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Sekundarna tehnologija regeneracije peska no-bake za zmanjšanje stroškov in izboljšanje livarskega okolja

Secondary no-bake sand reclamation technology to reduce the cost and improve the foundry environment

Izvleček

Livarna jekla z Bližnjega vzhoda je od lokalnih okoljskih oblasti prejela obvestilo, da bo zaradi območja, na katerem deluje, v primeru neuspešnega zmanjšanja količine hlapov pri litju morala zapreti svoja vrata.

Ta livarna se ukvarja z litjem v kemično vezani pesek na podlagi alkalno-fenolnega procesa za proizvodnjo form in jeder. Večinoma proizvaja ulitke iz manganskega, nerjavnega in drugega jekla, odpornega proti obrabi, s težo od 3 kg do 10 ton, s kombiniranjem mehanske formarske linije, formiranja v tleh in primarno mehansko regeneracijo.

Povezali so se s proizvajalci veziv, ki so si že prizadevali za uporabo zelo trdne alkalno-fenolne smole z malo dodatki, pri katerih se sprošča manj hlapov. Prav tako so se povezali z dobavitelji opreme, da bi poiskali rešitev za njihovo težavo s hlapi.

Po dolgotrajnem iskanju so našli rešitev, tj. posebno vrsto sekundarne mehanske regeneracije (sistem USR) (Sl. 1). Namen tega članka je predstaviti rezultate preizkušanja, ugotovitve o opremi za sekundarno mehansko regeneracijo ter pozitivni učinek sekundarne mehanske regeneracije na zmanjšanje količine hlapov ter druge pozitivne vplive na stroškovno učinkovitost in kakovost ulivanja.

Ključne besede: zmanjšanje količine hlapov, sekundarna mehanska regeneracija, USR, regeneracija peska za alkalno-fenolni proces

Abstract

A Middle Eastern steel foundry was informed by the local environmental agencies that due to the area in which they were located, they would have to close if a reduction in the level of casting fumes was not found.

The foundry in question is a chemically bonded sand foundry using the Alkaline Phenolic process for mould and core productions. They produce mainly manganese steel, stainless steel and other wear resistant steel castings from 3 kg up to 10 tons by using a combination of a mechanised moulding line, floor moulding and primary mechanical reclamation.

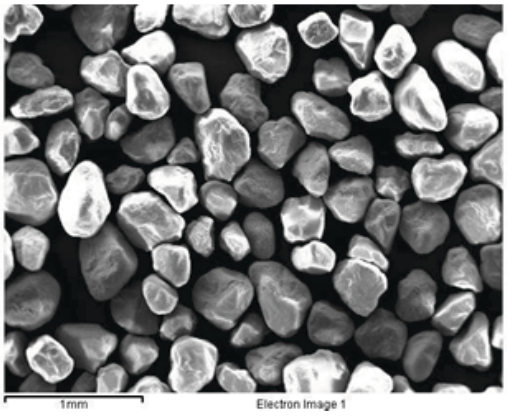
They have approached binder manufacturers, who have already been working on a high strength/low addition Alkaline Phenolic resin with less fume. They have also approached equipment suppliers to find a solution for their fume issue.

After a lengthy search, the found of a specific type of secondary mechanical reclamation (USR System) (fig 1) was the solution. This lecture is about the trial results and findings of the secondary mechanical reclamation equipment and the positive effect of secondary mechanical reclamation on fume reduction as well as other improvements of the cost efficiency and casting quality.

Key words: Fume reduction, mechanical secondary reclamation, USR, sand reclamation for Alkaline Phenolic process

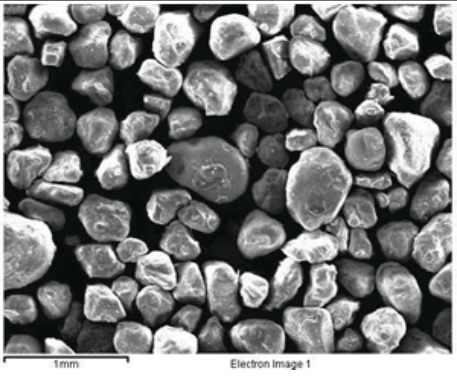
Sl. 1: Sekundarna drobljivost, sistem USR

Fig. 1: Secondary Attrition, USR, Unit



Sl. 2: Nov kremenčev pesek

Fig. 2: New silica sand

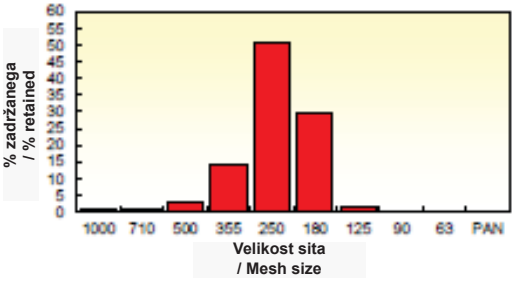


Sl. 3: Mehansko regenerirani pesek

Fig. 3: Mechanically reclaimed sand

SEJALNA ANALIZA / SIEVE ANALYSIS

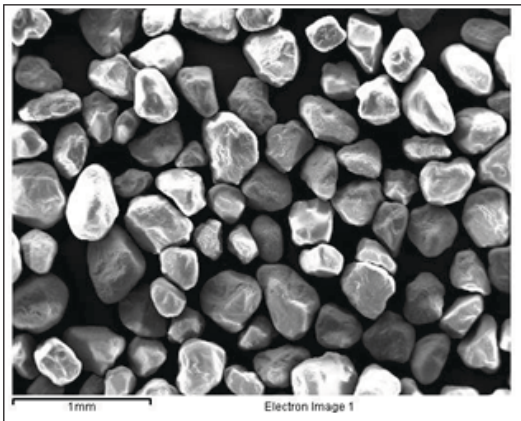
Velikost sita / Mesh size	% zadržanega / % retained
1000	0.50
710	0.48
500	3.01
355	14.12
250	50.53
180	29.66
125	1.55
90	0.12
63	0.04
PAN	0.00



KEMIČNA ANALIZA / CHEMICAL ANALYSIS

		Spodnja meja / Low limit	Zgornja meja / High limit
Izguba pri vžigu / Loss on ignition	2.22%	0.80%	2.00%
Kalij / Potassium	0.16%	0.05%	0.20%
Vlaga / Moisture	0.63%	0.00%	0.90%
pH-vrednost / pH	10.28	9.70	11.00

		Spodnja meja / Low limit	Zgornja meja / High limit
AFS	46	44	56
drobir / fines	1.67%	0.00%	5.00%
prašni delci / dust	0.04%	0.00%	0.50%

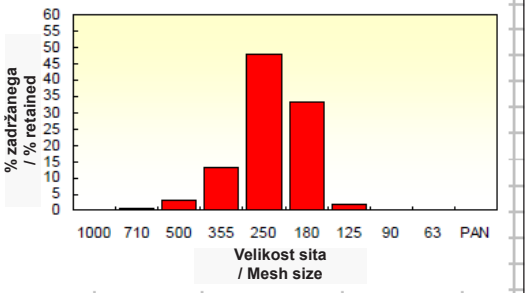


Sl. 4: Pesek po prvi in drugi obdelavi s sistemom USR

Fig. 4: Sand after 1st & 2nd pass through USR system

SEJALNA ANALIZA / SIEVE ANALYSIS

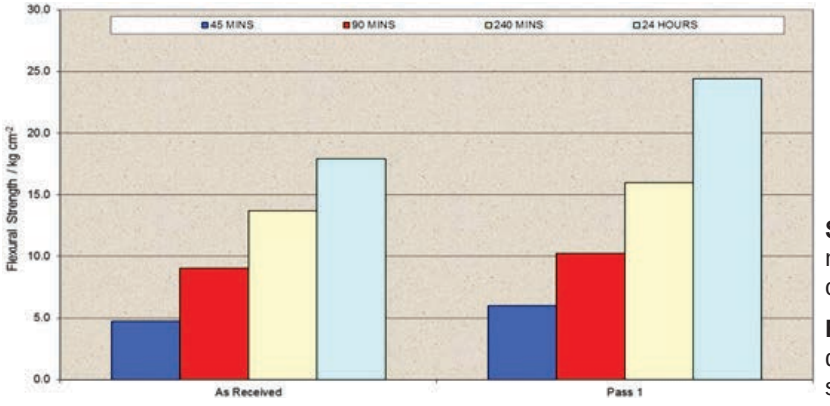
Velikost sita / Mesh size	% zadržanega / % retained
1000	0.12
710	0.36
500	2.93
355	12.89
250	48.26
180	33.30
125	2.08
90	0.06
63	0.00
PAN	0.00



KEMIČNA ANALIZA / CHEMICAL ANALYSIS

		Spodnja meja / Low limit	Zgornja meja / High limit
Izguba pri vžigu / Loss on ignition	0.91%	0.80%	2.00%
Kalij / Potassium	0.10%	0.05%	0.20%
Vlaga / Moisture	0.19%	0.00%	0.90%
pH-vrednost / pH	10.17	9.70	11.00

		Spodnja meja / Low limit	Zgornja meja / High limit
AFS	48	44	56
drobir / fines	2.13%	0.00%	5.00%
prašni delci / dust	0.00%	0.00%	0.50%



Sl. 5: Razvoj trdnosti novega peska po obdelavi

Fig. 5: Strength development of new sand after processing

Preskusi s peskom

Preskusi z novim in regeneriranim peskom stranke so bili opravljeni v prostorih za raziskave in razvoj družbe Omega v Peterboroughu. Po obdelavi regeneriranega peska stranke s sistemom USR so zrna peska postala bolj zaobljena, pri mehansko regeneriranem pesku pa je bilo prav tako odstranjenih vsaj 60 odstotkov površinskih vezivnih sredstev, ne da bi to vplivalo na degradacijo peščenih zrn (Sl. 2, 3 in 4).

Rezultati

Pozitivni učinki čistejših in bolj zaobljenih peščenih zrn so se odražali v večji adhezijski trdnosti forme z manj veziva (Sl. 5 in 6).

Sl. 5 prikazuje, kako novi pesek, obdelan s sistemom URS, za katerega so značilna bolj zaobljena zrna, potrebuje manj smole, zagotavlja pa večjo adhezijsko trdnost.

Kot je razvidno iz (Sl. 6), je bil regenerirani pesek obdelan trikrat, da bi zagotovili optimalno raven odstranitve vezivnih sredstev. V zgornji preglednici je prikazano, da je zadostovala že enojna obdelava (skozi posamezno celico za izpiranje). V primeru bistvene koristi zaradi dveh obdelav bi bil stroj lahko opremljen z dvema celicama za izpiranje, in sicer eno na drugi (Sl. 7)

Sand Trials

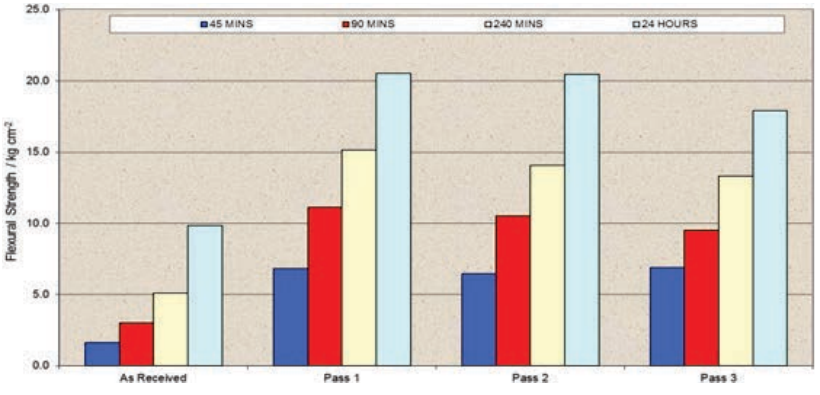
Trials were carried out at Omega's Research & Development facility in Peterborough with the customer's new and reclaimed sand. By passing the customer's reclaimed sand through the USR system the sand grain itself became more rounded and in the case of the mechanically reclaimed sand, at least 60% of the surface binder was also removed without sand grain degradation (fig 2, 3 & 4).

Results

The positive effects of a cleaner, more rounded sand grain were greater mould strength for less binder (fig 5 & 6).

Fig 5 shows how by processing the new sand through USR system the rounded sand grains require less resin but give a greater strength.

As you can see from (fig 6) the reclaimed sand was processed up to three times to find the optimum level of binder removal. It is clear from the above chart that a single pass (single scrubbing cell) was sufficient. If there had been a clear advantage with two passes then the machine could have been supplied with two scrubbing cells – one on top of the other (fig 7)

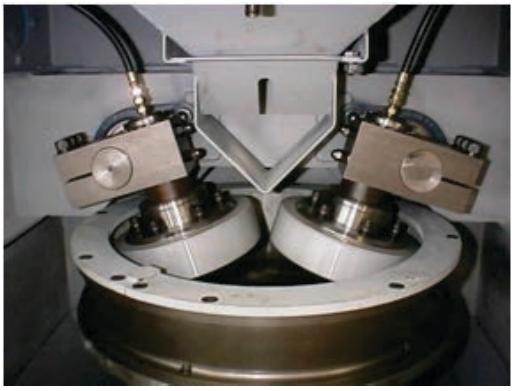


Sl. 6: Razvoj trdnosti regeneriranega peska po obdelavi

Fig. 6: Strength development of reclaimed sand after processing

Sl. 7:

Fig 7:



Sl. 8: Celica za izpiranje

Fig. 8: Scrubbing Cell

Načelo delovanja

Kako deluje sistem USR?

Enoto so razvili v družbi Sintokogio na Japonskem in je zelo učinkovita pri regeneraciji anorganskih veziv na podlagi alkalno-fenolnega procesa, npr. natrijev silikat CO2/ester.

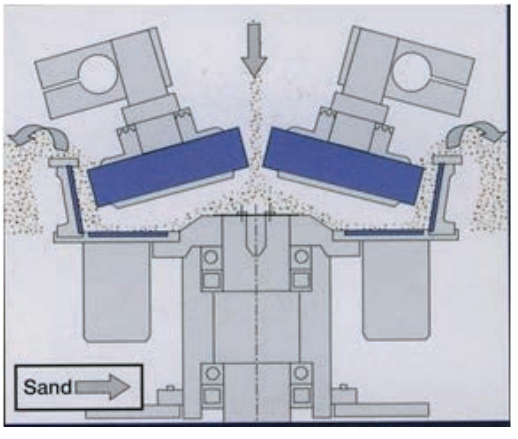
Načelo temelji na prehajanju novega in mehansko regeneriranega peska skozi celico za izpiranje, kjer se zrna peska stisnejo skupaj pod blagim pritiskom keramičnih valjev (Sl. 8), tako da ti vzajemno delujejo in na površini zrn peska ustvarjajo blago abrazijo. Ta abrazija zadostuje za odstranitev površinskega veziva in ostrih robov kremenčevega peska, vendar pa ni dovolj močna, da bi poškodovala kremenova peščena zrna.

Principle of operation

How does USR system work?

The unit was developed by Sintokogio of Japan and was very effective in reclaiming Alkaline Phenolic's, in-organic binders such as Sodium Silicate CO2/Ester.

The principle is based on passing the new and mechanically reclaimed sand through a scrubbing cell, where the sand grains are squeezed together under a light pressure with ceramic rollers (fig 8) so that they interact and produce a mild abrasive action on the sand grain surface. This abrasion is sufficient to remove surface binder and remove the sharp edges of silica but not so high as to damage the silica sand grain.



Sl. 9: Keramični delci

Fig. 9: Ceramic parts

Nato pesek z izpranim vezivom vstopi v fluorirano gredo, kjer poteče ločevanje in odstranjevanje drobirja. Z natančnim nadzorom negativnega tlaka znotraj separacijske komore lahko nadzorujemo raven odstranjevanja drobirja.

Največja prednost te vrste sekundarne drobljivosti je, da ima tri glavne spremenljivke – pretok peska, odpornost znotraj bobna in pritisk valjev. Vsaka od teh spremenljivk omogoča drobne nastavitve, da se uporabi natančna količina pritiska, ki zagotavlja optimalne rezultate izpiranja peska.

Kot je razvidno iz (Sl. 9) določa raven izpiranja kombinacija širine roba in pritiska keramičnega valja.

Sklep

Rezultati preizkusa z mešanim peskom so pokazali, da je posledica učinka priprave peska v enoti za sekundarno drobljivost (USR) v kombinaciji z majhno količino veziva razvoj večje adhezivne trdnosti forme. Manj dodanega veziva seveda pomeni bistveno zmanjšanje količine hlapov pri litju, kar je bila prvotna težava stranke. Nadaljnji pozitivni učinki so bili vidni v približno 50 odstotkov manjši porabi novega kremenčevega peska, približno 20 odstotkov nižji porabi smole, v boljšem zaključnem sloju forme z manj napakami pri litju, npr. poroznost, napake zaradi plina, in splošnem znižanju znižanje stroškov litja. Temu ni tako zgolj zaradi manjše količine porabljenega veziva, pač pa tudi zaradi višje stopnje regeneracije peska.

Ta študija primera jasno prikazuje neprekinjeni razvoj dobaviteljev vezivnih sredstev in strojev, pa tudi možnosti uporabe pri novih izzivih, s katerimi se sooča livarska industrija. Kombinacija teh razvojev lahko prinese hitro rešitev določenih težav v livarstvu, skupaj z dodatnimi in nepričakovanimi koristmi.

The sand together with scrubbed binder then enters a fluidised bed where the separation and removal of the fines takes place. By accurately controlling the negative pressure inside the separation chamber we can control the level of fines removal.

The major advantage of this type of Secondary Attrition is that it has three main variables – sand throughout, resistance within the drum and roller pressure. Each of these variables can be finely tuned so that the precise amount of pressure is applied to achieve the optimum sand scrubbing results.

As can be seen in (fig 9), the combination of rim width and ceramic roller pressure determines the level of scrubbing.

Conclusion

Mixed sand test results showed that the effect of sand conditioning in the Secondary Attrition unit (USR) combined with low binder additions resulted in a higher mould strength development. Lower binder additions of course resulted in a significant reduction in casting fume, which was the customer's initial key concern. Further positive effects were seen to be around 50% new Silica sand usage reduction, around 20% of the resin consumption, improved casting finish with reduced casting defects such as porosity, gas defects and overall moulding cost reduction. They are not only consumed because of the reduced level of binder but also due to the improved level of sand reclamation.

This case study clearly demonstrates the continual developments being carried out by the binder and machinery suppliers and how they can be applied to new challenges from the foundry industry. By combining these developments, a fast solution to a specific foundry problem can often be found with added, unexpected benefits.