Managing Ionizers :

Maintenance & Monitoring

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Abstract

This article serves to provide an insight into the management of ionizers, ie, how to derive the best performance from the ionizers by establishing a maintenance program and using software and / or feedback controllers and sensors to enhance the maintenance regime by providing predictive maintenance information, ensuring that the ionizers get serviced when they need to while confidently maintaining optimal performance of the ionizers .

How to establish a maintenance program ?

All ionizers (with the exception of nuclear type ionizers) require maintenance – there are no "maintenance free" corona ionizers . Basically the emitter points of the ionizer needs to be cleaned with electronic grade IPA and foam/polyester swabs or available small emitter point cleaning capsules that fit snugly into the emitter point holders to clean effectively. The frequency of cleaning of the ionizers depend on the following factors :

a. the type of ionizer (blower type, bar type with air assist – CDA, N2, ceiling emitter etc)
b. the working environment (cleanroom, non-cleanroom, presence of chemicals or solvents in working environment etc)
c. the type of manufacturing process being carried out within the facility (eg wafer fab, disk drive, flat panel, general electronics servicing etc)
d. the presence of AMCs (Airborne Molecular Contaminants) in the environment as these will settle on the emitter points as "fuzzballs" due to the gas to particle chemical reactions that occur at the tips . The presence of AMCs depends on the air treatment in the environment – for eg in cleanrooms this is a direct consequence of the treatment of fresh air as it enters into the HVAC / ventilation system .

The maintenance frequency should take into account not only the frequency of cleaning of the ionizers but the re-adjustment / re-calibration frequency as well .

As emitter points get dirty, a whitish substance forms on the emitter points (nitrides etc) and this is clearly visible via the naked eye . For recently installed ionizers, work out a sampling plan as not all ionizers need to be checked (a good indicator will be to check at least 25% of the ionizers) . Start off with a weekly inspection of the ionizers in all areas as some areas might require more frequent maintenance (ie, cleaning of emitter points) . At the same time check & record the offset voltage (balance or swing voltage) of the ionizer using a charged plate monitor or a hand held equivalent . There are 4 possible scenarios as follows (refer to Fig 1) :

a. Emitter points clean and offset voltage within specifications – this is the ideal case and the ionizer will still continue to perform well .
b. Emitter points dirty but offset voltage within specifications – in this case though the emitter points are already visually dirty the ionizer is still within balance. This will be the point where the ionizer will have to be cleaned but not calibrated . Once established, the cleaning frequency will have to be implemented first while continuing

with the establishment of the re-calibration frequency. This could be done everytime the ionizer is cleaned to ensure that the task does not become too cumbersome.

c. Emitter points clean but offset voltage out of specifications – this is an exceptional case where the ionizer might not have been balanced ideally during the initial set up, it is a poorly designed ionizer or a possibly faulty ionizer – this has to be verified .

Emitter points dirty and offset voltage out of specifications – this will be the cut off point where the ionizer will have to be cleaned as well as calibrated . For some applications this might not happen until 3 to 6 months later . So the cleaning frequency will be established first while this re-calibration frequency continues to be ascertained everytime the cleaning is carried out . Again, while establishing this recalibration frequency – a sampling of at least 25% of the ionizers need to be done at all the different process areas (eg : in semiconductor front end applications the different process areas like Reticle/Mask area, Lithography, Diffusion, Implant, CMP etc, all need to be assessed differently and might have different frequencies) .

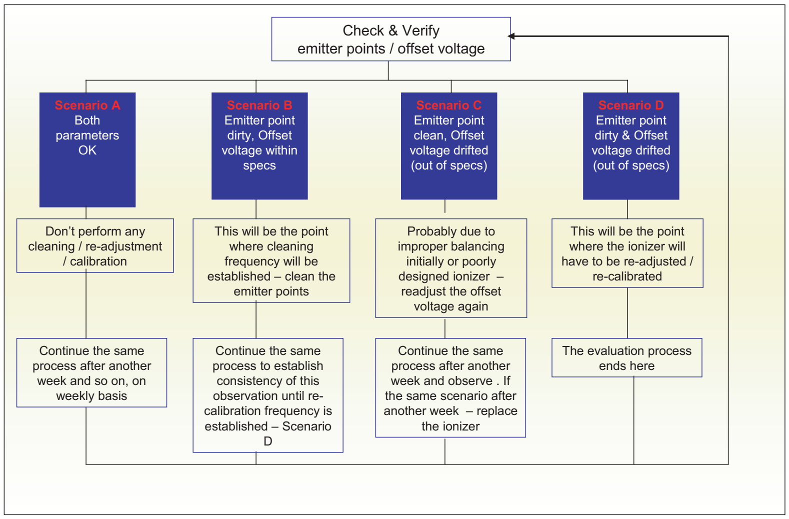

Fig 1 : Establishing Frequency of Maintenance of Ionizers

How do you define that the emitter point is dirty ? This has to be established before you start on the evaluation process to establish the maintenance frequency and is not an easy call . There are pictures available that will help you to establish the point at which the emitter points can be classified as dirty . Alternatively the materials lab or the Quality control personnel could be approached to define the "dirty" level . The easiest way is to off course classify the points as dirty the moment one sees white deposits on the points .

After completion, document the cleaning / re-calibration frequency for each process area or location .

The emitter points of ionizers will degrade over time and the efficiency of the ionizer drops off, resulting in more frequent cleaning and calibration . It is advisable therefore to repeat this evaluation process after one year to establish whether a more frequent cleaning / calibration of the ionizers is required . Alternatively the emitter points could be replaced if the cleaning frequency is found to be to short after a year . Most emitter points can last for about 2 years before they show signs of deterioration and cause a more frequent drifting of the offset voltage of the ionizer . Off course, in processes where tight balance control is required, yearly replacement of emitter points is encouraged .

Monitoring of Ionizers

To get the best performance out of the ionizers, it is important that the ionizers not only be appropriately maintained as discussed in the previous section, but also to ensure that the balance (or offset voltage) drift from ionizers be kept in check . For any corona type ionizer, there will always be some fluctuations or offset voltage drift that needs to be addressed. Typically the ion imbalance occurs due to (but not limited) to the following parameters :

a. Airflow fluctuations
b. Environmental conditions like temperature / RH
c. Introduction of charged objects into the vicinity of the ionizer
d. Design of the internal driving mechanisms of the ionizer like control board and high voltage power supplies

It is therefore important to ensure that the voltage drift stays within specifications. This can be essentially achieved through the use of appropriate software and / or feedback sensors (or controllers) .

Feedback sensors / Controllers

There are feedback sensors and/or controllers available that can be used to connect up to ionizers to form a continuous closed loop feedback & control or ionization sensors that just continuously monitor the ionization voltage / decay times only (without feedback to ionizer) and then alert the user when the ionizer has exceeded the alarm thresholds. These can be classified into two categories as follows :

a. Ionization Feedback sensors cum controllers

These type of feedback sensors are located directly below the ionizer (within the effective coverage of the ionizer) and can be directly connected and powered by the ionizer or the ionizer's controller to provide continuous feedback control and adjustment of the ionization levels at the worksurface . These are used mainly in critical applications to control steady state DC ionizing blowers, where the balance voltage needs to be tightly controlled to 1V (in such environments even slight voltage imbalances from the ionizers are a cause for concern) – refer to Figure 2 . There are also feedback sensors / controllers available that can control steady state DC or pulsed DC ionizers (without blowers) in tools or mini-environments . Such sensors are correlated to a charged plate monitor (CPM) and then connected to either the ionizer or in most cases to the ionizer controller – refer to Figure 3 . The ionizer controller is then connected to an appropriate software for continuous monitoring and adjustment or alternatively can be hooked up to the tool's operating software . The ionization sensor will sense the ionization voltage and then send a signal to the controller and via the software necessary adjustments will be made to increase or decrease the rate of production of positive or negative ions to ensure very close to equal swing voltages . For such an application, the sensor need not be located directly below the ionizer but somewhere in the vicinity of the tool and should be correlated to a CPM during initial set up .

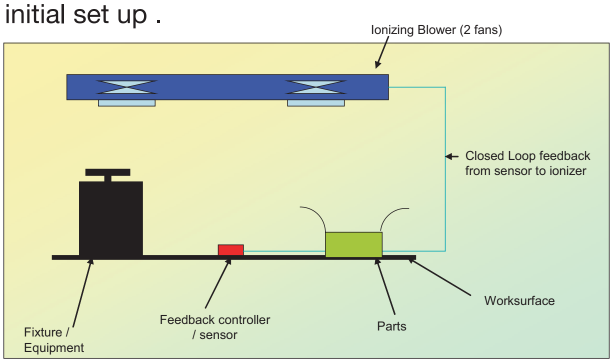

Fig 2 : Schematic of Closed Loop Feedback - sensor connected directly to and powered by the overhead ionizing blower

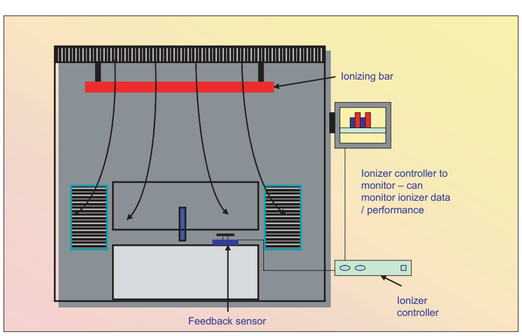

Fig 3 : Schematic of Closed Loop Feedback in an ionized minienvironment - sensor connected directly to an ionizer controller with output (via software) to a monitor displaying ionizer data / performance

b. Ionization monitoring sensors (no feedback)

Such ionization sensors work in a similar fashion to charged plate monitors and are small enough (about 37.5 sq cm or 6 sq in, in area) to be installed within the effective ionization coverage area of the tool or workstation and can continuously monitor the balance or swing voltage and decay times of ionizers – be these alpha-type nuclear ionizers, AC ionizers, steady state DC or pulsed DC ionizers . Such sensors typically come with necessary LED display of the actual offset voltage (or swing voltages) and decay times on the small sized unit itself or on a display unit, remote from the sensor . However, these kind of sensors just monitor the offset or balance voltage and decay times but do not control the ionization levels as there is no feedback loop . At least with such monitoring devices, the ionization levels are continually monitored and when the set parameters are exceeded, the ionization sensor or monitor goes into alarm mode thereby alerting the user that the ionizer needs to be either maintained or checked . There are sensors available that can be interfaced to trigger external alarms (like tower lights) or connected to the tool's internal software to alert the user or down the tool altogether . Refer to figure 4 .

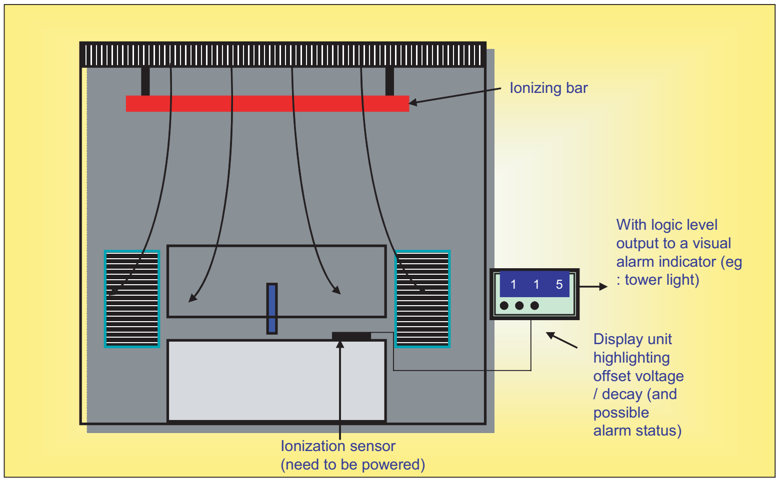

Fig 4 : Schematic of Ionization sensor connected to an external display unit while monitoring the ionization parameters in a minienvironment

Selection of appropriate sensor

The sensor that needs to be selected has to be small enough to fit within the work area or tools, should not react to static fields within close proximity (as this might send the wrong signal to the ionizer causing the ionizer to readjust unnecessarily) and should be able to have some form of connectivity or logic level output to an external alarm mechanism, an external LCD display of offset balance / decay time indications or to a data acquisition software (or real time monitoring software) so that continuous monitoring can be done .

Correlation with a regular CPM

Most of these commercially available sensors are small in size with a sensing plate of between 6.25 to 37.5 sq cm (1 sq in to 6 sq in) . When correlating to a regular charged plate monitor that comes with a 15cm by 15cm (6" x 6") plate, the sensor needs to be placed within this 15cm x 15cm square grid and several readings taken within this square area to arrive at an average value for comparison with a regular charged plate monitor – refer to Figure 5 . This is because the charged plate monitor actually averages the readings across the 15cm by 15cm area . The sensor actually gives a more accurate point reading as compared to a charged plate monitor . Once sensors are implemented there is no necessity to use the regular charged plate monitors anymore, as the necessary parameters can be easily read off these ionization sensors .

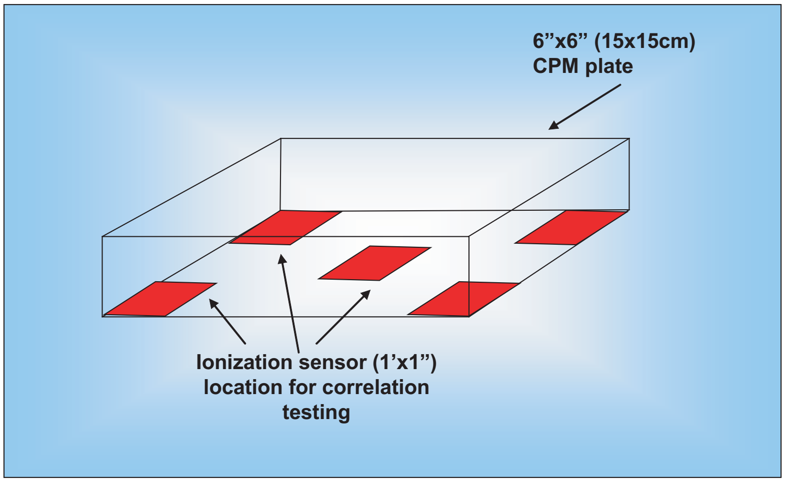

Fig 5 : Proposed correlation between Ionization sensor vs regular CPM plate

Data Acquisition (Monitoring) software

In the past, when dealing with larger geometry sizes and higher damage thresholds perhaps the monitoring of ionizers was not required nor expected . Now in an ever changing sophisticated (automated) manufacturing environment, where device sizes are diminishing with lower and lower ESD damage thresholds, monitoring of ionizers becomes an important and key consideration factor . Just like particle counts in a cleanroom environment need to be monitored continuously via strategically located particle sensors , it is becoming important to continuously monitor the ionization parameters as well . There are two ways in which this can be done :

a. Monitoring of ionizers via ionization controllers

Currently software is available that connects to the ionization controllers (via RJ45 etc) and monitors the alarm or functional status of all ionizers connected to the respective controllers. This kind of monitoring software gives real time feedback on the status of the ionizers and some even allow the end user to be notified in case of alarms and allow easy changing of ionization parameters like output settings, ionization production times, cycles times etc – refer to Figure 6 . Additionally ionization sensors can also be interfaced into the same system (and software) such that the end user has information on not only the ionization status and parameters but also the actual offset voltage and decay readings at various locations within the fab . For this to happen the ionization sensors need to have the relevant output connectivity (4-20mA or 0 to 5V output or something similar) .

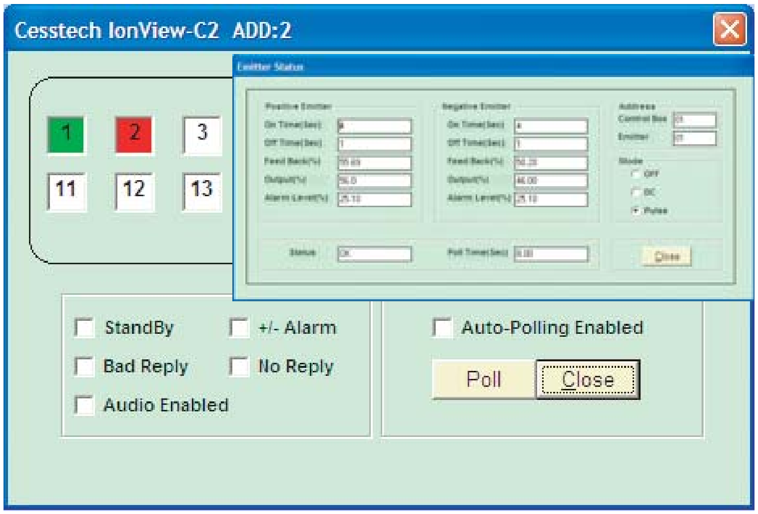

Fig 6 : Screen shot of an ionization software that shows continuous real time settings / status of ionizers

b. Monitoring of ionizers via ionization sensors

If the ionization system installed does not permit interfacing with a known monitoring or data acquisition software then ionization sensors can be used to monitor the performance of the ionizers by continuously giving feedback on these two parameters and alarming if any of the limits are exceeded . Some sensors can give relevant output with actual offset voltage / decay time data but some sensors only have a logic level output and just indicate whether the limits have been exceeded .

Either way, it is essential to continuously monitor the status of the ionizers so that any alarming ionizer can be promptly addressed and the situation rectified . Most ionizers will alarm when these go grossly out of balance due to lack of maintenance or when the high voltage power supplies within the ionizers fail . Besides allowing the maintenance personnel to be paged in case of excursions, some of these monitoring software also allow the regular printing of reports so that a hard copy of the actual data and performance of the ionizers / and/or ionization sensors can be filed for reference by internal or external auditors .

Conclusion

Proper maintenance of the ionizers is a “must” to ensure optimal performance – it is not an option . It is important to ensure that a rigorous maintenance program is drawn up and then diligently followed . Additionally, monitoring of ionization via sensors / controllers is ideal and ensures that your work area or process is receiving adequate ionization as the sensor helps to not only monitor the twin parameters of offset (or swing/balance) voltages and decay times but also alerts the users when the emitter points get too dirty, causing the offset voltage to drift . For critical locations, it is advisable to have a closed loop feedback between the ionization sensor and the ionizer such that the ionizer is continuously balanced even as the emitter points get dirty . And to top it up, all the ionizers and the sensors or controllers can be interfaced to a continuous monitoring software that immediately alerts the users when any preset limits have been exceeded .

Editor’s Note :

Inderjit Singh is presently a Director with Cesstech (S) Pte Ltd which is a provider of microcontamination and ESD solutions for ultra clean environments and processes including third party cleanroom and contamination control testing and ESDC surveys, audits & testing .

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