Process Equipment Design Considerations for Wheat Starch Dry Paint Stripping


OVERVIEW

This presentation details the necessary components of the cleaning, classification, and pressure delivery systems for wheat starch dry paint stripping equipment. The dry-stripping facility described uses precisely sized wheat starch media to remove coatings from high-performance aircraft.

This presentation covers the function of each component in general terms only. A paint stripping facility for a specific application will include the equipment described herein, sized to meet the required specifications and available budget.

CLEANING AND CLASSIFICATION

The cleaning and classification systems remove contaminants—such as dense particles, ferrous particles, and over-and under-size particles—from the wheat starch media.

Media cleaning takes place in several stages—each employing different technologies. The sequence, capacity, and efficiency of each cleaning stage must be precisely engineered to:

- retain the maximum amount of usable wheat starch media,
- eliminate all contaminants, and
- return sufficient media to the pressurized delivery system to maintain a high production rate in the stripping facility.

CLEANING STAGE 1: CYCLONIC SEPARATION

Cyclonic separation has been used to clean blast media for more than 30 years. It removes dust and fine particles from the wheat starch media. In a wheat starch facility, the cyclonic separator must be adjusted to remove the majority of the dust and under-size media particles.

The dust and fine particles travel with the exhaust air to the dust collector, where they fall into waste bins for disposal. A rotary air lock at the bottom of the cyclonic separator carries the wheat starch media and remaining contaminants out, without interrupting the air flow and the negative pressure inside the separator. Also, the rotary air lock meters the flow of media through the remainder of the cleaning and classification system.

CLEANING STAGE 2: DEIONIZATION

As the wheat starch media and remaining contaminants fall Continued on page four
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from the rotary air lock, they pass through a deionization mechanism. This significantly reduces the tendency for static cling between particles and increases the efficiency of subsequent cleaning stages.

CLEANING STAGE 3: MULTI-DECK VIBRATORY CLASSIFICATION

This five-deck system removes oversize particles at the top, undersize particles at the bottom, and separates remaining wheat starch media into three usable sizes for subsequent cleaning stages. As the name implies, layers of vibrating screens of decreasing mesh size, classify particles by size. The vibrating action shakes the small particles through the screens, and carries particles too large to pass to discharge chutes.

The top deck traps oversize particles, discharging them to waste drums. The remaining particles fall to the second deck, where all the large usable wheat starch particles are carried out for further cleaning. The third screen deck traps medium-sized usable wheat starch particles. The fourth, and final, screen deck traps the small usable wheat starch particles. The remaining dust and fine broken media particles fall through to the fifth deck, which is a pan that channels the material to a waste drum.

The particles that were classified by the second, third, and fourth screens now travel as separate streams of wheat starch media—coarse, medium, and fine. This classified working mix is most efficient for stripping coatings from aircraft.

CLEANING STAGE 4: MAGNETIC PARTICLE SEPARATION

Any ferrous material, steel or iron, remaining in the wheat starch media could damage the aircraft. Three separate magnetic particle separators are used—one for each media stream—though they operate in identical fashion. Baffles at the top of the separator direct the stream of falling media onto sleeved magnets. The magnets, within the sleeves, attract the ferrous particles and transfer them to a waste chute.

The remaining wheat starch media particles fall—still the three distinct size classifications—through the magnetic particle separators.

CLEANING STAGE 5: DENSE PARTICLE SEPARATION

This final cleaning stage discriminates between particles by density. Three dense particle separators are used—one tuned to efficiently clean a particular media mesh size. Inside the dense particle separator the wheat starch media particles flow onto an inclined linen deck. The inclined deck vibrates with an eccentric motion as a uniform stream of air is blown through it.

The air flow suspends wheat starch media particles just above the deck, allowing them to flow down the incline toward exit chutes. The dense particles, being too heavy to become suspended, are carried uphill by the eccentric vibration, where they fall from the upper edge of the inclined deck into waste drums.
Having separate dense particle separators for each of the three sizes of media allows the cleaning and classification system to retain more of the good, reusable wheat starch particles than would be possible with a single dense particle separator.

**CLEANING AND CLASSIFICATION REVIEW**

In the five stages of classification and cleaning, the system has incrementally removed contaminants that might adversely affect the wheat starch paint stripping process.

• Cyclonic separation removes dust and fines that would reduce visibility if reintroduced into the stripping enclosure.
• Deionization removes static cling that reduces the efficiency of subsequent cleaning stages.
• Vibratory classification removes undersize and oversize particles and classifies the wheat starch particles by size.
• Magnetic separation removes ferrous metal particles that would cut into the aircraft being stripped.
• Dense particle separation removes heavy particles that would strike the aircraft with too much force.

What remains are three distinct mesh ranges of clean wheat starch media.

**STORAGE HOPPER**

After the final cleaning stage, the three mesh ranges of media are mixed back together in the storage hopper. The result is a working mix of clean wheat starch particles, ideal for stripping coatings from aircraft.

Wheat starch media requires storage hoppers with features not normally found on hoppers for other types of media.

• Level sensors, either electronic monitors or visual sight glasses, reduce the possibility of overfilling. Overfilling the hoppers can result in media being accidentally lost due to carryover to the dust collector.

• Epoxy lining throughout the hopper interior prevents ferrous particles from the hopper's metal structure from contaminating the wheat starch media.
• Dehumidification equipment controls moisture inside the hopper to keep the wheat starch dry and free flowing.
• Flow enhancement devices, such as a vibrating cone at the bottom of the hopper, keep the wheat starch particles from clumping and bridging.
• The hopper, situated just above the pressure media delivery system, charges the pressure vessel(s) with clean wheat starch media each time the pop-up inlet valve opens.

**PRESSURIZED MEDIA DELIVERY SYSTEM**

The pressurized media delivery system must deliver the wheat starch media and compressed air at sufficient pressure and consistent volume to efficiently strip coatings from aircraft without damage. The key components include the pressure vessel, the volumetric feeder, and the pressurized air delivery system.

Any pressure vessel used in the U.S. must be built to American Society of Manufacturing Engineers (ASME) standards. For wheat starch applications, the pressure vessel should be rated for a 125-psi working pressure.

As with the hoppers, the inside of the vessel should be lined with epoxy to prevent media contamination. A 70-degree cone at the bottom of the pressure vessel and flow enhancement device combine to ensure smooth media flow down the 5-inch I.D. outlet. This large outlet allows a sufficient volume of wheat starch media to flow into the volumetric feeder mounted beneath the pressure vessel.
VOLUMETRIC FEEDER
The volumetric feeder performs the critical task of delivering the wheat starch media into the air stream at a precise and constant rate. This uniform flow of media into the air stream eliminates the pulsation at the nozzle common in less sophisticated systems.

For a high production aircraft stripping facility, the volumetric feeder should include these features:

- Large inlet to allow a smooth transition from the pressure vessel outlet. Capacity to precisely meter from 5 to 17 pounds of media per minute. This operating range allows the system operator to adjust media volume and air pressure to strip a variety of substrates without damage.
- Incremental adjustability in 1/4-pound increments, with repeatability and error rate within 5 percent at any selected feed rate within the operating range.
- Mechanism to balance the air pressure between the pressure vessel and the air delivery system. Pressure imbalances within the volumetric feeder will adversely affect the flow of air and media at the nozzle, usually causing erratic media flow or pulsing.
- Large outlet for smooth transition to the pressurized air delivery system.

Some stripping systems currently offered employ metering technologies that are inappropriate for use with wheat starch media. Belt Type Feeders are used in other abrasive technologies, but will not deliver uniform media flow over a wide operating range. They rely, to a degree, on the rate of media flow under gravity through an orifice and do not allow precise adjustment in the volume of media.

Disk Type Metering Valves are used extensively in traditional abrasive blasting. At the high media flow rates required for wheat starch stripping, a disk valve will cause excessive pulsing and erratic feed rates. Adjustments for the standard disk valve fall outside the range needed for wheat starch systems.

Simple Screw-Feed Valves exhibit many traits desirable for wheat starch applications. They deliver a relatively consistent flow at normal rates, but due to their inadequate inlet and outlet, and the lack of a true pressure balance mechanism, they tend to pulse and sputter at higher feed rates. Also, most lack precise control and repeatability.

VOLUMETRIC FEED VALVE
The ideal volumetric feed valve for wheat starch stripping has a multi-stage mechanism that first mixes the media, which breaks up any clumps. Then the media travels to the positive-displacement feeder, which delivers accurate, uniform flow into the air stream.

Even this multi-stage, positive-displacement design has limitations in its standard configuration. For applications that require especially heavy media flow rates—such as 25 to 35 lbs. per minute—a positive-displacement feeder with increased size and capacity should be used.

PRESSURIZED AIR DELIVERY SYSTEM
The pressurized air delivery system carries air to the pressure vessel, then travels down to the bottom of the volumetric feeder to pick up the wheat starch media and carry it through the hose to the nozzle.

As with the volumetric feeder for media, the ability to precisely regulate the volume and pressure of the air affects the production rate and repeatability of the stripping process. This system helps maintain the balance of pressure between the pressure vessel and the volumetric feeder to ensure pulse-free media flow.

For a high-production aircraft stripping facility, the pressurized air delivery system should be made with premium quality piping, valves, and pressure regulators.

CONCLUSIONS
In general terms, dry stripping with wheat starch media resembles other abrasive blasting technologies. However, the wheat starch media and the surfaces being stripped demand special attention to cleaning the media and delivering precise quantities to the nozzle. Technologies that focus just on media delivery, at the expense of media cleaning, risk severely damaging the high-performance aircraft being stripped.

Systems that clean the media well, but rely on standard abrasive metering and delivery technologies will not produce consistent, repeatable results with wheat starch media. To make wheat starch media dry stripping effective and efficient, the technology employed must do all of the following and do them well—

- Clean and classify the wheat starch by size, by composition, and density to maintain the optimum working mix.
- Transfer and store the wheat starch media without introducing ferrous contaminants that could damage the aircraft being stripped.
- Keep the wheat starch media dry and free flowing.
- Consistently and accurately meter the wheat starch media at high feed rates without pulsing at the nozzle.
- Allow precise, repeatable adjustments to the media feed rate and to the air pressure.
- Deliver uniform results.

Any technology that delivers less, or whose representatives dismiss the importance of these features, is unacceptable for stripping coatings from multi-million dollar aircraft.