

CASE STUDY

LEVERAGING OPTICAL TECHNOLOGIES TO INCREASE VALVE EFFICIENCY





CASE STUDY: FAST RESPONSE HIGH-PRESSURE CUTTING

At Custom Valve Concepts, we offer a variety of products that fit a full spectrum of equipment options. However, sometimes clients have highly specific and specialized requirements for their equipment, which means they need custom design concepts.

“Unicorn” concepts often seem beyond reach for custom applications. To address this, CVC utilizes specialized equipment and virtual modeling programs. In the following example, high-speed visual imaging was utilized to help create prototypes of those unique concept requirements that can only be created by mimicking high speeds during the testing and prototyping phases before final testing, production, and maintenance of the design. Custom products we’ve developed for specific applications that do not currently exist in the market fully effectuate “unicorn” concepts, making them real for our customers.

From process skids in multiple industries to specialized material handling and sorting equipment and a variety of equipment in manufacturing, we can work with clients to use this custom design process and assist companies in a wide variety of industries, from oil and gas to chemical to pharmaceutical manufacturing to agricultural production.

One specific product, Fast Response High-Pressure Cutting Solenoid Valve, and the results of its creation solved one food and beverage customer’s challenges by turning an ideal system into actualized designs, testing prototypes, and finalized products specific to the client’s exact needs even with conflicting application parameters. We’ve outlined the custom product and its results in the below case study.



OVERVIEW

Processing materials for categorization, removal of impurities, and arrangement for extraction are accelerated by the use of optical recognition software to identify characteristics at higher speeds and improved performance rates thought impossible. In applications where products require non-intrusive materials or avoidance of residual particles that may cause contamination in the cutting process, options have been limited by technological and design advances. High-speed optics capabilities to identify requisite actions further create challenging scenarios for mechanical devices to perform at equivalent speeds and duty cycles.

Custom Valve Concepts has used this process to meet the challenge while developing high-pressure de-ionized water manifolds with extremely fast-acting solenoid valves and nozzle designs for a customer's production needs. Specifically, valve operations that mirror the speed of a brain synapse at pressures that can effectively cut identified portions of materials from a part to improve product quality was a successful outcome to this recent product design challenge.



"CVC is creating products that can interface at the speed of visual imaging, creating processes to put our custom design offerings at the leading edge of product development. We use this process to make "unicorn" concepts reality for our customers."

– John Taube

THE APPROACH

The speed of response and the speed of recovery to respond again (cycle time/duty cycle) is one of the most challenging aspects of mechanical operation integrated with optical recognition software. Digital information transfer rates are the new bar set for designing products. Conveying systems now can operate much faster as a result.

These considerations impacted our critical parameters for the custom-designed cutting valve for this particular client application. Our list of parameters set by the customer included:

- Utilize de-ionized water as the cutting media to prevent contamination of the cut materials
- Achieve cycle time of fewer than 4 milliseconds to full open upon receiving an input signal, hold open for 3-50ms, and complete valve closure within 4ms of the absence of input signal, at a maximum 8 cycles per second
- Deliver a duty cycle in excess of 100 million cycles in a proposed 24/7 operating environment
- Sustain 15000 psi of fluid pressure
- Deliver laminar flow at the nozzle of 2 liters per minute
- Position up to 200 valves within a linear space of fewer than 60 inches
- Designed with the ability to efficiently service or replace valves and components as needed

One specific challenge within the above parameters required designing a unique coil that could accept a spiked voltage for fast response to the open signal yet not overheat while accomplishing the duty cycle. A force balanced valve design was critical to accomplishing this reaction speed while minimizing the coil energy requirement.

The physical dimensions of the coil were also addressed due to the number of valves in a very limiting space. A single pulse width modulating board and oscilloscope were acquired for establishing a coil reaction. High fluid pressure of 15000 psi with orifices in close proximity generated conflicting needs for wall thickness.



Valve closure did not require bubble tight seating but must not allow leakage to affect the system pressure. Nozzle selection involved both geometry and material to create laminar flow at desired flow rates and address wear at such a high duty cycle. Valve flow paths were impacted by requirements of delivery to the nozzle for laminar flow output, the proximity of each valve, wall thickness for high-pressure fluid, and the manufacturing ability of diameter to depth. High-speed cameras were required to validate cycle times and laminar flow characteristics.

THE RESULT

For the design, we utilized Peek as a material, creating a five-valve manifold with offsets that allowed manufacturing to drill flow paths effectively and stagger coils diagonally. The orifice outlets in each block were offset slightly in the horizontal plane to address manufacturing issues while maintaining the required uniform distance between each outlet.

The electro-mechanical requirements were accomplished by the balanced force design of the solenoid valve tube and plunger, which allowed the coil to be energized with a 24v, 2amp spike, and an 18v, 2amp hold. The resulting Cycle Time met the customer requirements of less than 4 milliseconds to full open upon receiving the input signal, hold open for 3-50ms, and complete valve closure within 4ms of an absence of input signal, at a maximum 8 cycles per second.

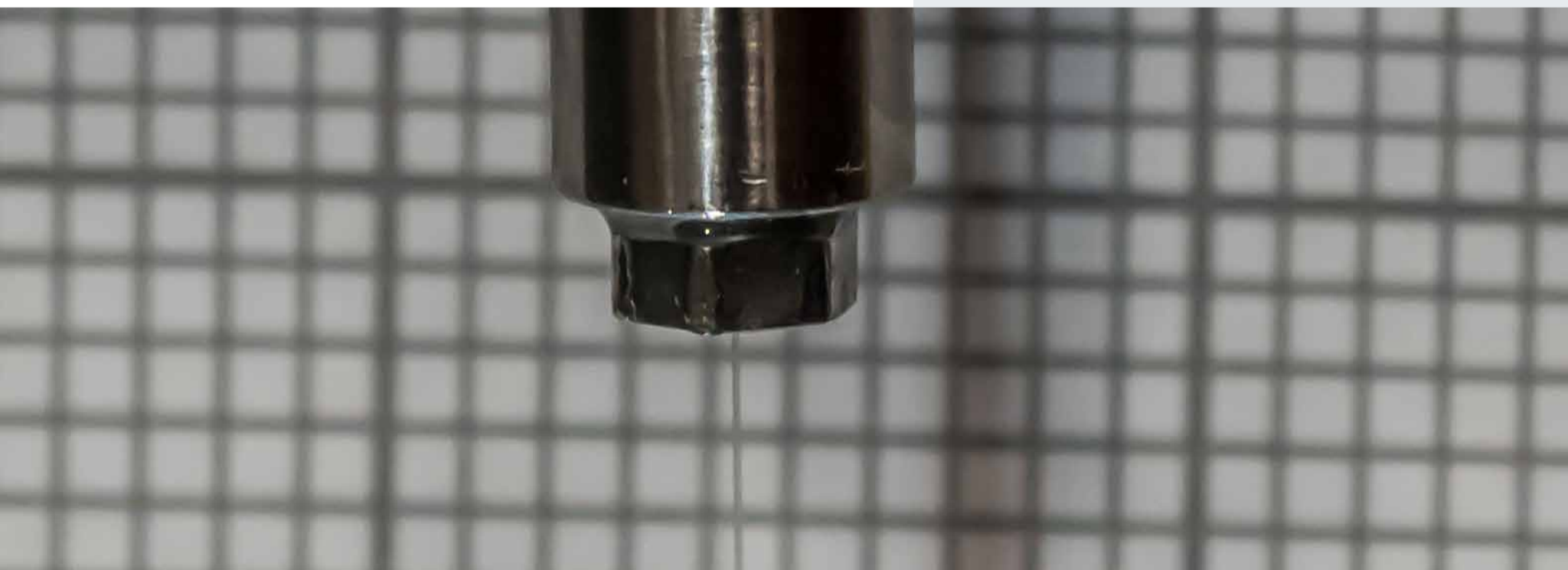
After testing various over the counter orifice designs, prototypes, and materials, we designed and created a special replaceable orifice insert that yielded the best laminar flow characteristic by incorporating it dimensionally with the porting design. As the orifice was also identified as the primary wear component, we focused on the ease of maintenance criteria here by allowing a threaded insert that is easily removed and replaced. Additionally, the solenoid coil replacement was made efficient by the orientation of the solenoids being above each five-valve manifold block.

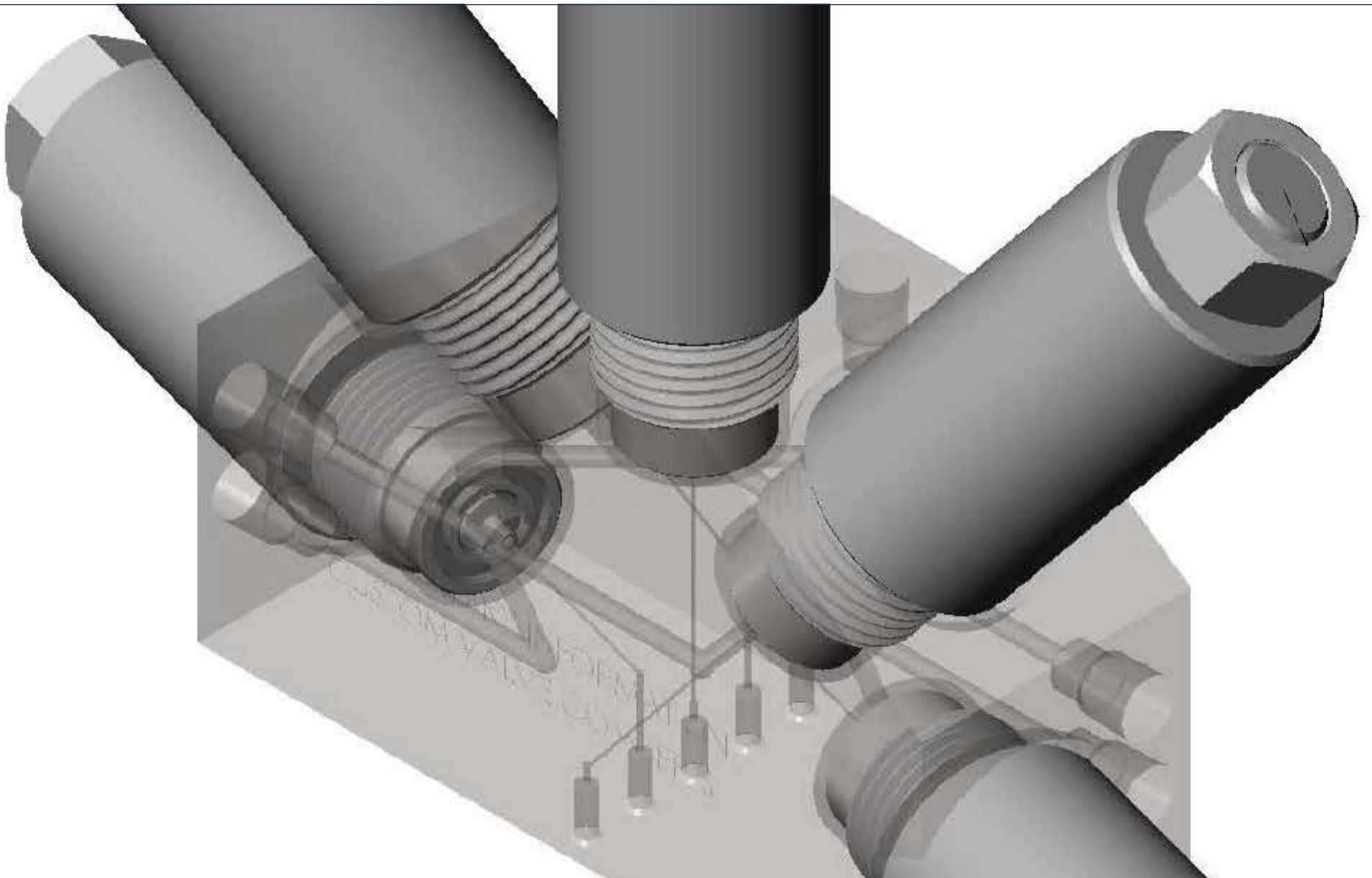
Finally, expectations for minimal leakage were exceeded at one drip every two minutes per valve with our design and ensuring flow rates were met by balancing the 15000psi pressure.

The resulting five manifold blocks allowed a modular design that could be assembled to over 200 valves in a continuous bar that would allow for cutting of materials anywhere along the approximately 60-inch length giving multiple opportunities to process impurities in products at speeds that increase efficiency without compromising quality.

Custom Valve Concepts' design and the incorporation of Optical Recognition Software created the integration of mechanical devices operating at speeds that rival a brain synapse. Our manufacturing design expertise also delivered proximity porting within the diameters of two human hairs, additionally with a remarkable diameter over distance drilling. Coil specifications of high-speed opening and high duty cycle were exceeded to increase time to a replacement, minimizing costly downtime.

Our customer's Principal Design Engineer, whom we worked with very closely, was very impressed with the design's response time and configuration of the manifold blocks. Early results demonstrate a rather significant technological leap for the food sorting industry and this customer's process in particular. While we are awaiting the cost/benefit results from the client, it's clear that the performance exceeds expectations based on our feedback thus far.





CONCLUSION

While this custom product was created for a particular need, we've explored the application in other industries, especially agriculture, where the identification and extraction of parts of a plant are beneficial rather than tossing the whole plant. We also foresee the food processing of meats and fish as a future opportunity for this type of process.

We embrace the challenge of creating custom concepts for customers who need their solutions for specific uses and to their specifications. It's hugely rewarding to deliver a product that far exceeds expectations, such as this solenoid valve. We work with clients across multiple industries and would welcome the opportunity to tackle any custom design/application challenges you may have and answer any questions about our process.



Ready to explore solutions
to your design hurdles with
a custom prototype from
Custom Valve Concepts?
LET'S GET STARTED.

ABOUT CVC

Custom Valve Concepts has designed, prototyped, tested, and manufactured specialty products and components for diverse industries worldwide. For 75 years, the process industries across the globe in oil and gas, food, power, water, and chemical have sought our expertise to improve systems quality and efficiency.



info@customvalveconcepts.com

Custom Valve Concepts
31651 Research Park Drive
Madison Heights, MI 48071

PH: 248-597-8999
FX: 248-597-8998

