EVACTHERM® technology: the modern processing of bentonite-bonded molding sand in foundries

Facts – Data – Arguments

The thermodynamic relationship between pressure and temperature in liquids (Fig. 1) enables special production processes to be performed safely, in a defined time, with exact temperature control and reproducible results.

Today, in the context of large-scale technical plants, pin-point control and reliable temperature management of process flows are indispensable for pasty materials and liquids, be it in the chemical, pharmaceutical, food or electronic industry.

In the early nineties the EVACTHERM® method was developed by Maschinenfabrik Gustav Eirich GmbH & Co KG by taking advantage of thermodynamic effects for foundry processes. This enabled always constant and accurate re-cooling and optimal preparation of green sand. By 2012, this innovative molding sand preparation technology had been successfully put into operation in the form of 43 EVACTHERM® plants and 55 EVACTHERM® mixers at iron and aluminum foundries worldwide.

Foundries which decide to work with EVACTHERM® technology are looking for a modern technical solution which offers a maximum efficiency and quality in order to become established and competitive on a market where the demands have grown far more challenging.

The most important advantages for the plant operators are as follows:

- The highest possible plant availability (empirical values lie at 98 %).
- Assurance of constant, reproducible molding sand grades in spite of fluctuating input and ambient conditions.
- Reduction of emissions and increase of environmental compatibility.

These effects can be reliably achieved by the comprehensive plant technology of the EVACTHERM® process.

The core process

3 process steps – 1 mixer – 70 seconds

The process steps "cooling", "preparation" and "mixing" are performed in one mixing unit within the core period of 70 seconds, which is fixed by physical and technical constraints.

Within this period

- the sand is cooled to exactly 40 °C,
- bentonite with a residual moisture content of 0.5 % is supplied with water and dispersed to optimum effect,
- and the molding material is effectively and intensively mixed with all components.

The cooling process is performed on the basis of the physical correlation between vapor pressure and temperature mentioned above. For this purpose a vacuum is technically generated in the mixing pan.

The water required for the cooling is added in accordance with the measured moisture level and temperature of the return sand. A pressure differential is then applied to create steam which is discharged to a condenser. The condensed water is then returned to the process.

At 73.9 mbar the returned hot and dry return sand reliably reaches 40 °C, regardless of any fluctuating starting conditions.

Result: The grains of sand are uniformly cooled in 70 s.

In comparison:

The cooling effect of the process water (at 15 °C supply line temperature) under atmospheric conditions, i.e. without evaporation, would be only approx. 9 K, which for the above mentioned example would be equivalent to an achievable molding material temperature of approx. 71 °C.

It therefore takes less than 70 s to fully prepare the bentonite instead of several hours of "tempering" under atmospheric conditions. And the results are reliable even with a residual moisture content of 0.2 % in the return sand. A residual moisture content of 2 % is recommended by specialists for preparing bentonite under atmospheric conditions,

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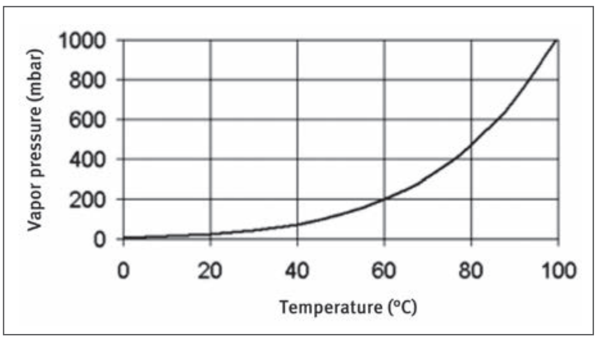

Fig. 1: Correlation between vapor pressure and temperature

Fig. 2: EVACTHERM® plant with two mixers, condenser and silo equipment →

	Molding material batch of 4000 kg at 80 °C and 0.2 % residual moisture	Value
1	Water requirement for prepared sand with 3.2% water content (process water)	120,0 l
2	Cooling from 80°C to 40°C: amount of heat to be discharged	134.400 KJ
3	Water requirement for evaporation (cooling water) Total water added	59,4 l 179,5 l
4	Process water needed advantage: recycling of cooling water and fines	3.024 l/h

Fig. 3: Example of water requirement

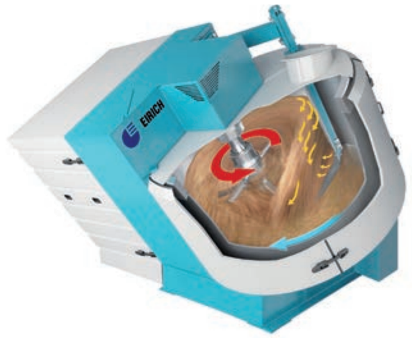

Fig. 4: EIRICH mixing principle

but this is not necessary in a technically generated vacuum.

The following mechanisms contribute to preparing the bentonite:

– Very few gas molecules exist in the technically generated vacuum.
– The process water loses its surface tension and, finely dispersed, moves through the pan in the vapor phase, performing the cooling process as described above.
– During the vacuum mixing period the layers of bentonite particles open spontaneously because the inner lying gas molecules have to escape.
– This expansion creates room for the very finely distributed water (vapor) molecules, which are literally forced into the bentonite layers when the vacuum is broken.
– The condensation effect takes place when atmospheric pressure is reached, resulting in the layers of bentonite being optimally covered with water within 70 s.

It should also be noted that for foundries equipped with EVACTHERM® technology the subject of *ratholing/piping* in the silo is a thing of the past.

The mixing process

Rotating mixing tools (Fig. 4) in the form of rotors ensure vigorous mixing and intensive energy input, which in turn enables a reduction in the additives required.

The rotating mixing pan moves the sand continuously into the area of the mixing tools.

Static scrapers with adjustable deflectors result in agitation of the material flow. Material accumulating on wall and bottom is removed continuously, helping to produce a clean mixing pan that can be completely emptied.

Various mixer sizes are available to meet many different requirements. Large foundries working continuously in 3 shifts prefer the technically efficient solution of two mixers with one condenser and shared vacuum peripherals.

Iron foundries which already have three RV32VAC mixers cover their demands in continuous 3-shift operation with more than 1500 continuous mixes and an output of over 8500 t of molding material per day.

Online measurement, control and documentation with the QualiMaster AT1 and the software SandExpert

Faster, more flexible and more efficient on the one hand, rising demands on quality and reliability on the other – a good molding material preparation system is unthinkable without systematic quality assurance.

To meet these needs, EIRICH has developed a seamless data integration strategy which ensures the networking of production and engineering parameters at all levels. Process, product and quality relevant information is thus available online at any time.

The QualiMaster AT1 molding sand tester offers, in combination with the SandReport or SandExpert software, proactive management and control of the molding material properties within close tolerances around a setpoint value.

In addition, the SandExpert software has a self-optimizing pre-control function which the program uses to calculate recommendations for mixing in additives and water on the basis of a standard parameter file.

To determine the control parameters of *compactability* and *shear strength*, 3 samples of a mix are taken by the QualiMaster AT1 and tested as soon as the mix is completed. These data form the basis for correcting the moisture and bentonite content of the next mix which is already in preparation. Given the previously described workflows it is clear that the corrections will have an immediate effect on the quality of the subsequent mix.

All important parameters and process values are visible online via the monitoring function.

Any deviations can thus be detected and suitable corrective action taken without delay.

Output in t/h	Output in m^3/h	Batch size in liters	Mixer type
7– 7,5	8,4	350	RV11VAC
10– 11	12	500	RV15VAC
31– 32,5	36	1.500	RV19VAC
61– 65	72	3.000	RV23VAC
102–108	120	5.000	R32VAC
143–151	168	7.000	RV32VAC

Fig. 5: Output and batch sizes

Step	Technical operation	Duration (s)
1	Charging of the mixer	15
2	Homogenizing	5
3	Measuring moisture and temperature	10
4	Water addition	15
5	Wet mixing	5
6	Vacuum-mixing	70
7	Discharging	30
	Total mixer cycle	150

Fig. 6: Example of preparation cycle with the RV32VAC, 7000 l for 24 batches/h and 150 t/h

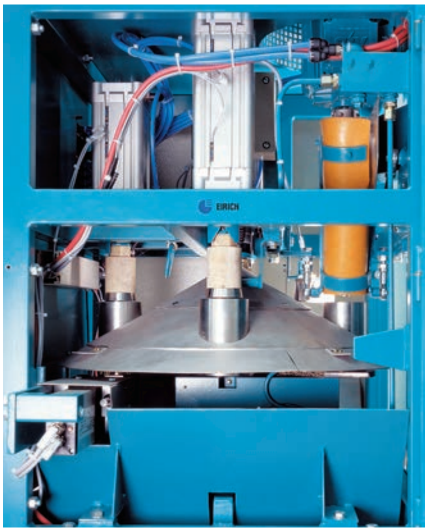

Fig. 7: QualiMaster AT1

Fig. 8: SandExpert: View of the temperature curve of the return sand and the newly prepared molding material

Arguments

EVACTHERM® process technology ensures:

- Optimum quantitative and qualitative disintegration of the bentonite in the technically generated vacuum.
- Reduction of bentonite consumption depending on the process control of the particular application.
- Optimization of the raw material infeed for each batch thanks to the QualiMaster AT1 tester.
- The mixing in of additives (starch or resin) can be reduced or discontinued completely thanks to the intensity of the preparation.

EVACTHERM® process technology enables:

- 25 % lower storage volume of return sand because no time has to be spent in storage by the return sand in order to absorb water.
- Optimum preparation of return sand even with a residual moisture content of less than 0.5 %.
- Bentonite activation and cooling in the technically generated vacuum within 70 s.

EVACTHERM® process technology and the environment:

- The dust extraction air volumes are reduced by half because the conventional air coolers are no longer needed.
  Example of 300 t/h molding sand output:
    Dust extraction air volume with vacuum 100,000 m³/h
    Dust extraction air volume with air cooling 220,000 m³/h
- Retention of reusable substances in the molding material system (fines).

A major advantage of preparing molding sand with EVACTHERM® technology results from the closed water circuit.
The fines which are entrained during the cooling process settle in the condenser and are returned to the preparation process via the water scale.
The discharging of valuable fines into the dust extraction system is prevented and considerable savings are achieved depending on the plant concept.

- Less costs for disposing of filter dust.
- Reduction of emissions and therefore increase in environmental compatibility on all counts. ◄