JOEST Casting Cooler Type FSMG

Application

A casting cooler provides a continuous, shock-free cooling for casting parts and is usually allocated behind the shakeout. The casting cooler is typically followed by sorting conveyors.

Technology

Three engineering disciplines are applied:

- Machine dynamics
  (vibrating feeder as a resonance machine)
- Thermodynamics
  (heat exchange cast/air in a reverse flow)
- Fluid Dynamics
  (turbulent cooling airflow with injector nozzle)

Resonance vibrating feeder system

Resonance conveyors are used when long conveying distances are required. A casting cooler is a heavy-duty version of such a resonance conveyor; the conveyor trough is sealed nearly air-tight with a cover. The vertical acceleration of the machine caused by the harmonic oscillation is less than 1G. That means the casting parts are not exposed to any micro throwing motions.

Design

Mostly bolted / riveted, modular steel construction set together from welded assemblies with the main ones being the trough, cover, trough frame, static base frame and the vibration absorbers.

The conveying trough is bolted to the trough support frame, which consists of angle sections. It is separate from the machine and can easily be replaced. The troughs are made from thick manganese steel and along with the covers, they feature thermal expansion joints. Furthermore, the bolting allows the troughs to move along the support frame when their temperature rises during operation

Functional principle of the resonance machine

The mass of the machine's trough forms an oscillating system with the spring constant being the sum of all working push-pull springs and directing leaf springs. This system has a defined, precisely calculated natural resonance frequency at which the system performs a harmonic oscillation, even at very low dynamic excitation forces. Within this system, there is a constant shift between kinetic energy (maximal velocity at zero crossing of the motion) and potential energy (the entire energy is stored in the springs under tension at the dead center).

It is to be noted, that the sum of the restoring forces in all working springs would be directly transferred into the ground as dynamic forces if no countermeasures were implemented. This would result in considerable vibrations within the foundation.

Drive unit

The correct exciting frequency for the oscillating system is provided by a slider-crank drive with a V-belt powered by a three-phase standard motor. The exciting frequency lies roughly 5% beneath the natural resonance frequency.

CASTING COOLER

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JOEST®

APPLICATIONS

- Green Sand Molding Process

SIZING

- Standardized trough widths 1400/1600/1800/2000/2500/3200 mm
- Length of the conveying trough up to 60.000 mm

SINGLE VIBRATION ABSORBER MODULE

Explanation of (*) natural flexural vibrations:
Natural flexural vibrations occur in long vibrating machines that don't have a fixed connection to the floor, meaning they are suspended on springs across their entire length. Natural flexural vibrations in conventional two-mass systems with great lengths are barely controllable. Even though the frequencies at which they occur can be calculated, a calculation for the oscillating counterweights filled with recycled cement is not possible. The reason being is the lacking definition of the recycled cement mass's E-module. (The elasticity of the counter frame cannot be calculated). If the natural flexural frequency lies close to the operating frequency, the lifespan of the main structure is drastically reduced.

ADVANTAGES OF THE FSM SYSTEM

- ☑ Very large manufacturing lengths (approx. 60m) in one piece without disruptive transition points
- ☑ Optimal spring accessibility thanks to comb shaped design
- ☑ approx. 30% less weight compared to two-mass resonance system
- ☑ can handle very heavy loads, even during start-up, low start-up current
- ☑ working springs operate within the fatigue limit, no fatiguing
- ☑ significantly lower drive power needed when compared to other systems
- ☑ Modular design with self-contained, functional units in standardized sizes
- ☑ Easy installation and transport to the site due to compact vibration absorber units (division possible between each module)
- ☑ No welding or concreting of counterweights on site
- ☑ No concrete components included in the construction, solid steel design
- ☑ Non-disruptive crossing enabled by the lack of a continuous counterweight frame
- ☑ By design, the system avoids hazardous natural flexural vibrations (*) of the trough or the oscillating counterweights since it is fixed to the floor

Vibration absorbers

In order to compensate the dynamic forces that are created by the trough's motion, vibration absorbers (active, driven counter-weights that are forcefully synchronized) are placed underneath the trough in regular intervals. The modular system is made up of massive steel counter masses that work in-phase with double the trough amplitude and contrary to the trough's motion. This way, the counter masses almost completely compensate the dynamic forces, which is called "balancing".

Heat exchange through reverse flow

The air-cooling flow runs against the material flow of the casting parts. This has two advantages:
This method of heat exchange is the most effective and offers the best amount of heat exchange per meter of casting cooler.
This method of cooling prevents thermal tensions caused by too rapid cooling within the casted part. By the time the air reaches the hot part of the cooler, (where the hot parts are discharged by the shakeout) the air has already heated up by rushing past the other casting parts. When using other methods of heat exchange (cross flow or coflow), the two advantages mentioned do not apply.

The heat exchange of the casting parts in the cooler can be precisely calculated using the computational basics of the reverse flow heat exchanger. There is a calculating software with which various layouts can quickly be calculated.

Air routing

The cold end of the casting cooler features the cooling ventilator above the cooler itself. At the hot end (feed end), an on-site suction pipe is connected which leads to an on-site filter system with a suction ventilator. The required negative pressure is 2000 Pa. The required extraction volume flow is determined by the client specific casting cooler calculation. A special nozzle design prevents dusty air from escaping the machine, even though both ends are open.

The exact calculation of a casting cooler requires the following information:

- Inner molding box size WxLxH1/H2 (mm)
- Output of the molding plant (molds/hour)
- Casting material
- Weight of the reference casting part (kg)
- Module of the reference casting part (cm)
- Number of reference parts in one molding box
- Total mass of iron (reference parts + gating system) in the molding box
- Expected temperature of the casts upon entry into the cooler (°C)
- Desired discharge temperature at the end of the cooler (°C)
- Maximum available cooling length based on the plant layout (mm)

The parameter "module" which expresses the relation between the cast volume and the cast's surface area has a large impact on the design of the cooler. Therefore, it is critical to determine its value very carefully. Inner surface areas of the cast may not be included in the calculation of the module.

Discharge temperatures typically range from 80° to 120°C. Low temperatures result in very large, cost-intensive coolers because the difference in temperature to the cooling air decreases. This results in the casting cooler becoming exponentially longer.

Typical cast entry temperatures are roughly 500-550°C. For temperatures >600°C, the risk of casts being damaged on the shakeout rises due to the rapid decrease of strength in casted parts with temperatures higher than 550°C. In this case, the inmould cooling time should be extended.

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