Analyzing the Cement Process

Bearing Application and Production Considerations

Power Transmission Engineering is collaborating with the Bearing Specialists Association (BSA) on a special section within the magazine. *Bearing Briefs* will present updated reports on bearing topics for each issue in 2016. Complimentary access to all BSA Bearing and Industry Briefs is available on the BSA website at *www.bsahome.org/tools*.

Quarry

The manufacturing process begins in a limestone quarry. Mining methods such as ripping, dozing, drilling and blasting are commonly employed. Limestone provides the first essential component, calcium, for the manufacture of cement. Materials are transported to the crushing plant for further size reduction. Common methods of transport are trucks, loaders and belt conveyors.

Bearing applications: Mounted spherical and tapered roller bearings, both set screw and adapter mount. Spherical roller, ball and cylindrical roller bearings are also used. Split housing cylindrical bearings and split to the bore cylindrical are often used in "trapped" applications.

Items to consider: Bearings are subjected to abrasive dust and fine dirt. Some bearings may need to withstand very wet conditions. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered. Bearing housings are often struck by heavy materials requiring cast iron or solid steel, pillow block construction. Many applications are relatively slow speed and may require additional lubricant.

Crushing

Quarried limestone is usually too large for effective use in the remaining steps of the production process. Impact and hammer crushers reduce the size of relatively soft material, while compression crushers are used for larger rock. Effective size reduction aids material transport, material blending and further size reduction through various grinding methods.

Bearing Applications: Mounted spherical roller bearings, spherical and tapered roller bearings.

Items to consider: This application is subjected to heavy shock loads which require all steel or cast iron pillow block construction. The area is heavily laden with abrasive dust and dirt, requiring robust bearing seals. Crusher related spherical bearings are specified with additional internal clearance and are constructed to withstand the heavy vibratory and shock loads (shaker screen).

Pre-blending

Crushed material is transported on belt conveyors to a stacker assembly. The stacker assembly builds a bed of material in either circular piles or long, linear rows. These "pre- blending beds" are built in layers and then reclaimed at right angles to the pile. This has a homogenizing effect on the material, providing a consistent product to the Raw Mill.

Bearing Applications: Mounted spherical and tapered roller bearings, both set screw and adapter mount. Ball bearings in idlers. Head and tail pulley contain spherical roller bearings.

Items to consider: Bearings are subjected to abrasive dust and fine dirt. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered.

Raw Mill

Blended limestone and clay are introduced to a grinding mill with sand, fly ash, and iron ore. Correct proportions are important to product quality, requiring a high level of automation and analysis. Raw materials are ground to a fine powder using vertical roller mills, rotary ball mills, or a roller press. Fineness is controlled with a material separator using airflow and rotating vanes to classify product. Coarse product is returned to the mill while fine product is conveyed to storage. Bucket elevators, screw conveyors, and air slides are utilized for material conveyance.

Bearing Applications: Pillow block and flange mounted spherical and tapered roller bearings are typically found on screw conveyors, belt conveyors and bucket elevators. Large fans may utilize babbitt lined, oil lubricated sleeve bearings. Smaller fans utilize mounted ball and spherical bearings. Some cylindrical but mainly spherical roller bearings (depending on design). Large mounted spherical roller bearings can also be found on vertical mill grinding wheel assemblies.

Items to consider: Bearings are subjected to fine, abrasive dust. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered.

Homogenization

Ground raw meal is stored in large silos that are air activated to promote blending of the raw meal, reducing chemical variation and promoting stable sintering in the kiln. Some systems utilize a series of mass flow silos: individual silos are sequentially filled, while product is withdrawn from all silos simultaneously. Dry material is conveyed pneumatically or by bucket elevator to the rotary kiln.

Bearing Applications: A variety of bearings are used. Mounted spherical and tapered roller bearings, are typically found on larger conveyors and bucket elevators, while smaller conveyors may utilize setscrew mount ball bearings. Fans may utilize mounted

ball and spherical bearings. Agitator– sealed single row deep groove ball bearings on the fixed end and cylindrical roller bearings on the free end. Housed or mounted spherical and ball bearings for bucket elevators. Pneumatic Blowers, both regenerative and non-regenerative Ball bearings including thrust bearing sets.

Items to consider: Bearings are subjected to fine, abrasive dust. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered.

Preheater/Precalciner

Dry, homogenized raw meal is fed into a preheater/precalciner where it is dried, heated and partially calcined before introduction to the rotary kiln. Calcination occurs at around 900°C and involves the disassociation of carbon dioxide (CO_2) from calcium carbonate ($CaCO_3$).

The resulting calcium oxide is then free to combine with alumina, silica, and iron oxide to form new mineral crystals.

Bearing Applications: Large fans may utilize babbitt lined, oil lubricated sleeve bearings.

Smaller fans utilize mounted ball and spherical bearings. Mainly spherical roller bearings.

Items to consider: Bearings are subjected to fine, abrasive dust. These bearings are usually mounted in outdoor applications, so rain is a concern. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered.

Rotary Kiln

Partially calcined material flows to the kiln, where heat drives the reactions necessary to sinter the raw meal. Maximum temperatures, inside the kiln, will approach 2000°C. Cement clinker is formed when the raw meal components combine, under heat, to form clinker minerals. The resulting minerals have the ability to chemically react and harden when mixed with water. Fossil fuels, preferably coal, provide the thermal energy required to drive this process. Alternative fuels, with good heat value, are also utilized.

Bearing Applications: Large fans may utilize babbitt lined, oil lubricated sleeve bearings. Smaller fans utilize mounted ball and spherical bearings. Double row cylindrical roller, cylindrical roller, spherical roller, and tapered roller bearings.

Items to consider: Bearings are subjected to fine, abrasive dust, heat and rain. Bearings should be fitted with robust seals. Lubricant for high temperature applications should be used when applicable. Closed end housings and protective covers should be considered.

Clinker Cooler

Fully formed cement clinker falls from the rotary kiln, into a reciprocating grate cooler. Fans force ambient air through slotted grates, which transport the hot material while channeling cooling air to the clinker. The heated air is recovered for combustion, reducing the kiln's fuel requirement. Cooled clinker is conveyed by pan conveyors, bucket elevators, drag chains and belt conveyors to storage silos. Screw conveyors are used to transport dust from dust collectors.

Bearing Applications: Pillow block and flange mounted spherical and tapered roller bearings are typically found on screw conveyors, belt conveyors and bucket elevators. Large fans may utilize babbitt lined, oil lubricated sleeve bearings. Smaller fans utilize pillow block spherical bearings. Spherical roller bearings, spherical thrust bearings, and thrust ball bearings.

Items to consider: Bearings are subjected to fine, abrasive dust and high temperature. Bearings should be fitted with robust seals. Lubricant for high temperature applications should be used when applicable. Closed end housings and protective covers should be considered. Occasionally, auxiliary bearing coolers may be required.

Finish Grinding

Cement clinker is drawn from storage silos using apron weigh feeders and ground with gypsum. The product is a fine powder referred to as Portland Cement. Grinding takes place in the same way as in the Raw Mill. Common systems are rotary ball mills and vertical roller mills. Product is classified with a separator and transported around the mill circuit with air slides, screw conveyors and bucket elevators. The final product is pneumatically conveyed to cement storage silos for later distribution to customers.

Bearing Applications: Pillow block and flange mounted spherical and tapered roller bearings are typically found on screw conveyors, belt conveyors and bucket elevators. Fans utilize mounted ball and spherical bearings. Spherical roller bearings.

Items to consider: Bearings are subjected to fine, abrasive dust. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered.

Distribution

Cement stored in silos is withdrawn for bulk shipment by truck, rail or barge. Redi-mix plants combine the cement with aggregate and water to form concrete. Cement is also packaged in 50 to 100 pound bags and palletized for use by smaller customers or for sale in places like home improvement stores.

Bearing Applications: Pillow block and flange mounted ball, spherical and tapered roller bearings are typically found on screw conveyors, belt conveyors and bucket elevators. Fans utilize mounted ball and spherical bearings. Spherical and cylindrical roller bearings. Fans use thrust ball bearings and thrust spherical roller bearings.

Items to consider: Bearings are subjected to fine, abrasive dust. Bearings should be fitted with robust seals. Closed end housings and protective covers should be considered.

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Case Study: JBJ Techniques and the BLOODHOUND SSC Project

Photo courtesy of Flock and Siemens

The Challenge

Specialist power transmission supplier JBJ Techniques Limited, of Redhill, Surrey, England were recently contacted by the staff of Bloodhound SSC R&D engineering team to solve a problem on the fuel pump test rig. JBJ Techniques had worked with various team members in the past and this previous experience made JBJ an easy choice to assist with this project. The scope of supply was to produce a suitable drive coupling with a maximum diameter of 160 mm, capable of transmitting 550 Nm @ 10,000 rpm, with as short an assembly as possible, and at the same time be able to accept misalignment within the drivetrain.

The Solution

JBJ proposed a Sier Bath coupling from their principles — RL Hydraulics, in Germany, a wholly owned subsidiary of U.S.-based Lovejoy Inc. The high-torque capacity of the coupling meant that, when assembled, it fit perfectly within the existing adaptor arrangement, and the crown tooth gear form on the coupling allows for relatively high misalignment without transferring loads between the shafts. JBJ had the blank parts in stock, having a comprehensive inventory of power transmission couplings of many types and designs, thus helping to keep customer downtime to an absolute minimum.

JBJ Techniques's proposed solution required a special driveshaft that, when connected to the output flange of an automotive gearbox, enabled easy assembly of the Sier Bath unit. 3D models were then supplied and approved by the Bloodhound team, and after manufacture, the complete assembly was dynamically balanced to ensure that the coupling operated without generating any additional forces.

The fuel pump is, in effect, the pump for the rocket; it's an end-suction centrifugal pump driven by a Jaguar 'F'- type V8 engine. Its role is to pump the oxidizing agent (hydrogen peroxide) into the rocket engine that contains the actual (solid) fuel (rubber). The other engine is a jet and does not require a separate pump.

The end-suction centrifugal pump (Fig. 1) is basically an impeller mounted within a volute housing; the impeller is mounted on a shaft supported on two bearings. One is mounted close behind the impeller with a pressurized, double-mechanical seal to prevent leakage. A bearing housing accommodates the length of the shaft and ensures a suitable gap between the bearings sufficient to support the rotating parts. The photo shows it standing on its suction inlet flange with the outlet (dis-

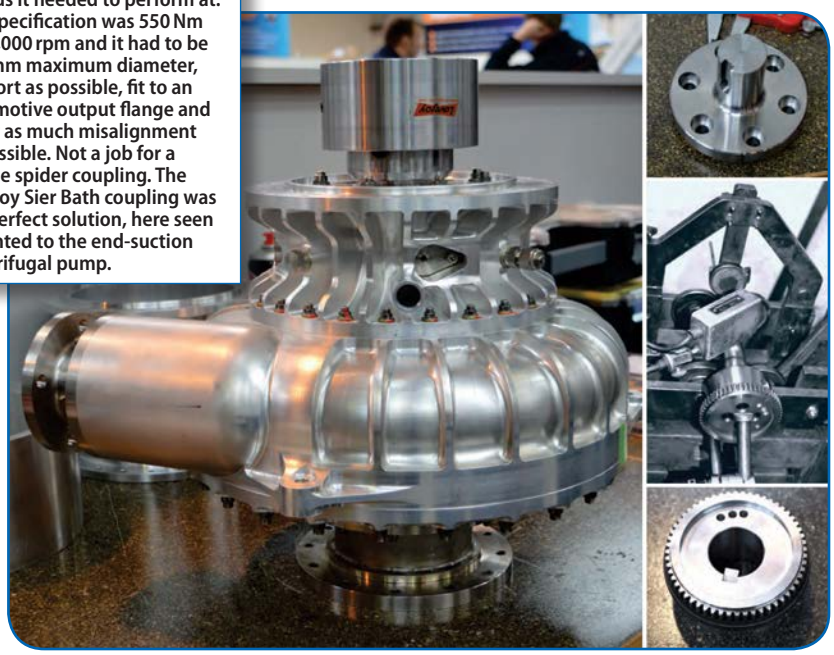

Figure 1 The coupling underwent dynamic balancing before delivery because of the high speeds it needed to perform at. The specification was 550 Nm at 10,000 rpm and it had to be 160 mm maximum diameter, as short as possible, fit to an automotive output flange and allow as much misalignment as possible. Not a job for a simple spider coupling. The Lovejoy Sier Bath coupling was the perfect solution, here seen mounted to the end-suction centrifugal pump.

charge) pointing left, and the coupling at top mounted on the end of the shaft.

The company takes pride in the fact that the coupling specified and supplied by JBJ Techniques performed exactly as designed. The research and development process has only added to the knowledge base needed to help Bloodhound SSC succeed in its mission of breaking the land speed record and, most importantly of all, to help inspire the young to be the future engineers that shape the world we all live in. We are all eager to see Bloodhound SSC "flying" across Hakskeen Pan in South Africa — driven by Wing Commander Andy D. Green — the British Royal Air Force fighter pilot and new World Land Speed Record holder. **PTE**

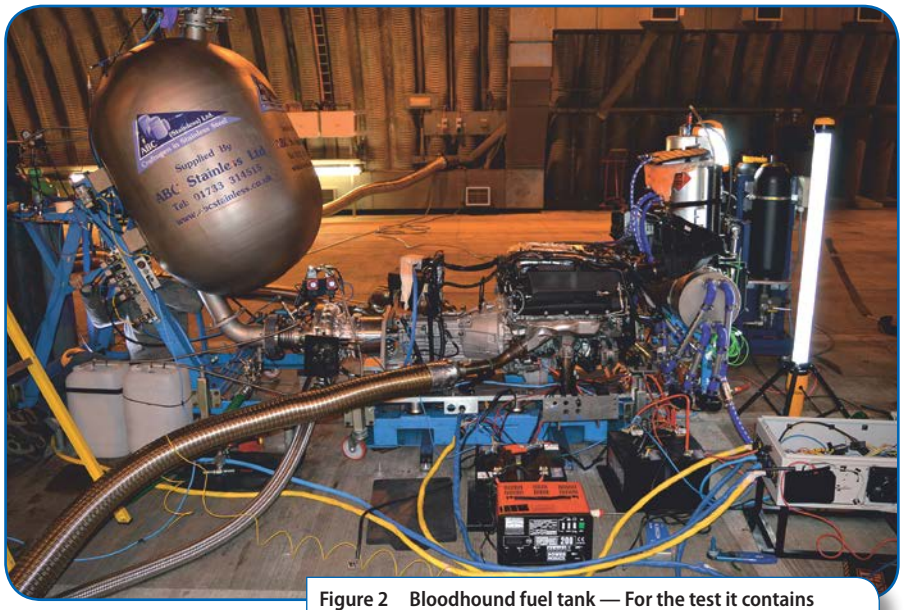

Figure 2 Bloodhound fuel tank — For the test it contains water to be pumped through at the same speed and pressure that fuel will be pumped during the actual land speed record attempt.

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