COMPRESSOR ENERGY SAVINGS Instantly by following the HEADER PRESSURE

Ashok.S / BEE Accredited Energy Auditor, POWERON Projects, Coimbatore. /

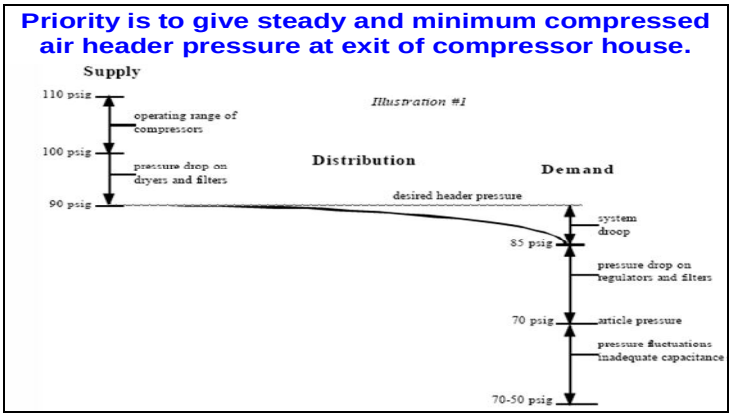
Mail to:- ashok@energymeasuretosave.com

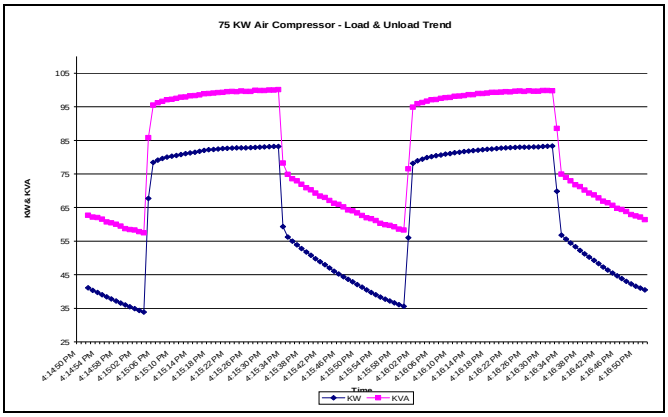
ABSTRACT:-

The brief idea is to relocate the compressor discharge pressure sensor from the screw compressor hood to the Air receiver. This will change the compressor load & unload pattern, give steady compressed air header pressure & improves safety of compressor working thus leading to ENERGY SAVINGS. The industry which runs on single or multiple air compressors in the compressor utility house, can implement this sensor relocation to maintain a narrow band but constant air header pressure. **The compressor Load & Unload pressure band of 6.5 to 7 Bar can be trimmed to 6.3 to 6.5 Bar, when the plant needs only steady say 6 Bar**.

DRAW BACKS IN EXISTING LOCATION:-

1. Compressor discharge pressure is sensed at the location of discharge pipe within the hood very near to the heat exchanger location and is subject to turbulence based on the discharge pressure fluctuations near the HX within the hood, due to the varying back rush of air flow from the dryer and restricted filters and even the sharp pipe fittings before the air receiver.
2. Wide pressure band of load and unload settings say 6.5 to 7 Bar are kept to give time to accommodate the above and the compressor to ramp up and down slowly to suit to fluctuating loads, hence consumes more power. If the band is narrowed, the compressor hunts and this is not healthy for the compressor.
3. **In spite of the above wide band settings, our energy audit study trends in many industries show compressor toggles between load to unload 30 to 60 times an hour, cycling every minute (image) during peak loading and sometimes due to phantom loads, artificial demands, choked air intake filters, leakages etc.**



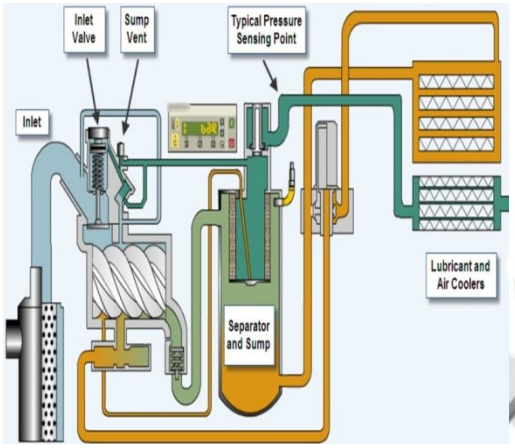


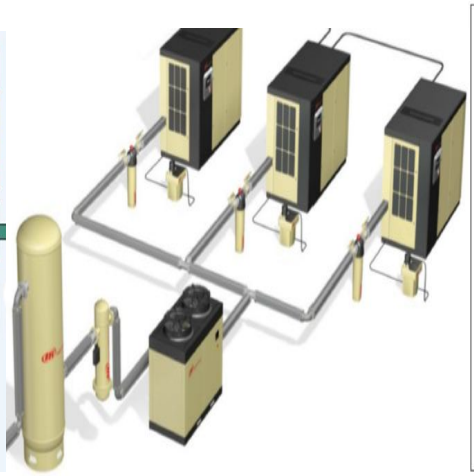
4. Frequent load & unload hunting in screw compressor is not healthy. And the unloaded power consumption is around 40% of rated power and its duration is more.
5. The compressor internals get weaker due to this frequent cyclic wear and tear.
6. In a battery of compressors feeding to the load, we find the each compressor's load & unload settings overlap with others; resulting in frequent load & unloading of many and more duration of frequent unloaded power consumption.

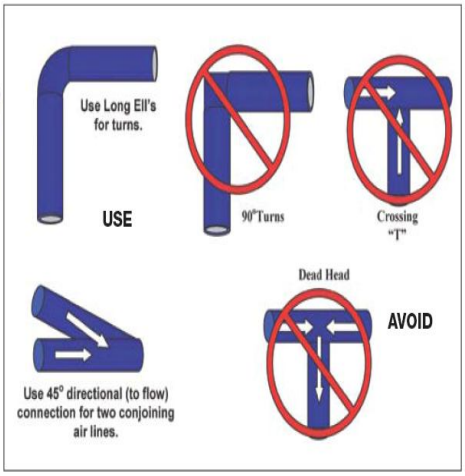
COMPRESSOR HOUSE PIPING LAYOUT:-

The existing Air compressor dealers & users compromise on the wet & dry type receivers and provide only one air receiver either after the compressor or after the compressor, dryer & filter. Even the compressor to receiver

interconnection piping connections increased pneumatic friction losses within the system (image). **Even today, the industry can re-arrange the L and Tee joints to 45* conjoining joints in the compressor house. We are aware that 70 % frictional loss arises in the sharp Elbow fittings leads to back rush of air, compared to Standard bends.**







PROPOSED COMPRESSED AIR SENSING LOCATION:-

Instead of sensing the compressed air discharge pressure within the hood as given by the OEM, we the consumer can relocate the digital pressure sensor to the main air receiver in the downstream. Now the compressor will modulate based on the pressure sensed from the air receiver. **In a single / multiple compressors & receiver system, it is better to smoothen piping by 45* direction conjoining joints within compressor house.**

MERITS IN PROPOSED LOCATION:-

1. The existing pressure load-unload band can be narrowed down to the minimum from the previous band say 6.5 to 7 Bar band to say 6.3 to 6.6 Bar; The setting is based on the air receiver volume & location with respect to dryer & filters pressure drop and plant dynamic load pressure variations, hence varying power savings.
2. If the same compressor is operated on VFD, the strain on VFD comes down and based on the closed loop steady pressure fluctuations, ramping up and down slowly now because **the external VFD vendors provide a separate pressure sensor on the air receiver as input to operate the compressor motor thro VFD.**
3. Since the pressure band is reduced now and we have made the plant header pressure steady, the KW savings due to lesser header pressure now. **BEE guidelines that Reduction of 1 kg/cm2 compressed air pressure (8 kg/cm2 to 7 kg/cm2) would result in 9% input power savings. + leakage savings indirectly by 10 %**
4. The VFD closed loop PID controller Proportional and Integral settings can be fine tuned to match the steady ramp up & down of header pressure, sensed from air receiver.
5. The slow and steady ramp of loading and unloading avoids the frequent cyclic wear and tear, as well the compressor de-rating due to accelerated ageing.
6. In a battery of compressors feeding to the plant loads, this working can be streamlined to operate the compressors only on need and we will be surprised to find one or more compressors going to switch off based on the automatic unloaded time delay settings, in some cases.
7. **The Piping & Instrumentation Standards calls for turbulent free, streamlined process location wherein the pressure sensor to be fixed to measure it steadily & accurately**. So it is always better to sense the pressure from receiver which is steady, pulsation free and reflects the load's air demands instantly; instead of turbulent pulsating pressure sensed at the existing discharge location inside the hood. **We in the industry is more concerned about the utility compressed air header pressure and what is measured inside the hood will not reflect the same always.**

8. **For accuracy of measurement, it is better to opt for 0 to 10 Bar input rated pressure sensor (instead of existing 16 Bar input rating) for our 7 Bar operated air utility**. This inaccuracy in detection reflects on the Automatic output pressure band control.

CASE STUDY:-

We conducted energy audit in a premium foundry unit recently. And based on our zero cost proposals in their compressor house, they achieved energy savings. A battery of compressors of ratings 160 KW & 75 KW screw compressors is running in the compressor house. **On relocation of the pressure sensor from the individual modulating compressors to the main 5 KL receiver, they achieved 5 % KWH savings per day average due to the load-unload pattern changes in their modulating compressors. This industry saved 300 Units per day out of their 6000 units per day average compressors' consumption.**

This industry studied this proposal and pounced upon the idea to implement immediately; and we as Energy Auditors are delighted to observe how the industry grasps the Low Hanging Fruit here in this case; and admire the industry's ECON initiatives. Why not the other industries too, take this quick Initiative now?

SAFETY IMPROVED, AND ADDITIONALLY SAVINGS TOO:-

The relocation of pressure sensor from the compressor hood to Air receiver will give power savings instantly from Day One and the overall KWH savings per day due to changing loading patterns. Even this saving is not appreciable; it is safe always & proper to operate the compressor on Air Receiver pressure and not on its discharge pipe pressure.

The compressor OEM has put all sub systems in one hood for convenience sake in transporting. But practically thinking, it is better to take away & relocate some sub systems like Air intake filter, Heat Exchangers, Pressure controls out of hood. This will sustain the efficiency of Imported Air compressors in this tropical India. At least here, they can approve this steady pressure sensing approach and allow the user industry to relocate their compressor discharge pressure sensor during the machine's commissioning at site.

In addition & after the discussions with OEM, we have to ensure the compressor safety, let us retrofit a pressure switch PSH at the location where sensor was located already. When discharge pressure HIGH alarm is sensed at this pressure sensor location, this will activate compressor unloading. It is always better to have two isolated controls, one analog control to throttle between load & unload; and other digital control along with delay timer interlock to safe switching to unload. This is apart from the Pressure Safety Valve in the system.

INDUSTRY & COMPRESSOR OEM PROACTIVE INTERACTION:-

The compressor energy savings can be achieved only if the user industry thinks that they are losing energy in compressed air. And the above exercise can be achieved instantly by industry after pro-active discussions with compressor OEM. **Here safety of machine is not compromised but compressor's sustained efficiency over many years till its life cycle is thought of. This avoids as well, the cyclic wear & tear of compressor internals, happening due to every minute loading & unloading pattern in the compressor now.**