Improvements in Blasting Process Media

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The development of the plastic media blasting process has been a 20-year progression of improving medias, equipment and process parameters. Today, engineered abrasives (with physical characteristics designed into the particles) are tailored to diverse aerospace surface and coating requirements. The latest media development is a nanocomposite that combines polymer, nanostructure and composite technologies to remove coatings faster without damage to a wider range of substrates.

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IMPROVEMENTS IN BLASTING PROCESS MEDIAS

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Abrasive blasting with loose abrasives has evolved over centuries. Abrasives used initially were sands, and other naturally occurring minerals. With the industrial age came slags, which were by-products of smelting, and agricultural by-products such as nut hulls and pits. Throughout this period the physical characteristics inherent to the material were adapted to. Today, desired physical characteristics are engineered into materials in order to make them capable with the substrates, coatings, and desired results.

Abrasives historically were measured on a MOHS scale originally designed to measure the hardness of minerals. The MOHS scale goes from 1-10, with 10 being diamond hard. Historically, it ranged from soft sands, which began around a 5 hardness, and went up to aluminum oxide, silicon carbide, and diamond, in hardness. Agricultural abrasives started around 2.5 and became softer going from walnut pits through corncobs and rice hulls. But, there was always a gap in the middle, in the 3-4 hardness range. Plastic medias developed in the early 1980's fit into this hardness range and made possible applications not previously feasible with existing abrasives. With plastic abrasive came the concept of a material that was harder than the coatings it was removing, but softer than the substrate beneath.

The first plastic abrasive developed was unfilled polyester. Throughout the 80's and early 90's, plastic abrasives utilized in abrasive blasting were still identified and used accepting their existing physical characteristics and properties. In order to adapt these abrasives to different applications, particle size and other process parameters were adjusted. Polyester being fairly soft was considered a very delicate abrasive and was widely used in electronics for cleaning printed circuit boards, and in some aerospace applications for coatings removal from composites and thin-skinned materials. However, on modern coatings, polyester was not considered to be fast enough for large production depaint operations, which lead to the development of the second material. Type II, which is urea formaldehyde. While polyester raw material had come from the button industry, urea formaldehyde was traditionally used in the electronics industry for light switches and wall plate covers. These materials fell within the family of thermosets, which are plastics which cannot be reheated and reformed. Type II, urea, became an industry workhorse, being highly productive and durable. It was reinforced with alpha cellulose fiber and could remove coatings at a high rate of speed. Type II was extensively used on aircraft becoming the media of choice for depainting the entire fleet of F-4 Phantom fighters and CH-47 Chinook helicopters. During that period of time, Republic Airline also stripped a number of commercial aircraft prior to their acquisition by Northwest. During these early days, the processes were very operator sensitive with narrow margins of error and required a high degree of control of process parameters. Today, Type II medias are primarily used for engine overhaul, component cleaning, landing gear, wheel and brake, AGE equipment and other durable components of the aerospace industry. Outside of aerospace, it is used in manufacturing processes, cleaning castings, molds, and other hardened aluminum or steel components. In some instances, it is used for profiling softer substrates such as graphite epoxy. The third abrasive to come along was melamine formaldehyde, which primarily comes from the non-breakable dinnerware industry. Type III media was harder than the Type II and had a hardness of 4.0 on the MOHS scale. This material has principally been used for removing tenacious powder coatings and cleaning harder coatings or contaminants from durable surfaces. Melamine in fine sizes is also extensively used in the integrated circuit industry for deflashing.

Type IV, phenol formaldehyde, did not prove popular with users and the next material developed was a high molecular weight cast acrylic. Type V acrylic had a hardness of 3.0 but had a reduced density of 1.2 combined with durable cutting edges and reusability. For the past 10 years, Type V acrylic has been the preferred media for dry stripping of military aircraft exteriors. Combined Type II and Type V history includes over 15,000 aircraft that have been successfully depainted using plastic abrasives. This includes the entire fleet of C-5s and most C-130s, plus F-16, F-18, F-14, F-17, fighters, trainers (T-38), attack aircraft (A-10), and rotary wing aircraft, including Sea Stallions, Chinooks, and Hueys.

The plastic media dry stripping process takes place within a confined area to keep the material free of contamination and to recover it for reuse. Equipment designed for this purpose recovers and cleans material prior to its reuse. This can be from as simple as cyclonic separation of dust to a complex system with dense particle separators, magnetic cleaners and sieve systems. The size of the systems ranges from cabinets, to full hangars for wide-bodied aircraft. The largest dry media dedicated facility is operated at Boeing Aerospace Support Center in San Antonio, and will house a C-5 or 747 size aircraft.

Critical to the use of plastic abrasives is process parameters control. The process parameters include particle size and shape, particle hardness and density, air pressure at the nozzle, media flow rate, nozzle size, stand-off distance which is distance from the nozzle to the surface), and the angle of attack. Each of these parameters is important and changing any one will change the resultant affect of the blasting and potentially the affect on the substrate.

In the early 1990s came the first attempt at engineering an abrasive to the requirements of a substrate and application. That effort resulted in a starch graft co-polymer identified as Type VII, which combined crystalline starch technology with acrylic by grafting them into a single molecule. This resulted in an abrasive which had unique capabilities and delicacy in substrate protection. However, commercial and military customers demanded higher productivity rates, lower fatigue rates, and greater cost effectiveness as compared to chemical strippers.

The second engineered plastic abrasive to be developed is an nano-composite material. Nano-sized particle engineering promises to be one of the greatest enhancers of physical, mechanical materials enhancement capability in the next 20 years. Opportunities are being developed in medical, metallurgical, and polymer sciences. One of these nano-sized structures developed in the thermosetting polymer arena is montmorillonite clays. These are produces in impermeable transparent sheets, having individual platelets, one nano-meter thin, but with the surface dimension extending to 1,000 nanometers. In the case of a nano-composite blast media, these particles are disbursed into a blend of amino-thermosetting polymers. When laid out, the montmorillonite materials are one-billionth of a meter thick and 750 sq. meters per gram. Small amounts of these nano-clays can have large affect on the rheological, structural, thermal, and barrier characteristics of base polymer.

The term nano-composite is relatively new and requires some explanation. For our purposes, a nano-composite is a polymer system containing an inorganic particle with one dimension of one-billionth of a meter in range. This is then compatiblized in an organic polymer such that the clay is chemically modified or intercalated in the polymer such that the spaces or galleries between the clay surfaces are filled. Because the surface area of nanometer sized particles is so large, small amounts of the additives can have an intimate relationship with the polymer and cause significant changes in the polymer behavior.

Toyota R&D labs initially conceived polymer clay nano-composites about ten years ago. By observing that most reinforcing materials in polymers, such as glass fibers, were not homogenously dispersed at the microscopic level, they theorized that a finely sized layer platelet would improve properties.

In the case of nano-composite abrasive, the nano-composite media is more efficient in coating removal by maintaining more durable surface integrity and cutting edges. This equates to a faster paint removal rate, less dwell time, and consequently, less fatigue to the substrate. By combining known particle characteristics in terms of size and shape with controlled process parameters, this one type of media is able to address a broad range of surfaces from clad to thin-skinned, honeycomb, and composite. It is the nature of aircraft today that they have beneath the coatings a wide range of substrates such that one media process, which is able address all of them, is desired.

Boeing has approved nano-composite Type VIII media for use on the KC-135 fuel tanker, B-52 bomber, and C-17 cargo aircraft. The current approval is for metals and additional aircraft systems approvals for metals and composites is in testing. Boeing materials characterizations studies in the structural testing labs found an improvement in fatigue life over baseline coupons. Of all media studied to date by Boeing, this is the first to actually improve fatigue life. The Air Force has included nano-composite type media as Type VIII under mil spec for plastic media and this material is in production use at the B.A.S.C. facility in San Antonio where 35 aircraft have been depainted with it over the past year.

Another development in the abrasive world is sponge media. Sponge medias come in abrasive and non-abrasive forms. Non-abrasive forms can be loaded with chemical or water to enhance cleaning capabilities. Sponge media can also be loaded with a wide range of standard abrasives including aluminum oxide and steel grit. The cleaning mechanism of sponge media is different than loose abrasives. While loose abrasives, whether plastic or mineral, chip the paint or contaminant from the surface, sponge medias flatten on impact with the surface and scoot across the surface dragging their abrasive. Because of this difference in mechanism, sponge lends itself to finely controlled processes for very lightly abrading or selective layer removal of coatings. The other benefits of sponge medias are they have a very low dusting level, and bounce back of the particles after impact. Due to these characteristics, the material is currently in testing for fuel tank interior cleaning, and other confined space applications. The ability of sponge media to selectively strip coatings or lightly abrade only, has created opportunities to replace hand sanding operations or scuff sanding prior to over coating.

Abrasives have continued to evolve in their ability to more accurately differentiate between the hardnesses of coatings and substrates. The range of physical characteristics of the medias combined with size and process parameters now create a broad spectrum of capabilities in surface preparation, cleaning, and depainting. From the days of sandblasting, which was dirty and aggressive, to dustless selective stripping of single layers of coatings from delicate surfaces, the dry stripping process have come a long way. Materials will continue to be developed to specific capabilities and applications to meet the evolving needs of industry.