O-156

Proceedings of the 72nd World Foundry Congress
21-25th May 2016, Nagoya, Japan

New Melting System of Briquetted Aluminium Chip Achieves Energy-Saving and Environmental Improvement

Hirotoshi Yabumoto
2nd Engineering & Designing Dept., Engineering Division, Sanken Sangyo Co., Ltd., Hiroshima, Japan

Every cast product produces machining chip (hereinafter referred to as chip) in the machining process. Unlike foundry returns such as rejected products, it is not an easy task to melt chip, because the chip is wet with coolant and has thin sections, which leads to much formation of dross/oxide when melted in a reverberatory or a shaft melting furnace. Also, coolant in the chip generates fumes negatively affect the environment. So, traditionally chip just after being crushed has been dried in a drying oven such as rotary kiln system before melting. Our conventional chip drying/melting system also consists of a rotary kiln dryer system and our patented submergence vortex melting system (for more details, see our website: http://www.sanken-sangyo.co.jp) which can achieve the highest metal recovery of up to 98%. However, even our advanced rotary kiln system still has some drawbacks: a large installation space and a large amount of maintenance are required. Then, we focused on a briquetting machine which was primarily used to reduce the volume of chip for easy transportation. In 2013, we began to develop a new chip drying/melting system with less installation space, reduced energy consumption and the highest metal recovery rate, utilizing briquetted chip.

Keywords: *chip, briquette, drying, melting*

1. Introduction

Every rotary kiln system used for drying chip has the inherent risks of a dust explosion or a metallic combustion caused by dust/fine in the chip as well as a fire caused by condensed coolant in the exhaust system. The reason why we focused on a briquetting machine was to eliminate these risks and minimize the installation space required.

Of course, in the days of 2013 and before as well, wet briquetted chip was melted together with ingot and foundry returns, however, almost no tests were conducted to demonstrate what percentage of the briquetted chip being charged could be actually recovered as aluminium molten metal.

In any case, when trying to continuously and efficiently melt non-dried, wet briquetted chip as it is, we are faced with the following issues to be solved: (1) potential risk of a steam explosion when briquette is quickly and fully submerged in the metal bath, and (2) when briquette is charged into the metal bath (the briquette will float on the bath) or onto the dry hearth, in any event, the said briquetted chip will spring back over time prior to melting under such a hot circumstance, resulting in a worsened recovery rate due to excess oxidation.

2. Basic study

For the realization of a successful briquette melting, we set up three agendas: (1) energy-saving drying system utilizing sensitive heat of the bath metal, (2) detoxifying of fumes generating from the drying process, and (3) the dried briquette is to be melted in a submergence vortex with a higher recovery rate which is conventionally achieved.

First, we studied the properties of briquetted chip and conducted drying tests of them in/on aluminium molten metal. Also, we assumed that any steam explosion can be avoided so far as the briquette is not fully submerged in the molten metal, and we verified this assumption during testing. In this study/test, a briquette with 80 mm dia. x 80 mm high was used.

2.1 Briquette - density vs coolant content

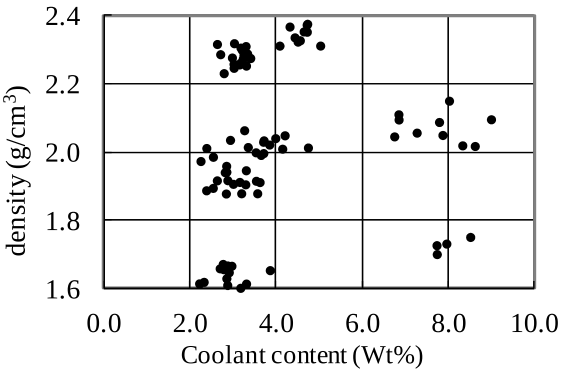

Fig1 Relationship density and coolant content

As shown in Fig. 1, we investigated the relationship between density and coolant content. The figure indicates that the coolant content drops to less than 5.5 wt. % and varies in a narrow range as the density grows, therefore, the briquetting machine requires an ability to constantly produce a dense briquette.

2.2 Briquette – drying time required

We had information already obtained by our past separate chip drying tests that moisture in a chunk of chip wet with coolant evaporates above 200℃ and residual oily ingredients evaporates above 400℃ at the center of the chunk. In our tests, the briquette was immersed in the molten metal by roughly 2/3 and the center temperature of the briquette reached 400℃ within 45 seconds. Fig. 2 shows the test results. During testing, no sign of steam explosions were seen.

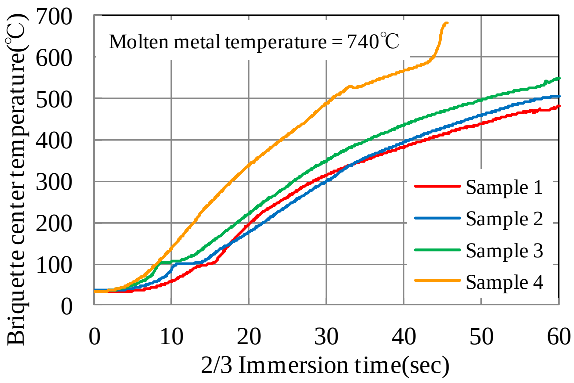

Fig.2 Immersion time vs coolant content

3. Development to actual drying/melting system

3.1 Concept of briquette drying/melting system

Based on our study and past experiences, we designed a new system which can meet the following criteria: (1) the briquette is to stay in the molten metal while not being fully submerged for more than 45 seconds, (2) then, it is to be quickly melted, and (3) the fumes are to be completely incinerated within the afterburner. Fig. 3 shows a schematic of the system.

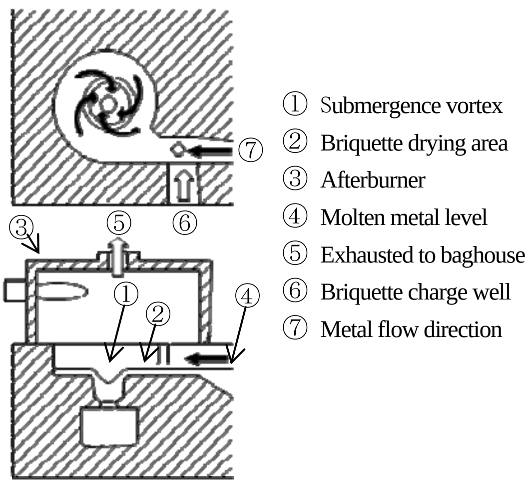

Fig. 3 Schematic of the new system

The briquette is continuously fed via a briquette charge well into metal flow generated by a mechanical pump and stays there for 45 seconds or more in a drying area which is located in a vortex periphery and has a shallow metal depth not allowing the briquette to be fully submerged, and the briquette is then quickly submerged in the vortex to be melted. The fumes including dioxins, generating from the drying process are completely incinerated in the afterburner which is mounted above the vortex chamber, and are then exhausted to the baghouse. To minimize the coolant content, the briquetting machine is expected to produce a briquette with a density of over 2.2 g/cm^3.

3.2 Commissioning results of the new system

We developed the concept to a new actual drying/melting system with a melting capacity of 700 kg/h and a metal temperature of 750℃. A briquette melting scene can be seen in Fig. 4 as we expected. Also, a performance comparision between the new system and our conventional system is shown in Table 1. With the new system, we have achieved energy saving by approx. 60% compared to our conventional one and obtained a 98% of metal recovery rate as high as the conventional one. Furthermore, istallation space was reduced by approx. 60%.

Both the new system and the conventional system are available, according to our customer's specific requirements.

Fig. 4 Drying/melting scene of briquette

Table 1 Performance comparison (our product basis)

Description	New System	Our Conventional
Energy consumption *	116 kWh/t	465 kWh/t
Power consumption *	100 kWh/t **	70 kWh/t
Metal recovery;	Up to 98%	Up to 98%
Installation space (ratio)	0.4	1

* Except for melting process. ** Including the briquetting machine

Acknowledgements

In closing, we wish to acknowledge Central Motor Wheel Co., Ltd., Aichi, Japan, co-developer of the new system, and without whose cooperation this paper would not have been possible.