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Compressed Air Audit Services

THANKS, but NO TANKS

Over the many years that people have held discussions with respect to compressed air systems design and operations, one of the main integral components that have never received the discreet attention they deserve is that of the ubiquitous compressed air receiver.

One school of thought is that you cannot design a compressed air system without putting in compressed air receivers.

Within that school of thought by the predominant visions is that you must have both wet receivers and dry receivers. Many authors and industry experts, and particularly those in the field of manufacturing and selling compressor receivers, are that you should have a wet receiver downstream of the compressor and any after cooler, just prior to the compressed air drying apparatus.

These people go on to expound at great length on the need for a dry compressed air receiver downstream of the dryer.

There has been a great deal of discussion over the past years on the design, sizing, and attributes necessary to have these devices in the compressed air stream.

The next group advocates putting receivers throughout the industrial production plant environment in order to provide local storage to accommodate for insufficient pressure and/or demands on the system that cannot be properly maintained by the infrastructure.

A third group advocates local dedicated storage to accommodate large sudden event demands at the point of use.

A fourth group focuses on large isolated receivers side streamed into the process, sized for anywhere from 10,000 gallons of capacity up to 60,000 gallons of capacity, based on metrics necessary to suppress pressure decay from large and longer-term sudden event demands.

And there is a fifth group consisting of a mix of the other four groups who continue to bake this situation ad infinitum.

WHY INSTALL A RECEIVER- OR NOT?

After listening to the various arguments over the last several decades, I am intrigued by the argument that you absolutely must have a wet receiver downstream of the compressor intercoolers and after coolers, in order to have a quiet zone in which to extract condensed condensate.

I would like to postulate that if the equipment tasked with condensing the water out of the air stream coupled with the best possible drainage devices, consisting of technically meritorious no loss drains is properly applied, a wet receiver really is not a necessity and might be an unintended liability.

After focusing on this particular issue of the wet receiver over the last several decades, I wish to suggest that not only is that not a necessary item, but in fact is a significant detriment to the operation of the system as well as a very serious health and safety risk to both plant employees as well as the entire physical infrastructure of the facility.

Very few facilities actually have in place a program to carefully inventory the entire population of compressed air receivers and keep accurate records of where these pressure vessels are within the facility or whether or not due diligence has been followed in keeping a program in place to do inspection and nondestructive testing as required by OSHA 29 CFR 1910(a), API 510 and the National Boiler Safety Code, Chapter 8, on the five-year time cycle basis that is recommended by these organizations as well as pertinent state regulatory agencies.

Please allow me to offer a couple of examples of why this is so very important for consideration in the overall operational domain of any facility utilizing compressed air at the usual pressures of between 80 PSI G and 125 PSI G found in most industrial facilities.

1,600 gallon air receiver in a fiberglass plant

This is a typical example of receiver's seen throughout American industry. Note the clean environment, the fact that it is under a current state inspection to operate, presuming the receiver integrity is well within accepted standards.

Inside view of receiver

Due to the suspicion on the part of plant maintenance and engineering staff brought about by guidance from their compressed air consultant that the condensate removal devices within this plant's compressed air system were ineffective, the receiver was isolated from service, vented to atmosphere, and the man way unbolted to allow for a physical inspection of the interior.

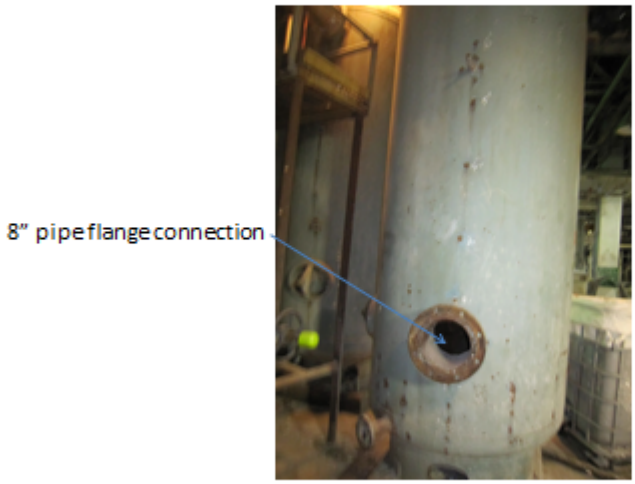
The results shown above constituted a shock to all concerned plant staff. There immediately ensued a concentrated effort to inspect the balance of the compressed air receivers in that facility.

It was subsequently discovered that there were at least seven more receivers of this size which failed sidewall integrity thickness testing. Those receivers, along with this example, were left isolated from the system and remain so today.

Strangely enough, consultation with the plant staff reveals that there have been no noticeable excursions in the production environment as a consequence of taking those receivers out of service.

A second example is that of an 1100 gallon receiver in a paper mill which, upon urging from their compressed air consultants, was subjected to nondestructive testing of ultrasonic wall thickness assessment, failed to meet the safety criteria established by the appropriate standards.

1,100 Gallon Receiver in a Paper Mill



When the supply pipe to that receiver was removed, and a photograph of the internal condition taken for record, the results are seen below.

Photo of Products of Corrosion inside the 1,100 Gallon Receiver

This writer cannot overstate potential for severe injury, death, catastrophic destruction of industrial facility that can be the result of the failure of one of these receivers.

One has only to go on an Internet search to discover that while these types of failures are not often seen on the conventional new services nor discussed in technical peer group meetings and seminars, they are nonetheless existent and numbers far more than one would imagine.

Is for this very compelling reason that this writer advocates very careful consideration before opting to design a system by intentionally putting a wet receiver in the piping, proper drainage in place or not.

It is equally appropriate to suggest that any industrial facility having a wet receiver currently in the system, and wishing to protect its employees and infrastructure, would immediately undertake a project to identify all such items and bypass them if there are valves in place to allow that, isolate them, depressurize them, and do an internal physical inspection. The purpose of the inspection is to determine the actual condition of the receiver if, for no other reason, than that of a learning experience. In the eyes of this writer it should not be for the purposes of determining the integrity and putting that receiver back in service.

WHAT DO I DO IF I DON'T HAVE A WET RECEIVER?

A better perspective of this issue can be taken from a standpoint of knowing that if a quality effort is made to properly design compressed air system, from the compressor, through its intercoolers, and if necessary proper after cooling, the temperatures in the air stream can be held to below the 100° F approach temperatures that most dryers are designed to handle, or the higher 400F needed for zero loss, blower purge desiccant twin tower dryers.

By establishing a firm and pre-eminent policy requiring the design-build engineers, mechanical contractors, and compressor manufacturer/vendor to stipulate in writing to the actual efficiency of the heat exchangers in the intercoolers, and after coolers under all possible site conditions and possible fouling problems, you can do a great deal to be sure that there is a good result from the installation.

By being absolutely certain that properly designed, state-of-the-art, and technically meritorious zero loss condensate drains are applied in these initial components, the dryers will not see liquid phase condensed water and thereby will operate to their design criteria and yield the dew point levels of compressed air in the system commensurate with production equipment requirements.

Aside from the cost associated with purchasing and installing these receivers becoming a cost avoidance issue, as well as being sure that a safety hazard is not intentionally placed within the system, there is one other benefit that accrues not putting the receiver in the line.

Almost without fail the pressure signal which controls the load versus unload cycles and/or modulating conditions on most air compressors is taken at the air compressor, either internally or at a pressure tap immediately adjacent to the compressor discharge.

If the plant compressed air demand load profile starts developed a decay of pressure, that pressure decay travels upstream toward the air compressors at a rate commensurate with the vitamin of air contained in the piping

When that pressure decay reaches a receiver, and in accordance with the Laws of Physics, the rate at which that pressure decay migrates further upstream is suppressed until sufficient air is taken from the receiver to allow that pressure decay to travel to the receiver inlet piping and further back upstream toward the air compressors.

This mechanism serves to delay the time that it takes for the controls in the compressors to realize that the plant needs more compressed air and change running state to accommodate that need.

As a matter of practice, due to experience on the part of the power house operators that if the plant compressed air pressure decays, the telephone rings and a production manager is on the other end demanding more compressed air on immediate basis, they opt to run more horsepower than necessary. All too often that conversation is not a very friendly exchange.

As a consequence of the influence of this delayed signal acquisition, all too often compressors are left to run loaded on contingency, that being the contingency to avoid the telephone and the power house ringing, and as a consequence excessive energy is purchased from the local utility.

WHAT ABOUT A DRY RECEIVER?

Virtually every compressed air system that this writer as observed and audited over the last 30+ years has at least one, and often times many more compressed air receivers.

It is suggested that there is no such thing as a dry air receiver. Even in a system where proper after cooling and drying is accomplished, there is always some degree of moisture present in the receiver. That moisture is commonly not seen until the temperatures get below the pressure dew point level to a point sufficient to create liquid phase condensate. Nonetheless there is moisture present.

For the most part, and once again, compressed air receivers are one of the least understood components in a compressed air system.

The Laws of Physics drive the following formula

Volume of receiver in cubic feet x(final pressure p.s.i.g.-initial pressure p.s.i.g.)/(atmospheric pressure)p.s.i.a.=cubic feet of free air required to raise a receiver from some pressure greater than zero gauge to a final pressure.

The amount of air necessary to raise the available volume to a certain pressure is also the amount of air available for decay to overall system pressure on demand.

Application of this formula controls actually effective storage versus perceived storage.

Stated another way, the effectiveness of storage is predicated on pressure differential more than on the actual tank size.

A 60,000 gallon receiver with 100 PSIG in and 100 PSIG out running to a mill header with 100PSIG pressures is merely a large bulge in the header ad NO truly effective storage is available..

In the vast majority compressed air system installations, the pressure into the receiver and the pressure out of the receiver is essentially the same.

There is a school of thought that using larger header piping can be substituted for having a receiver. I suggest that unless there is sufficient differential, the effort is a costly exercise in futility.

The effect at the point of use of larger headers does have some benefit, but only if restriction to flow to the end use item is negated.

This being the case the mass flow transfer of compressed air through a receiver or larger header with equal pressures is on a one-for-one basis.

Of additional concern is, that as in the wet receivers, the travel time of a decaying pressure is also delayed in the so-called dry receiver. The two receivers in series simply further retards signal acquisition for a longer time than a single one.

WELL, WHY DO I HAVE A RECEIVER IN THE PLANT?

The reality of the answer to the above question is that everybody has always seen receivers placed into the system and by golly they're going to do the same thing.

In the majority of the installations that this writer has viewed, it is abundantly clear that nobody has ever taken the time, on the initial design compressed air system, to accumulate hard and fast data as to the actual and factual requirements for the compressed air supplied to the production components downstream of the compressor.

But typically happens is that the designer the system has been coached by those who sell air compressors and compressed air receivers with respect to the size of the receiver(s) required for the system.

Is typically a very serendipitous decision-making process and all too often not predicated on the true demand load profile of the plant once it is operating at full production capacity.

A number of variables are involved in leading to the process of making a correct decision on whether or not a receiver is necessary, and if so how big receiver is necessary.

One of the major fallacies respect to receivers is the unfortunate habit of a number of sales agencies try to increase their profit margin by trying to convince facilities that they need to have an a device sometimes referred to as a demand expander or load shaping valve in the system.

There is a habit of trying to sell these devices based on the fact that they will stabilize plant air pressure. To some degree this is true.

The reality is if your demand is constant and you compressor horsepower is tightly aligned with the true process demand load profile, pressure gradients can be carefully controlled with proper compressor controls much more effectively the standpoint of the response times as well as capital costs.

The only true compelling reason to use a load shaping valve arrangement is if you have large short duration sudden event demands that impact the balance of plant compressed air system and cannot be engineered out in any other manner.

Equation above is equally applicable.

The must be recognized that the only truly effective and available storage is that amount of pressure differential between the highest stored pressure and the lowest acceptable plant running pressure, and not the entire volume of the receiver.

From a practical standpoint the Laws of Physics control and cannot be avoided.

It is a fact you get one available storage volume for each 14.7 PSI G differential between the pressure stored in the receiver and a downstream pressure required to operate the facility successfully.

By looking at your system from a common sense mathematical standpoint, more often than not will find a that the use of the demand expander is not necessary, and less you are an equipment salesman that wants to increase your commissions by selling the facility a piece of iron that they do not really need and cannot logically, reasonably, and prudently be justified both from a financial and operational standpoint.

Fundamental to the achievement of excellence in this process is to put into place a purchasing policy which absolutely requires each and all manufacturers of production equipment carefully stipulate in writing the actual demand flow and pressure required for each and all of the pieces of equipment they propose to sell to your company.

Equally important is that any company striving to reach the upper levels of excellence and be competitive in a world market economy, establish the energy footprint and not allow the vendors to do so. This concept was discussed by this writer in a prior article in this publication.

Once you have determined the actual requirement in terms of the weight flow of air, hopefully at a plant air pressure dictated by you, perhaps in the range of 60 PSI G, you then can accurately determine the amount compressor horsepower (energy purchases) you must install to ensure process reliability and repeatability.

Along with this portion of the decision-making process, you will also be able to determine if there are any large sudden event demands that will impact of the system.

In the absence of any large sudden event demands, this writer suggest that large receivers, or for that matter any receivers, are not really necessary for proper operation of the plant production facilities as long as initial design criteria holds the velocity of the air through the piping and components to a speed of around 10 FPS which allows for retention time sufficient for the properly sized clean-up devices to remove contaminants.

If you, the reader, are successful in implementing this new vision on the purchase and installation of pneumatically operated production equipment, you will then be able to accurately determine how closely you can tailor the cost of operations of the supply side to that required the proper operation of the demand side of this expensive utility and in so doing optimize the entire system to a lower life cycle cost basis.

Sudden event demands can be met from storage upon the proper application of the formula set forth above, but absent such a requirement, perhaps it is appropriate to say, “Thanks, but no tanks.”

The particular detailed methodology how to properly configure local dedicated storage, large sudden event demand storage, and other permutations on this theme have been discussed many times. There are a number of different permutations on this theme. Perhaps in a later article we

can explore this in more detail if the readers make their wishes known with regard to this issue by communicating with the editor of this publication.

Anyone wishing to explore the aspects of a different and more effective way of purchasing pneumatic equipment and or compressors can contact the author for some written suggested procedures.

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