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Paper

WHY AUTOMATION

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ABSTRACT

Safety is what drives our automation innovations. There is an inherent safety hazard associated with personnel handling pressurized lances during the cleaning process. Getting employees out of the line of fire, and on the other side of the safety barricade were the objectives behind the creation of automated tooling. With automation, we are able to reduce crew size, effectively eliminating exposure with reduced man hours. A secondary benefit of automation centers on the adherence to established cleaning standards and procedures. With automation, the ability to set specific hose speed, feed rates and flow settings gives you continuous cleaning at a controlled rate improving quality, value and efficiency.

Refinery and petrochemical owners receive these benefits from automation and at the same time see an overall reduction in their total cost of ownership (TCO). The use of automated tooling in place of manual hydroblasting tooling is not a short term trend. Instead, a complete shift in the perspective, practice and expectations of industrial cleaning. Automation may completely eliminate manual hydroblasting methods in the near future because of the tremendous value received from the advancements in hands-free industrial cleaning.

1.0 INTRODUCTION

The days of having three crews shotgunning on the pad is becoming a thing of the past. Over the last several years, it has been proven time and time again that using automated tooling is safer and more efficient than technicians working a shotgun or holding a lance. In some cases, the available automation is a perfect fit for the application, like cleaning a 20' heat exchanger on the pad. More often than not, significant planning and engineering is required to properly apply automation to the customer's needs. In the past, it was the norm for refinery and petrochemical customers to favor the contractor applying more physical muscle than brains to the project. Recently, we have begun to see significant shifts in customer attitude. Now, several very large national petrochemical companies have taken more of a leadership role by requiring the industrial cleaning contractor(s) to use automation in all projects 100% of the time within their facilities. Sometimes this will even require the facility owner to perform physical modifications to unit structures to facilitate the use of automated equipment. We believe that this recent customer interest in automation is because of the resulting improvement in the cleaning contractor's safety performance, service quality, productivity and reduced cost. In this paper, we summarize the value elements associated with industrial cleaning automation to explain why the use of automation benefits all involved.

2.0 BACKGROUND

In 2009 HydroChem funded a full time, dedicated Technology Center with the goal of eliminating water cuts. Since then, we have invested over 25 million dollars designing, testing and implementing new technologies to support our 40 branches and hundreds of customers in the US and abroad. Our Technology Center allows us to modify tooling in a safe and timely manner to fit site specific needs. We judge our success by the value we provide our customers. Sometimes an application requires our engineers to develop a tool from scratch, other times off the shelf tooling from a supplier makes the most sense. Whatever tooling option will add the most value, then that's what is used. Now, in 2015, we are fine tuning our automation program to guarantee everything we do is adding value and saving our customers time and money.

2.1 MANUAL CLEANING TECHNIQUES VERSUS AUTOMATION

Automated tooling has been a part of industrial cleaning for many years. Some of the early automated tools included roto-moles for line cleaning, ATLs for tube cleaning and 3D nozzles for tank or column cleanings. Lower invoice cost, as well as faster setup/rig-down times continued to give manual cleaning options the edge over automation through the 1990's and into the early 2000's.

2.2 AUTOMATION ADVANCES CLOSE THE GAP

At HydroChem, we have focused on decreasing the total job time and employee count. In most cases using automation decreases job time and number of employees required when compared to manual cleaning. Automated tooling also provides a safer environment, better quality, greater value and maximum efficiency.

2.2.1 SAFETY

Stopping water cuts and getting employees out of the line of fire, and on the other side of the safety barricade was the objective behind the creation of automated tooling. Tangled lances in work areas is another safety issue. It causes both a safety hazard as well as increased down time. The FlexReel™ system was designed to eliminate safety concerns caused by tripping hazards, entangled flex lances, kinking, and lance damage. The ability of having crew set up outside the barricade and eliminating the slicker suit is one more safety opportunity. Overheating in the summer heat is consistently problematic.

Figure 1. FlexReel™

2.2.2 QUALITY

The specific hose speed, feed rate and flow settings on automated tooling assure you receive a consistent clean every time. The angles and turning access without additional entry points that using automation provides, is another advantage to using technology. The Axys™ system automates tube-to-tube indexing. Job quality improves and exchanger cleaning times can be significantly reduced. This new generation of indexing technology makes the set-up a breeze and indexing between tubes is faster and more consistent. Using our Axys™ indexer systems allows you to move from tube to tube with greater precision, speed and safety. Axys™ reduces the chance of missed tubes and ensures a quality job. Automated tooling can dramatically improve heat transfer and flow rates leaving you with ideal operating conditions.

Figure 2. The Axys™ Indexing System

2.2.3 VALUE

Each job now requires fewer and better trained crew. For example, one person operating our PadBlaster™ takes the place of three operators on the pad. The main reason for this are the flow, trigger time, and smaller crew size. Employees not wearing a slicker suit are more comfortable, but also means they require fewer, less lengthy breaks. Using technology, you have effectively turned "heavy" work into "light" work.

Figure 3. PadBlaster™

2.2.4 EFFICIENCY

Our AutoBlaster™ can handle 3 times the flow of a manual shotgun, allowing you to maximize the horse power of the pump you are using. Trigger time triples over the use of a manual gun. The extra flow makes cleaning tough deposits much easier and thus increases the productivity.

With automation, you receive maximum efficiency with consistent cleaning the first time and every time.

Figure 4. AutoBlaster™

2.2.5 MORE CUSTOMIZED SOLUTIONS

Our dedicated Technology Center delivers a deep bench of talent. Every day we take on challenging projects and design custom tooling solutions to fit each customer's unique requirements. In many cases, our Custom Engineered Solutions group has given our customers the confidence to set the goal of a 100% automated facility.

3.0 THE EDUCATED CUSTOMER

Today our customers are very well educated on the value automation brings. As a result, several of the largest petrochemical companies in the world have decided to require 100% automation for hydroblasting services in all of their facilities. There are many key performance indicators (KPI's) that justify the use of automation over manual cleaning techniques including the ones that matter the most, safety and total cost of ownership. Service providers have improved their ability to measure and report value through metrics. In the sections to come, we will outline the improved performance and added value the customer can expect to receive when considering the critical KPI categories.

4.0 HOW AUTOMATION POSITIVELY IMPACTS KEY PERFORMANCE INDICATORS (KPI)

When generating a metric set for a customer, several primary areas are targeted for measurement and performance review. These metric sets include the categories of safety, quality, productivity and value. Really, the first three categories are sub-categories to overall value. For customer sites that have moved toward 100 percent automation, significant improvements in each of the critical KPI categories have been achieved.

4.1 SAFETY

Safety was the initial driver of automaton innovations. Most of the available automated tooling today allows the workers to operate outside of the barricade, once the system is energized. In addition, sophisticated tooling like indexers that also serve as anti-withdraw devices and hose reels that keep the work area free of tangled lances have helped to eliminate many of the hazards historically associated with hydroblasting activities. It is no coincidence that the OSHA rate at HydroChem has decreased by over 70% in the years following 2008, while the percentage of automation used in conjunction with the hydroblasting work has increased by approximately the same percentage.

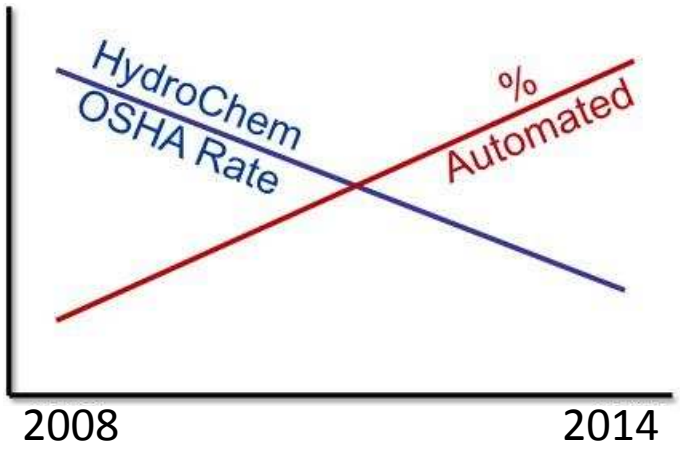


Figure 5. HydroChem OSHA rate versus % automation

Also, it is worthy to note that incident severity is much lower. From a safety perspective, the OSHA incident rate reduction is only one benefit realized from the implementation of automation. Insurance rates and Workers Compensation cases are also decreasing. Savings we are able to pass on to our customers. We briefly touch on additional safety benefits realized by automation below.

4.1.1 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Typically, the suite of PPE required at a worksite is a slicker suit, hard hat, rubber gloves, face shield, FRC, safety glasses, ear plugs and rubber boots. When using automation, the worker is

often able to stand outside of the barricade while operating the equipment. PPE will no longer become contaminated with product from the customer's equipment. This reduces the overall operating cost to perform the service and can lower the invoice cost to the customer as well.

4.1.2 FATIGUE AND HEAT STRESS

Automation eliminates almost all of the physical demands often associated with hydroblasting. Many times during a root cause incident investigation, fatigue and heat stress are identified as the primary or secondary cause of the incident. Therefore, automation helps to eliminate factors associated with most hydroblasting related incidents.

4.1.3 CHEMICAL EXPOSURE

Hydroblasting workers wear slicker suits in order to create a barrier between their bodies and the blast water or effluent exiting the customer's equipment. Often the effluent will contain toxic chemicals contained within the scales that are being removed from the plant equipment. Exposure to these chemicals can cause both acute and chronic health problems. Many times, the slicker suit tears or rips, exposing the worker to these toxic chemicals. The only way to eliminate this type of chemical exposure is to change the job setup to include automated tooling and move the worker outside of the barricade.

4.1.4 STAFFING

Average crew size is typically a metric the customer will request to review during the monthly and quarterly review meetings. When a manual hydroblasting project is performed, the crew consists of a crew leader and two technicians for a crew size of three. For manual hydroblasting work, at least two technicians are required in order to adequately address fatigue and heat stress. Today, using automation, fatigue and heat stress are significantly reduced, therefore, an automation crew can be reduced to a crew leader and one technician in some circumstances. The lower average crew size reduces the customer's costs for labor and with reduced crew size, exposure to safety threats are lessened as well.

4.2 QUALITY

The primary purpose of a job procedure is to define the series of steps that provide an expected result that meets the required specifications. For hydroblasting, the primary variables that must be defined within a job procedure to achieve repeatable results include pressure, flow and hose feed rate. Hose feed rate is defined as the time for the lance to travel the length of the heat exchanger. Typically, the pressure is set at the pump and flow is driven by the tip selection. However, the only way to guarantee a consistent hose feed rate is through automation. For most

modern automated tooling the hose feed rate can easily be set, thus guaranteeing that the feed rate defined in the job procedure is applied to each and every tube in the heat exchanger. This same level of precision is not achievable using manual cleaning techniques.

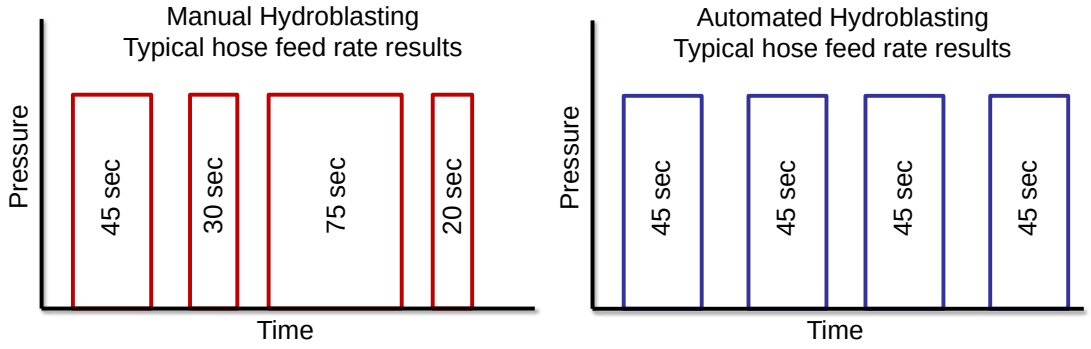


Figure 6. Example of hose feed rates for manual versus automated hydroblasting

Additionally, today's indexing tools have reduced the chances of skipped tubes or missed rows. When tubes are not properly cleaned, it can cause the customer's equipment to fail sooner than normal, costing thousands of dollars in lost production opportunity and additional cleaning cost. Often, borescope images are part of the customer's final inspection process before the job is considered complete. At HydroChem, we see 0% rework when a job procedure has been established and automation is used. This is compared to historic percentage of 5 to 10 percent rework using manual cleaning methods.

Edwards Deming, considered by many to be the grandfather of quality systems once said "A bad system will beat a good person every time." In the industrial cleaning industry, the bad system has been the manual cleaning methods. Often wet, hot and dirty work associated with manual cleaning has defeated and driven away promising talent from the industrial cleaning industry. With the new age of automation, we are discovering that talent is staying longer, thus driving down turnover rates. Our industry is now attracting and keeping new talent coming in from colleges and technical schools. They seem to match up well with the automation approach that includes challenging upfront procedural design, followed by the use of handheld control systems resembling that of an Xbox. Both the contractor and the owner wins in this environment. The contractor is reducing hiring and training costs, while the customer is getting a higher quality worker in their facility.

4.3 PRODUCTIVITY

Unquestionably, automation has changed the game when it comes to productivity. There are so many different positive impacts automation brings to cleaning productivity that we will focus only on what we consider to be the top areas of impact.

4.3.1 INCREASED PRODUCTION RATES

An amazing characteristic of automation is the ability to double, triple, or quadruple productivity. This can easily be demonstrated with heat exchanger cleanings. With manual flex lancing, a single tube is cleaned with each pass of the lance. With automation, tools have been developed that can easily clean up to 5 tubes with a single pass. Obviously, the significant reduction in cleaning times can lower the customer's invoice cost and increase production unit uptime.

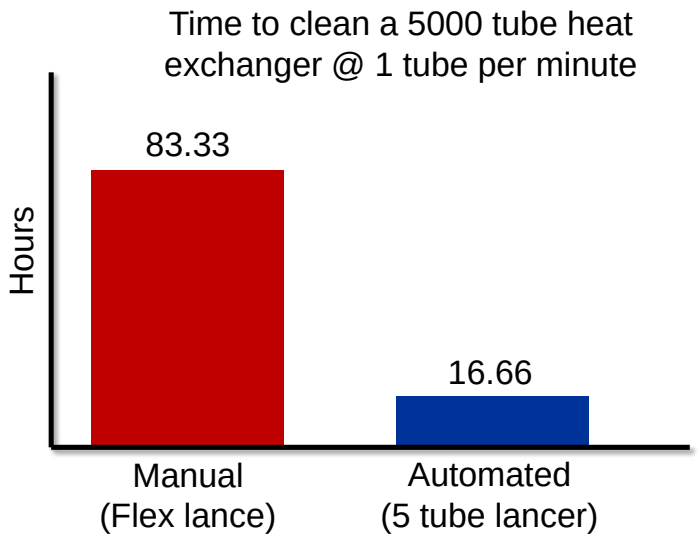


Figure 7. Example of the automation impact on cleaning times

4.3.2 DECREASED INDEXING TIME

The term indexing is defined as the time to move from tube to tube when cleaning a heat exchanger. We will once again use the 5000 tube heat exchanger example to calculate the improvement automation brings to the activity of indexing. We have measured the average index time for a typical heat exchanger located on a cleaning pad to be 15 seconds for a manual cleaning operation. This takes into account all typical fatigue and environmental delays the workers will experience during the course of the project. Using HydroChem's PowerIndexer™ technology, we can achieve average index rates of 8 seconds. Assuming that both the manual and the automated technology is setup to clean 1 tube per cleaning pass, the PowerIndexer™ will reduce the job time by 11 hours. Again, this will lower the customer's invoice cost and potentially increase production unit uptime.

4.3.3 SETUP TIME

For now, generally speaking, manual cleaning methods currently win out over automation when it comes to job setup times. Each iteration of automated tooling design brings to market smaller, lighter, more agile features. Today, our employees receive better training, more experience, and use improved tooling with fewer pieces and parts. The gap between manual and automated job setup time is continuing to shrink and most likely will tip in the favor of automation in the near future.

4.3 CASE STUDY

Refractory Removal in 70 inch Riser

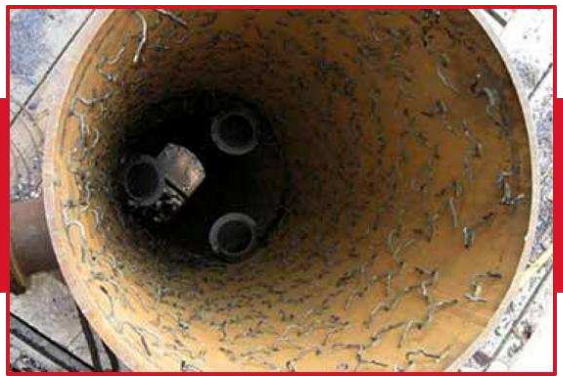


Figure 8. FCC reactor riser

Figure 9. 2250 HP Pump

Challenge

An FCC reactor riser line was scheduled for relining during the turnaround and a safer and faster solution to manual chipping was necessary. There was need to eliminate the risks associated with confined space entry as well as falling debris caused by stacking workers in this vertical riser line. A significant production improvement was also needed to achieve the refractory removal and reline in a turnaround time frame.

Solution

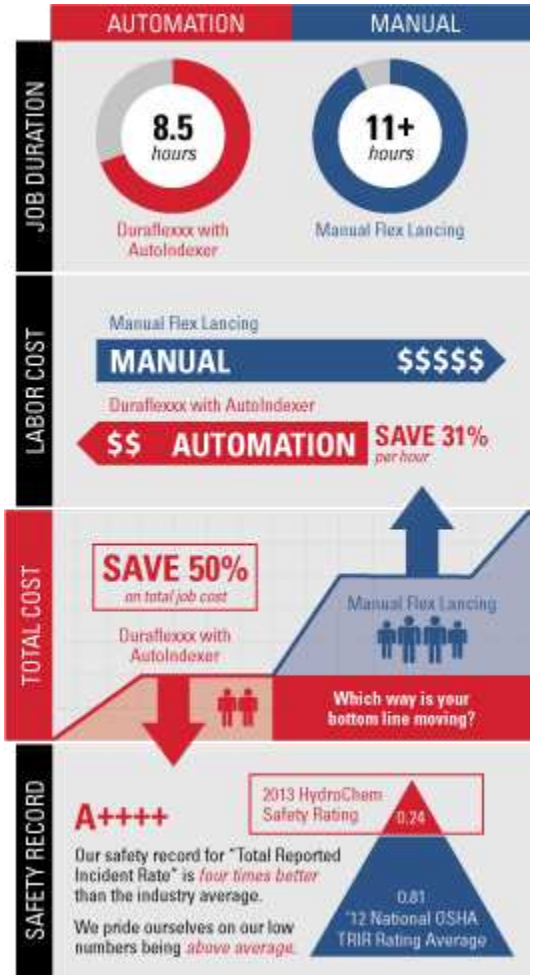
A specially trained team of operators mobilized our MoarJet™ high volume, high pressure and high horsepower refractory removal system to the refinery. Using this highly aggressive and technical system, we successfully broke up 17EC carbon impregnated refractory at a rate of over 20 sq. ft. per hour without entering the riser. Historically, these riser units are replaced during the turnaround which is not only capital intensive, but creates many logistical challenges and negatively affect other areas of the turnaround, thereby stretching the critical path. By using our MoarJet™ system, refractory can be removed, risers can be relined and put back in service at a small fraction of the cost of replacement. Our advanced technology MoarJet™ system is changing expectations of safety in the workplace and providing a more cost effective solution for risers and similar equipment.

Value Received

- Greatly Improved safety and work conditions
- Eliminated vessel entry
- Reduced job time by 60%
- Improved turnaround schedule

4.4 TOTAL VALUE – PUTTING IT ALL TOGETHER

Automated tooling is the secret to driving down cost, while maintaining the highest level of safety, service, and execution. Below, we provide a visual representation of the automation value model, when taking into account the elements of safety, quality and productivity.



*Results based on typical 20ft 800 tube exchanger clean with a 2 man crew

Figure 10. Automation Value Model

This paper has focused on why refinery and petrochemical customers will continue to support and often drive the conversion from manual to automation cleaning techniques in our industry. We need to briefly point out that this conversion is also in the best interest of the industrial cleaning company.

- Safer working conditions
- Lower turnover and higher skilled workforce
- Scheduling accuracy by accurately predicting job times

Automation is the proverbial win-win approach.

5.0 CONCLUSION

Safety was the initial driver of automation. However, refinery and petrochemical customers are realizing tremendous value in the areas of quality and productivity, which results in a lower TCO. Since automation also brings value to the service provider's company, we will continue to see automation replace manual cleaning tools and techniques. The likely outcome will be the extinction of manual hydroblasting altogether.

6.0 ACKNOWLEDGEMENTS

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