Comforting CA System to Deliver More

Introduction:

The compressed air system nowadays is an indispensable part of Automation of the plant. Whatever is the process control system upgraded and fitted to the process, the final control element is driven by CA system only. If the CA utility is kept comforted, then its usage is in our control. If CA system is left wild to work without monitoring, then its use & leak will swallow the industry profits.

The analogies told about the Compressed Air system in the industry is to drive home the user, the preciousness of air usage. Typically, in a classroom, when you feel like sleeping during class hours, please look at the other student who is already dosing. Psychologically, on seeing him you can get rid off your sleep and feel fresh automatically and listen to the teacher. The same analogy is being tried in this article, which wakes us up to stay alert seeing the existing pitfalls in our compressed air usage in industry.

CA Parameters To Grab & Ponder:

- Compressor working is like the Submersible pump working in air.
- Compressor needs air to suck in, and to surround, to deliver more air.
- Cool Compressor delivers more air.
- Continuously run Compressor delivers less than an intermittently run Compressor.
- Tune your Compressor cut-in / cutout to process & not vice versa to conserve air.
- Compressor hour meter is a must and a rough indicator of air consumption.
- Air pressure, temperature gauges cost hundreds, but parameters measured by them cost thousands to lacs of Rupees. Please don't delay installing them on lines.
- MLM - Micro Level Monitoring of air parameters daily shows your air health.
- MLA - Macro Level Analysis show where you lose air and how to curtail the losses.
- Air, air, everywhere, but no air to receive sufficiently (user complaint!)
- Elbow, Sharp Bend is the Silent Killer in the CA distribution system.
- Now in compressors, **it is no more FAD; it is CAD only ie costly air delivery**
- Are we Rupee wise and Paisa unwise or vice versa in our CA usage?
- Rupee wise is that to tune CA header pressure near to required pressure with air bottles at load ends, Paisa wise is that to steep raise the CA discharge air pressure

Focus area: Compressor Generation

- Existing practice in some industries is that CA housed hot humid, no-ventilation, condemned, scrap dump yard in the remote corner, working under hot blast of ceiling fan. The hot blast from fan will aggravate its localized heated surroundings. Better practice is that we have to ensure better cross ventilation at CA house and the open terrace above its roof shaded to reduce solar heat ingress from the top and the area must be neat and clean and should not gather dust etc

- After providing comfortable surroundings, we find the Compressor is the culprit in the house, internally exhaust hot air and this is being pulled back at compressor suction. So we have duct out compressor suction air and heat exchanger hot air with suitable expanders and contour ducts for free flow of air in & out of room.

- Typical of any industry the Compressor is located at the farthermost corner of electrical network. So the Power factor correction capacitor must act at the motor terminals with adequate protections. This indirectly improves the efficiency of motor ie the voltage realized at the motor end is better now.

Air Compressor Vs Submersible Pump: -

- The Air Compressor in the Utility in any plant is similar to Submersible pump in functioning. Water is the sucking medium for the pump inside and same water is cooling medium outside. Similarly Air compressor starves if its air filter is choked and as well compressor-surrounding temperature gets heated up locally. This is the mother of all compressor related problems, easy to attend but unfortunately not noticed and taken care by many.

- We see the Compressors breathe lightly and quickly often. The analogy is that we humans also do most of the times shallow breathing. This short breath goes unnoticed even when we keep our finger above our lip and under our nose. This short breath shows we have put our lungs to 30 % capacity only. That's why many industries in India started with in the premises the Breathing Exercises ie Deep Breathing Practices during shift changes. This helps us to remove the toxins from lungs and regain 70 % lung capacity to function that too efficiently.

- We understand one of the main yardsticks of human efficient living is not the shallow breathing but deep breathing practiced in the long run. Similarly we find in our industry the Compressors with its choked suction air filter, starve, and roar heavily due to want of suction like higher idling two stroke engine in two wheeler. So always we must see that Compressor gets good suction. It is cost effective to do Front End Correction than to strain more to reduce the interstage, discharge heat and reduce wear and tear of internals.

Daily On-Line Cleanable Filter: -

- Instead of providing the Suction air filter very near to the equipment skid, it is better to extend the suction of CA system physically out. Bigger & more visible Primary mesh pre-filter is to be provided in addition to the existing filter. And the pre-filter is located conveniently so that the same is on line cleanable daily. The retrofitting pre-filter with nylon material much bigger in size than the existing suction filter is made slide-in slide-out type.

- This retrofit mechanism suits not only to the Compressed Air system but as well to many other stationary engines at their air intake position. This enables the equipment to daily breathe clean and correct volume of air during running. . Shift by shift this can be cleaned conveniently and airflow & volume to compressor is steadily maintained. Here we see how the existing filter was clogging but what we must see and visualize is that how much of dust has gone inside compressor already wearing out the internals' faster.

- Look for correct symptoms of CA temperature at the suction, Air Receiver, after heat exchanger, inter and after cooler, Final air delivery from CA house to process. These locations can be fitted with temperature gauge with alarm setting (fixed in dial) so that any abnormal raise in temperature in any of the above can give visual RED remote Alert bulb and hooter alarm. Finally we want the cool dry air to be delivered to the process and any abnormal temperature if corrected there it, we foresee a lot in CA savings.

- If provision is not there in CA house either in equipment or in the piping etc, we can make use of the non-contact Infrared thermo meter and daily we can generate many readings to study the hot spots for any abnormal rise.

- Provide the standard 4” dial CA pressure gauge at compressor discharge, before and after the coolers, dryers, at the receiver and look for the standard and recommended pressure drops are read in the gauges. Optionally the pressure gauge with alarm setting will alert the user at remote location. Also the Delta P gauges across suction filter and other filters will give us the indication what is the pressure drop happening in the CA generation itself and is it in tolerance?

- Here we find too many Elbow fittings in CA house itself, which restricts free flow of air inside air piping and leading to pressure drop. You will see that the manufacturer in their equipment does not use elbows; sharp bends but long bends in his fluid system. Provision of pressure gauges in CA house will indicate the piping losses already occurred then and there.

- Now the industry has realized the Level sensed Automatic drain valve, which function fool proof in removing the water fully; this must function in CA house ie at Air receiver mainly & significantly. This auto drain to be retrofitted at outlet header ie at source and sink, load ends. We see timer based drain valves don't drain water always but lot of air too; or sometimes don't' work at all. The water carried over in CA header originates the problem of internal friction in piping. Once water in header is allowed to enter, leads to pressure drop in air piping and header pressure losses.

- The Hour meter fitted at the compressor circuit roughly shows the normal consumption and any changes that occur occasionally. The hour meter to monitor compressor ON status, as well loading and unloading status to figure out clearly the consumption pattern over varying production loads.

Accurately Measure Air: -

- Similarly when we talk of Compressed Air pressure in the plant, we talk only as 6 or 7 or 8 KGSC and not as 6.3, 7.5, 8.3 KGSC etc ie As far as compressed air is concerned we must talk in decimals of Kgsc only. By this we are monitoring more precisely and then we can control.

- Analogy from the petrol bunk is that now we inflate our vehicle tyre with digital air only ie we specify the pressure settings in psi accurately and the same is done. Previously some token air was inflated either high or low and the same is read coarsely. With Digital Air Utility in petrol bunks, the fuel saving is achieved in our vehicles apart from our prolonged tyre life. This is how the industry also must respond to measure and control the Precious CA utility precisely.

- In some industries, exists is the dial gauge of 25 kgsc which reads quarter scale only wherein both resolution and accuracy, or repeatability is poor. This is the existing practice because of over design of instruments to suit to design maximum of process parameters. Instead we start reading at 10 kgsc range 4" dial gauge mounted at around readable height to read the standard 7kgsc pressure, we know we read it correctly.

- This is not only applicable to pressure sensors, but also to many other measurements wherein the linearity, repeatability is more important when measured **"Half scale of the instrument"**.

- Similarly existing is the temperature gauge with small dial of 0 to 150^{o} C and the pointer does not even cross quarter scale. This is applicable to near ambient Temperature measurements wherein the range of less than 100^{o} C, 4" dial size will give correct temperature readings of 1^{o} C resolution. Every 1^{o} C change in CA parameters, ambient makes lot of difference in energy consumption. You will be surprised how many big industries are scratching their brains to precool the compressor Suction air? Even few degrees of precooling reflect a lot on the overall efficiency of the CA system.

Cut in - cut out switching CA suitably: -

- In the plant utility, the one equipment which is On / Off cycle in automatic all the 8000 hours per annum is the compressor. If the cut-in cutout switch of the plant compressor is adjusted in such a way so that the range and differential pressure settings allow the compressor to run comfortable duty cycle. When the variable differential band pressure switch controls the duty cycle in a fine tuned lower narrow band, the compressor gets rest as well gives more output in the intermittent running.

- For example, we switch off the fridge in the house say for two hours in the morning say between 6 to 8 am everyday. Since fridge is the one which runs 24 hours 365 days in a year, giving rest to the fridge, cools the compressor, defrosts the inside tray, and as well makes the compressor more efficient and power savings is achieved daily.

- If the CA system is big, and if we can afford to, then we can think of variable speed drive in compressor or online pressure controller cum valve for conserving air. Ultimately we need to give our equipments Regulated CA pressure with no pulsations, dips on shock loads etc.

Standby 2: 1 cycle: -

- Existing practice in some industries, we find though CA house two sets of compressor as Main and Standby, the operator runs the main compressor in loading - unloading cycle continuously for a month and then changes over to standby in the next month. Alternatively why not he operate main standby changeover switch in every 2 / 4 or 8 hour shift so that timed cooling by way of Main – Standby selection of compressors improve their volumetric efficiency?

- We humans are awake for 16 hours and sleep for 8 hours in our 24-hour day. This 2 : 1 concept of work & sleep schedule is universally practiced in industry too. We go from zero duty of sleep to light and heavy duty daily working. Similarly giving comfortably timed on-off cycle to the duty standby units in the above auto switch mode in consultation with the manufacturer can comfort the compressors or any other similar equipment coolly & efficiently.

- Existing Analogy on road is that now the traffic signal is equipped with Digital LED display count down timer. This is meant to help the vehicle driver to stop the vehicle with more than 30 sec & above sec left from Red Stop signal to Green; this reduces pollution levels in signal and as well fuel saving. But even now we find the vehicle driver don't' stop the engine during this idling time because they are not confident of sure restart of their vehicle when signal is nearing Green status. Because our mind is set for Panic Button Engineering working that we keep the engine idling for long hours and not allowing to stop. Similarly the operator does not changeover the main standby compressor in his shift.

- Remember your child inflating his cycle tyre with the hand cycle pump. After few strokes you find the bottom of pump gets so hot. At micro level if this is the case, visualize how your compressor at plant is hard working to generate mostly heat and so little fraction of Compressed air.

Focus Area: Compressed Air Distribution

- Similar to Electrical T & D losses in the industry, if we study the breakup of losses, drops in main air header is less compared to distribution losses. Precisely the loss increases in branch off headers from Tees and elbows, fittings and in Hose connections. Hence the industry started to replace the Elbow fittings in headers and other CA lines with the standard L bends. We are aware that 70 % frictional loss arises in each Elbow fitting compared to the Standard bend as per PCRA bulletins. The elbow & sharp bends in air piping from end to end increases turbulence in process air utility.

- The leakage starts more in hose connections than fixed main & branch headers. That's why the industry have switched over from nylon braided hoses and clamps to Poly urethane hoses held loosely in helical form and mating connections done with compression type fittings. See to it there is no mechanical pull or tension of hose clamp and this only initiate's leakage. (Visualize modern auto garage with helically coiled colorful PU hoses fitted with condo nozzle air guns used for cleaning of vehicles) to avoid distribution leakage.

- In the existing MS headers (long back the industry started to switch over from GI piping to MS, wherein friction head is less) wherever welding is not possible, they use branded soft and thin branded Teflon tape to reduce air leaks to bare minimum (as we all know Teflon is the slipperiest substance known to science), and this serves as good buffer in the fitting connections to arrest leak. Alternatively, the better practice also is the use of pipe sealant which comes in the form of Teflon paste or liquid to arrest joint leaks and this is far superior to tape in mating the fittings and excellent in leakage arresting applications.

- Looking through Lens the procedure, while applying the Teflon sealing tape on the tapered male thread (NPT fitting): First wrap the tape clockwise from the top of the thread and leaving a thread at its bottom. Hold the tape tight on the male thread; tightly wrap two layers of tape. Then firmly press & roll the thread. This Teflon sealing solves most of the leakage problems where welding is a constraint.

- The Pressure gauges are fitted in each and every user department at the incoming end as well at the other end of network within the bay so that we know the pressure drop in distribution header, before and after the equipment occurs due to process consumption inside equipment or leakage outside say in the piping.

- Remember that any small restriction anywhere in the CA main & sub header piping by way of fittings, kinks, sharp intrusions like burs, gaskets, tape etc can cause a momentary drop in pressure & flow at the equipment end. So to circumvent the problem, find out where & why pressure drop occurs and solve it or suitable air bottle at equipment will take care of equipment from this problem.

- OR that's why many industries are switching over from Radial Distribution to Ring Main distribution by which the user can even reduce the CA header process pressure ie around 1.0 KGSC above process requirements. Any amount of Pneumatic Lag in CA system can be managed by the above alternative arrangements the only symptom of this problem can be well seen at the end of line pressure gauges during on line running in which the pointer oscillates with the fluctuating load of the process.

Focus Area: Compressed Air Usage

Tropical Ambient Conditions: -

- **Why CA sub- header of equipment to stand adjacent?**

- We have to see that the sophisticated equipment in the plant is tropicalised and Indianised in such a way that it withstands the high humid & dusty ambient environment along with the seasonal variations in the inputs in air, and water etc. Otherwise we need to add retrofit gadget ie pre-filter in air and similarly in the water inputs to the equipment.

- Existing condition in industry is that the CA sub header along with FLR is kept inside the equipment and invariably FLR shows no oil & full water in the bowl.

- Keep them daily noticeable and hiding them inside equipment brings impending breakdowns. Caution is that the pre filters to kept out of the equipment package and not be built-in the equipment. Even in the air consuming equipments, the air sub header fitted inside with auto drain valve and FLR can be kept adjacent to the equipment. This enables easy daily monitoring of incoming air to the equipment.

- When FLR is used ahead of the equipment, care is taken to record the amount of oil fill & refill in the lubricator bowl along with dates. This dates and quantity of fill will indicate the internal health of pneumatic driven equipments. This helps in Predictive Preventive maintenance schedules to be planned during the condition based Monitoring & Maintenance aspects.

- What we need to keep in mind is that our pneumatic driven equipments like cylinders, actuators etc can work smoothly with constant air pressure only. If pressure fluctuates then, the actuator jerks over a certain position in its operating range and ultimately leads to its wear & tear in its constant jerky working. Sometimes, the combination of air, water dust and oil leads to emulsion. This gets embedded in inner surfaces of equipments leading to sluggish performance. Even the port type solenoid valves may not function at all. We should never allow the triangle of Air + water + heat to form inside our equipments and this triangle leads to corrosion of internals.

- Display board to show **"Air consumed per day in Rs."** be shown to user near the heavy drawing equipment / plant / cleaning applications. This can be kept in many areas where huge air consumption exists.

- Especially in cleaning applications, tamper proof Pressure Regulator kept in the Incoming side such that 2 to 3 KGSC only is used for cleaning. Existing practice is that either nylon hose, ¼" copper pipe / tube inserted at the end is directly used for cleaning. Better practice is that to use Energy Efficient nozzles or CONDA type or at least AIR GUN. At the point of cleaning, the user is forced to respect air when he uses AIR GUN, its shape will make him think it is precious; instead of casual throw of blunt hose or pipe.

Spot Air Receiver:

- Rupee wise if we think, is that to retrofit first, more Mini air receiver or air bottle at all load ends. Cost effectively if we add adequately sized Air bottle or mini Receiver in conjunction with the solenoids at load end ie every air consuming equipment, we ensure uninterrupted flow of air at constant pressure to the equipment and its working is not disturbed due to want of air. This Receiver is similar to capacitor retrofit at load end. This retrofit due to its buffer stock at load end, helps to reduce header pressure say around 1 kgsc more than the equipment operating pressure. For example, if we run existing CA system on 9 to 12 KGSC settings, and now let us retrofit air receivers at load ends. Now we can alter the settings to 8 to 9.5 KGSC. BEE bulletins say every 1 KGSC reduction say from 8 to 7 KGSC brings down power consumption by 9 % and here we envisage more.

Conclusion;

We find now the wake up call is given to the industry to cautiously use the precious & costly air utility. Our mind set is" After all Air only is wasted", this casual attitude should go out of the industry otherwise much causality in the form of equipment breakdowns would crop up suddenly. Assume you are asked to go 5^{th} floor of building, now you are climbing up through staircase steps (no lift please) to 10^{th} floor and then climbing down to 5^{th} floor. You face the agony, time waste, and pains. Similar is how you pump up your compressor to 10 kgsc to use the air at the 5 kgsc @ machine end. The industry has understood it has abused Air till date, now it uses Air as Colorless Gold.

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