Detergents
Surfactants
Soap &
Chemicals

desmet ballestra

SABIZ Detergent Powder Production Plant

203 2017-11-15

Desmet Ballestra Spray Drying Technology

The Desmet Ballestra technology for the production of detergent powder is today unrivalled, as proven by more than 350 plants installed under Ballestra's proprietary design and know-how all over the world as from 1960.
As a matter of fact the Desmet Ballestra plants are estimated to cover significative part of the world production of synthetic powder detergents.
A permanent qualified research staff is dedicated to improve the technology by optimizing the existing processes and developing new ones in the laboratories and pilot plants installed at Milan headquarters.
The close collaboration with researchers and scientists of University board, environmental organizations Scientific Committees, multinational companies etc. as well as the exchange of information at the main international congresses and seminars on detergency which Desmet Ballestra is attending with reports and papers, have contributed to increase the significant technological knowledge of the Company enabling it to meet the specific requirements of the worldwide manufacturers of detergent products.
The large experience and know-how in detergent plant operation allow Desmet Ballestra also to assist the Clients to better define their requirements in terms of production programs, training of operators, raw material purchasing, product formulation and packaging etc. so contributing to the best success of new projects.

New raw materials coming on the market are carefully studied and tested, to define the best plant operating conditions in terms of product formulation and process optimization.
The physico-chemical characteristics of detergent powders to be produced are studied to identify the optimum product characteristics in order to meet local washing habits and specific market requirements.
Great importance is given to the environmental pollution control.
Each plant designed by Desmet Ballestra is conceived to avoid liquid effluents, while the exhaust gases are treated to comply with the most strict international specifications, thus allowing to install the plants even close to urban areas.
Special care is given to energy saving, to reduce the overall fuel and electric power requirements.
For large plants capacities, whenever required by local conditions, Desmet Ballestra has also studied and implemented co-generation systems based on the use of gas turbines to produce electric power and on the use of relevant hot exhaust gases in the spray tower to substantially increase the overall plant efficiency.
The great flexibility of Desmet Ballestra plants, together with the flexibility of processing different raw materials and producing a wide range of formulations, make Desmet Ballestra spray drying plants able to meet even the most sophisticated market requirements.
Plants standard capacities range from 1000 to 30.000 Kg/h.
Each plant is designed taking into account the possibility of substantial future increase of production capacity with limited investment cost.

Desmet Ballestra engineers are available to study the best plant configuration according to the specific market requirements and to support customers with a wide range of additional services such as:

- **Feasibility study**
- **Project financing**
- **Supervision to plant erection and start-up**
- **Training of customer's operators**
- **Technical assistance to plant operation**
- **Spare parts service**
- **Turn-key projects**

Detergent Production via Spray-Drying

For synthetic detergents the powder form is, by far, the most preferred by manufacturers and consumers and this is due to several advantages which powder detergents offer in comparison with other physical forms.

Among them:

- **Wide range of incorporable ingredients**
- **Easy dosing (regardless the adopted washing procedure)**
- **Low cost per wash-load**
- **High marketing appeal**

The contribution of technical and marketing factors in addressing the choice and preference of the consumer to powder detergents may change in various market areas but it is the result of the specific characteristics of the available raw materials, and of the adopted formulation.

The basis of detergent powder manufacturing are therefore linked to the above topic for what concerns the chemical side, and to the concept of "Spray-Drying" operation.
This latter consists in evaporating the water contained in the detergent slurry, thus obtaining a dry-product with a physically modified and controlled form.
In particular, this is obtained by providing the largest and most efficient contact between the heating fluid (hot air) and the fluid to be dried (detergent slurry).
This solids suspension in water is segmented so to have it under the form of droplets that undergo to the water evaporation by countercurrent contact with the hot-air stream.
The physical modification of the slurry is made by spraying it (at high/controlled pressure) through specially designed nozzles where the infed stream is made turbulent and then passed through calibrated orifices.

Once that the droplets are formed, the water evaporation takes place along the contact-path through the drying-tower, where the hot-air is circulated.

This process is important in determining the size, flowability and density of the dryed particles, and mainly depends on factors like:

- **Slurry viscosity (solid content and composition)**
- **Spraying pressure**
- **Gradient of temperature between the drying medium and the slurry droplets**

SPRAY-DRYING of DETERGENT SLURRY

- HOLLOW-BEADS SHAPED PARTICLES
- HOMOGENEOUS INTIMATE COMPOSITION of DRY SOLIDS
- CONTROLLED WATER-EVAPORATION RATE
- CONTROLLED GRADIENT of TEMPERATURE THROUGHOUT THE PROCESS

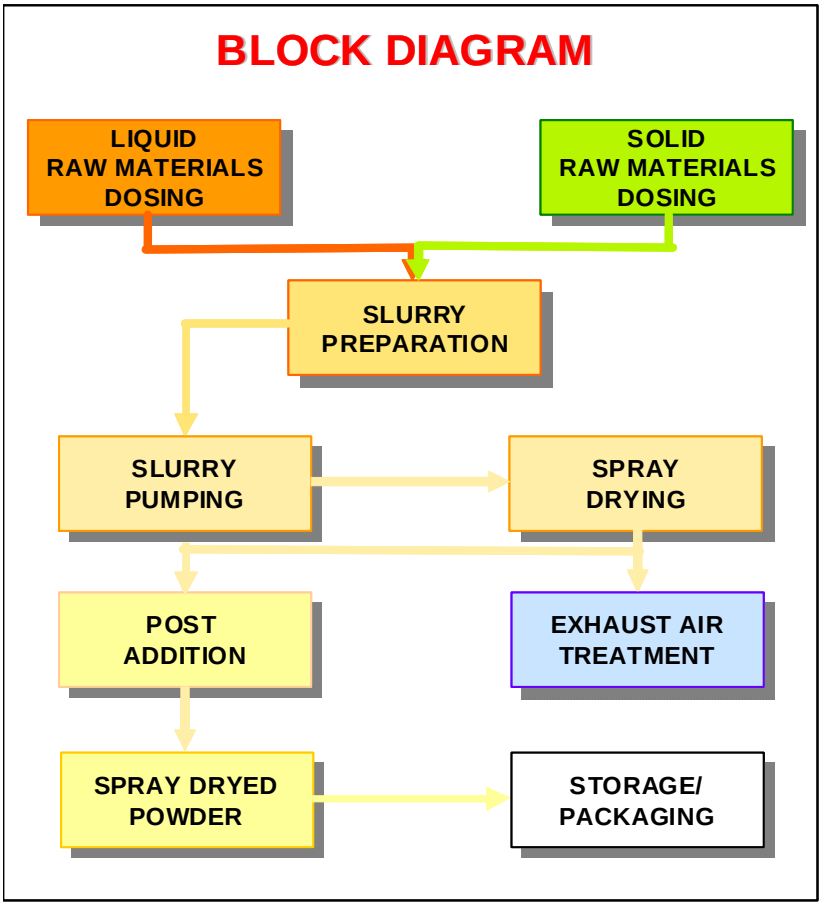
Sabiz Plant Process Description

The detergent powder production by Spray Drying Process requires the following steps:

- **Raw materials dosing slurry preparation and pumping**
- **Spray-drying and product conditioning**
- **Post-addition**
- **Exhaust-air treatment and heat recovery**

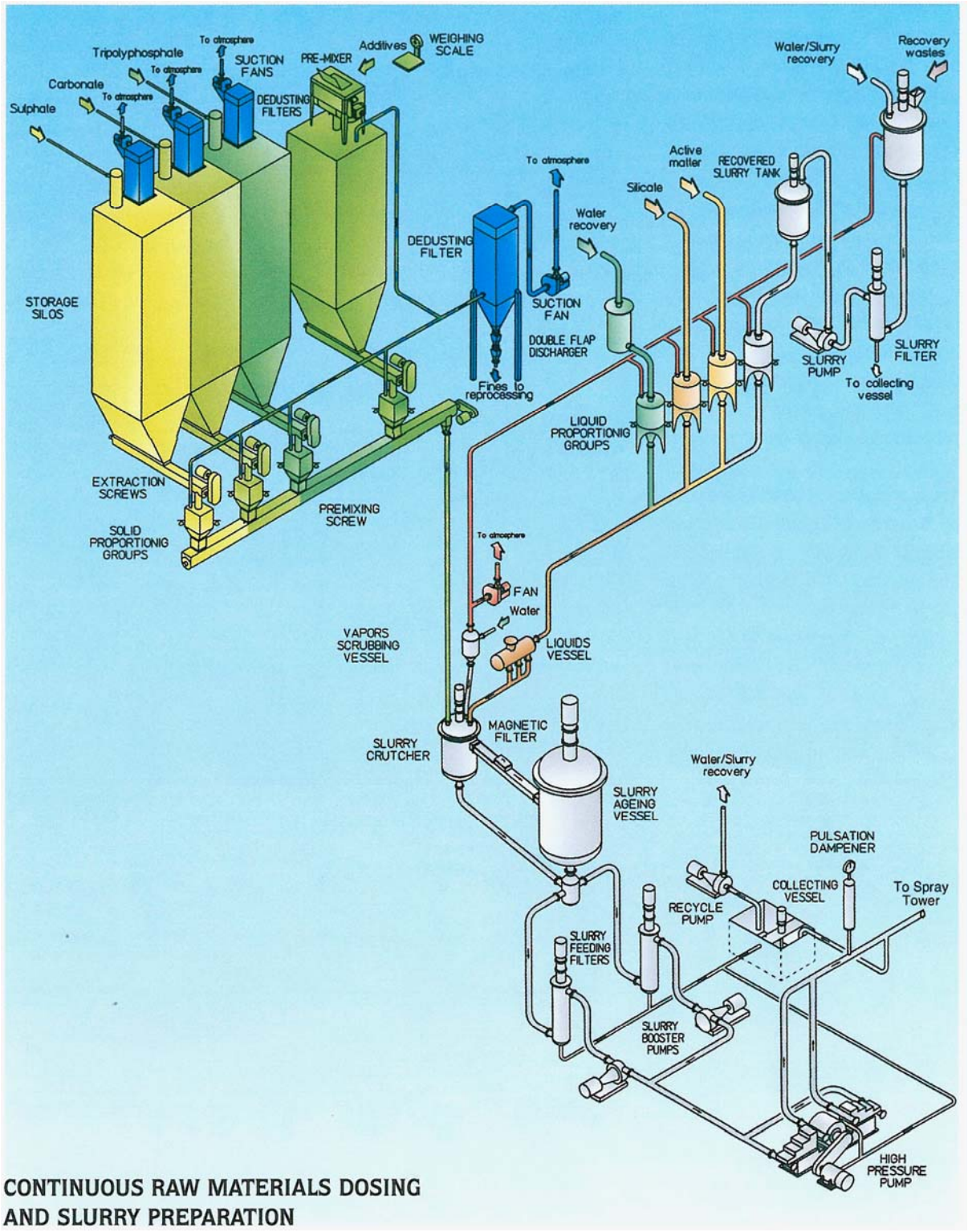
RAW MATERIALS DOSING, SLURRY PREPARATION AND PUMPING

The required characteristics of the slurry can be achieved both by continuous and by batch system, in all cases, the exact weight of each single component is provided (in batch system by weighing cycles, while in continuous system by means of independent dosing devices for each component).
The improvement nowadays achieved in accuracy of dosing is mainly derived from the adoption of computerised control system tailored on purpose (and applied to both continuous and batch system).



In the *Continuous Slurry Preparation system*, solid and liquid ingredients are individually and automatically dosed by means of electronic scales operating over variable weighing cycles, in accordance to product recipes and plant production capacity. The proportioned ingredients are continuously fed to the slurry crutcher.
In the *Batch Slurry Preparation system* the (pre)-weighed amounts of solid and liquid ingredients are fed to the slurry-crutcher (equipped with a high speed mixer specially designed for fine dispersion and perfect homogenization of the mixture).
Various options for raw materials weighing/dosing, with or without intermediate dedicated dosing hoppers, are available according to plant capacity and number of components to be incorporated in the product formulation.

The use of last generation load cells (both for liquid and solid component weighing) allows to achieve high accuracy (up to 0.1%) and to simplify the plant configuration.
From the crutcher, in both systems, the slurry is transferred to an ageing vessel, where it is further homogenized over a controlled residence time, fixed to achieve the ideal hydration degree of inorganic salts (mainly STPP) foreseen by the recipe.

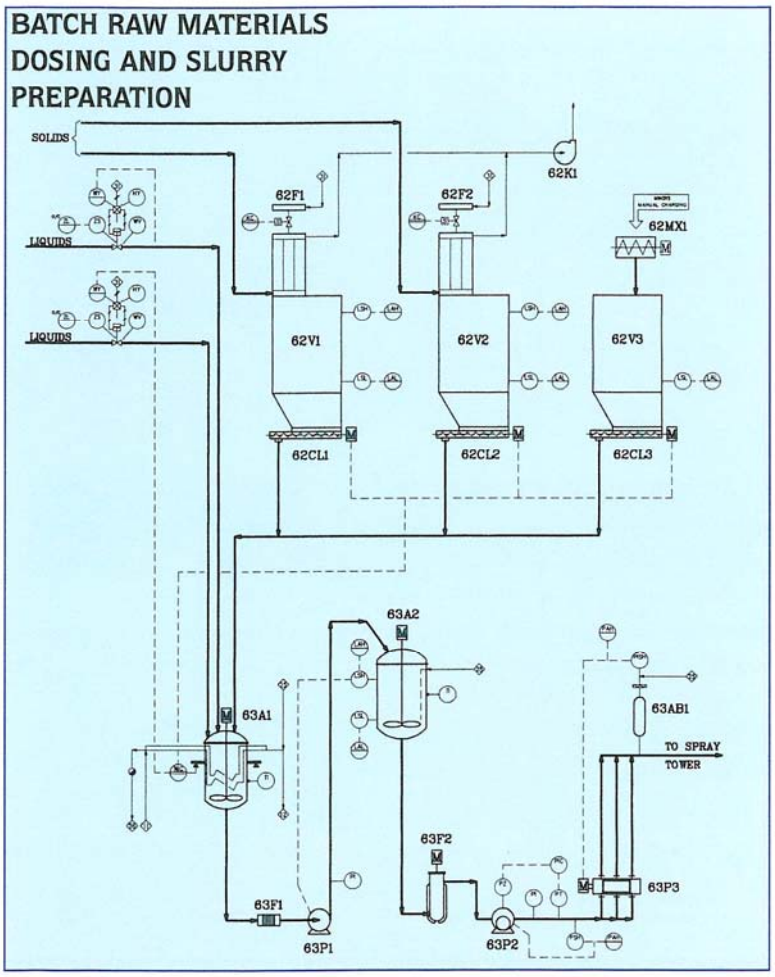


CONTINUOUS RAW MATERIALS DOSING AND SLURRY PREPARATION

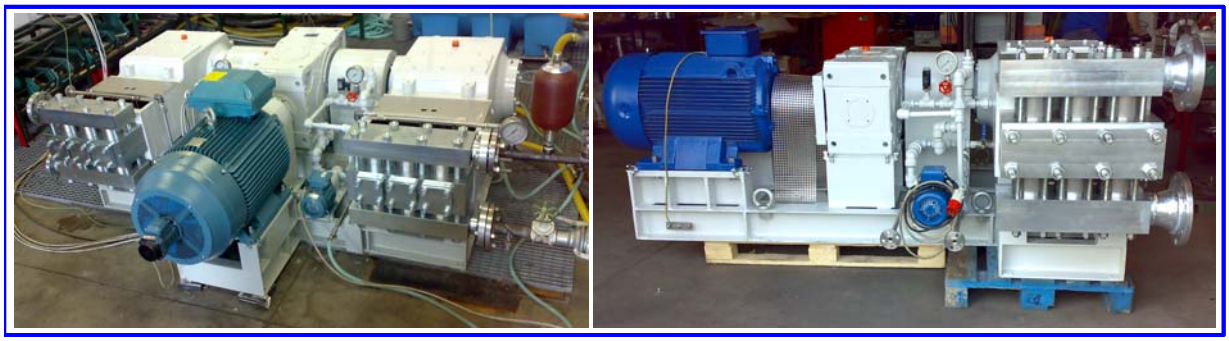
The concentrated, viscous slurry, is fed through magnetic traps followed by special self cleaning filters designed to remove any possible solid particles which could damage or clog the pumps and the spray nozzles.

The peculiar mechanical features of the slurry crutcher, filter and pumps allow to operate with a solid content in the slurry up to 70-72% with consequent benefit for the global process economy.
Booster pumps feed the slurry at controlled pressure to special high pressure pumps.

These pumps are specifically designed by Desmet Ballestra to handle viscous and abrasive slurries at a pressure up to 100 bar and to keep it constant at the required preset value.
Desmet Ballestra's high pressure pumps have a capacity ranging from 6.000 l/h to 27.000 l/h and they are designed for long lasting and maintenance free operation with high solid content abrasive slurry.



DESMET BALLESTRA HIGH PRESSURE PUMPS



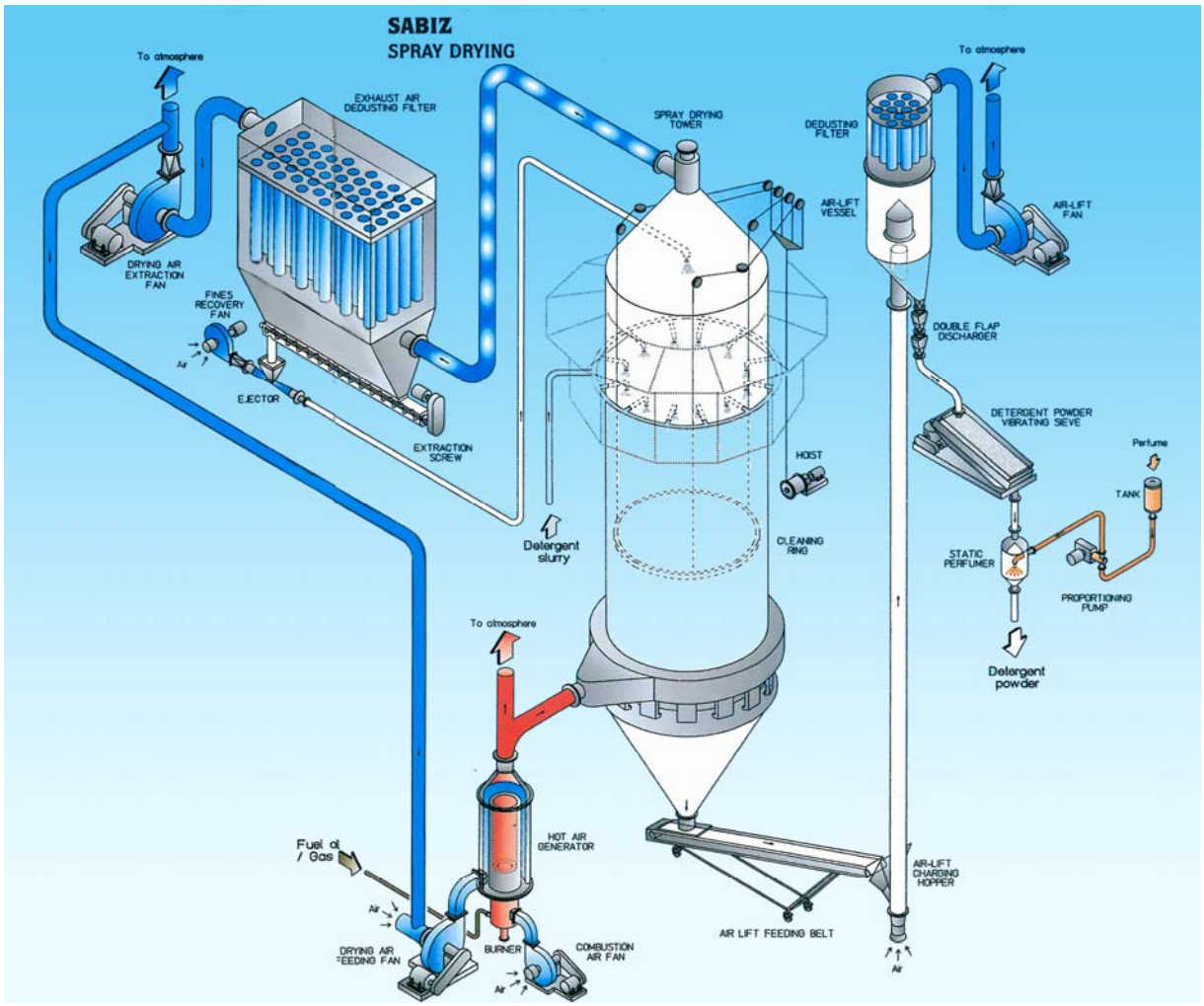
Spray Drying and Product Conditioning

The slurry is pumped to a spray nozzles circuit installed in the upper part of the spray tower.
The size and number of nozzles depends of the plant capacity and required product granulometry.
The spray is generally of the hollow cone type and nozzle size generally varies in diameter from 3 to 5 mm with a spray angle in a range of 50-70°.
In the spray tower the special design of the hot air distribution chamber allows operation with high differential temperature i.e.: hot air inlet temperature up to 400-450°C, exhaust air outlet temperature down to 85-90°C with consequent optimum thermal efficiency.
The optimization of the design of hot-air inlet ducts and the design and positioning of slurry distribution nozzles result in overall improvement of the drying path through the Spray-Tower.
This fact, together with the increase of solid matter content in the slurry and the increase of hot-air temperature result in increased evaporation efficiency of the Spray-Tower.
All the operating conditions are automatically adjusted by setting the proper parameters of fuel feeding, air flow, slurry concentration and all pressures/temperatures at the required optimum value, for controlled heat and mass balance of the process.
The characteristics of the powder beads are largely determined by direction, velocity and temperature of the hot air stream.
The hot air is generated in furnaces purposely designed to obtain smokeless combustion.
The most commonly available fuels (ranging from natural gas to heavy fuel oils), can be utilized without causing inconveniences nor affecting the whiteness of the finished products.

The hot air is conveyed to the lower part of the spraying tower. Two fans, determining the pressure conditions of the air circuit, are installed for regulation of the air-flow passing through the tower. By this circuit the hot air is conveyed via a special distribution ring located at the bottom and from there up to the top of the tower coming into contact countercurrently with the slurry spray falling down from the top.
The detergent powder with bulk density in the range of 200-450 g/l, is discharged from the tower at a temperature of 60-70°C and is transferred by means of a belt, to a continuous crystallization unit (air-lift), where it is conveyed upward by a flow of ambient air that cools it down so completing the drying and initiating the particles surface crystallization.

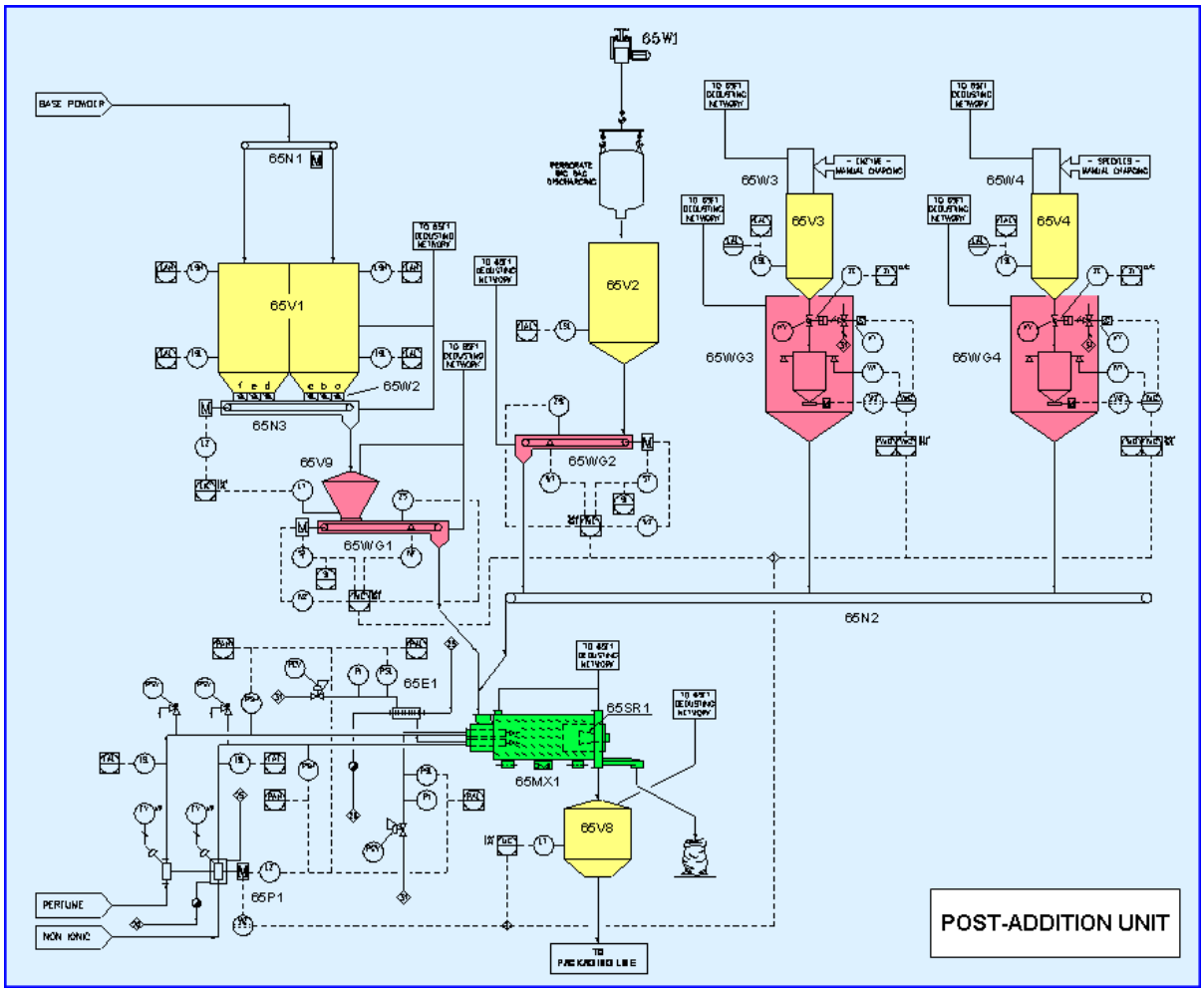
By this way the product is also lifted up to such a height as to allow the next operations by a gentle gravity-discharge avoiding as much as possible any breaking of the hollow beads.
Both the drying and transport air are sucked through sleeve filters before being discharged to atmosphere.

The separated fines are reblown into the spray tower, close to the slurry spraying zone, so to fully recovery them by agglomeration with the slurry droplets.
The detergent powder finally collected in the air-lift bottom cone are discharged into a sieve to remove any coarse agglomerated/wet material before eventual post addition, perfuming and packaging. The coarse material from the sieve is reprocessed via a separate dry or wet mixing/milling directly into the slurry preparation step.



Post-Addition

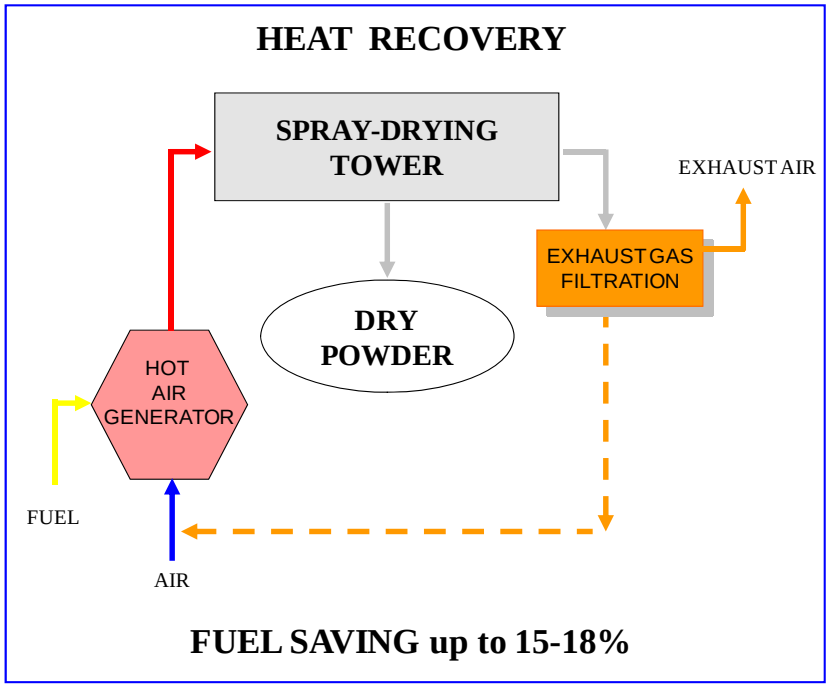
The base powder obtained by the steps of spray-drying and subsequent product conditioning doesn't contain those components that, due to their chemical characteristics, are sensitive to increased temperature and consequently have to be incorporated into the powder recipe in a way that preserves their chemical and physical structure.
The step of Post-Addition of these components is performed in a special Rotary Blender where the base powder and the thermosensitive component (both solids and liquids), are gently and intimately mixed and agglomerated, so resulting in a final product having characteristics of regular shape, high flowability and chemical stability / homogeneity.
The configuration of the post-addition unit can be very different according to the specific requirements of the final powder formulation and plant capacity.
For high production rates a continuous unit is recommended, which can be configured as here below outlined.



Exhaust Air Treatment and Heat Recovery

This process step is crucial for both process thermal optimization and for the minimization of the particulate emissions.
For what concerns this latter, the use of sleeve filter characterized by high efficiency, low pressure drop and resistance to high temperature, has permitted to reduce solid particulate emission up to 5 mg/m^3.
The option of sleeve-filter fitting on top of the tower represents the last tendency thus offering advantages for building and supporting structure simplification.

Energy demand reduction is accomplished by recovering part of the thermal energy contained in the exhaust-air which is partially recycled after filtration to the hot-air generation furnace, so ensuring a fuel saving in the range of 15-18%.



Spray-Drying plus Agglomeration (COMBEX)

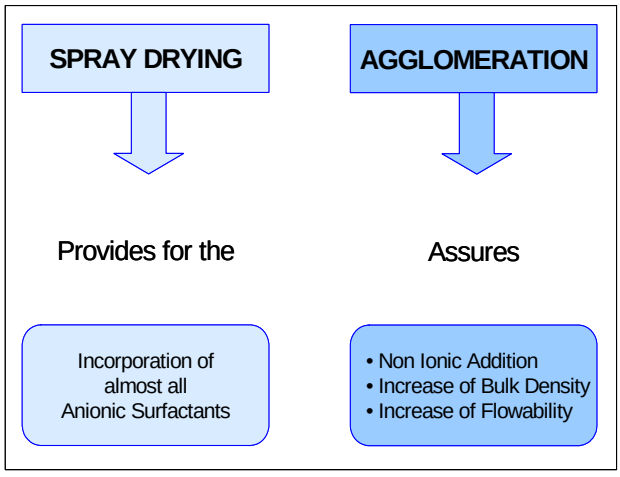
Due to the specific features of the Spray Drying plant and the operating conditions, particularly referred to the profile of temperature in the tower, it has always been a problem to produce formulated powders rich in Non Ionic surfactants and with final medium-high bulk density.
This problem can be easily covercome by coupling the Spray Drying process with an Agglomeration unit, so assuring consistent advantages both in terms of product characteristics and economy of operation.

The main advantage of this combination is the capability to produce concentrated powders of medium to high bulk density by using the best features of the two basic process operations.
In terms of process duty the Spray-Drying is used to include almost all the amount of anionic surfactant to be incorporated in the formulation, while the subsequent step of Agglomeration is required for Non Ionic surfactant addition and for physical modification of the final product (namely: increase of bulk density and flowability).

In the Desmet Ballestra COMBEX Unit (Combined Spray-Drying and Agglomeration process) the base powder is fed together with other solid components to a high-shear mixer **(Kettemix Reactor)** where liquid ingredients (like Non Ionic, Polymer solution or Na2SiO3 solution) are dosed. The solid and liquid components are agglomerated and the product formulation is completed for what concerns the surfactants content.
The agglomerated product from the above step is further processed in a low-shear mixer where minor quantities of solid are added as coating agents.

The combination of the mechanical work supplied by the mixers and the addition of solid (and sometimes liquid) components results in a granulation effect of the product. In other words the particles are densified and made more regular, while the further coating with solids assures free-flowness due to the non contact of sticky particles.

The final step of addition of thermosensitive components (such as perborate, percarbonate, bleach-activators, enzymes, perfume) and final sieving are performed in a rotary blender of the same type used in traditional Spray-Drying Plants.



The particular characteristics of the different mixers used for the above purpose, offer several advantages like:

- increase of the ratio of post-added components vs. the base spray-dried powder (with consequent increase of overall production capacity)
- increase of the total achievable level of active matters (range and types) in the finished products
- possibility to control the final bulk density by factor like:
  - ration of product from tower and post added component
  - mixers speed
  - sequence of addition of the components

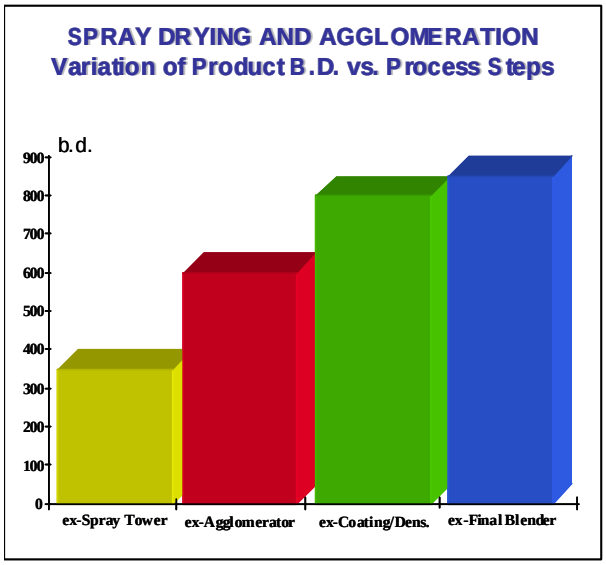
Anyhow, the most outstanding effects deriving from the combined Spray-Drying and Agglomeration process are:

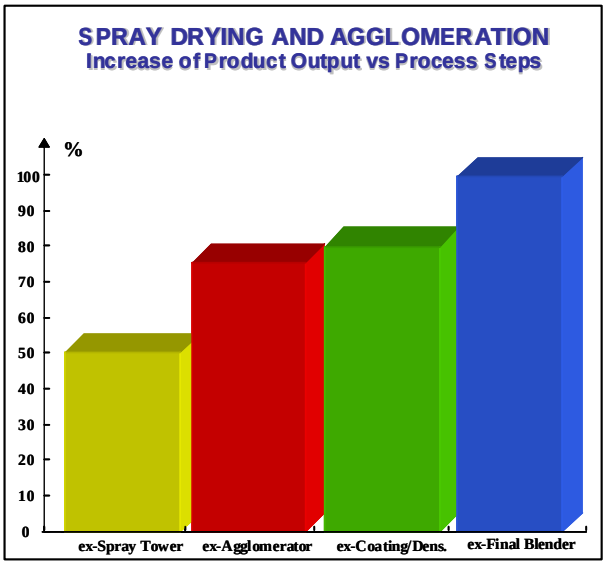
- the possibility to increase the non-ionics percentage in formula
- the modification of physical characteristics of the beads (manly density and average dimensions)
- the possibility to consistently increase the global product output

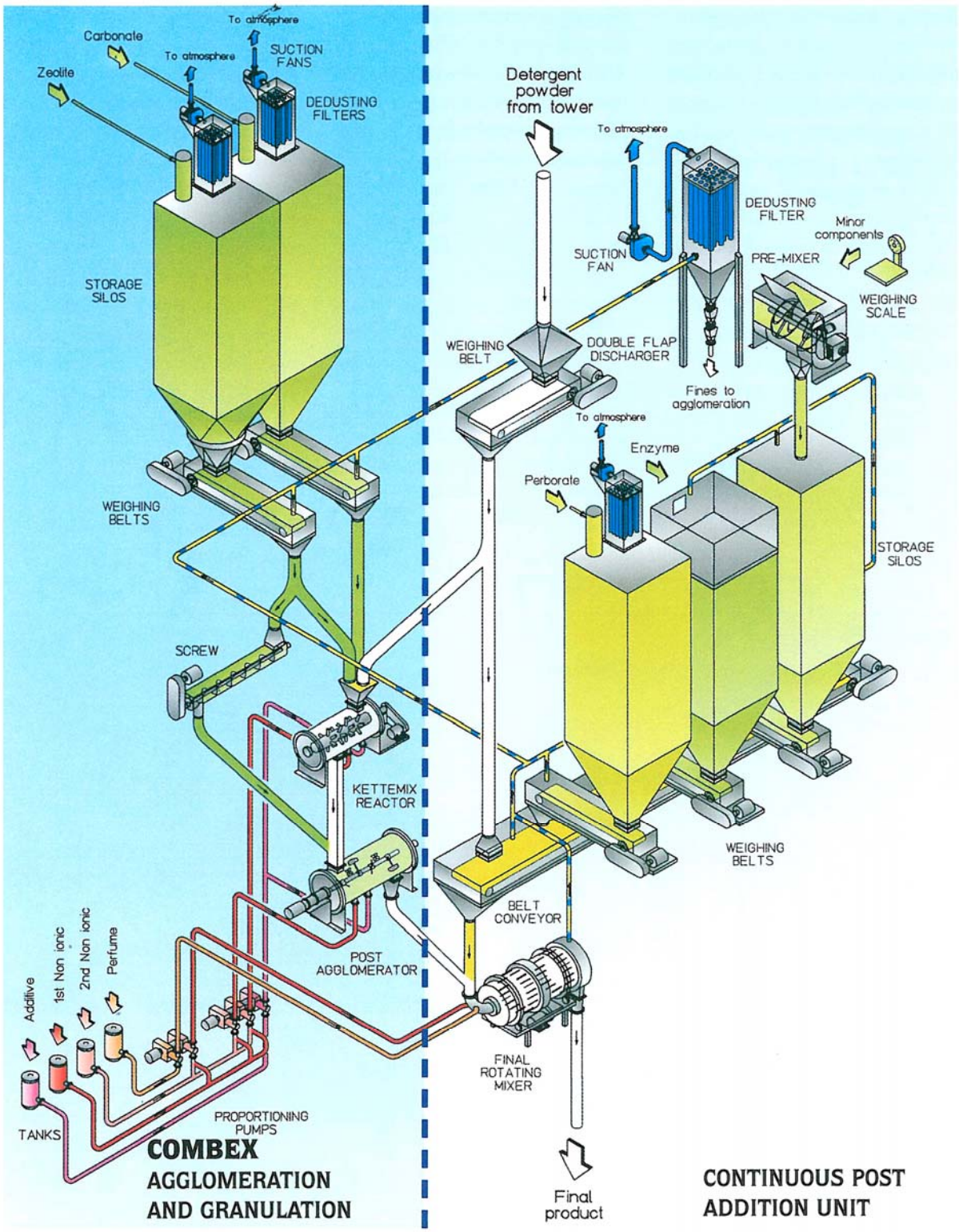
The possibility to produce a wide range of detergent powders rich in active ingredients (namely more efficient than traditional products) with reduced energy consumption increases the overall profitability of the plant.

The COMBEX process also offers the possibility to increase the capacity and the productivity of existing and already depreciated spray-towers with limited investment cost.

Powders with high bulk density (650-800 g/l), high active content (25-40%) and moisture content of 5-10% can be obtained by the COMBEX system.





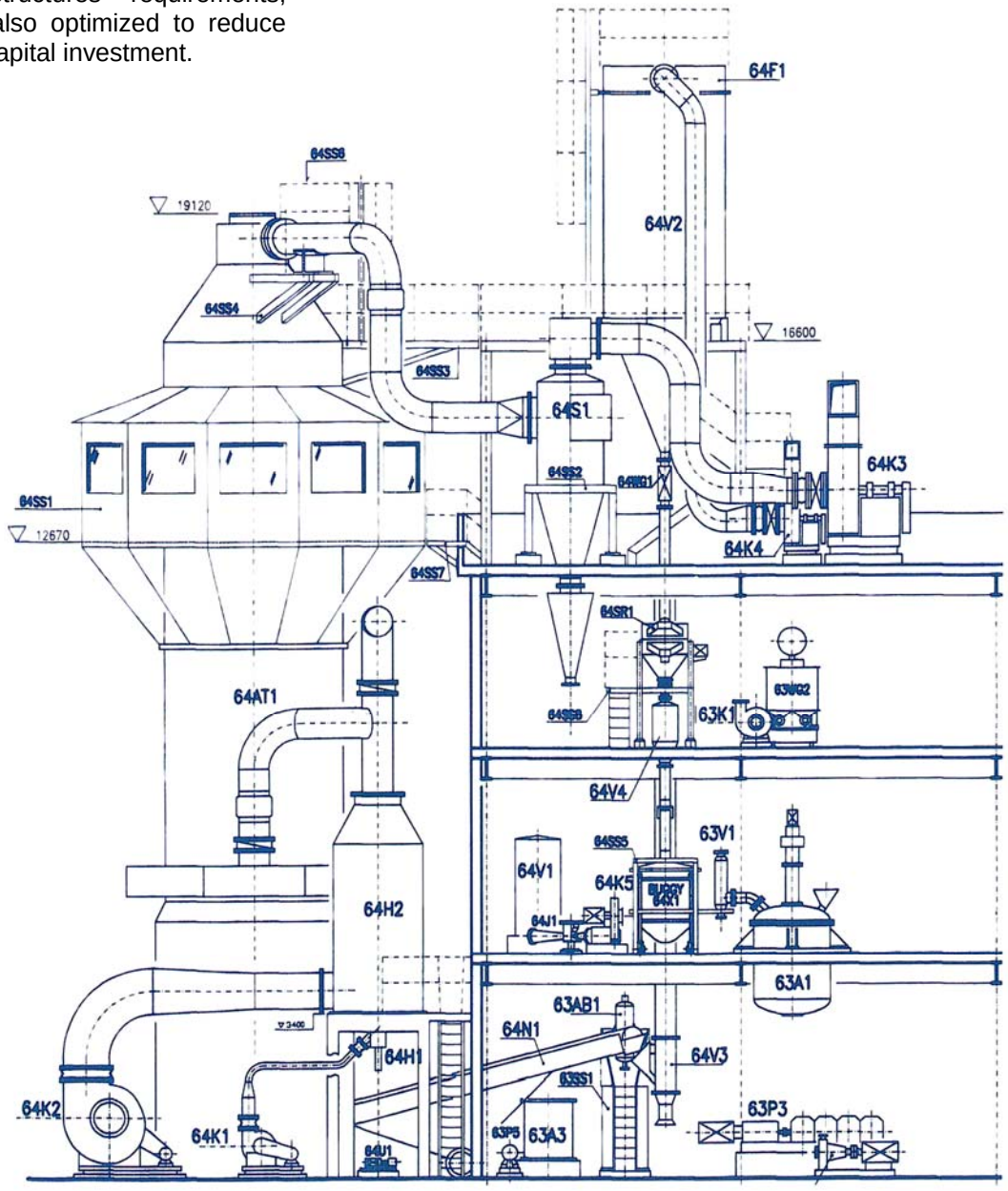

To atmosphere
Carbonate
To atmosphere
SUCTION FANS
Zeolite
DEDUSTING FILTERS
STORAGE SILOS
WEIGHING BELTS
SCREW
KETTEMIX REACTOR
POST AGGLOMERATOR
Additive
1st Non ionic
2nd Non ionic
Perfume
TANKS
PROPORTIONING PUMPS
COMBEX
AGGLOMERATION AND GRANULATION
Detergent powder from tower
To atmosphere
DEDUSTING FILTER
Minor components
SUCTION FAN
PRE-MIXER
WEIGHING SCALE
WEIGHING BELT
DOUBLE FLAP DISCHARGER
Fines to agglomeration
To atmosphere
Enzyme
Perborate
STORAGE SILOS
WEIGHING BELTS
BELT CONVEYOR
FINAL ROTATING MIXER
Final product
CONTINUOUS POST ADDITION UNIT

Simplified Plant Configuration for Small-Medium Size Plant

The Desmet Ballestra SABIZ Plant can be designed for a production capacity ranging from 1 up to 30 T/h still maintaining the same characteristics of environmentally-friend process, and ensuring optimized energy and utilities consumptions. Building and infrastructures requirements, are also optimized to reduce the capital investment.

The plant configuration for small-medium production capacity (i.e.: 2-4 T/h) results particularly advantageous due to the simplified process sequence (with particular reference to solid raw materials handling, batch dosing and simple discontinuous post addition).

The self standing spray drying tower allows to minimize building requirements and space demand (i.e.: for 2 T/h capacity the process building dimensions are only 15m x 12m with a height of 15m).



Process Control

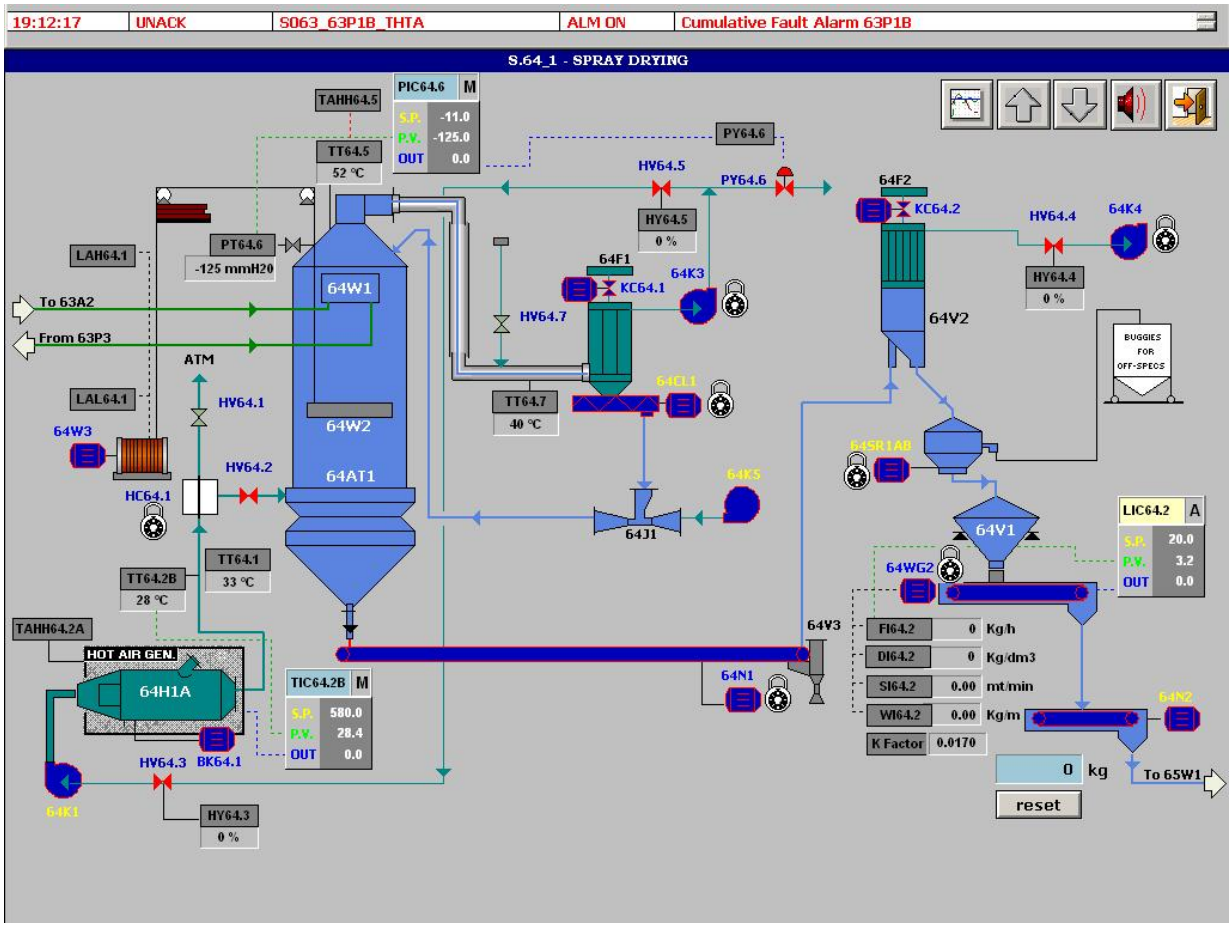
The SABIZ plant is operated by a Computer Control System “CCS” specifically designed for reliable and performing operation with an easy to use and friendly operator interface.
The computer control system ensures a trouble free plant operation with the automatic control of all the critical process parameters. It also guarantees a high dosing accuracy and therefore the accuracy and consistency of the product formulations. Moreover the computer control system reduces to the minimum the labour requirements for plant operation.

Up to 100 different preset formulations can be stored in the computer memory and the system automatically adjusts all process parameters and dosing devices to achieve the final formulation selected by the operator.
The CCS is built using the most advanced architecture that includes a PLC for process and production data control. The PLC is foreseen for digital and analog signals handling and it is provided with one or more CPU, designed to make all controls (PID loops, data acquisition, alarming, interlocks, sequences, etc.) by programmable logic.

The supervisory system based on PC establishes a “friendly interface” with the operator, using the platform **Windows XP** and the **HMI/SCADA** package.
The program has the necessary features to give to the operators all the necessary information to drive and control the plant, like:

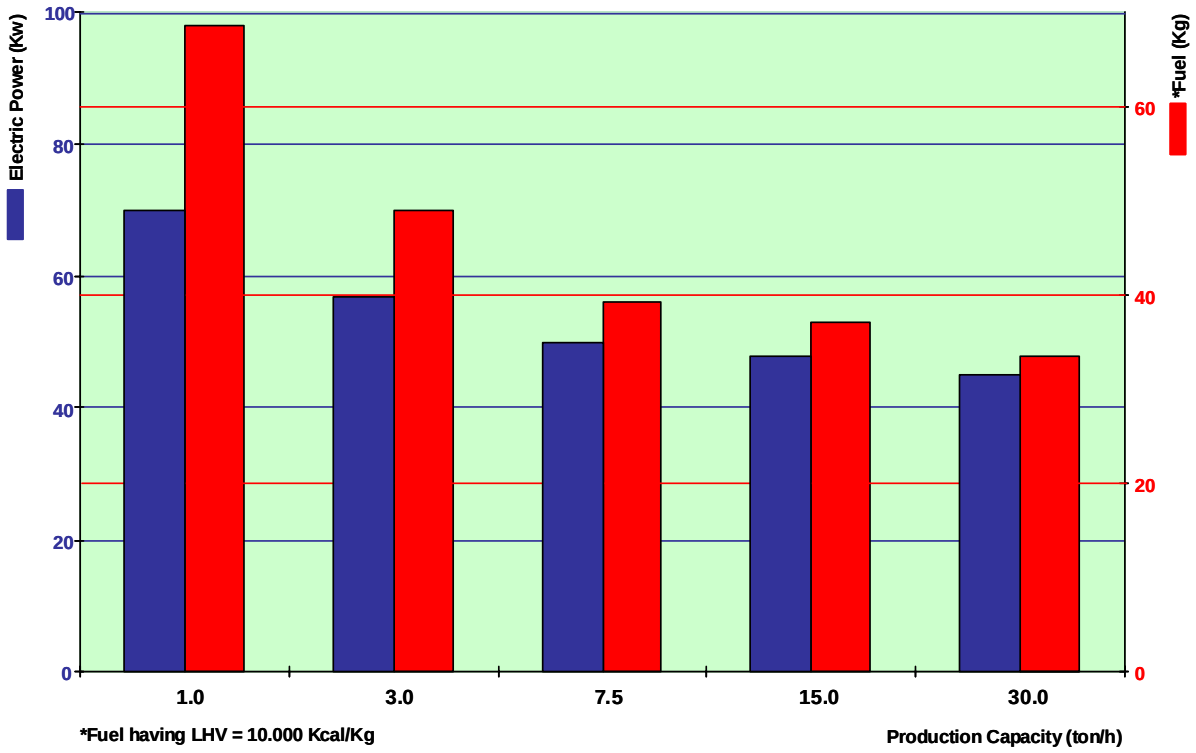
- Historical trend
- Historical alarm
- Free configuration of all analogue inputs
- Free configuration of all digital alarms

Video Page

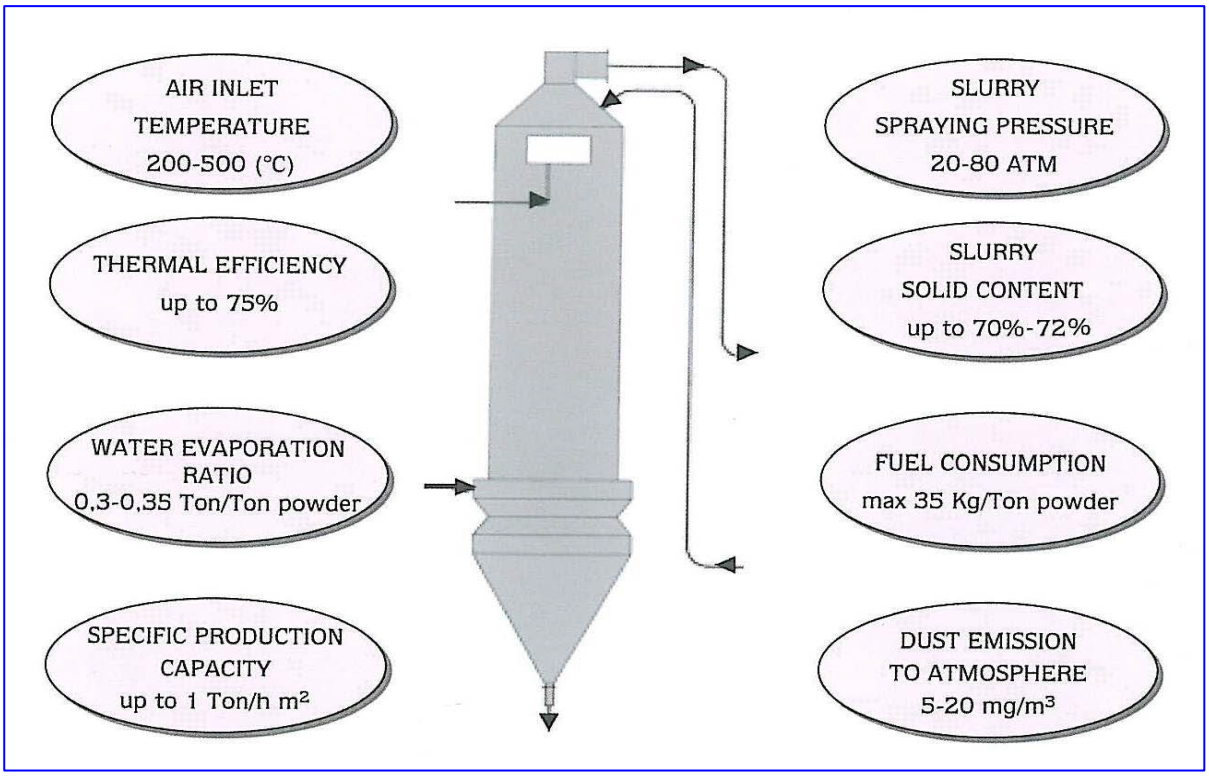


Sabiz Plant Overall Performances

ENERGY CONSUMPTION



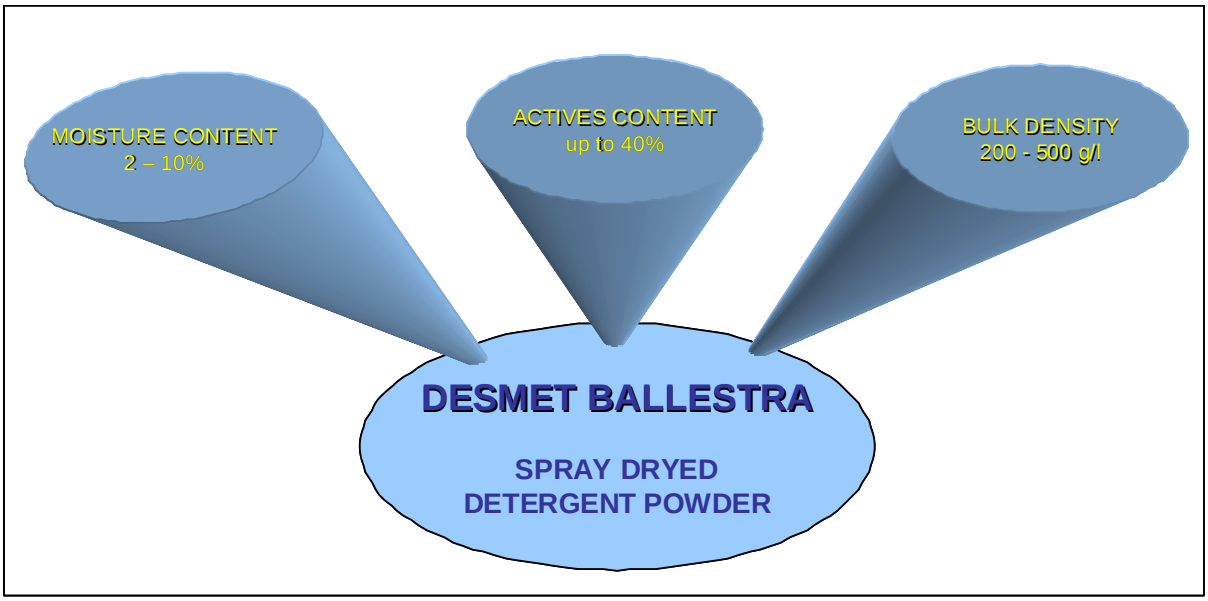
OPERATING FIGURES



BUILDING REQUIREMENTS

PLANT CAPACITY (t/h)	INDICATIVE BUILDING CHARACTERISTICS		
	SURFACE (m^2)	HEIGHT (m)	FLOORS (Nr.)
1-3	150-170	17-20	4
5-10	300-350	30-34	8
15-30	350-380	35-40	9

PRODUCT CHARACTERISTICS



Possibility of complete 3D design of the plant to ensure assembly and optimized plant lay-out

The Desmet Ballestra Group

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