

Ester cured sodium silicate

A valid process for sand reclamation

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Sodium silicate binder

- It's a binder based on a module with $\text{SiO}_2\text{-Na}_2\text{O}$ ratio varying from 2 to 2.6
- The most popular application method consists of hardening moulds and cores by injection of CO_2 gas
- Another possibility is the addition of a liquid hardener, generally organic esters, in a normal continuous mixer
- In the presence of aqueous silicate, CO_2 gas, or acid, released by hydrolysis of ester causes precipitation of a silica gel that, due to a further loss of water, solidifies the sand to make the required shape.

Advantages of sodium silicate

Low incidence of gas defects

Very low incidence of cracks in castings

No sulphur, phosphorus and nitrogen

Safety for operators and environment

Negative factors which effected sodium silicate use

- Low strength and break-down capacity
- Short preservation
- Low flow ability of the sand mix
- High shake-out time-bench life ratio (in case of silicate/liquid hardener)
- Difficult sand reclamation

Strength depends on

growing application percentages

growing silicate module

type of silicate

Break-down capacity depends on

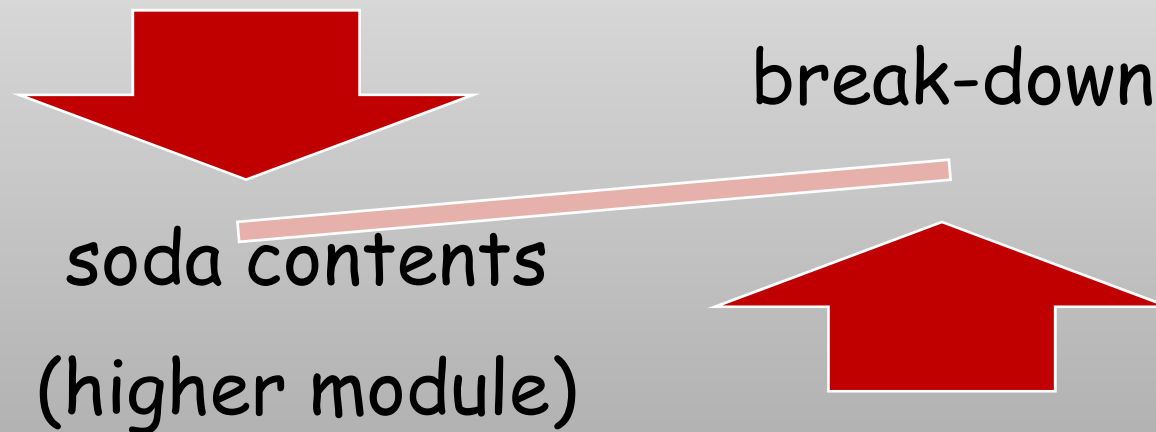
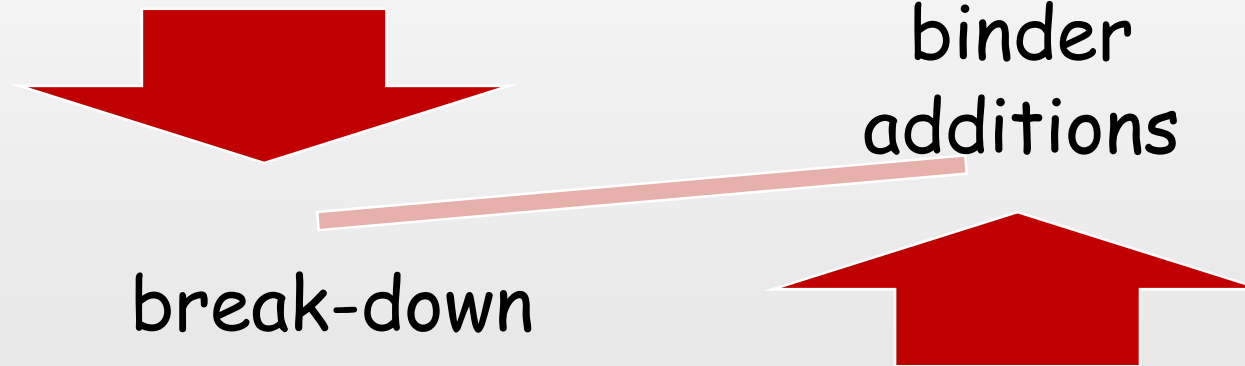
percentage of the applied binder

silicate module

type of silicate



Break-down relations



Remedies

Addition of

- saccharine
- dextrose
- wood flour
- graphite



better break-down capacity

loss of strength and core
preservation



use of special
organic material

Sand mix flow ability

Depends on:

- percentage of the applied silicate
- silicate viscosity



Development of products with low viscosity modified by special additives and which allowed to reduce considerably the percentage of application.

Bench life and shake-out time

- A short bench life means high module and, in case of silicate/hardener, a higher setting velocity.
- the higher the sand/ambient temperature, the shorter the bench life and, in case of silicate/liquid hardener, the higher the setting velocity.



Development of hardener which influences setting velocity

Sand reclamation

- wet sand reclamation with high yields requires very large volumes of sand to justify the high investment involved
- plant dimensions have to be very large and in addition washing water must be treated



Dry sand reclamation seems to be the only economically acceptable solution

Sand reclamation: problems

The following problems have been found during the development of this process

- due to its increased accumulation, residual binders in the sand interfere with the hardening reaction reducing the bench life of the sand mixtures to a point where regular production of moulds and cores is compromised
- accumulation of residual material also increases the content of soda in the sand, continuously reducing sand refractoriness.

Sand reclamation: target

**REMOVING THE ELASTIC
FILM OF SILICATE FROM
SAND GRAINS**

Sand reclamation: solutions

From chemical point of view:

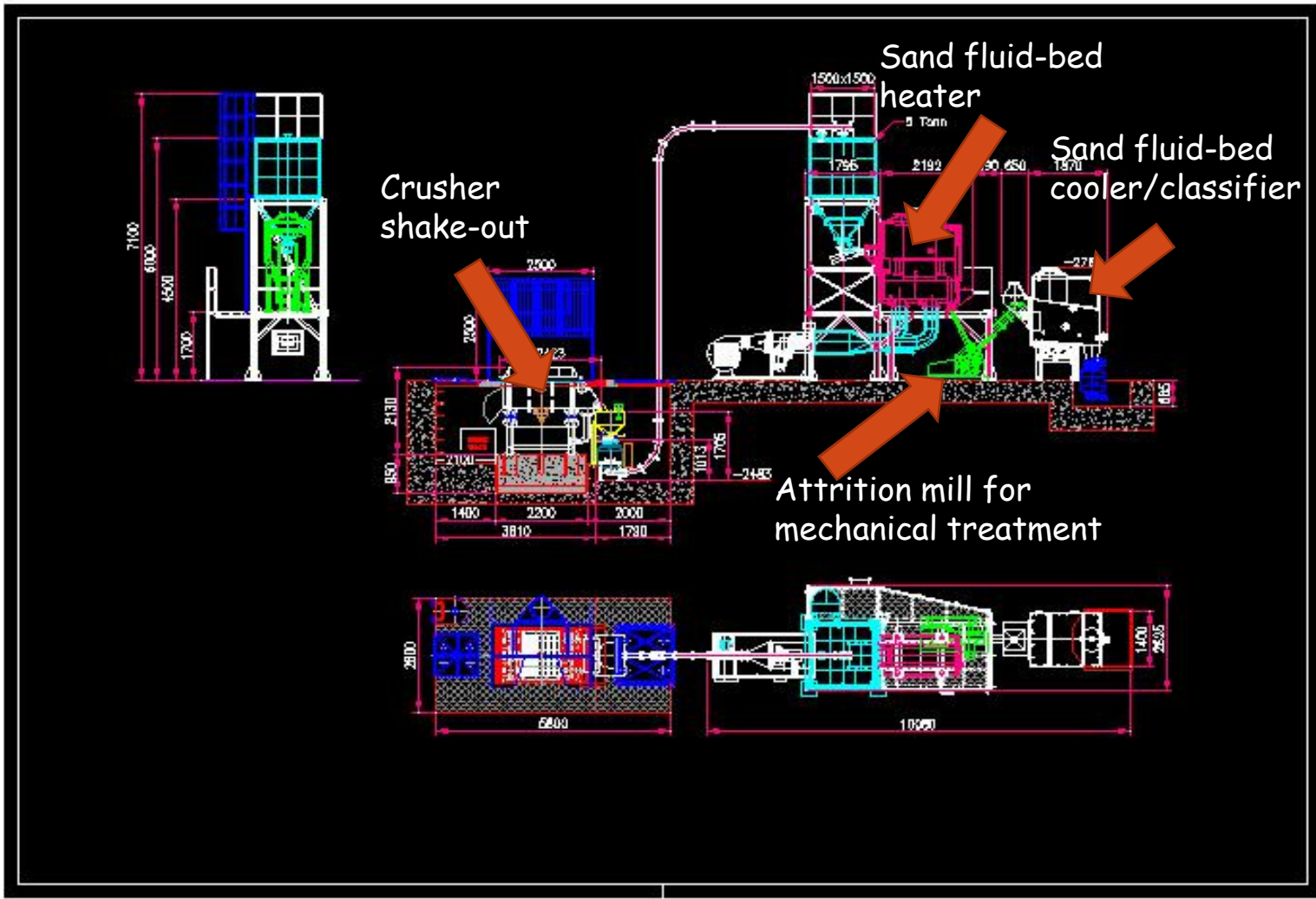
- use of propylene carbonate (ester) which, when in contact with silicate, hydrolyse, causing the precipitation of silica without leaving any residue to effect the plasticity of the silica film

From installation point of view:

- Use of a thermo-mechanical reclamation because heating the silicate film which covers the sand grain greatly helps the removing of the elastic film of silicate

Sand reclamation: topics

- sand heating in a fluid bed dryer with a temperature of 150 °C where sand loses the main part of its incorporated water, therefore the silicate film which covers the sand grains becomes stiff and fragile.
- mechanical attrition to remove the silicate film
- sand cooling, classification and dedusting in a fluid bed machine
- pneumatic conveying of sand to storage silos





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Reclaimed sand: typical results

- L.O.I. at 550° C. 0,6% max
- Alkalinity 0,3% max (NA₂O content)
- Fines < 100 mesh 3.0% max

 Bench life and shake out time at 20°C are doubled if compared to new sand

 Yield of reclamation is 90-95% with only 5-10% addition of new sand, mainly with cores

To keep these results constant ...

... it is necessary to check the following parameters:

- % of binder and hardener in use (3-3.5 % of sand for binder, 10% of binder for hardener)
- chemical and physical features of the sand
- working conditions of the reclamation plant, with special attention to sand temperature inside the drier, wear of the friction mill and dust collection of the sand.

Case study: Farem foundry Remanzacco (Italy)

- Steelmaking foundry producing valves, castings for mechanic industry
- Weight from 10 to 5000 kg
- 4000 ton/year production
- Ester cured sodium silicate as binder
- Use of silica sand and chromite sand
- Thermo-mechanic reclamation plant
- Chromite separation from silica sand

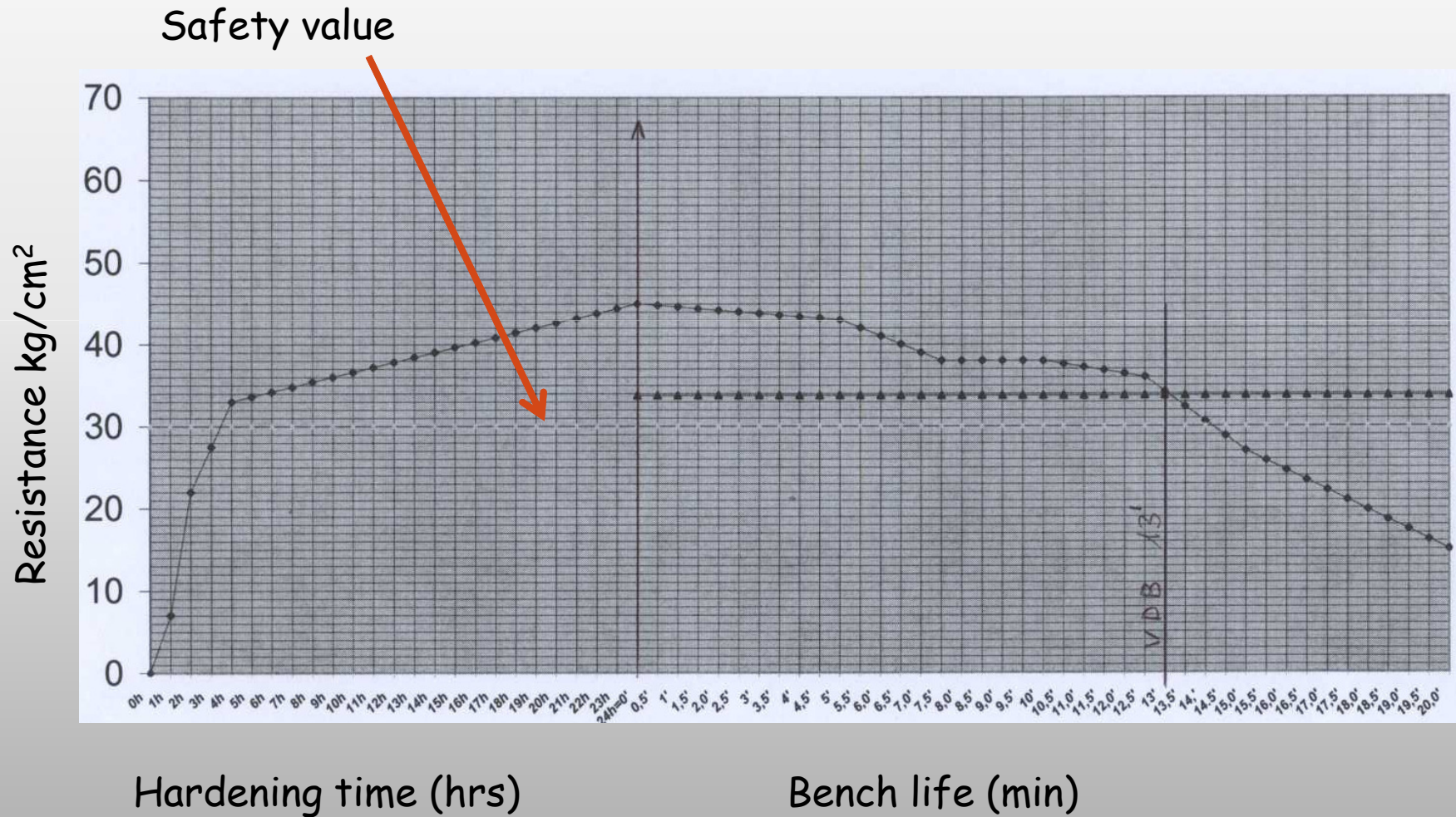
Typical castings produced by Farem



Reclaimed silica sand analysis

- **L.O.I.** 0,33%
- **NA₂O content** 0,08%
- **Fines < 100 mesh** 4.3%
- **Compression resistance**
 - 7 kg/cm² (1 hr)
 - 33 kg/cm² (4 hrs)
 - 43 kg/cm² (24 hrs)
- **Bench life** 13 min

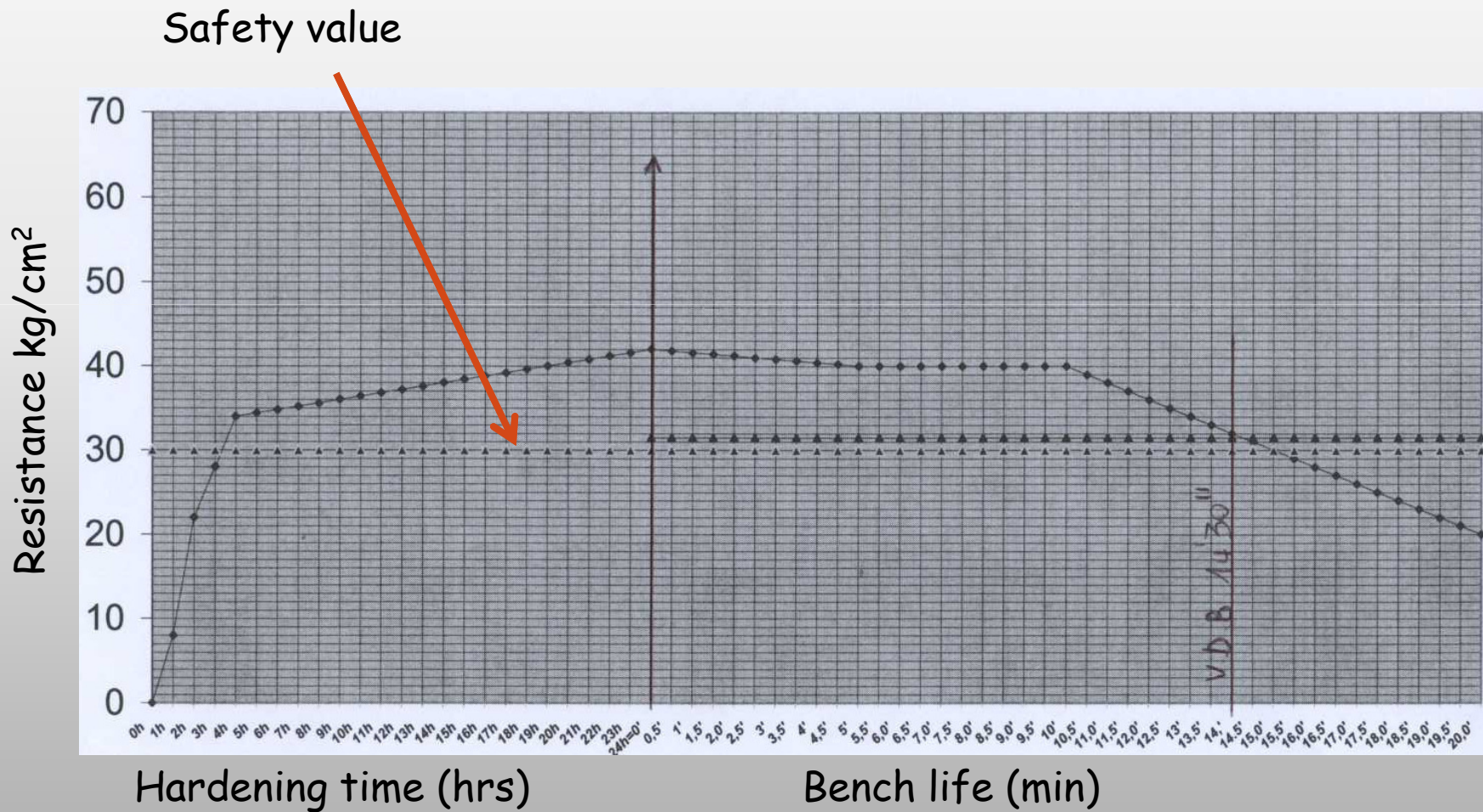
Sand bench life graph



Reclaimed chromite sand analysis

- **L.O.I.** 0,33%
- **NA₂O content** 0,15%
- **Fines < 100 mesh** 2.6%
- **Compression resistance**
 - 8 kg/cm² (1 hr)
 - 34 kg/cm² (4 hrs)
 - 42 kg/cm² (24 hrs)
- **Bench life** 14.30 min
- **Silica sand content** 1.24%

Chromite bench life graph



Results

- 100% use of reclaimed sand for moulding (backing)
- 100% use of reclaimed chromite for moulding (facing)
- Only 5% addition of new sand/chromite through cores

Additional remarks

- The process can be applied using different types of sand, such as: chromites, silica, olivine
- Approximately 30% of sand hardened by CO_2 does not create any problem
- Latest sodium silicate gives good bench life and compression strength with high room temperature too

Conclusions

This process has given the following advantages

- Low moulding costs due to a lower use of binders and higher sand reclamation.
- Very good castings with good surfaces and impressive reduction of defects caused by gas.
- Healthier working environment and no dangerous gas evolution.

**Thanks a lot for your
attention**

For more details: www.sogemieng.it