Improvement of Dust Management at the Gardanne Alumina Production Plant BRDA

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Abstract

The Gardanne alumina production plant operates a Bauxite Residue Disposal Area (BRDA) located 4 km from the plant, where red mud has been stored from the beginning of the 20th century until 1966, as a wet residue. Afterwards, during almost fifty years, red mud was sent to the 'Fosse de Cassidaigne', a trench in the Mediterranean Sea, via a 60 km pipeline to a discharge point 7 km offshore and 320 m deep. To ensure compliance to new regulations, the red mud was dehydrated using press filters as early as 2006, and this filtered residue is being stored on the historical BRDA following the successive commissioning of three press-filters installed over a period of 10 years. As it is located near residential areas, dust management represents a major challenge at the site, particularly during windy, warm and dry weather conditions that are not uncommon in southern France. In order to effectively avoid dust emissions at all times, ALTEO has adopted and implemented various solutions on the BRDA over the last few years. This was achieved using two strategic ways: working with specialized partners in dust management, employing technical solutions to affix the dust to the ground and adapting the current operating procedures.

Keywords: Dust, Bauxite residue, BRDA, Press filter.

1. Introduction

The problem related to dust emissions in the environment is not specific to the alumina industry, in the sense that it represents a major health and environmental issue, and concerns many sectors of industry. Bauxite residue dust, however, has an extremely staining character, which makes its impact on the environment particularly noticeable.

In order to better understand this problem, in the context of a BRDA, it is first necessary to understand the reasons for which the bauxite residue can have a dusty character, the associated problems and the consequences that this can have.

The bauxite residue when it is produced using press filters, generally has a moisture of around 30 %. At this stage, it is not dusty, and can be easily transported to its storage place without fear that it will generate dust. The residue will then dry in the open air, until it takes on a "cooked" appearance. When the residue is in this state, if it undergoes the slightest mechanical action, it will turn into extremely fine dust particles and becomes powdery. On the site, the main dust-generating cause is the movement of earth moving machinery used to stack the residue, which, by crushing the bulk residue, transforms it into dust. On the other hand, the bauxite residue contains traces of soda which in contact with air can be transformed into sodium bicarbonate. The appearance of this sodium bicarbonate creates a white film on the surface of storage areas, which can be very volatile.

BRDAs generally cover a fairly large area of several tens of hectares. As part of the Gardanne alumina production plant BRDA, the area of the site in operation is approximately 25 hectares.

The appearance of red dust on such surfaces can therefore have significant consequences in the event of dust emissions in the environment.

The Gardanne alumina production plant BRDA named “Mange Garri” is located in the south of France in Provence, a region well known for its prevailing wind called "Mistral". This northerly, dry and cold wind blows throughout the year approximately 100 days per year, and can reach more than 100 km/h. The less frequent East wind can also reach 90km/h in gusts. In terms of precipitation, the Mange Garri site receives an accumulation of rain of around 600 mm per year, mainly in autumn during intense Mediterranean episodes. The rest of the year rain is rather rare. With such a climate, where rain is rare, and where the wind blows all year round, the dust management on the site therefore represents a real challenge.

In April 2018, while the site was in operation for several years to store the bauxite residue produced by press filters, a strong episode of easterly wind at more than 90 km/h raised a cloud of red dust over the neighbouring village of Bouc Bel Air. This incident had a strong media impact at the local level.

Figure 1. Dust storm over neighbouring village.

This type of incident can be extremely detrimental to the image of a company. ALTEO, which had already implemented numerous means of combating dust, had to think about finding new solutions, in order to make the management of this risk more reliable.

2. Technical Solutions to Affix the Dust to the Ground

In order to be able to fight against dust, it was first necessary to find technical solutions to treat dusty areas. Intuitively, the use of water was immediately preferred, however it was necessary on the one hand to learn how to optimize its use, and on the other hand to find alternative solutions.

2.1 Applying Water to the Surface

The use of water on a powdery surface will make it possible to find a wet, almost muddy appearance, which when drying will leave a non-dusty "crust", as long as it is not subjected to mechanical action. The simple action of rain on the scale of the site is sometimes enough to eliminate any risk of dust emissions for a few days.

However, in order to control this watering, and to be able to use it in an appropriate way, a technical solution had to be found. A fairly simple piece of equipment consists of combining a tractor and a water tank. This assembly, which constitutes a mobile irrigation system, makes it possible to spray water on the ground, and has the advantage of being able to access both tracks and even steep bauxite residue surfaces. This system is preferred for the treatment of tracks on a daily basis, as well as for occasional use during windy episodes.
Some areas in operation, however, may be equipped with fixed sprinkler systems due to the relatively small area to be treated and/or the area is regularly reworked. On the Mange Garri BRDA, two areas have been identified as such:

- The peripheral tracks of the site, which are not likely to change during the operation of the site, where a permanent automated sprinkling system has been installed.
- The area in which the mineral waste from the plant is stored, excluding bauxite residue (other mineral waste from the refinery, etc.). In order to regularly wet this area, in which the mineral waste can be powdery, an automated mist cannon has been installed. It allows both to avoid dust emissions when unloading trucks and to wet the piles once unloaded in the area.

Figure 2. Watered track for the traffic of dumpers on the left of the image, and mist cannon in the background.

However, since water is a precious resource, and sometimes rare in certain dry regions, a detailed assessment was carried out in order to limit its use, and this, in particular in areas that are not subject to regular traffic.

2.2 Dust Control Binding Agents

Work, in conjunction with partners specializing in dust management, made it possible to find dust control binding agents to create a resistant crust on the surface of the residue stopping dust emissions. The binding agent is diluted in the watering tank and sprinkled over the surface to protect it (Figure 3). This surface crust can last several months, depending on weather conditions. Applying binding agents reduce water consumption and more importantly treat surfaces preventively ahead of a possible windy episode.

Figure 3. Implementation of binding agents on a short-term unused area.

2.3 Hydrocovering

On a BRDA, some areas such as rain water ponds may be difficult to access with conventional machinery due to their own weight. The challenge arises as to how to treat these flat surfaces which can be prone to the formation of sodium bicarbonate.

This scenario arose in 2019 when ALTEO was working on the waterproofing of the BRDA rainwater pond. This pond, which had to be drained as part of the work, had never been fully emptied before. As a result, the substrate was not load-bearing and was not accessible with the mobile watering equipment. Additionally, the position of the pond was in the immediate vicinity of neighbours and required a surface treatment to avoid any dust emissions.

An innovation approach was successfully implemented with a product usually used in landfilled sites for temporary cover to prevent plastics from flying away. This technique called “Hydrocovering” allows to create a temporary tarp on the surface of the residue, and has the advantage to be applied with a jet allowing to reach inaccessible areas (Figure 4). The product is made of cellulose fibre (62 %), wood fibre (30 %) and additives (8 %).

2.4 Composting

The operation of a BRDA generally provides for its progressive rehabilitation. For this purpose, compost can be used in revegetation. ALTEO has chosen to use this technique not only on areas to be rehabilitated but also on areas that will not be operated for a few years. This solution is, in fact, the most economical and the most effective in the long term. Putting in place a simple 10 cm-thick layer of compost with a bulldozer (Figure 5) eliminates any risk of dust emissions and contributes to a better integration of the site into its environment. Depending on the weather conditions, vegetation then starts to appear after 3 to 6 months. Between 2018 and 2021, approximately 25 000 tonnes of compost were implemented at the BRDA of Gardanne refinery.

Figure 5. Composting of a long-term unused area.

2.5 Coir Geotextile

Some areas such as ditches, berms or embankments have a landscape that does not allow easy access for watering or implementation of binding agents. These structures, although necessary for the flow of water or the stability of the stock, can however channel the wind, and be source of dust emissions. A suitable solution had to be found for the development of these structures. A successful pilot trial was implemented with a coir geotextile on the slopes of a ditch, which regularly emitted dust during windy episodes, due to its location in the direction of the prevailing wind (Figure 6).

The result was very positive, both in terms of the total elimination of dust that could come from these surfaces, and the aesthetic appearance to the site. This geotextile, on the other hand, is biodegradable after approximately 4 years. Placing a layer of compost under the geotextile can make the landscaping more sustainable.

Figure 6. Installation of a coir geotextile on a water collection ditch.

3. Adaptation of Operating Methods

The search for technical solutions to reduce dust has made it possible to better control the risk locally. On the other hand, the need to take into account the risk at the site level required a global assessment to review in detail the overall operating methods.
The primary objective was to reduce the daily operating surface areas to the minimum as it is on these areas where the risk of dust emissions is greatest. On the Mange Garri site, storage is carried out in compartments of approximately 1 hectare in area and 5 meters thick. It was decided to keep only 4 compartments in operation for a surface of 4 hectares. This approach allowed to compost or to apply dust control binding agents on the rest of the site. In addition, all the embankments, which can be landscaped, have been covered with coir geotextile.

In the operated areas, an adaptation of the operating method was also necessary in order to avoid dust emissions. The bauxite residue, which was stored in heaps for several days before being spread by a bulldozer, is now spread daily in a thin layer of about 40 cm. This allows to leave a flat ground at the end of the day on which the mobile irrigation system can access at any time.

A new practice increased the speed of consolidation of the soil to guarantee better accessibility of the machines and also reduced dust emissions. This practice consists of harrowing the residue once it has been applied in a thin layer (Figure 7). The surface roughness introduced by the harrowing makes it possible to reduce the speed of the wind on the surface of the residue, and thus to effectively limit dust emissions. Harrowing also limits the appearance of sodium bicarbonate on the surface, unlike compacting surfaces which greatly favours its appearance.

Figure 7. Harrowed area in an operated compartment.

The photos below (Figure 8) show the landscaping of the site between 2018 and 2021. The 2021 image shows clearly the reduction in operating surface areas of the overall area of the BRDA. All of these improvements make it possible, during windy episodes, to concentrate the watering efforts on the areas in operation.

Figure 8. Comparison between a satellite image (Google Earth) of ALTEO BRDA in 2018, and a drone view (ALTEO) of the site in 2021.

The innovation and research work carried out by ALTEO in collaboration with specialized partners in dust management and experts in geo techniques made it possible to transform the site using with best available techniques of operation to minimise risk of dust emissions. All these measures, however, are effective only if they are accompanied by a robust organization that allows for anticipation and responsiveness.

4. Organization

Dust emissions in the environment can be due to the activity of the site in operation (truck traffic for example) but also due to unfavourable meteorological conditions (absence of rain, strong wind). If the first cause can be controlled simply by temporarily stopping the activity, the second cause is random. Faced with this randomness, daily monitoring of the weather quickly proved to be essential, in order to be able to assess the level of risk on a daily basis.

For this purpose, daily supervision is carried out by a person assigned to this function. The main responsibility is to assess the risk on a daily basis, taking into account the weather forecast and the activity planned for the site's operation, in order to deploy the appropriate means and take the necessary measures to avoid any dust emission. Part of this work consists in anticipating windy episodes, by preparing the surfaces in a preventive way (composting, applying binding agents, various arrangements). The other part consists in being able to intervene on the areas in operation (tracks, operated compartments) during the windy episodes, in order to reach the objective "zero dust".

In order to guarantee the presence of a driver of the mobile watering system when necessary, an on-call system has been set up, making it possible to request a watering intervention in the evening, or even on weekends.

This strong organization improved the monitoring of the risk of dust emissions throughout the year without interruption, by combining anticipation and reactivity.

5. Conclusions

As a result of the level of difficulties faced in the past, ALTEO has worked closely with companies specialized in this field, to find concrete solutions to the major risk of dust emission into the environment close to the BRDA. The wide range of technical solutions now available to ALTEO, combined with a robust organization ensure effective and reliable measures to prevent dust emissions.

The daily consideration of the risk of dust emissions has become for ALTEO a real philosophy, demonstrating the priority given by the company to the consideration of environmental issues.