The diamond in level measurement

Reliable level measurement under extremely harsh conditions is now possible thanks to VEGApuls 64 radar level sensors. This article highlights the exciting example of the instrument's use in diamond ore processing and the advantages one operator was able to gain by switching to radar level measurement at 80 GHz.

The dense media separation (DMS) process is a special flotation process in diamond ore processing. Dust and dirt are, among other things, the major factors that adversely affect level measurement in the flotation tank.

The Maluti Mountains in the Kingdom of Lesotho is home to the highest diamond mine in the world at 3 200 metres above sea level. The environmental conditions there are correspondingly rough, with frequent, abundant snowfalls, temperatures that fluctuate between -18 °C and +20 °C and strong winds that intensify the low temperatures being part of everyday life.

The conditions in the ore preparation process are also pretty rough. The mine transports the ore to the surface through two kimberlite pipes. These are vertical chimneys of volcanic origin that extend deep into the earth's crust. The source rock is crushed and further processed to extract diamonds. This whole procedure is extremely laborious. Worldwide production of natural diamonds is now about 20 t per year but covers only about 23% of industrial demand. The rest is manufactured industrially.

The two pipes in the Lesotho mine contain only a very small proportion of diamonds. Their yield is less than two carats per hundred tonnes of rock. A huge effort is required to get at these diamonds. In the mine, 70% of which belongs to Gem-Diamonds and 30% to the Lesotho government, 5.8-million tonnes of ore are processed per year in two plants. An additional 1.2-million tonnes are mined and processed by a contractor at a separate plant. The combined tonnage produces approximately 100 000 carats per year. Approximately 18-million tonnes of rock that cannot be used for anything are left over each year.

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The smallest antenna of the VEGApuls 64 is no bigger than a one-euro coin. This makes the new radar sensor ideal for installation in small wells and containers.

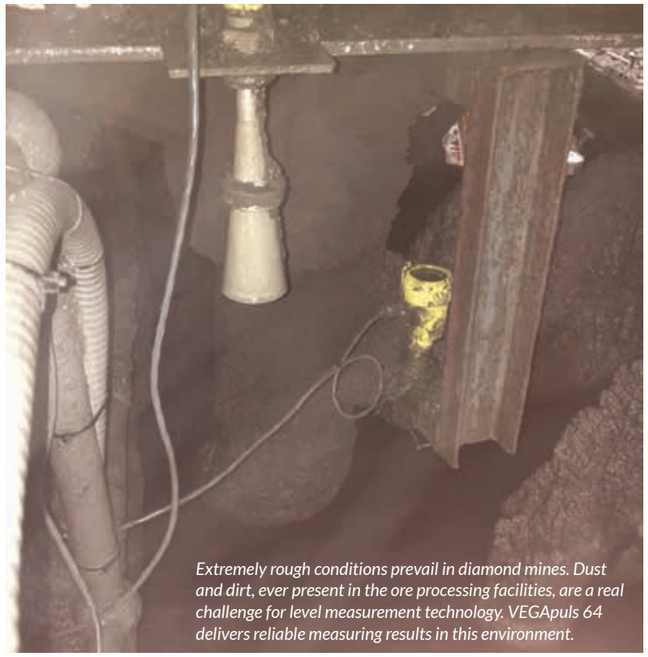
Separating diamonds from kimberlite

In a DMS plant, ferrosilicon – an alloy of iron and silicon – in powdered form is suspended in water to obtain a fluid with the same density of diamond, about 3.52 g/cm^3. To this is added the previously crushed diamond bearing material, in order to separate the heavier minerals from the lighter rock. The DMS process produces a concentrate, which generally amounts to less than one percent of the original material fed into the plant at the beginning of the process. An alternative processing method is centrifugation, where the denser material is swirled at low and high speeds in cyclones. In the process, the diamonds and other dense minerals are pressed to the walls and then out the bottom of the cyclone. The wastewater rises at the centre of the cyclone and is sucked out and screened to remove the remaining particles.

Both methods have their advantages and disadvantages. The investment costs for a DMS plant are ten times higher than for a cyclone. The DMS plant, however, provides better yields. The water consumption and operating costs for a DMS plant are also significantly higher than is the case with centrifuge processing.

However, the service life of kimberlite mining facilities is very long, which makes it worthwhile to build stationary infrastructure that, in the long run, leads to higher productivity of the overall process. Of course the efficiency of a plant also depends on the skill of the operator and the applied technology. Decisive factors for the smooth operation of a DMS plant and, ultimately, the whole process, are, among other things, a high level of automation and measurement technology that can deliver reliable measured values.

Thanks to VEGApuls 64's narrow beam angle of only 3°, false echoes caused by internal installations are no longer a problem.



Extremely rough conditions prevail in diamond mines. Dust and dirt, ever present in the ore processing facilities, are a real challenge for level measurement technology. VEGApuls 64 delivers reliable measuring results in this environment.

Turbulence and inlet tubes make measurement more difficult

In the flotation tank, the level of the flotation liquid containing the enriched material has to be precisely measured. However, this is far from easy because of the harsh environment and the internal components of the tank. The medium is fed into the flotation tank through pipes from different directions. These pipes cause extreme turbulence and water splashing inside the tank.

An older radar sensor with a transmission frequency of 26 GHz, which was installed there a few years ago, always had problems. For example, it displayed the built-in pipes as the level, which was totally incorrect. Another difficulty was the accumulation of dust and debris on the antenna, which resulted in false readings again and again. Although radar technology is a non-contact measuring method and therefore ideal for dirty environments, the sensor no longer worked optimally because of the extreme ambient conditions. Due to the resulting signal attenuation and interfering reflections, the measuring point could only be kept in operation through constant servicing.

80 GHz technology brings stable measurement

Last spring, when the first 80 GHz radar level sensor for liquids was introduced to the market, VEGA's South African subsidiary quickly suggested replacing the existing technology with the new VEGApuls 64. The previous 26 GHz sensor, with its 80 mm antenna, had a beam angle of 10°. It was mainly the narrower beam angle of the VEGApuls 64, only 3.0°, that promised a solution to the problems caused by the inlet pipes. This considerably tighter focusing of the radar beam made it possible to better distinguish the actual measurement signal from the interference signals. The new radar sensor also has significant advantages because of its higher dynamic range of 120 dB. What is more, VEGApuls 64 provides higher accuracy, reproducibility and reliability in general within the application.

The measuring process itself is completely independent of process conditions, which is one of the greatest advantages of radar technology. Varying temperatures and pressures affect the measuring results just as little as the properties of the liquid to be measured, e.g. density or viscosity. This is important, especially in the inhospitable temperatures that prevail in the diamond mine.

VEGApuls 64 measures under pressures from -1.0 bar to +20 bar and process temperatures between -40° and +200 °C. Despite the considerably shorter wavelength of the 80 GHz sensor, it is hardly affected at all by deposits or condensation. This is achieved mainly through special signal processing in the area close to the sensor. The distance-dependent dynamic adaptation reduces the effects of interference directly in front of the antenna system and at the same time allows very high signal sensitivity at a greater distance. The measuring distance can be up to 30 m with measurement accuracy still remaining at ±2.0 mm.

Problems in the mud bath?

Besides the exceptional stability of its measuring signal, the radar sensor is also characterised by mechanical robustness, i.e. it is virtually wear- and maintenance-free. Even if the sensor has to be freed of large quantities of mud now and then, the process can go on unhindered. Cleaning is fast and uncomplicated.

In conclusion, the extraction and processing of diamond ore definitely has nothing to do with the glittery glamour world where the diamonds later make their grand appearance. The environment in the mine is harsh and forbidding. But what really matters here is the efficiency of the process. For the mine operators, the very idea that a process would have to be interrupted just because of a defective measuring instrument is unacceptable. They are keenly aware that most of the mining and extraction processes are interconnected and depend heavily on each other.

The first 80 GHz radar level-measuring instrument for liquids has proved to be a real godsend for the mine. Everything in the flotation tank has been running smoothly since the VEGApuls 64 was installed.

A PROCESS webinar with numerous application examples about why radar level measurement with 80 GHz technology is suitable for use in process automation in different areas of industry is available for viewing at process.de/webinar and more about 80 GHz can be found at www.vega.com/radar. ❑