Dry Mining China Clay

Imerys, the world leader in industrial minerals, has recently invested £6.9m to convert the operation of two of its largest china clay quarries in Cornwall from the traditional high-pressure wet extraction into classical extraction and processing of the kaolinic matrix in a central washing plant. It allows the Company to have greater control of its variable costs and reduce the impact of energy price increases. It also reinforces Imerys' commitment to ensuring Cornwall remains an essential element of its global kaolin production portfolio.

Cornwall is a county known for its historical mining heritage. Unlike its tin and copper mines, the extraction of kaolin is one of the few significant minerals processing industries remaining in Britain today.

Kaolin came to prominence in the mid eighteenth century, when its value as a component in white porcelain was recognised by a Plymouth chemist, William Cookworthy, who first discovered kaolin deposits in Cornwall in 1746, at Tregonning Hill, near Helston. Two years later he discovered even more extensive deposits in the St Austell area. Cornish kaolin was found not only in abundance but also of an exceptional quality with properties that would ensure its use in a wide variety of industries throughout the developing world.

Soon leading potters and ceramic producers began to mine their own pits. Wedgwood started Treviscoe Pit, the industry's oldest operational pit, in 1785 before selling it to the Martyn family, one of the three largest kaolin producers who amalgamated to form English China Clays Ltd in 1919.

Imerys acquired English China Clays plc in 1999 and today operates 120 mining sites in 47 countries world-wide, producing 29 different minerals or mineral groups.

Its Western Area kaolin operations, located in mid-Cornwall, near St. Austell, produce in excess of 500,000t of kaolin per annum, making it one of the largest mining operations within the Imerys group.

Traditional “wet mining” has always been the industry standard in the UK. It starts with the removal of topsoil, which is used for landscaping. The overburden covering the kaolinised granite matrix is loaded on to large dump trucks and taken to a local tip. The kaolinised granite is charged with explosives and blasted, then pushed by bulldozers ready for washing by a high-pressure water hose known as a monitor. The resulting water mixture of kaolin, sand and mica forms a slurry and flows to the lowest point of the pit. It then passes through a series of mechanical classification systems to remove any unwanted sand and mica before being pumped to the surface of the pit by centrifugal gravel pumps.

However, over the years, the pits have become much deeper and extraction has become more dependent on energy to pump the large volumes of water and clay slurry to the surface. This prompted Imerys to move to a dry mining operation at two of its quarries in Western Area, where the matrix is transported to the washing plant for processing in order to extract the kaolin.

Designed to process several million tonnes of matrix a year from the Melbur and Virginia quarries, the plant operates six days a week and is shut down one day a week for routine maintenance. By processing this volume of matrix, Imerys is able to recover a significant quantity of saleable product. The difference being the waste streams of rock, gravel, sand and mica, which are removed at various stages of the dry mining process. This change makes it possible to revisit the way mining operations are conducted, in particular in terms of grade definition and level of in-pit selectivity.

During the day a fleet of 65t payload dump trucks transport the matrix to the washing plant, where they tip directly into a feed hopper or into one of the storage bays where stockpiles are built and then subsequently used during the night. This enables the plant to stay operational 24 hours a day.

To achieve maximum recovery from the wide range of feed material delivered to the dry mining site, the process is fed at different rates and controlled by the speed of the apron feed situated at the bottom of the feed hopper. For example, a semi-kaolinised matrix low-yield feed will be processed at almost twice the hourly rate of a well-kaolonised high-yield matrix.

From the apron feeder, the matrix drops onto a reinforced grid where the oversize rocks (+800mm) are trapped and subsequently broken with a hydraulic rock breaker. Material passing through the grid then travels over a Grizzly Feeder where it is blasted with high-pressure water to break up the material. The oversize rock falls off the Grizzly Feeder into a jaw crusher, while the crushed material is transported via belt conveyors before being stockpiled by a radial conveyor.

The underflow from the Grizzly Feeder is fed into a rotary washing barrel where the majority of the kaolin is released from the matrix. The rotational speed of the barrel can be changed depending on the type of matrix that is being processed. Semi-kaolinised material can be passed through the barrel fairly quickly, whereas a highly-kaolinised material will require more work input to release the kaolin. The mix stays in the barrel for approximately 60 seconds, although this is adjustable to suit specific conditions by the use of a variable speed drive.

Having passed through the washing drum the material is separated by a drain screen into gravel and finer materials of clay, sand and mica. The gravel is then washed on the wash screen to remove traces of clay and sand before it is transported by belt conveyor to a radial conveyor from where it is dropped on to a stockpile.

The clay, sand, mica and water from the drain screen flows into a sand separation system comprising of two bucket wheels and de-watering screens.

The kaolin and mica is removed as a slurry and then pumped to a bank of 12 primary cyclones where the majority of the mica is removed leaving a final clay slurry of 0.2% +53 microns, which is then pumped to the refiner for further classification and processing.

The underflow or residue from the cyclones can be added to the sand on the bucket wheel dewatering screen, where it would then be conveyed to the sand stockpile or it can be pumped directly to a mica residue dam.

The sand that has been separated on the bucket wheels is de-watered on the de-watering screens and then conveyed to the radial spreaders. Here it is stockpiled ready for transportation to the waste tips by the mobile plant fleet. Sand is the single largest waste stream derived from the original matrix and can be generated at plus 300 t/hr.

The system has been designed to operate as economically as possible, particularly in terms of water usage. With this in mind, there are many recirculation facilities within the process that can be used to maintain high density final product; ie several tank overflows can be used for make-up water supplies further upstream in the process.

Imerys worked closely with Fairport Engineering Ltd to develop and implement the new dry mining operation and appointed them as principal contractor. Fairport is one of the few organisations in the UK that can claim to be both a consultant and contractor with both minerals processing and materials handling expertise and capabilities available from in-house resources. This was one of the main reasons that Imerys commissioned Fairport to assist with an initial feasibility study.

During the early stages of the project, Fairport undertook formal design reviews and risk assessments that allowed a detailed installation plan to be developed and implemented during the course of the project's construction. The partnering approach adopted with Fairport enabled both parties to enjoy a high level of visibility in apportioning project risk and reward, and has formed a significant part of a continuing smooth and productive relationship.

Against a background of rising energy costs, the "dry mining" project enables Imerys to keep its production and energy costs under control and offer its customers in the ceramics industry products with the same quality and technical know-how at a controlled price.

Imerys' long-term commitment to its UK kaolin business is demonstrated by its recent £35m capital investment programme, of which the move to dry mining in Western Area represents 20%. Cornwall remains an essential element of Imerys' global kaolin production portfolio, with around 88% of its annual production exported to more than 60 countries.

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