Efficient cleaning will boost productivity

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J-Tec Material Handling provides process engineering solutions to market leaders in the food and chemical industry on a global level. As a process partner, we go beyond designing and building installations. For the food industry specifically, the decisions driving the **operational cost of an installation** are carefully weighed out during the design phase.

A lot of times people focus on the hourly design throughput of an installation without spending enough time focussing on changeover situations. Recipe changes mean the line will not be producing at that time, hurting production averages. This downtime will creep up over time and negatively affect total production volumes, in some cases even questioning the original business case. By talking about topics like recipe changes and cleaning times during the design phase we make sure everybody's expectations are met.

How ?

First, we measure the actual cleaning time of existing installations and compare the performance against benchmarks. Then we analyze how to reduce the cleaning time and how these process and component optimizations can be implemented in new installations.

Frequently halting production for cleaning and maintenance purposes is detrimental to a factory's efficiency. In the food industry and particularly in sectors where contaminations can occur, it is essential on one hand to minimize the number of cleaning intervals and on the other hand optimize the cleaning times.

Why is it necessary to clean a food installation?

Installations need to be cleaned for these two reasons:

- Elimination of products or micro-organisms that are unspecific to the end product.
- Prevention of contaminations between different runs or batches. Contaminations can occur in terms of taste and colour, or in case of allergens, vitamins or probiotics.

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Cleaning time analysis of a powder processing installation

To achieve measurable results, our food engineers have shadowed cleaning crews doing a recipe changeover at one of our customers. The tests were performed on a J-Tec mixing line for infant nutrition, in which powdered products, such as base powder, milk powder, vitamins, aroma, and probiotics are being mixed. (See image gravity mixing line)

1. Research set-up

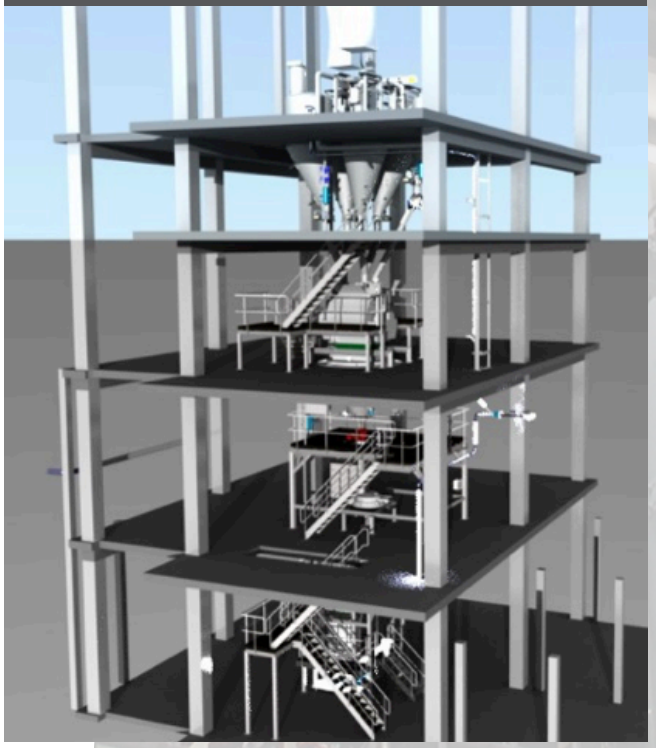
There are 3 methods for cleaning dry substances. The nature and the degree of contamination determine the required action.

Run empty (1): emptying the installation.
Run empty is applied when the production continues within the same recipe. The emptying of the installation creates a clear separation between batches, facilitating the traceability of each batch.

Basic cleaning (2): vacuuming or blowing off the installation with compressed air.
For a product change within the same product family, basic cleaning is the most efficient cleaning. A dedusting system will prevent dust from getting out into the production area.

Profound cleaning (3):
cleaning the installation with alcohol. Profound cleaning is the most thorough cleaning and is applied if contamination on parts per million (ppm) level poses a health hazard, for example in the case of probiotics or allergy-sensitive ingredients.
The installation is first cleaned by a run empty, followed by a basic cleaning and finally a profound cleaning.

Basic cleaning is carried out using vacuum cleaners. To measure how much residual product is left in the entire installation, the vacuumed product in the vacuum cleaners is weighed. The profound cleaning is performed with a cloth and alcohol.
The results of these tests are analyzed and shown in the table below.



Set-up of the gravity mixing line for which the cleaning times were measured

“Product Free” cleaning

Level	Part	Items	Cleaning “Powder free” * (min)	Number of station(s)	Total (min)
Level 3	1	Put the automation in cleaning mode & depressurize	14	1	14
Level 3, 2 & 1	2	Apply LOTO incl. Administration on each level	9	3	27
Level 3, 2 & 1	3	Collect & prepare cleaning tools on each level	3	4	12
Level 3, 2 & 1	4	Remove, open & vacuum clean fluidization nozzles	4	7	28

Extract from the cleaning time overview broken down per individual component (basic and profound cleaning)

2. Results of the different cleaning methods

Run empty: Measured duration = ± 15 minutes

Basic cleaning: Measured duration = ± 3500 minutes (after run empty)

Profound cleaning: Measured duration = ± 1600 minutes (after basic cleaning)

The results clearly show that the actual cleaning times are significantly higher than planned for in the initial business case.

3. Conclusion of the analysis

The efficiency of the line is proven to increase by limiting the downtime from inefficient cleaning practices. Benchmarks like these give us tangible data to facilitate decision making during the process design phase. We broke it down into 3 key topics to pay attention to during a design review meeting for a new production line.

Key point 1:

Reducing the number of cleaning intervals by optimizing product planning

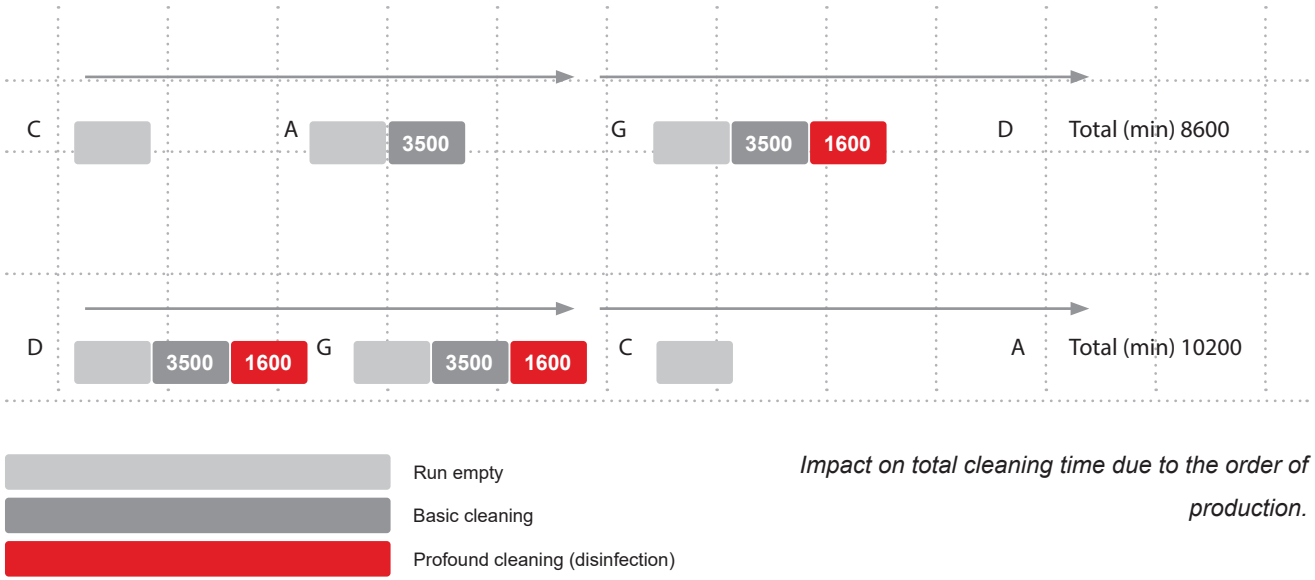
Not all optimizations require changes in the process, some come from how the production line itself is operated, and often more advanced automation-related upgrades prove a lot can be simplified for operators through software. To reduce the number of cleaning intervals to a minimum, an efficient and well-thought-out production plan is essential. Efficient production planning takes the cleaning matrix into account. This matrix shows which cleaning method is needed in between certain recipes, runs, or batches. (See figure cleaning matrix)

Example of a cleaning matrix

Key point 2:

More efficient course of the cleaning

Besides the number of cleaning intervals, it is also important to understand the cleaning procedure itself. When a production run is nearing the end it means the equipment upstream is idling and waiting for the equipment at the end of the line to finish up. Extra flexibility is created on how to organize the cleaning cycle by dividing the line into different cleaning sectors. Ensuring the safety of the operators and products through the design, the individual sectors can be closed off from each other by using various cleaning modes in the control system. By doing so, the cleaning cycle can be initiated much earlier. In the case of the example, it means basic cleaning is being performed while the end of the line is still finishing up with the final batch.



Impact on total cleaning time due to the order of production.

The order in which products are produced has a major impact on the cleaning times:

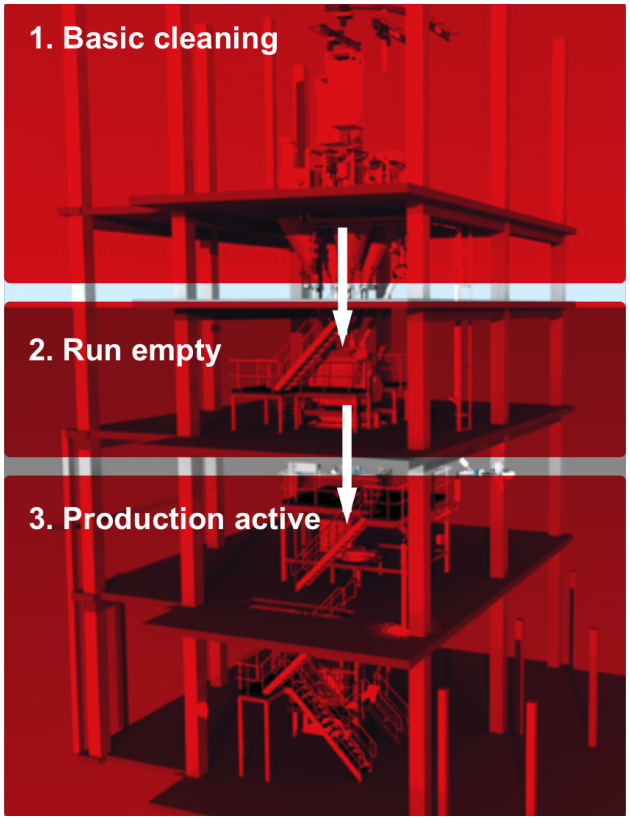
- In example 1, the order of which the recipes are made is C-A-G-D and the total duration of the cleaning time associated with that production schedule is 8600 minutes.

- In example 2, the same products are made but produced in a different order: D-G-C-A. Due to a greater chance of contamination when produced in this order, an additional profound cleaning is needed, bringing the total duration of the cleaning time up to 10200 minutes. (See figure)

Key point 3:

Optimise cleaning time by lean concept and hygienic component design

Lean engineering and hygienic design have a positive impact on the cleaning time of an installation. During the design and component selection phase, the team opted to go for an easy release rotary valve. These have the ability to fully retract using sliding rails, making the rotary airlock easily accessible for maintenance and cleaning. As a result, the cleaning time was considerably reduced to just 18 minutes in contrast to 120 minutes for a regular fixed mounted rotary airlock.



Optimization by starting the cleaning process while still producing

Easy retractable rotary airlock

Standard rotary airlock

For years, J-Tec has been focusing on lean engineering and hygienic design within the food industry with the J-Tec dosing valve being the perfect example of that. The dual functionality of the valve being able to accurately dose in powders together with the quick clean design labels this piece of advanced engineering an advantage to many process installations. Because of the compact design, the valve has a low installation height and is easy to take apart for cleaning compared to equipment with a similar throughput. The cleaning time for this component is only 30 minutes.

J-Tec quick clean dosing valve that is easy to disassemble

Conclusion

Leading companies are continuously looking for ways to do things faster and better. The goal is to keep the quality level the same or even improve it. Specifically in the food industry, it is of utmost importance to have a proper cleaning strategy. This will not only safeguard you from contamination issues or off spec product but will improve the overall yield of the manufacturing line. Spending time analyzing the changeover times during the design phase pays off. Some design decisions might require a higher initial investment but these optimizations will have an impact on the cleaning efficiency during the lifetime of the installation, ultimately generating a higher throughput and reducing the operating expenses of the installation. This is how the race is won.

Standard butterfly valve that is difficult to disassemble and clean

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