Ozone & Dialysis Water

The usage of ozone in water treatment has been governed by what is happening in the US. Though Ozone has been wide spread in Europe, US had been pretty slow in its adoption only due to the fact that the USFDA had not listed Ozone as a safe disinfectant- until recently. The moment The Food and Drug Administration has listed ozone as "Generally Recognized As Safe" (GRAS) for both potable and bottled water , the usage in US has multiplied leaps and bounds. Now nearly all bottled water produced in the U.S. is Ozonated as it is bottled so as to disinfect both the water and bottle. The Environmental Protection Agency has been reviewing and updating its requirements for disinfecting drinking water and for permissible levels of residuals. As a result, ozone is quickly becoming more popular.

Currently the most popular method was to have a large RO system that will directly supply to the Dialysis unit. This was considered as safe and probably the only economical method of Dialysis water production The use of storage tanks can eliminate the problem of maintaining proper sanitation in the storage tanks through the application Ozone disinfection. Apart from producing safe, economical water benefits will include low consumption of incoming water and the low power usage needed for the much smaller RO units. Safety of the product water can be demonstrated with no growth, as well as endotoxin measurements of <0.5 EU/ml.

Today there are many dialysis water supply systems in the US are disinfected exclusively through the use of ozone. The use of ozone gained particular Importance due to the fact that maintaining a clean RO system is particularly very difficult In addition water treatment experts have always been troubled by water containing high levels of organic materials .Ozone has provided them with lasting solutions.

The primary objective of the of a good dialysis water supply system is to be risk-free to the patient as humanly possible. A good system must achieve the goal of costs containing and achieving standards of Microbial and Endotoxins levels.

In the normal Dialysis process the design and operational factors were the only consideration The cost of reverse osmosis (RO) product water being discarded to drain being one RO water is discarded is particularly high.

With the use of ozone RO product water produced can collected in holding tanks. A one-day storage capacity with a recirculating loop supply system would minimize the product water costs while providing the necessary operating capacity The control of microbial activity and endotoxins is the primary safety concern with a water storage system of this type, and the dangers inherent in using fluid chemicals for disinfection purposes have made the use of storage tanks unacceptable earlier .

Considerable research data are available showing the overwhelming ability of ozone to act as a bactericide, virucide, and a cyst inactivator, with the additional ability to reduce endotoxic materials by oxidation to harm-less carbon dioxide and water.

Various comparisons of disinfectants have shown ozone to be many times more effective than chlorine, chlorine dioxide, or chloramines in the treatment of drinking water, based on concentration Ozone is an unstable gas with a very short life, less than 12 hours in the gaseous state and less than 30 minutes in an aqueous solution. Ozone decomposes back into molecular oxygen . Apart from its bactericidal and veridical properties, Ozone has found to remove many contaminants that are present in water including compounds of phenol, pesticides that are often present is water. Ozone has been a. solution for removal of many of these contaminants as part of the water pretreatment process in water treatment plants all over the World. In addition the use of ozone was found to Ozone to reactivate charcoal used in filtration beds. All of the data indicated that ozone would be safe, effective, and cost effective for use in treating dialysis water.

Designing the System

Through the use of ozone, the safety requirement of having to rinse out the water treatment system to remove all traces of the chemicals commonly used to disinfect the dialysis water is completely eliminated. To ensure the complete removal of ozone, Ozone input is discontinued a minimum of one hour before start up of the dialysis water circulation. Additionally, all dialysis water must first pass through an ultraviolet (UV) light unit sized at double capacity to our flow (for germicidal efficiency). The radiant energy of the UV lamp causes the almost instantaneous breakdown of the ozone back to molecular oxygen. The dialysis machine itself de - aerates the water as one of its primary functions.

Care must be taken that Inadvertent input of ozone into the system is prevented by a interlocking electrical devise we can have either dialysis water circulation or Ozonation, but not both. The ozone injectors are selected in such a way that it operates at a higher differential pressure that the pressure of water in the recalculation loop. That means we have to ensure that the differential pressure required for the working of the injector is always never met. Even if the ozone pump was to be started in error, no ozone could be drawn into the loop through the injector

Compatibility of the materials used in the RO system. The present regulations and recommended standards for materials acceptable for the dialysis water supply system are, for the most part, Quite compatible with ozone. All ozone contact parts are to be of SS 316L, The ozone injectors are to be either SS or natural Kynar (approved by USFDA)

UV as a Back Up Disinfecting System

A backup disinfection has to be provided by passing all incoming water through a UV disinfection unit; all of the water entering the recirculating loop would also be subjected to an additional UV treatment.

Ozone Start up

A QA protocol has to be developed that will test and verify the effectiveness and sterility of each Component and system prior to going online with ozone.. Water analyses has to be conducted and bacteriological culture samples taken at locations both before and after each system component. Chlorine should be used during the construction phase to disinfect the tanks and loop piping .The sections of piping that show positive cultures have to be again disinfected with chlorine this time using a longer contact time —to eliminate the problem.

Before using ozone as the exclusive disinfectant. the entire water distribution system has to be been maintained in a no-growth Condition .All loop water flow will be through a UV unit before reentering the storage tanks. This UV unit will serve as the final treatment for all RO product water before it entered the tanks The residual ozone in the water will be removed . Be-cause of this, initially there may be problems minor microbial activity in the storage tanks.

To handle this problem a bypass line in the ozone supply sys-tem can be made to feed part of the flow directly into the storage tanks during the Ozonation cycle.

Two Pass RO Unit: The RO units are controlled by dual float control switches during normal operation, which also control the in-coming (Product) water after UV disinfection unit. It should be preferable a two pass system. The first RO unit should start with minimum draw down, while the Second unit should starts after the storage water is drawn down to approximately one-half of its capacity. Both these units are to be rotated monthly to equalize hours of use on each;
This rotation is done after the monthly cleaning of the membranes. All maintenance schedules and records are based on hours of service, even though most maintenance is scheduled on a monthly cycle.

The storage tanks were installed and connected in series. The dialysis water supply sys-tem is a recirculating loop; all water entering the loop is passed through a UV disinfection unit and then through a dual 20½, 0.1 micron ultrafilter set. The circulating pump draws from the first tank, and the loop return discharges into the last tank; thus, all water is circulated.
Two main circulating pumps used One is used primarily for water circulation, the other as the Ozonation circulation pump. The pumps can be made interchangeable via flexible tubing with unions. Pumps are to be of SS 316 with ozone resistant parts such as viton seals & pressure gauges

The Ozonation system is basically a side loop to the main recirculating loop. Ozone is drawn into the system via an hydro injector and then into a length of 2½ multiple U tube piping for a thorough mixing before discharging into the water supply loop. Back flow preventors are installed in the loop piping. Maximum ozone injection is controlled by a injector by pass valve. An ORP monitor can be used to monitor the relative level of ozone in the loop water. This is a relatively economical method than using Ozone in Water monitors that are very expensive.

The Ozone generator should use Oxygen as feed gas. Air, as feed gas must be avoided.

Training & Control of operations: Extensive training are to be imparted to the employees . It should include start up, shut down procedures , recording the various meters and gauge reading; If the readings are within the set parameters listed on a control sheet, the sys-tem is in the correct mode and operating normally. In-depth monitoring of the entire system and structured routine maintenance is mandatory.

Chemicals Recommended: Among the only fluid chemicals now used, on a limited basis, any-where in the water systems will be bleach per water conditioner brine tank once a month, followed by a forced recharge of the conditioner during the clinics' off hours. The other fluid chemicals used are 20% citric acid with a minimal amount of ammonia, added as a trace chemical, for the monthly cleaning of the RO membranes. This membrane cleaning is performed during the off hours, and all cleaning water and solutions are directed to drain.

Ozone should not be used for dialysis membrane sanitation. This is due to the fact that Ozone is extremely reactive to the RO membranes. Ozonation, however can be used to sanitize RO machine's entire fluid pathways provided the manufacturer of the dialysis machines use parts that are compatible to ozone. Ozone can also be used to sanitize the incoming water line. Using Ozonated water as an alternative to bleach for disinfecting/cleaning our dialysate concentrate containers.

References

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