

## Challenging Tailormade Solutions, Implementing New Conveying Equipment into Existing Systems

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### Abstract

If a new process equipment is added to an existing plant, there are several restrictions for the installation and commissioning of the equipment. Firstly, the process parameters need to be identified and verified by modelling and upscaling. Sometimes this is exceeding the known limits and pretesting of the real equipment is needed. Especially for installations in the potroom, a real scale model of a new installation is beneficial to verify the installation and process limitations. When it is necessary to explore new materials or new process steps, a pretest in industrial scale is needed. In this paper an example for such a pretest and its evaluation is given. The effects of the different material parameters on handling and storage are outlined.

**Keywords:** Alumina handling, Storage, Pilot test, 3D-scan

### 1. Introduction

When new equipment is added to an existing plant, there are several boundary conditions that need to be considered. The existing installation might need to be disassembled or modified with a minimized effort. It could well be that there are no detailed drawings available for all areas. The new equipment must be added to the existing control logic and there might be several space or access restrictions. In regard of accessibility a 3D-scan can help to define the right equipment dimensions. While with new installations the form will follow the function, with modifications often the function must follow the given form, so it could be necessary to stress the process parameters. In this case pilot scale tests could be needed.

In this paper an example study on 3D- scan and pilot testing is explained.

### 2. Example Study

We took as an example for restrictions in the field, the replacement of a crane feed system with an aerated distribution system.

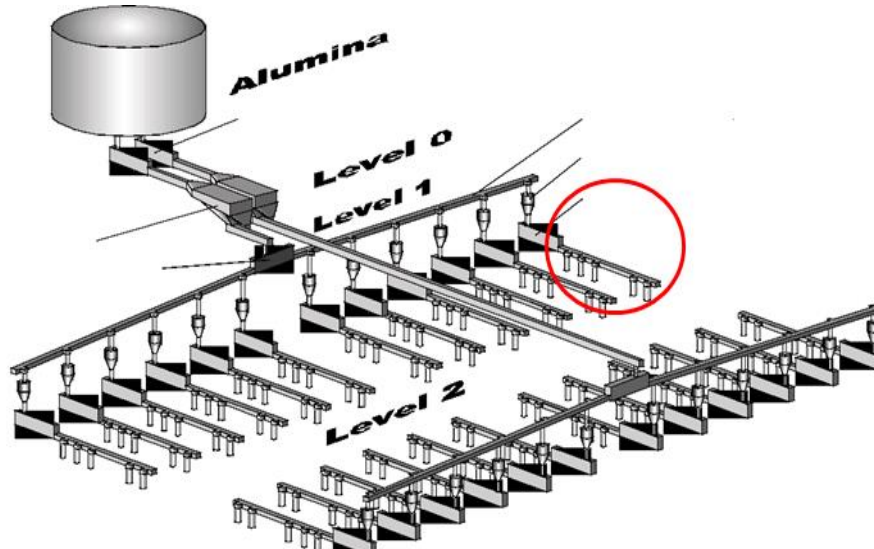
A standard layout of an aerated distribution system is shown below. But if this is added to an existing plant, there are several boundary conditions that need to be considered. Fig. 1 shows a sketch of the function of the system. The transport to the intermediate bins as well as to the prebins of the reduction cells is realized by means of special aeroslides with an inclination of approximately 1°, which are aerated section-wise in a controlled manner. The system is self-controlling and automated and does not use any mechanical valves opening and closing inside the abrasive alumina.

The control system for the aerated distribution system (ADS) is divided into two levels: Level 1 comprises the transport aeroslides from the alumina silo to the buffer silos in front of the pot superstructures. Level 2 includes the aeroslides from the buffer silos to the prebins on the

electrolysis cells. Because of the intermediate buffer silos these levels are independent, both system and control-wise, i.e., transport and distribution from the alumina silo to the buffer silos are decoupled from the pot feeding. For more details about ADS see [1, 2].

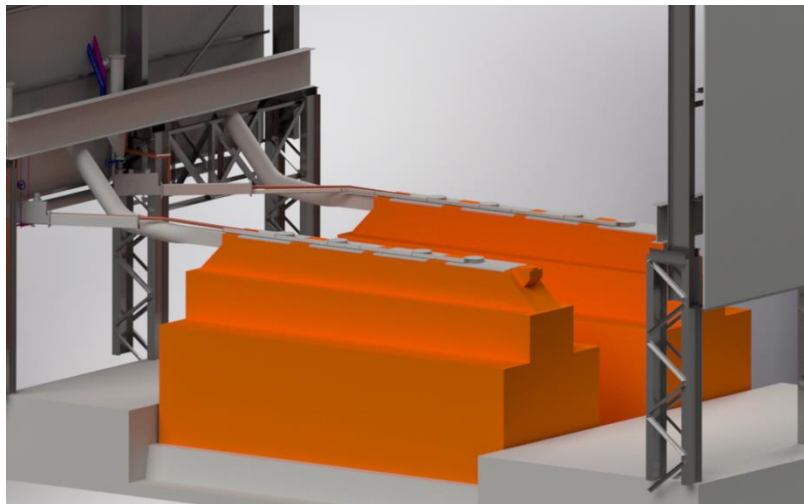
Main design data of the typical plant are:

- Transport capacity of each distribution aeroslide: 50 t/h, inclination 1°.
- Transport capacity of each cell aeroslide: 10 t/h; aeroslide inclination: 0.5°.
- All pot operation is monitored by the control system via level switches giving the operator the full control of the system and feedback of the status of each particular cell.



**Figure 1. Example of Aerated Distribution System.**

When the crane and the PTM remains unchanged and the crane feed system must be in place because the modification must take place with all the equipment in operation, there is only very limited space available for a new Aerated Distribution System. The sketch in Figure 2 shows an example; the feed system is nearly submerged in the superstructure.



**Figure 2. Example of new pot room feeding.**

As at the pot all the available systems still need to be accessible, the space only allows for a very small system and a very limited space. That means the aeroslide can only go horizontally without

inclination. This would reduce the possible capacity drastically and possibly need another control of the system with a continuous aeration. Therefore, it was decided to do a test with a pilot installation.

### **3. From 3D Laser Scan to Point Cloud**

In many cases it is useful to identify exactly the given dimensions, as sometimes there maybe old installations or modifications to existing equipment that did change the outline. This method allows to create point clouds that can be used to improve the design of the equipment and avoid collisions.

#### **3.1 From Analog Measurement to Digital Object Detection**

Laser scanning technology is used when planning into existing environments is required. This brown-field plant planning is increasingly used in the modernization of old plants and is increasingly replacing the use of paper, folding ruler and camera. With laser scanning, only a fraction of the time is needed to record the actual condition as opposed to measuring by hand. In addition, it is almost impossible to forget measurements.

#### **3.2 Terrestrial Laser Scanning TLS**

Terrestrial laser scanning TLS is an automatic measurement technology. Starting from the laser scanner standpoint, angles and distances are measured with a laser beam in all surrounding spatial directions. In this way, an object is discretized in its geometric form by a very large number of measurement points (point cloud) (decomposition of continuous objects into a finite number of discrete objects). Within a few minutes, the laser scanner delivers a detailed 1:1 copy of the object surface, e.g., of an industrial plant, which can be further processed in many ways. Possible applications include sections, views, nominal/actual comparisons, embedding in CAD models and collision checks.

In just a few steps, a point cloud can be created. The following is a brief explanation of the procedure and the time involved [3,4].

#### **3.3 Preplanning for the Creation of the Recordings on Site**

For the measurement with the help of a laser scanner, it is important to think in advance about the perimeters of the areas to be scanned. This determines the number of scanner positions required and thus the time required. This is important in order to select the correct resolution on the scanner based on the number of scanner positions and the time available. Furthermore, it is important to ensure unrestricted access to the system or the areas to be scanned. It must be ensured as far as possible that no persons disturb the recording or objects are moved during the measurements.

The creation of a field book (script for the operator) has proven to be useful. Here, all scanner positions are entered and labeled on the basis of a sketch or an existing drawing of the existing plant. This ensures, even before registration, that the scanner has been set up at all necessary locations. This also has advantages in the later processing of the individual scan clouds, especially in the selection and creation of subgroups for the organization of the scan project.

#### **3.4 Resolution and Quality of the Scans**

The resolution and quality of the clouds determine the times required per scanner position. For example, a scan can take between 2 and 45 minutes, depending on the equipment used. If, for example, the preliminary planning results in 100 necessary scan positions, the required net scan

time is between 200 and 4500 minutes (i.e., between 3.5 and 75 hours). In addition, there are times for selecting and positioning the scanner; depending on the circumstances; this process can take up to 30 minutes per location. Practical experience has shown that between 30 and 40 scans can be acquired within one day (10 hours) at a relatively low resolution (6 minutes per scan). The size of the area to be scanned and the time available therefore play a major role in the choice of resolution.

Furthermore, a distinction is made between resolution and quality. When selecting the resolution, it is determined how many measuring points are recorded per location. By increasing the distance between scanner and object, the laser measurement points on the object will also be larger. By increasing the resolution, the individual points will again be closer together. Furthermore, the beam widens with distance due to beam divergence to the object. Increasing the quality results in a more homogeneous point cloud and thus better data quality. However, increasing resolution and quality also increases scan times [5].

Laser scanners measure with the help of a laser beam that can only reproduce intensity values (light/dark). This results in black and white representations when viewing the point cloud later. If one wants to colorize the measuring points according to the coloring of the objects, 360° spherical images are taken after the scanning process. These 360° spherical images also have the advantage that one can move around in a photo-realistic environment after registration. Figure 3 is an example of a collision check in a given plant area.



**Figure 3. Example of collision check in laser scan point cloud.**

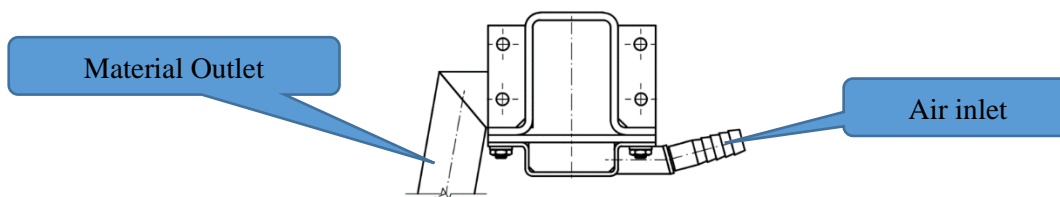
### **3.5 Factors for the Choice of Resolution and Quality**

- Distance to the object
- Time available
- Requirement for quality of the data cloud
- Color scans and 360° spherical images
- Beam divergence

### **4. Dimension of a Cell Aeroslide Modification**

In our example study, we assumed, that we have only a 100 mm square space available for an aeroslide. This would not be sufficient to install an inclined aeroslide. It would only be possible

to install a horizontal aeroslide. An example of such small unit is given in Figure 4. In the upper part is the material chamber, the lower part is the air chamber.



**Figure 4. Cross-section of cell aeroslide (sketch).**

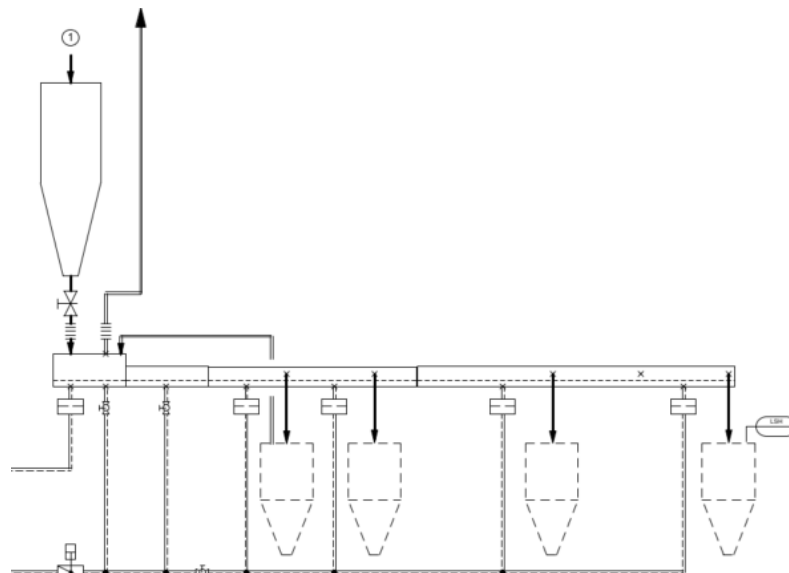
The system is only deaerated at the discharge points. So if used horizontally this system will operate as a combination of gravity transport and pneumatic transport. This could be seen in our pilot test.

## 5. Pilot Test

Testing the known material [6, 7, 8] showed, that with standard alumina the horizontal system did only show a limited capacity and the system was in the long term blocked with coarse material. So, it was decided to set up a pilot test to clear the following questions:

- a) Will the system run continuously without blockages?
- b) What is the influence of the aeration velocity on the capacity?
- c) What is the capacity that can be achieved with the small aeroslides at no inclination?

The Flowsheet of the pilot test is shown in Figure 5 and the actual installation in Figure 6. The material was screened to 1 mm grain size and filled to the prebin. The conveyed material was weighed at the discharge points and the sealing of the material was tested.

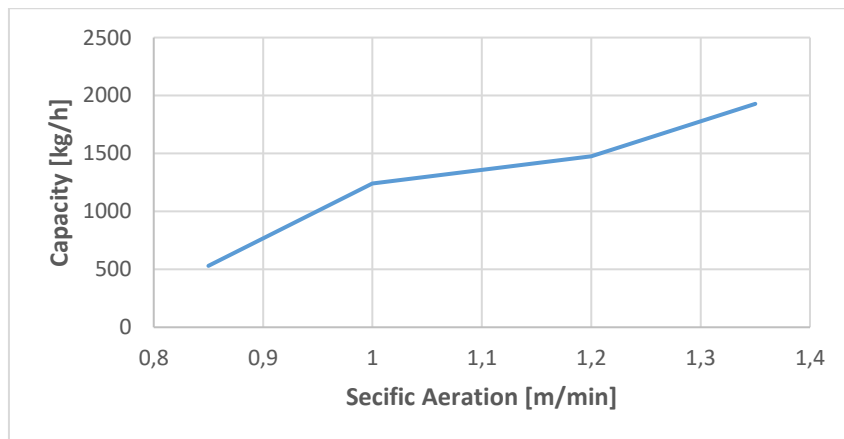


**Figure 5. Flowsheet of Pilot test.**



**Figure 6. Picture of pilot installation.**

With this installation it could be found that it was possible to achieve the desired capacity, when the material is not exceeding a certain grain size. The system reacted quite sensible to variations in aeration velocity, as this did directly increase the velocity in the material chamber. As well, the capacity did change with varying deaeration pressure in the inlet area. Some result is sketched in Figure 7.



**Figure 7. Capacity with varying aeration pressure.**

It can be concluded, that the Aerated Distribution System did as well work if the cell aeroslide is installed horizontally. The capacity is reduced by a factor 5 compared to a conventional unit, so more aeration time is needed compared to an inclined aeroslide, but the function is given.

## 6. Conclusion

When new equipment is added to an existing plant, there are several boundary conditions that need to be considered. In an example case the various steps of the design process are outlined. If available a terrestrial laser scan can help to get sufficient dimensional data. But in large installations this can be very time consuming.

From the given data, a small pilot test was done to verify the process data. The pilot test showed in this case the feasibility of a minimised version of an aerated distribution system.

## 7. References

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