Humidification plant – are we humbly utilising?

INTRODUCTION: -

The Industry Best operating Practices, Humidification plant Manufacturers and the relevant standards give many a tips and schedules to the user industry. Apart from the time based preventive maintenance schedules for the Humidification plant, its condition based monitoring helps in **Total Productive Maintenance (TPM)** practically.

Down below, many a practical points are bulleted to study condition based monitoring of the plant The Humidification utility user industry understands now by logical running the plant and actually feeling the **Positive Cross Ventilation effect in conditioned premises using Sensors**, they can comfort process parameters to achieve say around 10 % more productivity. The industry has practically understood that the distribution losses start from & at the poor functioning of nozzles and have reduced the pumping losses and simultaneously have improved humidification effect immensely.

EXISTING OPERATING CONDITIONS / SYMPTOMS:

Kindly go thro the following bullet points and please try to match your existing plant has the similar symptoms of working. If so, many of the symptoms can be corrected at no greater extra cost, you will see **the Humidification plant improves your productivity**. These finer points toe in line with the existing user operating manual for the plant.

- The plant is partly used, like switch off fans & pump for sake of power saving
- Water is hard, higher TDS, and sedimentation is more
- Fans are scaled at hub, blades, loaded with dust and fluff
- Heavy voltage drop at the motor terminals
- **Conditioned premises RH & temperature not sling- measured**.
- RH & Temp are sensed at one stagnant spots, giving deviations
- Water in the sump is very chilled compared to ambient wet bulb and stagnant
- Water pump discharge pressure not measured
- Sharp elbows immediately at pump discharge
- Suction & discharge piping mismatched to fluid velocity in pipes
- Rusted GI piping at the water circuit
- **The plant premises look dilapidated & not spot clean**
- **Daily visual check for 10 minutes inside the plant room**
- Water pumping heavily, plant floor is watered
- Nozzles getting choked frequently
- **Half of nozzles water jetting, the tail nozzles are plugged, pissing or oozing**
- Plant plenum area is not made weather proof
- Water piping with high friction head losses, heavily scaled inside
- User conserves electricity by not running water pump, fan often
- Sharp bends instead of contour at supply plenum at masonry, at air ducts
- **Positive cross ventilation is not there in premises, but hot pockets existing**
- Hot spots near equipments, motors are becoming hotter day by day.
- **The user thinks Humidification plant is unwanted mandatory liability.**

HUMIDIFICATION - AIR CIRCUIT:

- The industry has understood now that by running HP (humidification plant) scientifically and practically by feedback sensing & control, they can improve production. To be precise, if **we concentrate at the Spray Dwell Time** of humidified air in the spray chamber, then we can improve the HP performance and this definitely gives a boost in product output apart from improved in quality.
- Usage of High Efficiency GRP/ FRP fans (properly weight-sized to the air throw & cfm specs and installed correctly) instead of M.S. or Aluminum blades consume less power input for the given air output. The thrust point is that compared to metal fans, the weight of the blade is **concentrated at the center than at the ends and by flow curves**, this gives more air power with less weight ie hence with less power.

* Domestically, We know how the unbranded ceiling fans consume more power due to heavy weight compared to branded fans. Here we must mention that the FGRP fan has proved its superiority in the heat exchanger applications like cooling tower, air heat exchangers etc here the textile industry calls for more stringent & different specs like higher static delta Pressure for the given power input.

* Here again care is taken to avoid or **remove masonry sharp bends in the chamber** and in the duct for smooth flow inside premises. This is what, is concentrated in the Vaasthu as Free Flow of Air and no Obstacle in the air path ie the bends to guide the air smoothly in change of direction but not block and detour the air path. In some plants, we find the supply air fan blasts the air against a sharp & blind wall, then take 90* turn to diffuse turbulently thro supply ducts. The velocity of air is reduced then & there itself.

* Always bear in mind **the break- up of the T & D losses for any energy medium input**, the distribution of air thro diffuser is the focus area. Like the industry understood now that the lighting levels in the given area, first must satisfy visual tasking of the workmen than the general lighting. So the industry reduced the height of the luminaries to focus the lighting on the work area.

* **Likewise, industry has to drop down the supply diffuser** so that the air is diffused to the focus work area & hot pockets are avoided at the work area. Here we must not see the aesthetics of dropping the supply diffuser. In fact, the ideal alternative for the industry is to bring down the false ceiling to the minimum possible convenient height. **This helps in minimum buffer space in between and the plant conditioning is faster now due to frequent air changes.**

* Ultimately, the premises should be kept at Positive Cross Ventilation air currents. Care is taken to avoid hot pockets especially at the user and equipment area. Existing conditions indicate either the fans are switched off to save power or the exhaust trenches are not cleared off dust. These results in suffocation of equipments, localized heat buildup, product suffers due to harsh environment. These parameters are essential for machine health and healthy product the industry till date has not given proper attention to this aspect.

HUMIDIFICATION PLANT & ITS LOAD:

* The load to the plant is mainly due to the equipments say three fourths the load and the balance quarter load is due ambient dry weather conditions. We have to reduce the load on the plant, and to make conditioned area more comfortable. It is **very much rupee wise and pays unwise move to reduce the above - ceiling temperature** and is easy too.

- Now we are allowing the solar heat to enter the premises from the top and then do false ceiling to suppress the heat further. What is happening to us for example, we feel the comfort differ in three ways as 1) When we stand under the sun, 2) Walk under the sun, 3) Go by two-wheeler under the sun. The impact is least felt under the sun when we go by two-wheeler because of the air breeze. Similarly the roof or the attic is made ventilated by force like the lateral high volume low pressure exhaust fans or by self propelled roof extractors. This brings down the under roof temperature by say 5 * C .The existing attic hot stale air is forced out and heat is not felt in false ceiling as well in supply ducts.

- Generally the roof heating by solar radiation causes 50 % of the heat load in any premises. Though we have gone for false ceiling to avoid the same, still the plant needs to be insulated from the climate extremes of day & night and that of summer & winter. What **we suggest is that two-stage insulation at an affordable cost will improve the ambient**. If the roof of plant room (where lacs of cfm is generated) is concreted, we can think of covering the open terrace in patches with the standard asbestos sheet at a height of say 2 feet above the terrace.

* This is an **alternative only, cost effective and non-contact type method of primary cooling**. There are other methods like green housing, pucca comfortile type weatherproof tiling, roof extractors, lateral ventilators, acrylic based reflective coating, or an eco-friendly idea of growing tall trees around conditioned premises to provide shade before & after noon times of day. This can be done above HP chamber, MCC, compressor house and wherever open terrace on RCC roof. This primary insulation is meant to avoid the solar heat load.

* In the secondary insulation i.e. under deck insulation, the attic fan definitely helps to remove the stale hot air under ceiling & insulate false ceiling from solar heat load. This method of attic ventilation and cross ventilation inside premises is low cost energy saving type compared to high cost cooling of equipments & premises.

- **Remember**: A few degree temperature drop of air inside duct at the start; and at the outside duct due to attic ventilation is easy to achieve and consumes less power. This is less compared to the power required to temperature reduction inside the premises

* Next to ambient loading, one of the factors of major loading to the humid. Plant is the motor heating inside the premises. Now the industry is washing the motor with hot pneumafill air, which aggravates the motor temperature further instead of soothening. This hot inside air from the equipment is hotter compared to the cool dry ambient air outside. Especially in a high load factor industry like a ring frame of a textile mill, cooler the motor and its surrounding air, better is the motor efficiency and ultimately Energy savings to the industry. So it is better to provide

separate Fresh outside ambient air intake to cool the motor or a group of motors through duct. And the hot exhaust air from the motor can be relieved in the normal exhaust trench routes, after filtering the same.

* Here we notice that more the Rewound motors inside the premises; more heat is spilled away by motors. Hence the increasing load on the Humid plant indicates that one more factor of motors inside premises are not operated at optimal loading, localized heating of motors, poorly maintained motor, blocked cooling-off passaged motor, right quality & quantity of greasing, poor alignment, vibration etc. This is apart from equipment and product demanding the comfort-loading form the plant.

HUMIDIFICATION – WATER CIRCUIT:

- For humidification plant, **water Softening plant is the first priority**. This is like giving cool dry air intake to the compressor instead of hot dried stale air, as this aggravates the air compressor problems and losing energy. Frequent Water analysis is a must before putting the water to use inside the equipments so that we know the TDS, pH etc parameters of the incoming water and the used water; this will help to ascertain the scaling effects in the wetted parts of the equipments and pipe lines etc. **Rainwater harvesting done recently in industry premises definitely helped to improve the condition of existing water to reduce its hardness etc.**

* The **Sump water temperature in the spray chamber is the practical day-to-day indicator of Humidification plant efficiency versus Scaling & choking in the spray chamber.** This shows the water circuit resistance in the air washer area and its choking status & the need to clean up the air washers. Daily monitoring of sump temperature will indicate plant correct working. **Cooler the sump water temperature today compared to yesterday, more choke in the distribution at the spray chamber.**

* The pump water circuit's Pipeline strainer must be functioning in the plant. Daily we have to purge this bucket strainer bottom point for visual checking of water condition. We can provide a purge valve outside the plant, on the extended piping from the strainer to outside the plant. This purge water has to be one of daily checklist points for operator.

* **Water on-line metering is a must for the humidification plant**. This helps to assess the plant performance daily. Once the water circuit is getting choked up in the spray segment, this is shown in the reduced water intake per day and we can take early steps to rectify the same. Moreover, **"the right amount of water to be mixed up with air per hour"** as stipulated by the manufacturer is daily followed or not, this parameter can be studied. **Less water / hour consumed by the plant today compared to yesterday means Humidification efficiency is detoriating day by day for the given load.**

WATER CIRCUIT: RING MAIN VS RADIAL DISTRIBUTION:

* The existing plant **water circuit distribution thro nozzles are typical of radial System**. If we can think of Ring main distribution as recently switched over by all the Compressed air user industry from the radial distribution, we can employ similar logic to the water circuit here. For a given load, in the CA ring main system, the air can come from right side or from left side of supply and ultimately the load is starved of air supply. We could ensure the right amount of volume and pressure of air in this Ring main than the radial and as well we could reduce the header pressure; this is energy saving too.

* Similarly the pressure and flow at the Nozzle end must be constant to achieve steady humidification efficiency. So we see to it that the nozzle gets water at correct flow and pressure either from top or bottom of the raiser pipe. This reduces water circuit pressure, energy saving possible, and steady functioning of nozzle and constant efficiency.

* Let us consider the pump discharge circuit consists of one main header and four sub headers are Tee – branched off from the main header. In those horizontal sub headers, the vertical raiser has many nozzles clamped on to it. The problem is that, of the four sub headers, after few days, half of the nozzles in the given raiser pipe are choked and not working. The plant operator does not open to see daily whether all the sub headers and the corresponding nozzles working.

* Alternatively to circumvent this problem and to elongate the choking intervals in water circuit, we provide additional piping arrangement from the main header to each of the raiser pipe from the top. By this arrangement, each nozzle will get the adequate flow with pressure either from the top or bottom of the raiser piping.

* This modification is proposed to the existing humidification plants keeping in mind of the existing operating practices now prevailing. This modification brings in round the clock steady pressure to the nozzles and the existing pressure gradient ie the pressure drop comes down automatically. Here the water-air mist cone must spread, stay in the air more, with optimum breadth and length. **With this modification, the tail end nozzles neither starve & ooze piss out water; nor first sub header nozzles jet out with higher pressure.**

* We have to bear in mind that **unlike the electrical distribution wherein the load ends are active devices, which grab the energy from distribution; here the nozzles are passive load end devices in water circuit**. The nozzles are to be fed at the rated pressure and flow and this will maximize the mist efficiency.

* Thinking Macro at the breakup of T & D LOSSES for any system like Electricity, Water, Air, Gas, Fuel oil distribution in the industry, **the losses are more and varying in the distribution whereas the losses in transmission losses are fixed and relatively constant**. Hence always keep a **Frequent Lens vision on distribution circuit compared to transmission circuit and that is what a clever industry does.** Here in water circuit transmission losses account for upto the nozzles and the distribution losses start from the nozzle only

• Now the industry pumps with higher discharge pressure, more water to spray chamber in order to achieve better RH. **This leads to short circuiting of water from pump to chamber to & fro only, and the portion of humid air going inside the duct goes less only.** From the Energy saving angle, if the water pressure drop in the pump discharge circuit is minimized, then this nozzle rated pressure warrants only less power from the pump. We see to it that the discharge header pressure at the nozzle end must match the nozzle rated pressure for its maximum effciency. **This is the Focus area in the plant now.**

* The industries have circumvented this problem now to adopt less number of Bulk nozzles instead of hundred of small nozzles. Also they optimized the pump delivery to match the nozzle rated pressure. This critical change ensures uniform & constant
Distribution of whirl- water. This resulted in the changed size of air-water mist spray to dwell longer in the air throw area in the chamber. Finally the conditioned area gets quickly the RH & temperature.

  Like the change from 50 Hz ordinary choke to the 20 KHz electronic ballast, Some industries have started various nozzles, trying from 2 Kg rated nozzle to 4 Kg rated bulk nozzle or even more to 50 Kg mist nozzle to suit their requirements.

DO WE MEASURE HUMIDIFICATION PLANT EFFICIENCY?

Condition based monitoring of the plant is done from outside and it is not possible for the operator to measure the operating parameters of the plant by opening the plant frequently and daily. So we have to fix remote monitoring instruments outside the plant to monitor the operating parameters of the plant frequently (the operator need not go inside) either the instruments can be re-located outside or at least the provision and impulse piping are brought out of the plant room with end fittings for intermittent fixing & measuring of parameters.

* The plant can be measured at the water & air circuit. **The industry thought before that we need to monitor essential parameters only, that are prone to breakdown. But now to improve the efficiency of the auxiliary, the industry thinks now what else can be measured to get the maximum output from the sub systems.**

The **water pressures that can be measured in the plant are:**

- Water pump discharge pressure
- Water spray header pressure at the tail end of the last sub header.
- Hour meters for pump, fan as required to study seasonal changes in premises.

The pump discharge pressure gives an indication of the pumping status and the pumping range is within the normal limits of operation. The tail end pressure shows what is choked up pressure in the sub headers after few weeks of operation.

During commissioning the plant itself, the industry must do the trial of choking quarter, half, three quarter and full nozzles and study the pump discharge pressures readings. This helps us to compare the system pressure in the normal running of the plant.

The **air pressures that can be measured in the plant are:**

- Difference in static air pressure across the fan
- Difference in air pressure across the spray chamber
- In-situ manometers or portable manometers give us the pressure in mmWC.

The **parameters to be measured & recorded at conditioned area:**

- RH & db, wb temperature monitoring at minimum of four grids and above.
- Skin temperatures of the distribution boards, cable chambers
- False ceiling skin temperature both below; and above at the attic
- Motor rib or fin temperatures at drive and non drive end
- Equipment panels wherein electric switchgear, electronic modules are housed
- Probable area for hot spot generation as listed by the equipment manufacturer

* Skin temperatures can be measured using contact type leaf RTD sensor cum digital meter or alternatively and more conveniently using infrared gun non-contact type. **We must make special mention Infra red thermography is not thoroughly put to use by the industry for pinpointing what is Normal & Abnormal skin temp like Go NO Go gauging**. This is a very user-friendly tool and its accuracy depends on the emissivity of hot spot surface. Instead of relying on sight, hand- touch senses to measure the abnormal equipment parameters, this is a better, cheap alternative to spot the abnormalities and a very quick to scan type **We at the industry maintenance wants a tool to tell us what is wrong. Though this Heat Spy gun is slightly but consistently inaccurate, but is a very effective day-to-day handy tool to condition monitoring.**

* Pressure gauges are fixed outside the plant wall. The impulse lines to the gauges can be flexible hosing type or diaphragm type sensor gauges can be used. The range is selected to match the discharge pressure of pump along with factor of safety. This is to measure the water pressure at pump discharge and at the tail end nozzles.

- Provision can be made in the HP to measure the air circuit resistance across HP fans, filters. We can know what is the actual delta pressure in few inches water column across them during commissioning or routine cleaning maintenance schedules and we can follow the same after few months' operation.

- Humidity control inside premises can be made automatic or at least semi automatic if possible. By semi automatic means, the combination logic ie AND / OR logic of Humid stats & Ambient temperature sensing Bulb Thermostats (incidentally the sensor cum switches are available at affordable prices in R & AC market) can give visual alarm to the user and he can operate the HP fans one by one in the Multi-fan arrangement system. **Here, the user must take caution that the sensor is always force drafted and the response will be fast and accurate and repetitively reliable.**

Pumping system – savings

Parameters	**EXISTING PUMP – NEW PUMP**	
• Motor rating HP	7.5	5
• **Suction pipe mm**	**65**	**75**
• **Delivery pipe mm**	**50**	**75**
• **Piping material**	**GI**	**White PVC**
• Foot valve	local	ISI
• Discharge LPS	3.68	5.03
• Input power KW	6.18	4.35
• Increase in discharge	--	36.7 %
• Input power reduction	29.66 %	--
• Saving in Energy		48.44 %

- Above listed are the possibilities mentioned in the existing pumps as found in PCRA bulletins. **The Indian farmer has switched over from GI piping to Rigid PVC piping**. Here too, when we switch over, the friction losses reduce, consequently the pressure drop is reduced. The line sizes are matched to pump system curve so that the high discharge pressure as well the heavy pressure drop at the tail end is avoided.

HUMIDIFICATION – ELECTRICAL:

END-OF-LINE CAPACITOR:

End-of-line capacitor in the electrical distribution network especially at the tail end loads helps immensely in the motor efficiency indirectly. This is similar to the end-of-line Receiver in the Compressed air system in the plant. Likewise in the plant safety circuits especially in the Fire & Gas system circuits End-of-line Resistor is a must for the fail-safe functioning of the electrical loop & continuity circuit. **Thus End-of-line Capacitor / Resistor / Receiver concepts are gaining much importance in the energy conservation aspects because they pay us back early and quickly & often indirectly.**

* Typical of any industry the Humidification plant 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. **Spot capacitor @ motor terminals inside HP premises is more important & this aspect is often neglected in many units.**

CONCLUSION:

The industry must give importance to the Humidification Auxiliary right from purchase of good quality plant and user-friendly maintenance schedules. Here the industry needs to rope in the Manufacturer even after the supply & warranty of the plant. **The industry & the vendor have to work as a team to sustain & improve energy efficiency of the plant.** We have to frequently ask the manufacturer what best can be done on his equipment often to improve the plant efficiency. **This is not only for humid plant but for other equipments too; the industry has to co-ordinate with their existing vendor to improve upon the product's energy efficiency**. Now many clever members of industry understand **that Humidification is a Tool to improve the productivity. This utility is under our control, the parameters are defined and they point to the user, road to better productivity.**

* To sustain in the industry segment, we have to think in terms of **Motivation of the Man first and Lubrication of machine next**. On the contrary, we try to motivate the machine ie overload the same first, and lubricate the men ie compensate them next. The priority is now changing. And it is welcoming trend too.

* In the field of medicine, the elders say practically, **"Shake the bottle before use and shake the body after use for better results".** The same concept is applied to the industry that Humidification is like medicine to the industry. Instead of running the plant constantly it is better to run the plant, practically based on the feedback parameters from the premises.

* Now the industry is aspiring to go in for Variable Speed Drive for fans and the same will function on the basis of MP based automation of premises' parameters. **One humble thinking now is that First and foremost perquisite for the plant is to Healthy Running of plant in Air & water circuits. Then we have to think of Fine-tuning of process parameters, and later retrofitting of energy saving gadgets to the process will definitely achieve better results in the overall plant productivity.**

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