

SELECTION OF SELFSET MOULDING SYSTEMS

David Hughes



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DISCUSSION TOPICS

- **TESTING OF RECLAIMED SAND**
- **BINDER SYSTEMS :**
 - **FURANE**
 - **ESTER SET ALKALINE PHENOLIC**
 - **SELFSET PHENOLIC URETHANE**
 - **ESTER SET SODIUM SILICATE**



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SAND TYPES AND TESTING

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SAND SIEVE ANALYSIS

- FOR BOTH NEW AND RECLAIMED SAND TO MONITOR
 - SAND DISTRIBUTION AND GRAIN SIZE
 - SAND RECLAIMER EFFICIENCY IN LUMP BREAKING AND DUST REMOVAL
- DUST AND AGGLOMERATES INCREASE SAND SURFACE AREA
- RESIN ADDITION
- MOULD/CORE PERMEABILITY
- HARDSAND AND GREEN SAND



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TYPICAL SIEVE ANALYSIS CHART

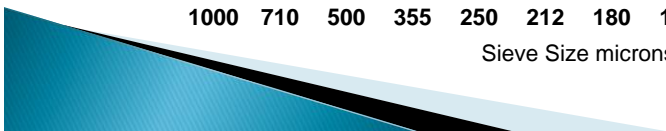
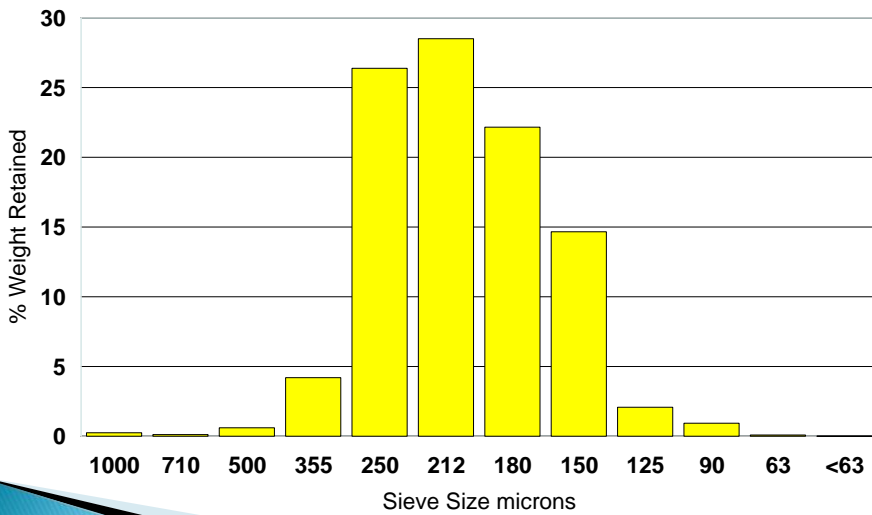
- 2% TOTAL FOR 90,63 & PAN
- OTHER SIEVE COMBINATIONS CAN BE USED
- AFS (Grain fineness number)
- Average grain size metric ISO sieves
- CONSISTENCY

SIEVES	WEIGHT	%	FACTOR	AFS
ums				PRODUCT
1,000			10	
710			16	
500			22	
355			30	
250			44	
212			60	
180			72	
150			85	
125			100	
90			120	
63			150	
PAN			200	
TOTAL			AFS =	



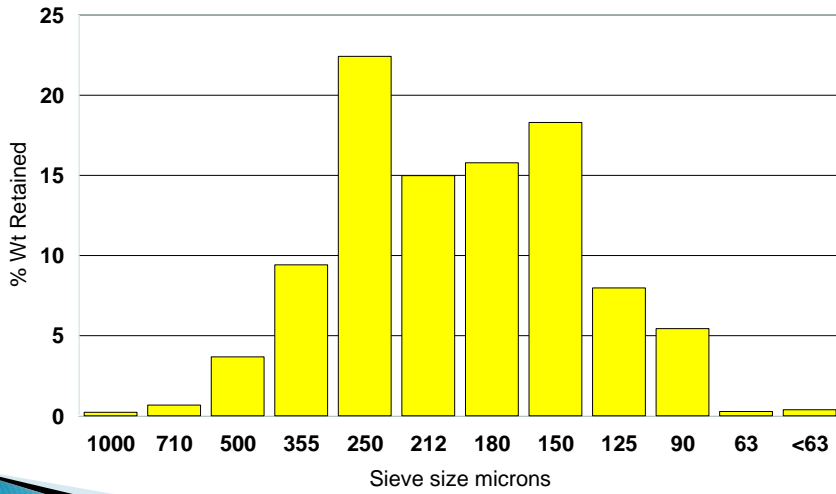
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SIEVE ANALYSIS SILICA SAND AFS 62



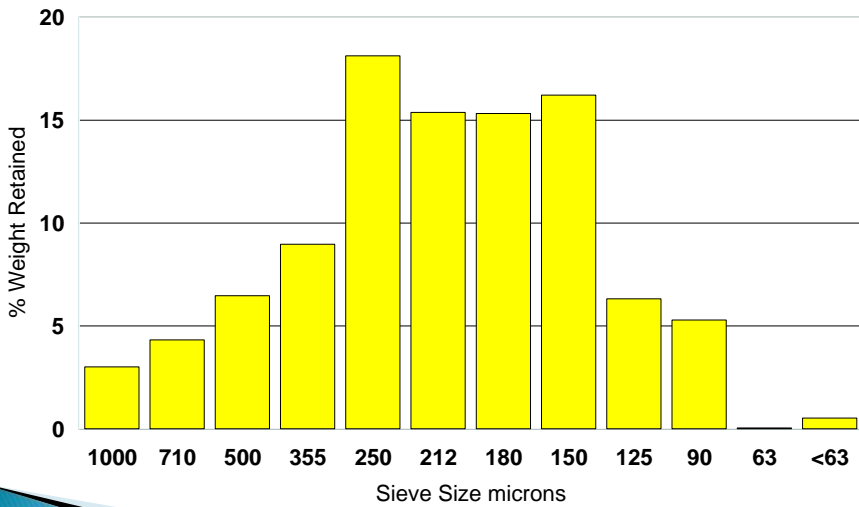
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SIEVE ANALYSIS SILICA SAND AFS65



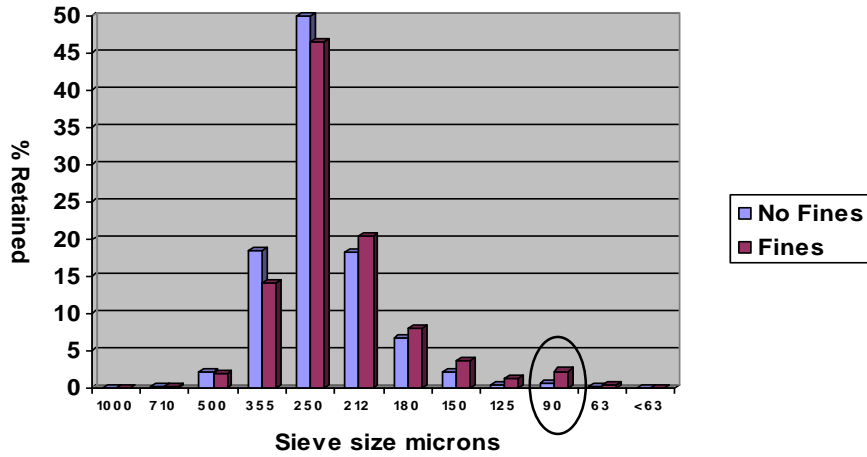
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SIEVE ANALYSIS RECLAIMED SAND AFS60



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RECLAIMED SAND SIEVE ANALYSIS



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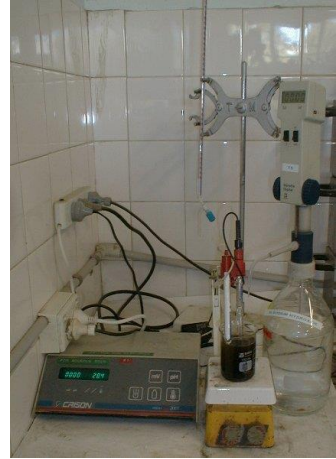
TENSILE STRENGTH COMPARISON EFFECT OF FINES

Sand	Fines	No Fines
½ hour	10	17
1 hour	17	31
4 hour	19	47
24 hour	38	72
Resin %	1.6%	1.6%
AFS	52	48
LOI%	0.37	0.31
Alkalinity %	3.66	3.28

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ACID DEMAND VALUE

- DETERMINED BY ADDING ACID TO THE SAND
- NEW SAND INDICATES CALCIUM CONTENT (shell)
- FURANE NEW SAND SLOWS RATE OF CURE AND LOWERS STRENGTH
- PHENOLIC URETHANE AMINE CURED SHORTENS MIXED SAND BENCHLIFE AND EFFECTS CURE RATES
- pH SHOULD BE NEUTRAL , AN ACID OR ALKALINE SAND WILL IMPACT ON THE CURING RATES OF ALL BINDER SYSTEMS



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LOSS ON IGNITION

- TO DETERMINE THE AMOUNT OF ORGANIC COMBUSTIBLES ON THE SAND
- ORGANIC VEGETATION IN NEW SAND
- IRON CASTING 3% MAX
- STEEL 2% MAX



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SAND MOISTURE

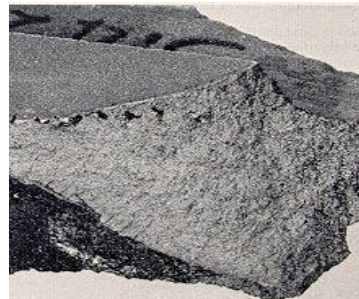
- MAXIMUM FOR NEW AND RECLAIMED SAND 0.5%
- SLOW RATE OR THROUGH CURE
- BRIDGE SILOS IN RECLAIMED SAND
- PHENOLIC URETHANE AMINE CURED FAST
ERRATIC CURE WITH LOW STRENGTH MAXIMUM
0.1%
- GENERATES HYDROGEN GAS ON CASTING



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NITROGEN DETERMINATION

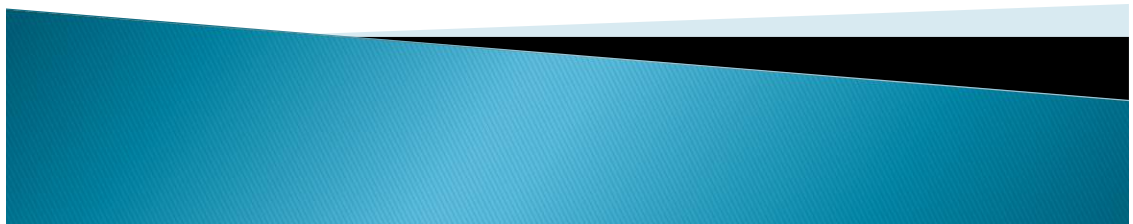
- NITROGEN IS PRESENT IN
FURANE & PHENOLIC URETHANE
SYSTEMS
- METAL MOULD REACTION
- SUB SURFACE PIN HOLES
FISSURES
- ACCEPTABLE LEVELS:
 - . STEEL - 0.10%
 - . ALLOY IRON & SG - 0.15%



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BINDER SYSTEMS

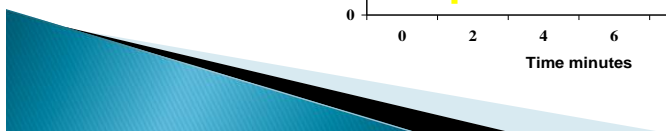
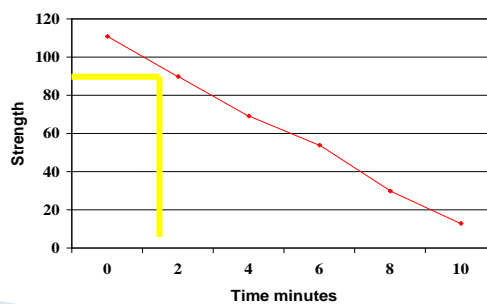
DEFINITIONS & FACTORS IMPACTING ON PERFORMANCE



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MIXED SAND TESTING

- **Mixed Sand Bench life**
 - Working time of the mixed sand before accelerated curing takes place with loss of sand strength.
 - This can be calculated by ramming test cores at set intervals and allowing to cure for 24 hours, the bench life is 75% of the ultimate strength under the test conditions

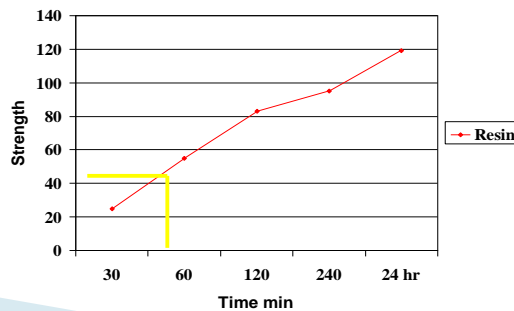


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MIXED SAND TESTING

▪ Strip Time

- Is the time needed for the binder to develop enough strength to allow the mould to be stripped away from the pattern without distorting or breaking
- Strip time can be calculated by determining the rate of strength development of a binder system, the strip time is quoted at 25% of the ultimate strength



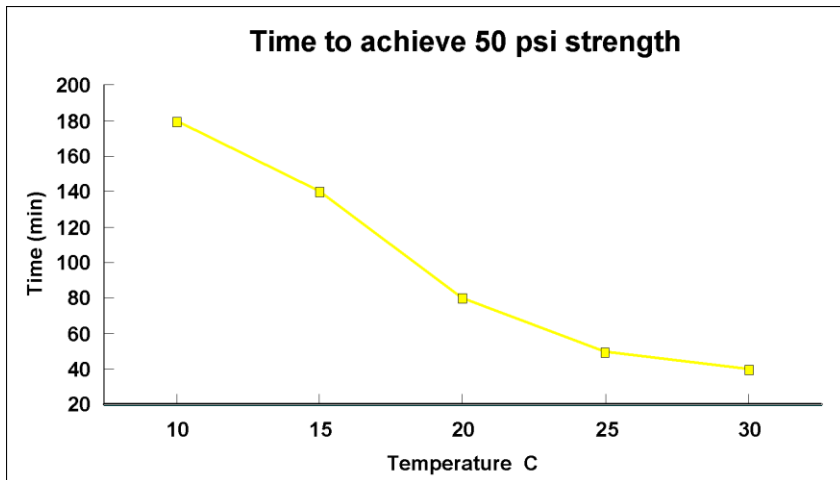
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FACTORS EFFECTING

- Sand Temperature
 - An increase in sand temperature of 10 C will half the mixed sand bench life for a specific setting
 - A decrease in sand temperature of 10 C double the mixed sand bench life and extend the curing time and strip strength
- Ambient temperature will influence the crusting of the mould strickle surface
- Gel testing can be done on phenolic urethane and Alkaline phenolic systems as an indicator on strip time at varying temperatures.

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EFFECT OF TEMPERATURE ON CURING TIME



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BINDER SYSTEMS

FURANE



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TYPES OF FURANE RESINS

- UREA FORMALDEHYDE / FURFURYL ALCOHOL UF/FA
- PHENOL FORMALDEHYDE / FURFURYL ALCOHOL PF/FA
- A COMBINATION OF BOTH SYSTEMS UF/PF/FA
- In Australia all the furane resins are from UF/FA family with different manufacturing techniques
- They are sold based on:
 - Nitrogen content
 - Productivity requirements
 - Fumes and odours

ACID CURED COLD SELF SETTING SYSTEM



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WHICH GRADE OF RESIN Nitrogen content

METAL	NEW SAND	RECLAIMING
PLAIN STEEL	2.0%	1.0%
HIGH ALLOY STEEL	2.0%	1.0%
SG ALLOY IRON	3.0%	2.0%
GREY IRON	3.0%	3.0%
ALUMINIUM	ANY	ANY
COPPER ALLOYS	ANY	ANY



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FURANE CATALYSTS

- CAN BE A BLEND OF THE FOLLOWING:
 - PHOSPHORIC ACID
 - PARATOLUENE SULPHONIC ACID PTSA
 - XYLENE SULPHONIC ACID XSA
 - LACTIC ACID
- THE ABOVE ACIDS CAN BE BLENDED TOGETHER BASED ON :
 - WATER CONTENT
 - FUME
 - REACTIVITY, STRIP TIME, BENCHLIFE



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FURANE ADDITION RATES

- | | |
|---------------------|---------------------|
| •NEW SAND | •RECLAIMED SAND |
| •RESIN 1.1 to 1.6% | •0.9% to 1.2% |
| •CATALYST 20 to 40% | •CATALYST 20 to 40% |

If the catalyst addition is used out side the suggested ranges above, it is advised to change the grade of catalyst, increase or decrease reactivity.

Bench life to strip time ratio:

New sand 3:1

Reclaimed sand 2:1



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FURANE SYSTEM BENEFITS

- EXCELLENT SURFACE FINISH
- HIGH MOULD AND CORE STRENGTHS
- LOW GAS EVOLUTION
- GOOD RESISTANCE TO EROSION
- EXCELLENT BREAK DOWN
- COMPATIBLE WITH BOTH WATER AND SOLVENT COATINGS
- SUITABLE FOR ALL FERROUS AND NON FERROUS ALLOYS
- HOT TEARING CAN BE CONTROLLED BY METHODING

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POTENTIAL DEFECTS

- **SULPHUR**
 - HOT TEARING STEEL CASTINGS
 - REDUCED NODULE COUNT SG IRON
- **PHOSPHORIC**
 - LOW MOULD STRENGTH
 - PITTING DEFECT IN IRON CASTINGS
- **Veining**



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STEEL CASTING EXAMPLE



7 Tonne Pinion Gear produced in reclaimed furane sand

Alloy steel

Zircon coating

0.5% Nitrogen resin

XSA based catalyst

80% reclaimed sand

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PHENOLIC URETHANE SELFSET SYSTEM



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PHENOLIC URETHANE SELF SET BINDER SYSTEM

The common name is - Phenolic urethane cold set.
Like the cold box system there are 3 parts.

- ▶ Part 1 Solvent based anhydrous phenolic resin water free.
- ▶ Part 2 Solvent based solution of methylene di-isocyanate (MDI)
- ▶ Catalyst A liquid tertiary amine with a solvent carrier the speed of the catalyst is based on the amount of liquid tertiary amine present.

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THE PROCESS

Mix clean dry sand with Part 1 & Part 2 in the
ratio 50:50 to 55:45 Total resin addition 1 to 1.5%

↓
Add Catalyst based on weight addition of Part 1 typically 5 to 10%

↓
Fill core box by hand and compact, can be vibrated.

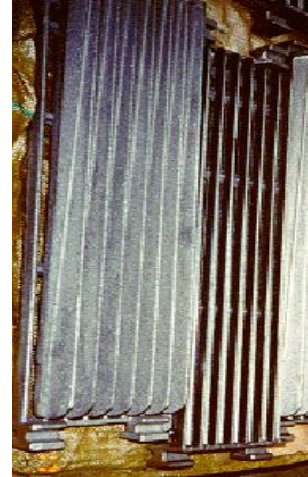
Bench life 75% of strip time

↓
Strip mould or core from pattern

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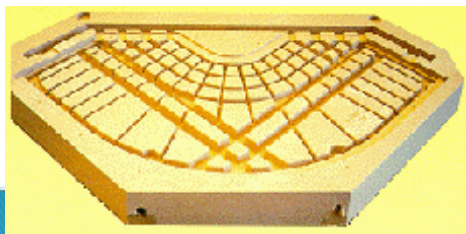
PHENOLIC URETHANE SELFSET

- ▶ Can be reclaimed up to 90%
- ▶ Very high mould strengths
- ▶ High dimensional accuracy
- ▶ PRODUCTIVITY - fast strip times
- ▶ Lustrous carbon LOI max 2%
- ▶ Veining
- ▶ Ideal for iron castings
- ▶ Caution with steel castings



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ESTER SET ALKALINE PHENOLIC MOULDING SYSTEM



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BINDER SYSTEM

- **ALKALINE PHENOLIC RESIN:** Produced by reacting phenol and formaldehyde together in a kettle. The reaction produces a very thick and unstable product. To make the resin stable and have a suitable viscosity for use a combination of sodium hydroxide and potassium hydroxide is added together with surface active additives to reduce surface tension and help the resin coat the sand grains easier. This resin is water soluble.
- **HARDENERS:** Produced by cold blending together a ranger of esters. The Hardener range is from 5 minute bench life to 130 minute bench life. The typical addition rates vary from 20% to 25% by weight of the binder, the variation based on how fine the sand is. To change the mixed sand bench life and reaction time the grade of Hardener has to be changed.



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ADDITION RATES

- NEW SAND
- RESIN 1.3 to 1.8%
- CATALYST 20 to 25%
- RECLAIMED SAND
- RESIN 1.5 to 1.8%
- CATALYST 20 to 25%
- WATER 20 TO 25%

Strip time 3 times bench life



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SYSTEM BENEFITS

- GOOD THROUGH CURE AND STRENGTH DEVELOPMENT
- NITROGEN FREE
- FLASKLESS MOULDS CAN BE Poured 2 TO 3 HOURS AFTER MOULDING
- EXCELLENT CASTING SURFACE FINISH
- HIGH SAND FLOWABILITY
- LOW EMISSIONS AT MOULDING AND CASTING
- EXCELLENT HOT STRENGTH TO PREVENT HOT TEARING AND SAND EXPANSION DEFECTS

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ALKALINE ESTER SET PHENOLIC

- LOI max 2.0%
- Dust 2.0% max bottom 3 screens
- Alkalinity 6% max
- Ni Resist Sewerage Pump
- Finished weight 13.6 tonne
- 80% reclaimed mould
- New sand core



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ESTER SET SODIUM SILICATE



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BINDER SYSTEM

- ▶ Sodium Silicate with SiO_2 : Na_2O ratio range 2.5:1 to 2.8:1 typical addition rate 2 to 4.5%
- ▶ Hardener organic ester blend reacting with the sodium silicate, the ultimate strength achieved by dehydration of the sodium silicate as the ester undergoes hydrolysis in alkali conditions. Typical addition rate 10 to 18%
- ▶ As with the ester set alkaline phenolic, the grade of ester hardener has to be changed to increase or decrease the strip times.
- ▶ Strip time to bench life 1:3

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SYSTEM BENEFITS & CONCERNS

- ▶ Sodium silicates being inorganic, do not produce any form of carbon during the casting process, and the system relies heavily on the coating used to produce a suitable casting surface finish.
- ▶ Only solvent based coatings should be used or moulds and cores oven dried after application.
- ▶ Core breakdown is an issue
- ▶ The system has very low gas evolution and it is rare to find metal/mould reaction defects, the hot tearing properties is the best for all the systems discussed.
- ▶ Reclamation is limited

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COMPARISON SELFSET SYSTEMS

ATTRIBUTES	Ester set Sodium silicate	FURANE	Ester set Alkaline phenolic	Selfset Phenolic Urethane
Reclamation Rates	60%	90%+	75- 80%	90%+
Typical Strength at stripping	11 psi Tensile	31 psi Tensile	21 psi tensile	45 psi tensile
Mould rigidity	Tough / Medium Strength	Brittle / High Strength	Tough / Good strength	Brittle / High Strength
Pattern Stripping	Acceptable	Can be a problem	Good	Can be a problem
Resin	Water soluble	Partial	Water soluble	Not soluble 2-part system
Catalyst	Ester Blends	Acid Blends	Ester Blends	Liquid tertiary amine
Resin Addition	3.5% up to 4.0%	1.5% down to 1.0%	1.4% to 1.8%	0.8 to 1.2% total
Catalyst	15 TO 20%	20% up to 50%	20% to 25%	5 to 20% based on part 1
Bench life strip time ratio	1:3	1:2	1:3	1:0.75 rapid cure
Coatings	Alcohol, must coat	Water / Alcohol	Water / Alcohol	Water / Alcohol
Hot Tearing	Little to none in steel	Can be a real problem	Little to none in steel	Can be a real problem
As cast Finish	Fair	Good	Good	Good
Gas Defects	Hydrogen	Contains nitrogen & Sulphur	Low nitrogen, hydrogen	Nitrogen

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**THANK YOU FOR
LISTENING**

