*The demands of global competition are growing all the time. Besides high cost pressure and short delivery times, foundries need to meet the highest quality requirements. In time for its 50th anniversary, Grunewald has taken account of these needs: with a new hall and ultramodern process technology in the moulding shop and reclamation plant, it has been able to increase its capacities considerably. In the course of this, together with ASK Chemicals from Hilden, an innovative PEP SET system, which is optimally tuned to local processes, has been developed.*

# PEP SET – an efficient and environmentally friendly binder system

Next to tool and component construction, the casting segment is the third largest pillar of the international business of Grunewald, which employs 240 staff at six sites worldwide. The company is one of Europe's leading manufacturers of thin-walled aluminium structural parts for the automotive sector, the semiconductor industry and machinery construction, possessing excellent know-how in prototype and small series production for the different industries.

In response to new and increasingly varied customer demands and rising cost pressure, the foundry was expanded to a total 2800m$^2$ in 2013. This was an important step towards future safeguarding and enabled the company to concentrate and restructure the whole production at one site.

In the early stages, work was carried out in conjunction with ASK Chemicals to change the binder system so the company could achieve further optimisation in terms of processing and costs, such as improvement in the casting quality and greater productivity in mould making. The furan resin system used hitherto was, firstly, unable to satisfy the demands for an improved casting surface with simultaneously improved productivity. Likewise, the reclamation of used furan sand is subject to certain limitations - a thermally reclaimed mould material produced by an acid-hardening process has a high proportion of metal oxides; these metal oxides slow down the acid-catalysed hardening reactions on the reclaimed material (see fig.1).

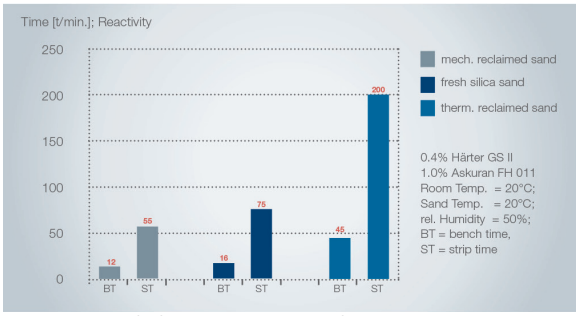


Fig.1 Reactivity of a furan resin system with fresh sand, mechanically reclaimed sand and thermally reclaimed sand

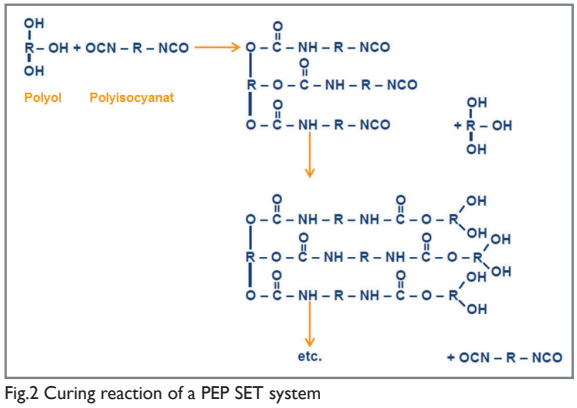


Fig.2 Curing reaction of a PEP SET system

The use of a thermally reclaimed mould material compared to fresh sand and mechanically reclaimed sand prolongs the strip time almost threefold. To bring reactivity (the strip time) to the level of mechanically reclaimed sand, it is necessary to increase the acid catalyst amount by approximately 30 per cent. An increase of the acid catalyst, however, leads to a considerable increase in $SO_2$ emissions and also results in a deterioration of casting quality. Thermal sand reclamation was not planned initially, but after extensive analysis it offered the advantage of a higher quality of reclaimed material and, due to the increased proportion of reclaimed sand, an almost 15 per cent reduction in the waste sand requiring disposal.

## FINDING AN ALTERNATIVE

Due to its many outstanding advantages, the polyurethane no bake system, so-called PEP SET system, was a potential alternative system for Grunewald. PEP SET binders are based on a poly addition reaction between a phenolic resin (polyol component) and an isocyanate component. PEP SET involves a three-component system consisting of a binder (part 1), a hardener (part 2) and a liquid catalyst. Hardening occurs without the formation of elimination and by-products such as water or formaldehyde (see fig.2).

The PEP SET system is characterised by a relatively long processing time with simultaneously very rapid curing (see fig.3) and thus guarantees maximum productivity thanks to very fast cycle times.

The strengths are at a very high level (fig.4), enabling the addition of binder to be significantly reduced, which in turn reduces emissions of the contaminants during moulding and casting. The standard addition of a PEP SET system is very often below 0.6 per cent per part.

The curing speed is only negligibly dependent on the ambient temperature and/or sand temperature (fig.5) and can be controlled, almost as preferred, with the quantity and/or quality of catalyst (catalyst amount specific to part 1: 0.5-5.0 per cent).

Another important aspect for Grunewald was that the binder system doesn't interact chemically with the company's polystyrene models (fig.6). To fulfill these needs solvent combinations and manufacturing processes for part 1 as well as for part 2 have been optimised.

In close collaboration, an innovative PEP SET system was developed, which can be applied directly to polystyrene models in aluminium casting without coating. PEP SET 10 part 1, PEP SET 20 part 2 and Catalyst 3595/20 have since been successfully used for the series production of moulds with thermally reclaimed sand. The castings are now created with such excellent surfaces that the amount of reworking, especially in deep pockets and cavities, has decreased significantly (fig.7).

## CYCLE TIME INCREASED

Owing to the optimally adjusted ratio of processing work time to strip time, accompanied by very high final strengths, it has been possible to increase the cycle time in the mould shop considerably. The excellent flowability of the PEP

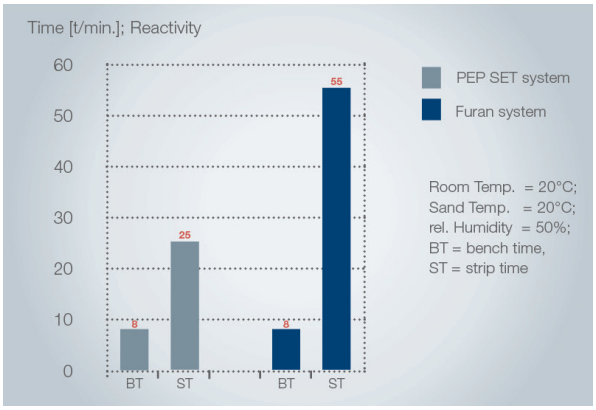


Fig.3 Hardening diagram of a PEP SET system compared to a furan resin system

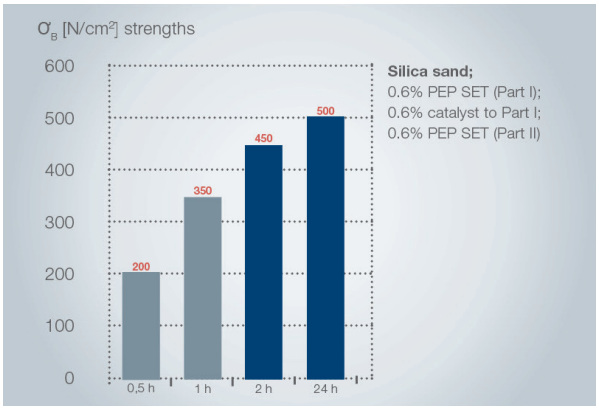


Fig.4 Strengths of a PEP SET system using silica sand H33

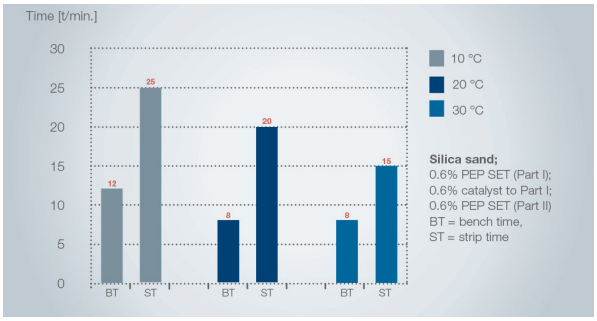


Fig.5 Dependency of reactivity on temperature

SET mould sand enables even the finest model contours to be formed with maximum precision. Due to this the need for proper models as well as for high qualities in mould and tool making processes has even increased enormously.

The sand strengths also attain high values with the thermally reclaimed material. Despite the sometimes-complex geometries, it is possible with the new system to work with a minimum binder and catalyst amounts. The thermal reclamation of the used sand proceeds in a very stable way (fig.9) and facilitates both resource-efficient and cost-saving work.

## CONCLUSION

Thanks to the efficient collaboration of Grunewald and ASK Chemicals, an innovative PEP SET system has been developed, and both productivity and casting quality have increased considerably. At the same time, due to the thermal reclamation of the used sand and the possibility of binder and catalyst reduction, not only are cost savings made but also the health of staff and the environment are protected because of lower $SO_2$ emissions.

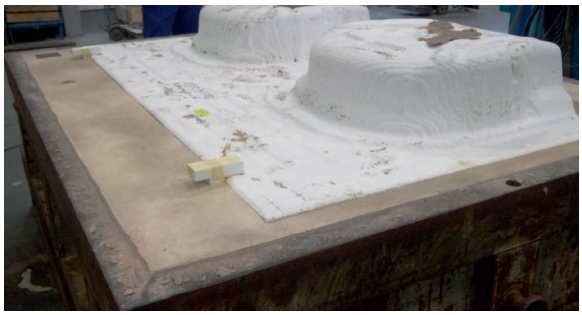

Fig.6 Polystyrene model after demoulding


Fig.7 Comparison of casting surface - sand moulds manufactured: old (with furan resin), new (with PEP SET binder)

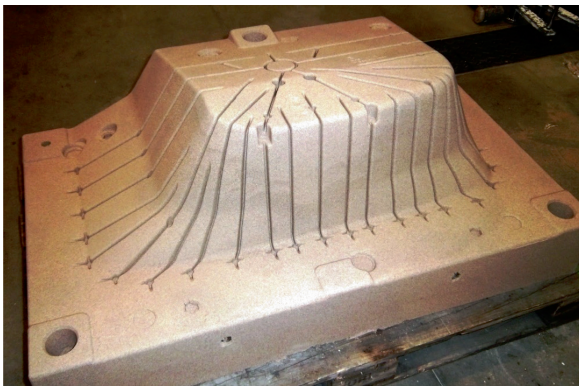

Fig.8 PEP SET mould with thermally reclaimed sand

| Characteristics | Therm. reclaimed sand | Silica sand H 33 |
|---|---|---|
| Average grain [mm]: | 0.27 | 0.27 |
| Fines content (<0,125 mm) [%]: | 0.30 | 0.40 |
| AFS number: | 52 | 53 |
| pH value: | 9.3 | 7.0 |
| Electr. Conductivity [µS/cm]: | 49 | 11 |
| Loss of ignition [%]: | 0.15 | 0.00 |

Fig.9 Characteristics of the thermally reclaimed material versus silica sand H33

## AUTHORS

Anton Gieniec, business line manager no-bake Europe; Natascha Hurkes, head of laboratory; Peter Vietoris, area sales manager Germany North West (ASK Chemicals, Hilden); Harald Dieckhues, foundry head (Grunewald GmbH)

Contact: ASK Chemicals, Tel: +49 211 71103 0, email: info@ask-chemcials.com
web: www.ask-chemicals.com