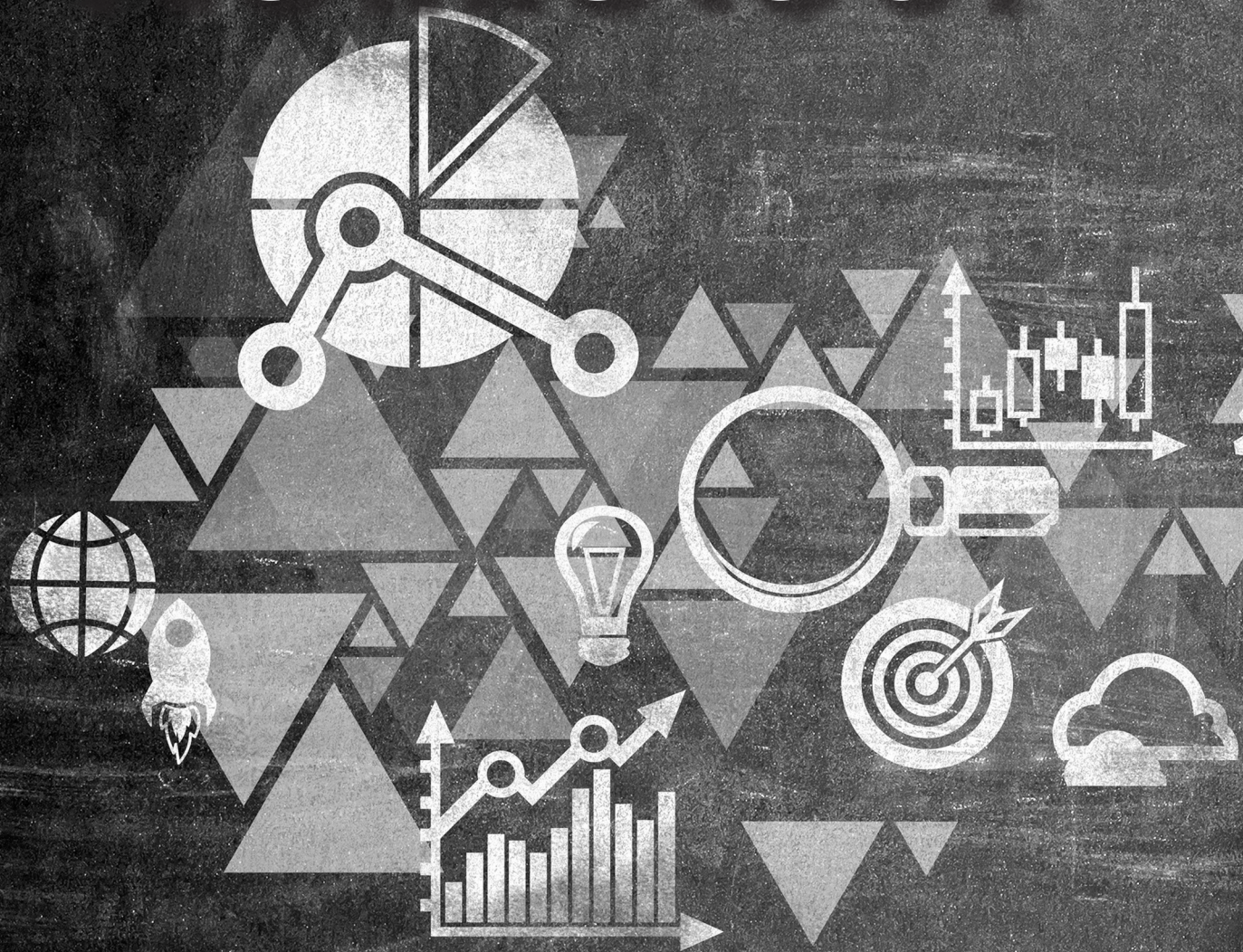


# OPTIMISING FLUIDISED BED TECHNOLOGY



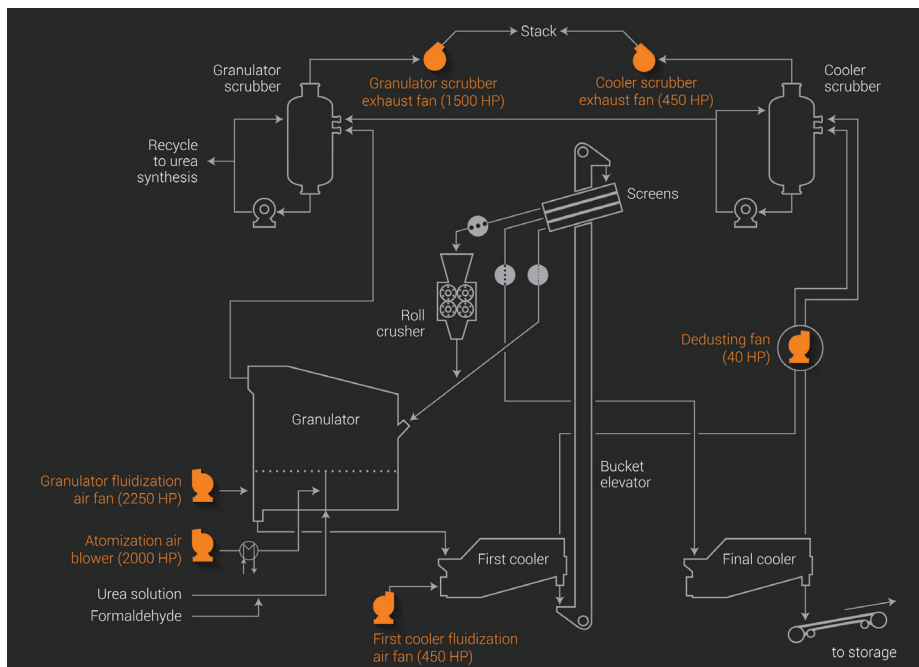
**Sergio Di Vincenzo, Boldrocchi, Italy,** discusses how fan packages can help increase the performance of fluid bed technology.

Fans play critical roles in the fertilizer production process and the packages around them are equally complex. Without precisely engineered and manufactured fan packages, the process simply does not achieve objectives, and at times, the desired transformation process quite simply does not occur. Fans not only ensure the process functions, but well engineered and manufactured fan 'machinery trains' (all process equipment around fans) can help increase capacity and

lower energy consumption – goals for all fertilizer plant owners and engineering, procurement and construction (EPC) contractors.

This article will highlight the importance of precise fan machinery train engineering and manufacturing to ensure performance objectives are met (or surpassed). It will also focus on the advantages of purchasing complete fan packages for urea granulation units, rather than buying the fan and the remainder of the systems piecemeal. These two points will be exemplified using a case study: an expansion project in North America that was commissioned a few months ago and that has been in operation since late 2017. The particular project involved fluid bed technology for a urea granulation unit.





**Figure 1.** Boldrocchi supplies complete fan packages for multiple points in the urea granulation process.



**Figure 2.** Granulator scrubber exhaust fan being mounted at Boldrocchi's in-house manufacturing facilities in Italy.

## New urea granulation unit

An existing nitrogen production plant was adding a new urea production unit, with the goal of increasing urea production capacity by 1800 tpd. Boldrocchi was hired in 2014 by KBR Houston to be the single point of responsibility for the complete fan machinery train of the fluid bed urea granulation unit, up to the main process interface. Therefore,

Boldrocchi designed, manufactured, carried out the technical coordination and oversaw the installation of all main components, including the mechanical, instrumentation, acoustic, electrical and piping components.

## Fan packages – a critical part of the urea granulation process

Process fan packages (fan machinery trains) are among the most crucial systems in the fertilizer process, and urea granulation units are no exception. Indeed, fan packages in urea granulation units are directly related to process – and therefore plant – reliability and performance.

Fan packages for this process are complex to design because their high ratings require careful mechanical design and their multiple components require the expertise of a number of different disciplines:

- Mechanical expertise for large rotating pieces of equipment.
- Acoustic expertise to achieve safe noise levels and reach noise reduction goals.
- Filtration expertise to ensure the final product is not contaminated.
- Thermal design expertise to ensure heated air is maintained at a targeted constant temperature to preserve the quality of final product.
- Expertise in the piping associated with the layout arrangement and lubrication system.
- Electrical and instrumentation expertise in order to define and program monitoring systems that protect the machinery. This includes anti-surge control systems for the atomisation air blower.

Another challenge is designing all these systems for a compact space, in order to minimise the impact on the overall layout of the urea granulation unit.

## Fan scope of supply

For this project, Boldrocchi supplied complete packages around six fans and one blower, all designed according to demanding API 673 requirements for special purpose units to ensure maximum reliability and all designed to fit into the requested space requirements. Fan packages were engineered around the following:

- First cooler fluidisation air fan, rated 450 HP.
- Granulator fluidisation air fan, rated 2250 HP.
- Atomisation air blower, rated 2000 HP (main component of double-stage package).
- Granulator scrubber exhaust fan, rated 1500 HP.
- Cooler scrubber exhaust fan, rated 450 HP.
- Dedusting fan, rated 40 HP.

- Fumes extraction fan, rated 40 HP.

## Fluidising the bed: air fan packages

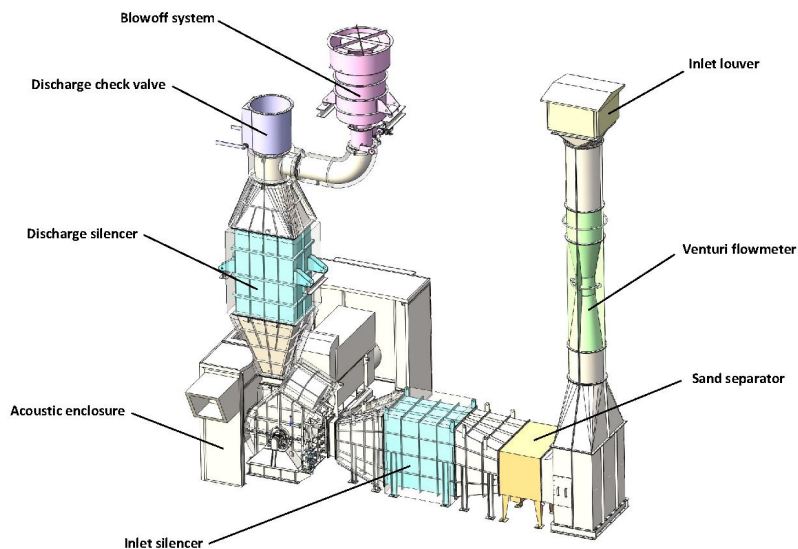
To fluidise the bed (where solid particles are subjected to a specified amount of pressure that forces the particles to mix and also behave like a fluid), air must be heated to a specific temperature, filtered, and sent to the bed.

Boldrocchi designed and manufactured two air fan packages (and one blower package, discussed below) that help fluidise the bed: a granulator fluidised air fan and a first cooler fluidised air fan. The team engineered each component properly to ensure that:

- Inlet filtration systems, consisting of high efficiency fibre filters, were removable, cleanable, and protected by rain protection louver dampers.
- Air preheaters, using steam, were designed to reach the requested thermal control over the process. These air preheaters have finned tubes, are heavy duty, ASME U stamped and were designed, fabricated and tested (with hydraulics tests) at Boldrocchi's in-house air cooled heat exchangers (ACHE) workshop. They were specifically designed with a reduced number of rows to minimise pressure loss and absorbed power, while reducing fouling, therefore reducing maintenance and making cleaning easier.
- Inlet silencers, absorption type, were placed directly at fan inlets to reduce noise emitted from both the ducts and the plant surroundings. Boldrocchi has a team that specialises in noise protection. They undertook noise studies of the air intake systems in order to design optimal silencers and duct insulation for these air fans. Noise reduction had to conform with strict noise regulations in the area.
- Inlet dampers, regulating the systems, were operated by pneumatic actuators to effectively save energy at different plant operating loads.
- Transition ducts, in flanged sections, were designed to optimise space requirements and reduce losses, hence improving the efficiency of the overall package.
- Electric medium voltage (MV) motors, the main drivers for all fans, were supplied and tested.
- All control logistics were programmed for normal operations, as well as for startup, shutdown and emergency situations.

Boldrocchi customised each of these air fan packages to the system's exact process parameters and was able to ensure such crucial elements as:

- The airflow rate caused the desired evaporation and attrition to allow for the targeted granule size.
- Clogging and impurities in the final product were avoided.
- The noise levels conformed to the area's strict regulations.



**Figure 3.** Rendering of Boldrocchi's atomisation air blower package.

- The air preheaters minimised pressure loss and absorbed power, while reducing fouling, therefore making them easier to clean.
- The dampers helped save energy during partial load operation.
- Plant operators had easy control over the system.

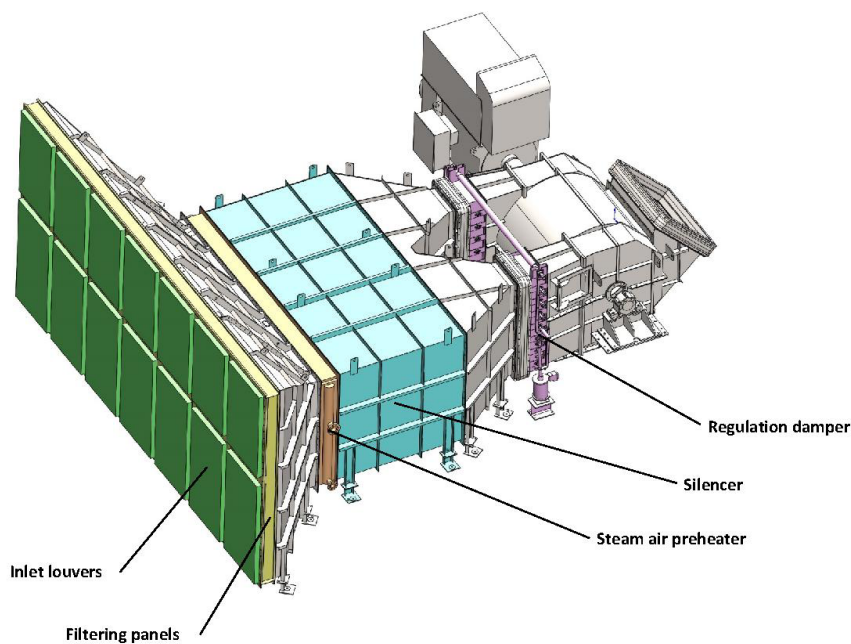
## Fluidising the bed: air blower packages

It is crucial to add an atomisation air fan or blower that is regulated very precisely and accurately because in a fluid bed unit, a pressure drop will affect the degree of material fluidisation significantly. Indeed, insufficient pressure translates to longer fluidisation time and may not create enough pressure for the exhaust damper to function.

Boldrocchi, therefore, engineered a double-stage atomisation air blower to achieve the high delivery pressure required. Designing this air blower required dedicated rotor analysis and the dimensioning of the complete lubrication system (by separate forced oil unit). The company included redundant accessories for long-term, reliable operation.

The team designed the atomisation air blower's package to include the following:

- An air intake system, complete with a silencer and a Venturi-type flowmeter, that ensured reliable flow measurement for blower control and anti-surge protection.
- A blow-off system, automatically controlled from the distributed control system (DCS), that works with the inlet flowmeter readings to prevent blower operation in surge areas where vibrations could lead to critical damages to the machines.
- An inlet filtration system, consisting of an inertial air filter for sand separation and an exhaust fan (scavenger fan), both of which ensure high efficiency and reliable airborne sand removal in any ambient conditions with a virtually maintenance free design.
- Discharge piping with a silencer and a check valve, to ensure blower isolation from the process during shutdown.



**Figure 4.** Rendering of an example of one of Boldrocchi's fluidisation air fan packages.

- An acoustic enclosure that reduces noise to 85 dBA (this level includes the noise from the ventilation fans and internal lighting). Boldrocchi's noise protection experts did a noise study of both the acoustic enclosure and the blow-off silencer and engineered an acoustic enclosure that would ensure such high noise reduction targets.
- An inlet damper, operated by a pneumatic actuator, that regulates the system and is designed to save energy at different plant operating loads.
- An electric MV motor as the main driver for the unit.

The atomisation air blower package was designed as a walk-in with inspection doors for operator maintenance, an internal lighting system, heat extraction fans with switch panels that can select local operation, profiled columns and a base with removable sandwich panel walls, which are fire resistant and weatherproof for easy assembly/disassembly in case of rotor or motor removal.

The lube oil system is designed according to API 614 and feeds the fan and turbine bearings with fresh oil cooled by a TEMA C water-cooled heat exchanger. The bearings on the system are sleeve type with common forced oil lubrication for the complete machinery train. The oil is pressurised by a shaft-driven main oil pump. An auxiliary motor-driven standby pump is to be used as both a backup and a startup pump to ensure reliable backup.

## Scrubber fans

A fluid bed granulation unit has two scrubber fans: a granulator scrubber and a cooler scrubber. The challenge with these fans is that there is high potential for corrosion and they undergo significant stress. There is also a high risk of vibration and imbalance as urea dust can easily accumulate on scrubber fans and this urea dust can unbalance the rotating parts and create high vibration levels.

The scrubber fans had to combine corrosion protection with high stress capabilities. Their construction and controls

were also carefully engineered and built, as they are critical for reliable long-term operation. Both scrubber fans for this project were manufactured using SS316 casings and rotors in duplex stainless steel to avoid corrosion due to the high levels of acid condensation downstream of the granulator scrubber system. The parts of the fan shafts in contact with corrosive fluid were also jacketed in SS316. Finally, the seals at the shaft passages, both labyrinth-type, were built in polytetrafluoroethylene (PTFE), and were designed to eliminate corrosion related problems in critical areas of condensation where the shafts met ambient air.

## Monitoring the system

High quality urea granules depend on the plant operator's ability to monitor various process parameters. Boldrocchi, therefore, supplied a fully packaged unit with 100% redundancy on all auxiliary components (filters, coolers and oil pumps) and

continuous monitoring of the main parameters. The monitoring system was designed to be intelligent and monitor all variables to ensure long-term reliable operation and offer plant operators control in case of faults.

The customised local instrumentation module sends alarm and trip signals in case of oil pressure loss, temperature hikes or low levels. Boldrocchi also supplied all field instrumentation for machine monitoring connected to plant's main DCS/ESD system.

## Testing

A large space is required to test these systems, and Boldrocchi's Italian workshops provide the space, a large test stand and the high power requirements necessary. Technicians were therefore able to perform successful functional tests of all the equipment in-house before shipping the solutions, careful to ensure proper settings and reliable operation. This testing is a crucial step on such highly engineered applications.

## Erection and commissioning

Boldrocchi fast-tracked this project and was able to deliver all packages within a short nine months, whereas a typical delivery would take 11 months to a year. Delivery was on time. Erection and commissioning were overseen by a Boldrocchi site expert, who was on-site for two weeks to ensure the proper installation and smooth operation of all fan packages.

## Conclusion

Fan packages for fertilizer plants, including processes such as urea granulation, are highly complex and can sometimes be considered mini-plants onto themselves. Engineering on the fans and on the package components must be precise in order to achieve the targeted production/process goal. So much in these processes depends on fan package performance. **WF**