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SMART RESERVOIR TECHNOLOGY

The Complete Guide to Fluid Management

Introduction

Fluids are often seen as one of the trickiest and stickiest points of the production process, placing a limitation on what can be achieved through continuous improvement and in the worst cases causing product failures that are both costly and time consuming.

However, with a little bit of knowledge and technological innovation, it is possible to set the parameters to ensure the same level of consistent performance as anywhere else on the production line, which means manufacturers can meet tolerances that were previously thought impossible.

In The Complete Guide to Fluid Management, we will discuss:

- The five fluid management techniques needed to enable consistent performance
- Common issues encountered by manufacturers and production operatives and how to overcome them
- New innovations in technology and automation that can aid consistency, reduce downtime and help avoid costly product failures and time intensive reworks

Fluid management doesn't need to be complicated, and a little bit of knowledge can go a long way. The Complete Guide to Fluid Management aims to provide manufacturing owners and operators, engineers, research and development teams, quality assurance specialists and production operatives with the necessary information to identify any issues within their own process, enable continuous development and ensure consistent results.

Loris Medart is a fluid dispensing engineer with more than 20 years' experience. He founded pressure vessel manufacturer SR-TEK in 2014 after having become frustrated with the limited functionality of existing vessels that were more suited to 1970s style mass-production.

SR-TEK prides itself on producing cost-comparative, large and small-scale pressure vessels that are better suited to modern methods of small-batch, agile manufacturing and continuous improvement.

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The 6 steps to consistent fluid performance

1. External Environment
2. Internal Environment
3. The Top to Bottom Effect
4. Agitation
5. Monitoring & Management
6. From R&D through to Production – the science of fluid engineering

Step 1 External Environment

It is a little-known fact that the production environment, and particularly temperature, can have a significant impact on the performance of fluids.

A production plant operating in the Russian winter will need a whole different set of parameters to one operating in Spanish summer for the same application and fluid. The temperature changes do not have to be that extreme though; a shift of just a few degrees from the morning to the afternoon at a UK site is enough to disrupt what had been a steady production process. In a traditional setting, this will often lead to a lengthy reset as parameters are reviewed and adjusted to achieve optimum performance.

There are some practical steps that can be taken to reduce the impact of the external environment. Minimising feed lines by ensuring fluid is stored as close to the dispenser as possible is one option, as this will drastically reduce the time that the fluid is outside of a controlled environment (see Step 2 - Internal Climate).

The oversized nature of traditional vessels, typically built for large quantities of cheaply available, low-quality fluids, meant it was almost impossible for machine builders and production line engineers to locate fluids close to the dispensing point in the past. However, with a thorough understanding of the fluid and application it is now possible to specify a compact pressure vessel that can be incorporated as and where needed. Where minimising the distance between vessel and application isn't possible, insulated feed lines can be added to help mitigate environmental changes.

Humidity can also enter vessels and react with the fluids. Coalescing filters on the compressor and compressed air lines will counteract this. Similarly checking the integrity of seals and keeping vessels under pressure when not in use or reducing the number of times they are pressurised and depressurised minimises the chance of outside air contaminating the fluid.

Step 2 Internal Environment

Mitigating the impact of the external climate is an important first step. However, that will only be successful if you're able to maintain a consistent internal temperature during production.

A lack of internal temperature control during production can lead to inconsistent performance, parts failure, machine downtime and, in the worst cases, costly chemical alterations to create bespoke fluids. All too often, manufacturers and machine builders will turn to their fluid provider when they encounter such problems. In fact, taking a closer look at the internal environment of the production line will often lead to better results, much quicker and at a fraction of the cost.

The starting point is transport and storage. Thankfully, many fluid manufacturers will have this covered for you, making use of heavily insulated container vehicles to cope with extreme temperature changes and providing storage options that will ensure fluid consistency.

Having investigated hundreds of fluid performance issues as head of customer service for Nordson EFD in Europe I can confirm that the majority of faults can be traced back to the production process itself. Even the transition from storage through to production can lead to fundamental changes in the chemical composition of fluids due to temperature fluctuations or excessive movement (see Step 3 – Agitation).

A key way to mitigate the impacts of moving fluid from storage line and any changes during process itself is to ensure full temperature control during production. While a lot of focus is given to dispensing, industrial fluids can spend as much as 90% of production time in the reservoir.

Full temperature control at this stage not only ensures consistency at the point of use but can also enable operatives and line builders to optimise fluid performance, reduce waste and eliminate fluid related parts failure.

Case Study: Unsticking Cyanoacrylate

It is not just temperature but also humidity that can have a damaging effect on fluid performance.

During my time at Nordson EFD, I visited many production facilities for process improvements over fluid handling and dispensing. For example, I was often contacted for process improvement over cyanoacrylate (superglue) handling and dispensing. The customer was using one litre of cyanoacrylate in a time / pressure dispensing system. After a day, production operatives found that the glue was crystalising and thickening, causing costly rejects and rework.

After a line survey, we found that the air coming from the compressor had a lot of moisture in it, which was carried through the tubing into the compressing vessel.

We also identified that one litre of fluid would last a full 30 days. Following our advice, the client performed routine maintenance on the compressor, installed coalescer and particle filters on the air line before the tank and reduced the amount of fluid in the vessel. We also advised the client to maintain the pressure, as pressurising and depressurising every day can also cause moisture to enter the tank.

As a result, the client prevented the glue from crystalising and thickening, avoiding the need to scrap and rework. As an added benefit, reducing the amount of fluid in the pressure vessel meant less wastage, should a future issue occur.

Step 3 The Top to Bottom Effect

Surprisingly, the top to bottom effect has only been fully investigated by scientists and engineers in the last few years.

Essentially, it gives an indication of why a fluid's performance may change dependant on the amount that remains in the container when all other parameters are set. In manufacturing terms, operatives have long noticed a steadily decreasing flow rate when using a time / pressure system.

The pressure remains consistent, the volume of fluid has decreased, and the compressed air has increased. The top to bottom effect is caused by the constant change in volume of air and fluid inside the vessel. As the fluid level goes down inside the vessel, the volume of air increases but the ratio of compressed air, at a given pressure is not linear in comparison to that of the fluid.

To put it simply, at constant pressure, an increasing volume of compressed air cannot sustain a consistent pressure on a fluid, therefore generating a different amount of force. This can be understood when you consider one of the fundamental differences between pneumatic and hydraulic law. Namely that air is indefinitely compressible whereas water and a vast majority of fluids are not. As such, air is always the variable and yet it is an essential part of a process that requires consistency.

The solution can be pieced together by a combination of using the right sized vessel and managing the pressure in a more precise way, enabling control over the amount of compressed air inside the tank, to deliver a consistent amount of force.

For advanced applications, where the process is under tight tolerances, this must be assessed based on volume of fluid dispensed, flow rate and dispensing cycle speed. This can be both difficult to achieve and costly. For most manufacturers, however, a cheaper and much more effective way to mitigate the effect is to simply use a smaller amount of fluid from the start. This will reduce the differential in volume between the top and bottom of a vessel, minimising the number of adjustments that need to be made and preventing variances in flow rate that can cause inconsistent deposit sizes, parts failure, and reworks.

Step 4 Agitation

One of the other major impacts on the chemical composition and performance of fluids is movement – whether that be too much or too little.

These are known as thixotropic fluids and can include anything from, UV adhesives, Epoxies, Silicone, RTV (room temperature vulcanising), rubber sealants and heat sink compounds.

Thixotropic fluids are more common than you would think, as anyone who has had the ‘pleasure’ of wallpapering or painting a room can attest to. Both paint and wallpaper paste are significantly affected by movement, with the latter being the best example. The paste is often difficult to stir at first but the more you stir, the easier it becomes to mix. What is happening here is that the viscosity of the material is changing as a result of the movement applied to it.

While this might not be so much of an issue for those doing home décor, in a production setting it can lead to dramatic inconsistencies resulting in too much or not enough material being added to parts which may have to be reworked, cleaned or in some cases even scrapped. The answer lies in viscosity control through agitation. This can be either set as a fixed parameter for a full production day or coupled with sensors to adjust to changes within the fluid itself.

Step 5 Monitoring & Management

By its very nature, fluid is continually changing and adapting.

Up until now we have focused on the changes you can make to the fluid to ensure optimum performance. However, it's important to look at how you know that the set parameters are being maintained and how to know if the parameters chosen for a full tank of fluid will be the same when the levels have dropped. This is where sensors, adaptive automation and pressure come into effect.

Engineers should look at this as an equation, where each parameter is a variable. The key is to set as many of the possible variables as fixed data and keep only one as the variable for easy adjustment/fine tuning. In a time / pressure dispensing system, where pressure is used to displace the material and time is used to control the dispensing volume, we always suggest keeping temperature and humidity as constant as possible.

While the dispensing head is an important focus point, it's also important to monitor and set the air pressure regulation that will be applied into the tank. With all other parameters set, pressure can be used as the variable and can be controlled over time to ensure flow rate remains consistent throughout the production cycle.

Ultimately however, there is no better sensor that the human eye. Major manufacturers such as Johnson and Johnson are now taking advantage of a new innovation to ensure consistent quality control - transparent pressure vessels. Not only does this provide the added reassurance that sensors and fluids are performing in line with expectations, it can also provide an early warning sign of any issues such as, crystallisation, thickening of the fluid due to solvent evaporation, skinning or colour changes due to deterioration. A transparent pressure vessel allows engineers to spot these signs early on in the process and resolve them with less product wastage. Transparency also enables operatives to identify and rule out any issues earlier on in the line, including faulty compressed air lines or parts degradation that can lead to excess air, oil or detritus entering the fluid. For many of the production line managers we speak to, the main benefit of transparency is simply being able to see when a fluid needs topping up or adjusting from virtually anywhere on the line

Step 6 From R&D to Production – the science of fluid engineering

One of the biggest pain points for a lot of production engineers is scaling up from research and development through to full production.

As we have seen in steps one through five, however, the science of fluid engineering doesn't need to and shouldn't end with the Research & Development department.

A great example of this was a project SR-TEK recently completed for an automotive parts manufacturer. The company had been using the same fluid provider for a number of years and there hadn't been any changes to the composition or even transportation of the liquid. However, suddenly, the client couldn't achieve the necessary viscosity and production was brought to a halt. Having adjusted and tested all the parameters and observed the reaction in real-time, SR-TEK identified a solution to control the viscosity through agitation. Agitation dropped this material's viscosity to its set point, allowing consistency from batch to batch, something that was not possible when the fluid remained static. What could have been weeks and months of lost production time as a new fluid was developed or sourced from an alternative supplier was solved through the simple application of agitation in the pressure vessel. With all other parameters confined, the engineers are now able to eliminate batch to batch variation.

Conclusion – Taking control of fluid performance

Fluid handling needn't be rocket science. Controlling, monitoring and adjusting parameters where needed enables consistent production, reduced waste and a significant reduction in unplanned downtime.

Major manufacturers in many industries such as automotive, electrotonic, aerospace, medical, pharmaceutical are simplifying fluid handling by using increased automation and transparency to enable them to plan and adjust. Through this type of careful management, there is no reason why even the most temperamental of fluids cannot be tamed to ensure consistent results.

The golden rule when it comes to fluids, whether you're speaking to fluid manufacturers, machine builders, pressure tank manufacturers or dispensing companies, is that excess information is far preferable to too little. Working with a respected specialist within each field will ensure the best possible result at a fraction of the time and cost.

Kanban and continuous development are now central to manufacturing, whether driven by research and development, internal quality assurance teams, OEMs and client companies, or ever-changing legislation. As the familiar adage goes however, 'insanity is doing the same thing over and over again but expecting different results.'

Technological innovation has given us more transparency and control over production processes and fluid management than ever before. We can now achieve tolerance and consistency levels that were not considered possible even a few short years ago. To enable this, however, engineers need to look at the technology they are using and how they are using it.

It is hoped that this guide will have given you some useful hints and tips on how best to manage fluids in production.

For further advice and support on effective fluid management visit: www.smartreservoirs.com, email Loris loris@smartreservoirs.com, or call 0044 (0) 20 8242 4853.

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Connect with Loris on LinkedIn:
www.linkedin.com/in/loris-medart-srtek

Follow SR-TEK on LinkedIn:
www.linkedin.com/company/srtek

smartreservoirs.com

+44 (0) 20 8242 4853