicate is 1.1 times) and baked for about 1hr in 150^{o}C can be used for small scale production. As it is made from the by-products of an existing foundry, it is supposed to be low cost compared to the commercial grade riser sleeves.

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