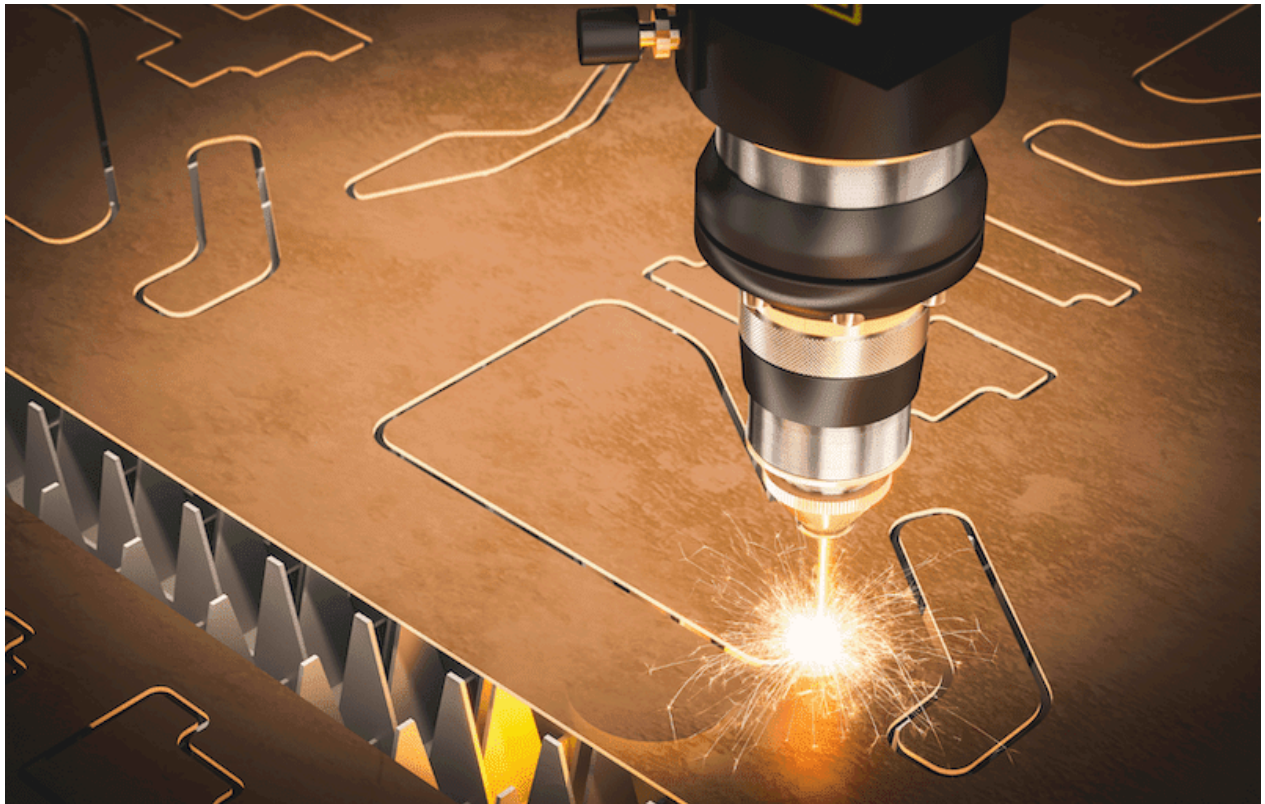


Application Case Study: Pressure Protection in CO2 Lasers



Introduction

Tuesday mornings are arguably the best possible time of the week to be reminded of high school science terms we haven't thought about for too many decades. Or at least for one Tuesday morning in particular, in which we received an email asking about our experience in gas control for interferometry propagation. We'll save you a Wikipedia search - lasers; they were referring to lasers.

This email was from a leading CO2 fabrication laser manufacturer looking for assistance in solving a gas mixture delivery challenge for an upcoming continuous laser marking application. Since the concern involved process fluid control, the solution seemed to lie in process

instrumentation. As a known partner to cost-conscious OEMs, Whitman's name came up as a potential advisor and supplier, prompting the client to reach out. Tuesday's as good a day as any, so we set out to see what direction the laser beam would point us.

About Us

As a veteran-owned small business, Whitman Controls is dedicated to supplying premium quality, reliable, technologically advanced instrumentation for use in nearly any application. Our Bristol, CT manufacturing facility embodies over 40 years of engineering, fabrication, and customer service expertise, serving both end-user and manufacturing customers nationwide through direct and distribution channels.

Application Summary

Did you know that the word 'laser' is in fact an acronym? Laser stands for Light Amplification Stimulated Emission Radiation - though we like 'laser' a whole lot better, for simplicity's sake. Lasers serve a wide range of commercial fabrication and production technologies where their extremely precise measurement, cutting, engraving, and marking capabilities shine.

Creating a laser beam for such processes is a hallmark example of engineers translating a scientific phenomenon into a practical toolkit. In essence, laser beams are created by energizing bodies of specific gases to the point that the gas' atomic components collide and excite enough to generate far infrared radiation. This radiation builds as more atomic excitation occurs, and thanks to the construction of the laser tube in which this reaction is occurring, the desired laser wavelength concentrates and is emitted in a narrow, focused beam.

In industrial manufacturing, CO2 lasers are of particular interest because they can provide high-quality products at reasonable operating costs. Most production-scale CO2 lasers consume a mixture of CO2, nitrogen, and other gases specific to the work and materials at hand. This CO2 mix is supplied by bulk gas cylinders and fed at a tightly controlled pressure and rate into the laser tube, displacing fouled gas before it can degrade the quality of the cut. In CO2 laser cutting and marking, laser beam wavelength, clarity, and intensity control are altogether the name of the game.

Challenge

Laser engraving and marking is a rather mature technology, but as with any established manufacturing method, somebody will eventually want to take it to the next level. Our client for this project was that somebody, looking to utilize CO2 marking lasers on moving parts in a continuous production fashion. Having a laser emitter power up, reach steady state, focus, orient, and imprint fine-detail markings on components as they're being transported down a conveyor in rapid succession is quite the process control endeavor. Luckily, our client had most of that problem sorted out already, and only needed Whitman's help on the CO2 gas control feeding the laser tube within their continuous laser systems.

Now, *that* we can do.

The challenge was rather straight forward:

- CO2-based mixed gas would be supplied by high pressure gas cylinders, regulated down to process pressure and connected to multiple laser systems.
- Each laser system would have an incoming gas supply valve train with regulators, back flow preventors, flow control needle valves, and on/off solenoids.
- From this valve train, CO2 mixed gas would need to be fed at a very precise, micro-flow rate and pressure into the laser tube, maintaining a consistent environment within the laser tube at all times that the laser was in operation.
- A discharge orifice and valve on the laser tube released a very small, fixed amount of consumed gas over time.

Of utmost importance (our client conveyed) was to assure that the pressure within the laser tube was consistent, as fluctuations in gas mass would influence the laser beam, leading to inconsistent laser performance. With marking parts on the fly as they continuously race by on a conveyor, inconsistency would be detrimental and lead straight to product rejects.

"Our older systems used on/off pressure controls to dose the laser chamber, sending bursts of new gas in to flush out old gas. We knew this caused slight beam attenuation skews, but that was acceptable for static systems. These [fluctuations] weren't going to cut it with our new continuous systems, and Whitman's suggestions to go to an analog transmitter and controls got us to much

tighter attenuation." - **Product Manager, Inline Marking Systems, Confidential Laser System Manufacturer**

Solution

Accounting for maintaining a maximum air mass in the laser tube while also protecting against too high of a fouled gas discharge rate, our application engineers concluded that we needed two pressure setpoints in the control loop - high and low pressure. Since gas mass is a function of pressure (referring to the ideal gas law that correlates gas pressure, temperature, and volume as interdependent), we set our sights on pressure controls as being the most functional control solution to implement. Two sensors proved to be the best fit:

Whitman's MIP Series Pressure Transmitter

- This pressure transmitter would be placed on the discharge leg of the gas supply train, providing real-time pressure feedback that would modulate the upstream flow control valve.
- The MIP sensor offers a total error band of +/- 0.75% of the unit's 100 PSig full scale span, based on a baseline +/- 0.15% accuracy and +/- 0.25% long term (1,000 hr) stability rating.
- The MIP's IP67 stainless steel housing and high shock, vibration, and 10 million cycle time ratings made it a perfect pair to the aggressive manufacturing environments that our client's laser systems would be installed within.
- In addition, the unit's 207 bar burst pressure rating made it a very safe choice in the event that the upstream regulators fail and the unit is subjected to full gas cylinder pressure.

Whitman's J205G Pressure Switch

- This pressure switch would be placed on the bleed port leading out of the laser tube, specifically monitoring for under-pressure conditions such as in the event of leaks or failures in the incoming gas supply, laser chamber, or other components.
- Fast switching for low pressure conditions would protect the system against sub-par laser performance and rejected markings. In fact, this sensor would be tied directly into a

conveyor-stop condition so that mismarked units would not be possible (at least those driven by low beam chamber pressure).

- The J205G's stainless steel housing, high pressure ratings, high temperature range, and compact body size made it equally suitable for this application's expected environments.

Even better, both sensors offered very appealing price points for our client's budget, as these sensors are specifically designed for OEMs and Integrators.

Results

Our client tested two systems using Whitman's suggested sensors, and after a bit of tuning using the new analog pressure control scheme, concluded that the MIP and J205G instruments were the winning solution. Since this project, our client has standardized on these sensors for their inline marking systems.

Last we checked, our client had installed systems in promotional materials, woodworking, CNC machining, consumer products, and medical device manufacturing applications. If you don't happen to work around industrial or military technologies where lasers are used, at least take it from cats chasing laser pointer toys - where the laser beams point clear and bright, good things are sure to happen.

Data Bullets

- **5%** CO2 laser gas mixture saved per system
- **15%** increase in CO2 laser tube working life expectancy
- **1-2** weeks' lead time on custom pressure instrumentation
- **3%-5%** increase in annual laser uptime due to shorter start/stop cycles and maintenance downtime

Here at Whitman Controls, our values drive us to provide the highest level of servant partnership that you can find. To discuss your applications or to learn more about our capabilities, please contact us at (866) 868-8883 , via email at info@whitmancontrols.com, or online at www.whitmancontrols.com.