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The Influence of Selected Water and Alcohol Based Coatings on Bending Strength of Foundry Moulds and Cores Manufactured in Furan Technology

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Abstract

The subject of this paper was to compare the influence of selected coatings on bending strength of moulds and cores manufactured in a furan technology. In a range of study, there were used three kinds of coatings - water based coating and two kind of alcohol based coating manufactured by FOSECO. Coating were applicated by brush, overpouring/flow and spraying. For each application method, there were realized different kind of drying- at ambient temperature, in a furnace and by burning. Physicochemical properties of coatings were such selected to accommodate them to the application method and type of coating. Based on the conducted studies it was observed that for water based coating application method doesn't have an important influence on bending strength and it is necessary to optimize the time and temperature of drying to achieve better results of bending strength. For alcohol based coatings, drying by burning causes significant deterioration of bending strength of the mould and core and drying process at ambient allows to obtain high bending strength of mould/cores in regard to time of drying.

Keywords: Water based coating, Alcohol based coating, Bending strength, Moulding sand, Furan resin

1. Introduction

Chemical and physical interactions between liquid metal and sand entail defects on the surface and worsen the quality of the final product of cast process.

Penetration of metal into pores of sand during pouring the mould causes roughness of surface of the final cast. The degree of penetration depends on dynamic and metallostatic pressure, size of pores or thermal extension of the sand. Simultaneously, high casting temperature is a reason of chemical reaction between sand and metal. It causes burn-on of the sand and carbonaceous defects.

Application of a good quality and well selected coatings is the best way to avoid that kind of defects, by reducing or even eliminating unfavorable occurrence on the boundary metal-mould/core.

Well applied coating have to be characterize by good adhesion to the substrate, proper suspension and remixing properties, has good application, high refractory properties in order to resist the temperature of liquid metal.

Coating can be spread on mould surface by dipping, swabbing brushing, overpouring or spraying. Each application method requires different coating's parameters.

There are two main liquid carrier used in production of coatings: water and alcohol. Liquid carrier must be removed before solidification of the cast, and its most important function is to transport the filler on the sand. Water career is cheap, but evaporate long, so that requires drying in an oven. On the other hand, alcohol based coating dry more quickly and can be remove fast by burning. It is more expensive than water instead.
In presented studies was analyzed how the type of coating influences bending strength of foundry mould and cores [1-6].

2. Range of studies

The aim of this study was to determine how the type of coating and the way of its applications and drying influence bending strength of foundry moulds and cores manufactured in furan technology There were used two kind of coatings manufactured by FOSECO:

- zircon water based coating
- zircon alcohol based coating
- ✓ with penetration layer (zircon under-layer coating)
- ✓ without penetration layer

Zircon water based coating is a water based ready-to-use coating on a zircon silicate base for use in steel and grey iron casting up to greatest wall thicknesses, is applied on resin-bonded moulds and cores. It is supplied ready for brushing. When applied by overpouring / flow coating or spraying further dilution with clean water is required. Coating has very good suspension properties.
Zircon alcohol based coating is a dispersion of refractory filler materials in an organic solvent. The coating provides excellent flow characteristics. Due to the unique filler combination it can be applied to a variety of cast metals.
Zircon under-layer coating is suitable for moulds and cores made in resin bonded sand. After dilution with pure isopropanol the coating penetrate completely into the surface of the moulds and cores, thus filling the pores between the sand grains several millimeters. The treated mould surface will give an optimum protection against scabbing, erosion and metal penetration.
Moulding sand used in a range of studies was composed of following ingredients: (manufactured by FOSECO)

- silica sand 0.20/0.315/0.16 (medium)
- Acid catalyzer based on mixture of sulfo-benzoid acid and p-Toluenesulfonic acid
- Furan resin containing the mixture of Furfural alcohol and Phenol formaldehyde resins.

The optimum composition of moulding sand was defined on the basis of measurement of bending resistance of samples formed from different content of ingredients. The best results and the closest to the real ones in the foundry were achieved for a moulding sand containing 1.2% of furan resin and 40% of catalyzer compared to resin and this mould sand was an object of further researches.
A sample was formed from the moulding sand made according to the composition given above. The bending strength of the reference samples (without cover and primer) was measured 8 hours after being moulded. 8h in question, this is the time that was adopted as the most common in the actual work of the foundry, the time between moulding and preparation (cleaning and application of coatings) of the mould and core. For the remaining part of the samples, a coating was applied after 8 hours from the formation.
From obtained results, it was counted mean value of bending strength which was compared to bending strength of referent test pieces.
Detailed research project and methodology considering drying time is presented in table 1. Samples before coating application and during self-drying was stored in ambient temperature what was 21°C±1°C and relative humidity of the air was 45-50%. The bending strength of the tested sample was calculated as the arithmetic average from 3 samples.

Table 1.
Research project

penetration layer	coating	application method	penetration layer drying time	break	coating drying, time
Referent test pice					
-	(Holcote 110)	overpouring spraying brush	-		0.5h
-	(Holcote 110)		-		24h
-	(Holcote 110)		-		60°C/1h
-	(TC ZBBP16)	overpouring spraying brush	-		20min
-	(TC ZBBP16)		-		12h
-	(TC ZBBP16)		-		burning
(TC ZKPX)	-	Brush spraying	20min		-
(TC ZKPX)	(TC ZBBP16)	Brush spraying	30min		30min
(TC ZKPX)	(TC ZBBP16)	Brush spraying			burning
(TC ZKPX)	(TC ZBBP16)	Brush spraying			12h
(TC ZKPX)	(TC ZBBP16)	Brush spraying	5min break/burning	20 min	burning
(TC ZKPX)	(TC ZBBP16)	Brush spraying	5min break/burning	20 min	12h

The parameters of coatings in regard to application method is presented in table 2. Physicochemical properties of coatings were such selected to accommodate them to the application method and type of coating.
Coatings were applicated using three methods: by overpouring, brush and spraying. For each application method, there were realized different kind of drying: air drying (at ambient temperature), in a furnace (60°C) and by burning (burning only for alcohol based coatings). On some of the test pieces, before application of alcohol based coating, it was imposed penetration layer by zircon under-layer coating (fig. 1).

a)

b)

c)

Fig. 1 Pictures taken during the studies: (a) samples before application of coating, (b) after application of penetration layer, (c) after coating application

It is important to note that all samples were coated with the same layer thickness, these values were also accurately measured and arithmetic average calculated. Due to the possibility of maintaining the coating thickness at the same level on all samples and the lack of a direct impact on the final bending strength, these data were omitted in this study.

Table 2.
Parameters of coating in regard to application method

	Application method	Temp of coating [°C]	Viscosity [s]	Density [g/cm^3]	Baume [Be]
Holcote 110	spraying	21.6	16	2.04	78
	overpouring		16	2.04	78
	brush		22	2.17	86
Teno Coating ZBBP16	spraying	21.6	16	1.84	72
	overpouring		16	1.84	72
	brush		22	2.02	82
Teno Coating ZKPX	spraying	21.6	16	2.04	78
	overpouring		16	2.04	78
	brush		22	2.17	86

3. Results of studies

In fig. 2 are presented the results of bending strength measurement. Alcohol based coating evaporates quickly and this is the reason why there were applicated shorter drying time.The best results were obtained for cores with water based coating dried at ambient temperature by 24 h (setting of furan was completed). High bending strength were also achieved for cores, where alcohol based coating were drying at ambient temperature by 12 h. Presence of alcohol accelerates setting time of furan, however partly destroys irreversibly bending strength of mould / core.
Water based coatings in general terms, applicated after 8h from the moulding, slow down the process of bonding and negatively affect the binding bridges of sand grains, however, unlike alcohol base coatings, this negative process is largely reversible, after removing water from the system, or in short, after drying the mould and core strength returns to the native (after 8h), what more drying process itself allows to finish the binding process, in particular when we talk about drying at highest temperatures (60°C).

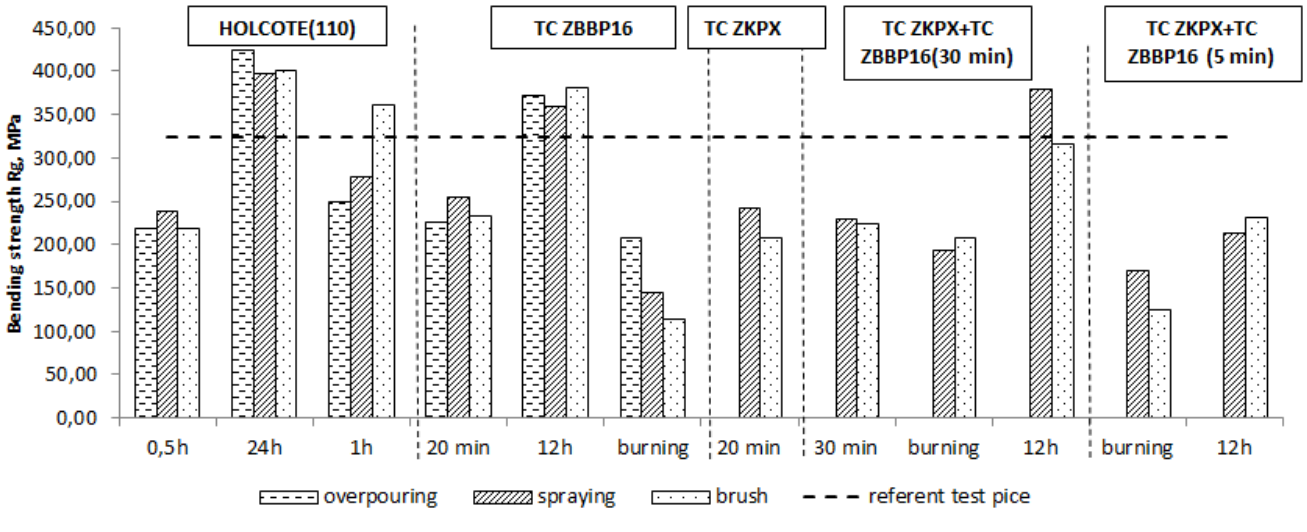

Fig. 2. Influence of different kind of coatings on bending strength of furan moulding sand

4. Conclusions

Based on the conducted studies the following conclusions have been formulated:

1. Water based coating:
   - Application method doesn't have an important influence on bending strength.
   - It is necessary to optimize the time and temperature of drying to achieve better results of bending strength.
2. Alcohol based coating:
   - Drying process by burning causes significant deterioration of bending strength of the mould and core.
   - Drying process at ambient temperature allows to obtain good bending strength of mould and cores in regard to time of drying.
3. The process of drying of the coating at ambient or elevated temperature, e.g. in a furnace (60°C), allows to maintain high bending strength of mould/cores.

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