The Two Minute Solutionizer

Controlling Leaks in Compressed Air Systems

Leaks in a compressed air system cause more problems than are normally recognised. For instance, the imbalance of pressure in most air systems is a function of the level of unregulated demand of which leaks are the greatest contributor. The inability of the system to maintain consistent pressure throughout the header piping is also function of the unregulated demand. The increased power and elevated pressures which are required, as a system ages are a result of a combination of factors including leaks at the point of use. Some company's frantically attempt to keep on top of leaks in a compressed air system and others don't bother at all. This solutionizer is Ingersoll-Rand's answer to this problem.

Lets examine the impact of leaks from a systemic point of view. The flow through a leak is similar to an orifice in that the pressure immediately upstream of the opening determines the flow. The pressure drops in the line supplying air to the leak based on the line's ability to support the rate of flow. For example, the airflow across a 3.17mm orifice at 6.2-barg is 44.37 l/s but the flow through 3 metres of 3.17mm I.D. copper tube at 6.2-barg will be less than 18.88 l/s because the pressure will drop to 2.4-barg in the tube. If you attempt to raise the pressure at the discharge of the tube, the flow increases and the pressure will not rise at the discharge as fast as it does at the inlet to the tube. Leaks in an air system make it impossible to equalise pressure in an air system for the same reasons.

When a new user enters the system, it is called a demand event. The air to support the event is removed from the header, which causes the pressure to drop in the header from the application back to the compressors. The size of the drop in pressure is a function of the size of the event, the transmission time from the application back to the compressors, and the capacitance of the system. When the compressors respond with increased delivery to the system, the pressure will rise from the compressors out to the system. Unfortunately, as the pressure increases so does the demand for air in all users, which are unregulated including leaks, open blowing, and users with the regulator cranked all the way open. This phenomenon is called artificial demand and it prevents the compressors from being able to equalise the pressure throughout the header. The pressure will rise to the modulation or unload set point at the compressors before the pressure in the piping system will equalise.

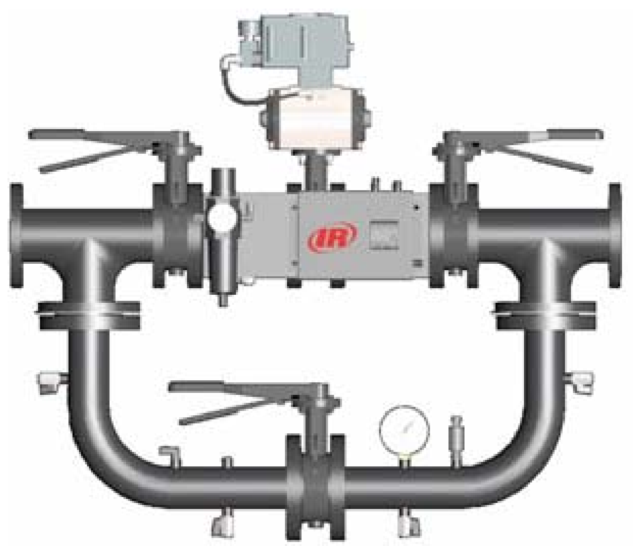
The reaction of operators to the lower header pressures is to crank open the regulator to the maximum setting on any critical pressure applications. This will increase the point of use or article pressure up to the level allowed by the header pressure minus the differential on the regulator and filter (if fitted locally).

The article pressure on critical applications now fluctuates with any variation in header pressure. When this impacts the quality of the product, production operators will request higher system pressures to elevate the minimum article pressures above the requirement. The pressure will continue to fluctuate at a higher level and the higher operating pressure will increase artificial demand across the entire system.

When leaks are repaired, the pressure will rise in the vicinity of the repairs. The higher pressure increases the flow through any remaining smaller leaks. The velocity through the leaks increases exponentially to the increase in flow. The result is dramatically increased propagation of the remaining leaks, which in a short period of time, returns leaks to the original level. The long-term solution to these problems requires controlling the demand pressure with extraordinary resolution so that decreases in leak load will not cause increases in localised pressure. Response to less than 0.05 of a bar change is required. Compressor controls and sequencers, even PLC based systems, can not possibly provide this type of resolution. The only device we are aware of that can respond in this manner is a demand expander or in Ingersoll-Rand speak an Intelliflow valve.

Intelliflow uses precise control of a very low differential control valve to expand the air from the supply pressure down to the lower demand pressure without a detectable loss of energy. This is very different from a regulator, which restricts the flow with springs or pilot air to control the pressure. The typical demand expander consists of a primary electronic PID controlled circuit.

Intelliflow separates the supply side of the system from the demand side of the system. The pressure in the supply system can be set to maximise the efficiency of the compressors independent of any impact on the demand pressure. In fact, this is a critical factor in the proper operation of an expander-controlled system. Maintaining a higher pressure on the supply side creates effective storage, which can be used by the expander to respond in fractions of a second to changes in demand. The maintenance of this potential energy in the supply system can be designed to support intermittent increases in demand without necessitating the use of additional kW's. A number of parameters must be considered to make a controlled system function appropriately.



- the maximum and minimum system demand
- size of the largest demand events
- the capacitance of both the demand and supply systems
- the longest transmission time of large events in the system

Once the system is controlled, the rate of leak growth will be limited as much as possible. It is then important to determine the appropriate leak level to maintain. A target of 5% is excellent but even 10% is considered good. This benchmark should be established based on economic factors. The goal is to minimise the labour costs of repairing the leaks and maximise the reduction in compressor kW.

The type and quantity of leaks will determine the labour costs in the system. An assembly plant with hundreds or thousands of points of use will have many more leaks than a process facility with more pipe and fewer points of use. Some leak problems are specification and purchasing issues. For example, certain fittings, hoses, and disconnects are available which are markedly more leak resistant. The reverse is also true, some hardware is markedly more leak prone. While there is a higher initial cost for the better hardware, it is relatively small when compared to the costs of the leaks or the future repairs required. The use of a quality ultrasonic leak detector* is the best tool to minimise labour costs in locating leaks, which can often be most time consuming part of the process. Leaks should be reduced to a level, which allows one or more compressors to be turned off. Any other goal is a waste of time. With an average of 2.5 l/s/kW (if the compressor is operating well), it does not take long to justify a leak control program with an appropriate budget. At £0.045 per kWh, the costs to support 47.2 l/s or 18.5 kW of leaks will be more than £6,660 per 8000 hours operation. The key to this approach is that if 47.2 l/s of leak repair allows you to turn off the next compressor the savings will be much greater.

Leaks are inevitable in a compressed air system and left unchecked they will cause production and quality problems. The cost of supporting leaks in system makes a leak management program appear attractive. But efforts to repair or control the level of leaks actually increase the rate of reoccurrence. Definitely a case of diminishing returns. One time leak repair is a waste of time and money. The application of some effort at understanding the actual critical article or point of use requirements and the proper application of system controls, such as an Intelliflow valve, can make leak control a manageable and financially attractive effort.

ONE OFF LEAK DETECTION SURVEY WITH NO SYSTEM PRESSURE CONTROLLER, YOU ARE WASTING YOUR MONEY.

Have a profitable day!

*Available from IR