Increase Product Yield of Rocket Propellant Process

LOW SHEAR CONVEYING IMPROVES OPERATIONAL EFFICIENCY

Rocket propulsion uses a combination of fuel and oxidizer to create a working mass that is shot backwards to provide thrust, accelerating the rocket forward. The challenge here involves nothing less than overcoming gravity itself—namely, ensuring that enough propellant is used that the push of the thrust up is greater than the force of gravity's downward pull.

One particularly powerful oxidizer is Ammonium Perchlorate (AP). The primary use of ammonium perchlorate is involved in making solid fuel propellants. When AP is mixed with a fuel, such as powdered aluminum and/or an elastomeric binder, it can generate self-sustained combustion at pressures far below atmospheric pressure. This is ideal for high altitude flight and space flight. With a decades-long history of use in solid rocket propellants, AP has proven an important oxidizer. It has repeatedly been used in space launches, including the Space Shuttle Solid Rocket Booster, as well as military applications, amateur projects, and hobby high-power rockets. In fact, AP is even used in some fireworks.

Importance of Gentle Conveyance

Ammonium perchlorate is an inorganic compound, colorless or white when solid and soluble in water. The production process requires the AP-solution to be pumped with very low shear force to maintain a crystalline structure. Shear force involves forces that are unaligned pushing parts of a body in opposite directions. The reason that shear force needs to be minimized is because it can lead to damage to the AP-solution used to launch the rocket.

Here, a progressing cavity pump, a type of positive displacement pump that conveys a product through cavities created by offset rotors and stators, provides an ideal means of transferring the fluid. This is because the pumps put a low shear force in the product, minimizing the potential for damage to the crystals. Another aspect of progressing cavity pumps that helps preserve the crystalline structure is their low pulsation. Ultimately, the lesser the damage to the crystals, the better the product yields of the manufacturing process. The space organization detailed in this case study had used progressing cavity pumps in the past with good success. When considering an expansion in production volume, however, the organization turned to one of NETZSCH's distributors, Tech-Flow, LLC. Josh Borg, a representative from Tech-Flow, quickly realized the unique demands of the particular application and worked closely with the NETZSCH to develop a custom solution that involved several specialized elements.

With the organization using AP for their rocket launch, NETZSCH wanted to ensure that they achieve the lowest shear force possible, as well as low pulsation, in order to preserve the crystalline structure of their AP-solution. This led NETZSCH to recommend the use of their NEMO® progressing cavity pump, which is an industry leading pump due to its low shear force that conveys products with high levels of operational efficiency, protecting the integrity of the conveyed product.

NEMO® FSIP® Advanced design allows Full Service-in-Place allows access to the rotor and stator without removing any process piping.

NEMO® Progressing Cavity Pumps Address each Issue

The final NETZSCH NEMO® progressing cavity pump configuration for this rocket launch employing AP includes the following selections, all of which were developed in close cooperation between the end-user's Facility Engineering team, Tech-Flow, and NETZSCH:

1. Installation space was very tight, so the pump features the NETZSCH proprietary Full Service-in-place (FSIP®) design. NETZSCH's FSIP® design enables the user to maintain and service the rotor stator system without having to remove any piping from the pumping system.

2. Stainless steel housing, hard chrome plated rotor and EPDM stator for chemical compatibility and operational durability. The EPMD stator was chosen for chemical compatibility, and the hard chrome plated rotor for abrasion resistance.

3. Double Cartridge seal with buffer fluid system. The seal created a positive barrier between the fluid and the atmosphere, with a positive differential pressure applied to that barrier fluid. This leads to deeper resilience, improving facility safety by mitigating the risk of a leak.

4. Customer-specified lubricant for pump joints. The specific oil used here was an approved vendor oil that allowed the joints of the progressing cavity pump to be lubricated in a way that had chemical compatibility with the product.

The first two NETZSCH NEMO® Progressing Cavity pumps were delivered in August 2021, installed quickly, and were actively being used in September. Pump performance has been better than expected. Additionally, the shear on the product is so low that the production yields have increased, exceeding the customer's expectation. This improved performance, along with a further increase in demand, has resulted in a repeat order for two additional pumps, doubling the initial production capacity.

Tech-flow's Josh Borg said that when he was presented with the project specifications, he knew exactly where to turn, stating: "NETZSCH Progressing Cavity Pumps are the ideal solution when it comes to low-shear, low pulsation conveyance."

Ammonium Perchlorate Solution Application Data

Pump Type:	NM053BY
Differential Pressure:	30 psi / 2 bar
Nominal Flow:	50 gpm / 190 lpm
Suction Pressure	Flooded
Viscosity	100 - 200 cPs
Fluid Temps	30 °F to 40 °F / 1.1 °C to 4.4 °C

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NETZSCH customers rely on our rigorous standards in design, engineering and manufacturing to deliver products with absolute functional reliability and exceptional quality. NETZSCH service, like NETZSCH quality, is geared to surpass our customers' expectations.

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pumps-systems.netzsch.com

NETZSCH Pumps USA · 119 Pickering Way · Exton, PA 19341
Phone: 610 363-8010 · Fax: 610-363-0971 · npa@netzsch.com

NETZSCH Pumps USA · 1511 FM 1960 Road · Houston, TX 77073
Phone: 346 445-2400 · npa@netzsch.com

NETZSCH Canada Incorporated · 500 Welham Road · Barrie, ON L4 8Z7
Phone: 705 797-8426 · Fax: 705-797-8427 · ntc@netzsch.com