

Points to Consider When Purchasing an Ozone Generator

In an effort to guide all buyers of ozone generators in purchasing the right ozone generator; to suit their requirement; and to stop the propagation of misleading information that many cheap vendors are providing in order to make quick sales, we have hereby come up with a checklist; so that every buyer considers the following parameters and asks for such clarifications from any ozone generator vendor before making a purchase.

The main essence of an ozone generator's performance lies in the **concentration with which it produces ozone. It is called as '% wt/wt concentration'**. One often comes across vendors **specifying the ozone concentration as say X g/Nm3.**

What does that mean?

Ozone generators produced all around the globe; be it air-cooled or water-cooled; rely on the following chart:

Ozone In Oxygen

| Gram of Ozone/ Nm3 of Oxygen | %wt/wt | %wt/wt | Gram of Ozone/Nm3 of Oxygen |
|---------------------------------|--------|--------|-----------------------------------|
| 10 | 0.70 | 1 | 14.3 |
| 20 | 1.39 | 2 | 28.8 |
| 30 | 2.08 | 3 | 43.3 |
| 40 | 2.77 | 4 | 57.9 |
| 50 | 3.46 | 5 | 72.7 |
| 60 | 4.14 | 6 | 87.5 |
| 70 | 4.82 | 7 | 102.4 |
| 80 | 5.50 | 8 | 117.5 |
| 90 | 6.17 | 9 | 132.6 |
| 100 | 6.84 | 10 | 147.8 |

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For Example,

Say you require an Oxygen Fed Ozone Generator of 50 gram/hour (Air Cooled).

The next thing you must know or ask from an ozone generator vendor is % wt/wt concentration.

Once you know the %wt/wt concentration, say 4% in Air Cooled system.

Refer to this chart, in our case, it says '57.9 g of ozone/Nm³ of Oxygen', this means that if you feed 1 m³ of oxygen into the ozone generator, 57.9 gms of ozone shall be produced.

Therefore, to produce 50 gram of ozone per hour, 0.86 m³ of oxygen per hour shall be required.

Converting m³/hr to lpm, the requirement comes out to be **14.32 lpm of oxygen**.

Now you can check for yourself, if the vendor has provided you the minimum oxygen requirement.

Hence, even you can now calculate the oxygen required for generating any capacity of ozone generator just by confirming the %wt/wt concentration.

Commercial Ozone Generators are mainly classified by the feed gas which is fed:

1) Dry Air Fed-

Such ozone generators utilize dry compressed air to produce ozone, the wt/wt ozone concentration attained in dry air fed ozone generator is around 1-3% (i.e. 12.8g of O₃ per m³ of 'air' to 38.4g of O₃ per m³ of 'air'.)

2) PSA/VPSA Oxygen Fed-

Such ozone generators produce ozone when fed with oxygen. The method of oxygen production can be PSA (Pressure Swing Adsorption) or VPSA (Vacuum Pressure Swing Adsorption) based. The wt/wt ozone concentration attained in such cases varies from 4-10 % (i.e. 14.3g of O₃ per m³ of 'oxygen' to 147.8 g of O₃ per m³ of 'oxygen'.) Depending on the working conditions i.e. if the ozone generator is water-cooled or air-cooled, the % wt/wt ozone concentrations change.

3) Purchased LOX

In very large ozone generators, the use of LOX (Liquid Oxygen) is also observed. A typical LOX system comprises of cryogenic storage tank, ambient vaporizer and nitrogen injection system.

The % wt/wt ozone concentration achieved ranges from 10-13 %.

In most parts of India, the ozone generator manufacturers are promoting the sale of ozone generators even up to 300+ grams per hour based on the combinations of medical oxygen concentrators. The oxygen purity attained in such concentrators is usually around 89-92 % for 5 LPM, 10 LPM or 20 LPM oxygen concentrator. However, the problem with such oxygen concentrators is that when it comes to heavy duty or long operational hours, the performance of the oxygen concentrators slowly starts to drop; and in such conditions the oxygen purity might even drop to 89% which eventually drops the

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concentration of ozone production. Hence, for large scale ozone generators (say 100 gram and above), one should always go for a proper oxygen generating plant and not rely on oxygen concentrators.

| Sr. No. | Particulars | Remarks | Has the vendor shared the information with you? |
|---------|--|---|---|
| 1 | At what wt/wt % is the ozone generator producing ozone? | <p>Most of the ozone generator manufacturers make claims of producing ozone at 1-14 % concentration. A smart buyer however needs to analyze what will be the right wt/wt% of ozone concentration for their requirement. The solubility of ozone in any solution follows Henry's law which means to say that higher the concentration of ozone in a gas mixture, more will be its solubility in water. Hence, it is highly recommended to inquire about the wt/wt% of ozone produced from the feed gas. Also, the method of calculating the concentration of ozone produced should be shared with the vendor and kept transparent.</p> | YES/NO |
| 2 | What is the procedure for measuring the concentration of ozone gas produced? | <p>It is often seen that the buyer requests for quote for an ozone generator producing say X 'g/hr' ozone. A manufactures might show you the flow rate of the gas coming out saying we are producing X g/hr ozone as claimed. A smart buyer however needs to know the way of measuring the ozone output. BMT 964 Ozone analyzer is a German manufactured analyzer which works on the principle of UV adsorption and tells you the gram of ozone produced per cubic meter of feed gas.</p>  <p>Please follow the link for more details www.bmt-berlin.de/category/products/ozone-measurement/ to know more about the product. The reading which is given by the analyzer is in 'g/m³'. There's a stand reference chart which then needs to be referred to ascertain the wt/wt % concentration of ozone gas produced. As discussed above, concentration of ozone gas produced becomes a crucial factor whenever you are purchasing an ozone generator and the buyer must always ensure the production concentration by such instruments. If there's any shortage in the production of ozone, the desired results might not be achieved.</p> | YES/NO |

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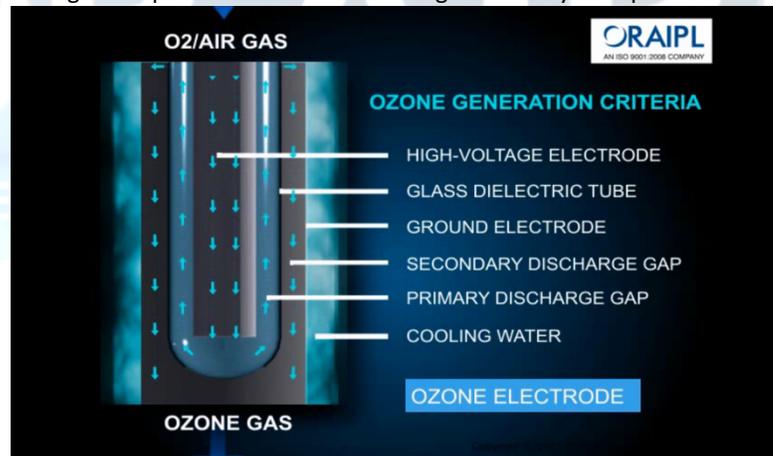
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|---|---|--|--------|
| 3 | AIR COOLED or WATER COOLED | <p>Air Cooled Ozone Generators are usually cheaper than the water cooled ones since they don't require an additional requirement of Chiller etc. However, a smart buyer must know that most air cooled ozone generators in the market produce ozone at concentrations 1-3 % wt/wt. This means that such ozone generators will require a bigger feed gas preparation unit and as discussed in section one; ozone's solubility in water as per Henry's law will be less as low concentration ozone is being produced by air cooled ozone generators. Due to poor solubility 80-90 % of this ozone will be off-gas and needs to be destructed to comply with the environmental norms (This fact is rarely shared with the end users). Many ozone generator manufacturing companies get away by selling their air cooled systems cheap not realizing the consequences it will create for the client in future who will be ultimately blaming the ozone technology rather than the manufacturers who misused the lack of knowledge of the masses about ozone.</p> | YES/NO |
| 4 | Feed Gas Preparation(Dry-Air Fed/ Oxygen-Fed) | <ol style="list-style-type: none"> 1. In feed gas preparation, the buyer must know whether the ozone gas will be produced from dry air as feed or oxygen or LOX. 2. When dry air feed gas is considered, the buyer should be informed what the dew point will be achieved in the process. 3. When going for oxygen fed systems, a buyer must know the oxygen purity (Recommended 90 %) attained and also the dew point (Recommended -40 deg Celsius). 4. What will be the type of compressor used- Reciprocating or Rotary Screw? 5. Whether it will be lubricating or non-lubricating- (Non-Lubricated Compressors are preferred) 6. What will be the method of generating oxygen-cryogenic or PSA (Pressure Swing Adsorption) or VPSA (Vacuum Pressure Swing Adsorption)? What shall be the power consumption for both? 7. In a large scale-setup, what kinds of intermittent pre and post filters shall be provided for air purification? 8. What instruments shall be provided to measure oxygen purity and dew point? | YES/NO |
| 5 | Ozone Generator Specifications | <p>The basic principle of ozone generation is corona discharge. Reliable electro module standards have to be followed in generating ozone. The ozone generator module is fabricated as a stainless steel cylinder, holding several smaller stainless steel tubes, welded through a plate at the top & bottom. This particular cylinder serves as a ground electrode in an electrical field whereas an inserted hollow steel rod serves as the high voltage electrode. The entire cylinder can be considered as a heat exchanger when cooling water removes the excess energy as heat-energy, which is not being used in ozone generation. The positioning of the specialty glass tube, closed at the bottom between the two electrodes serves as a dielectric, & allows a narrow annular discharge column.</p> <p>The feed gas to be ozonated crosses the ozoniser through the annular thin spaces between the dielectric tubes as well the space between the high voltage electrodes & dielectrics. The HV- electrodes are maintained</p> | YES/NO |

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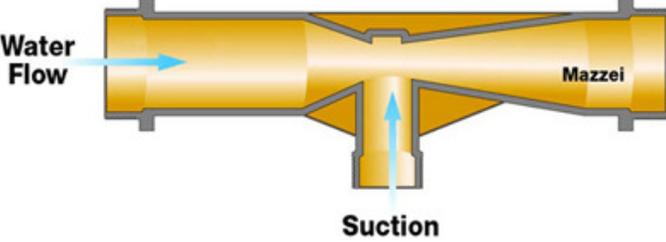
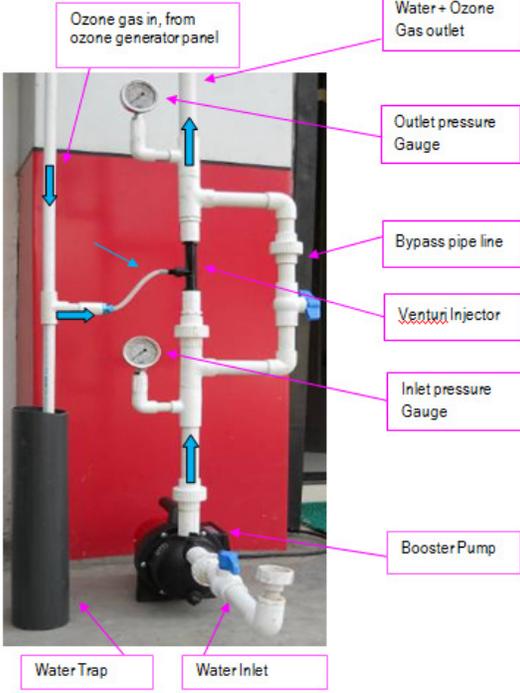
at high voltage, and the vessel is connected to earth. The high electric field in the two annular spaces produces in a silent electrical discharge (cold plasma) the corona. A part of the electric energy necessary for this ozone generation is transformed into heat. This heat is removed by the cooling water passing through the vessel. When high voltage is applied to the electrodes, a silent electrical discharge takes place in the annular column. This causes the generation of ozone through impact ionization & the combination when air or oxygen flows through the module. A mixture of O₂/O₃ with a specific concentration leaves the generator modules.

The ozone production can be varied by changing either the secondary voltage or the frequency of the electrical power. The electrical control circuit for the high voltage regulation & all peripheral installation & their power supply are integrated into a common low voltage control unit. It contains all necessary switches, control, measurements, safety & signal installations.

This is the basic principle of ozone generation. Ozone Generator manufacturers however, need to use the highest quality of materials to ensure continuous production of ozone with very less maintenance. The MOC of dielectrics, ground electrode and High Voltage electrode especially needs to be looked into. As the expected life of an ozone generator for a buyer is 15+ years. Hence, a smart buyer must go through the specifications of the ozone generator system provided.



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| 6 | Ozone Injection System | <p>It is but natural that any normal buyer would satisfy himself just after getting a good price for the ozone generator; however; he/she must treat the proposed ozone dosing system as important as the ozone generator. The ozone dosing system usually comprises of a Venturi Injector and a Booster Pump (unless case specific). Although the procurement of these items seems easy, a smart buyer should always inquire about the inlet and outlet pressure required for proper suction of the proposed amount of ozone.</p>  <p>Whether the size of the venturi injector matches the amount of dissolution you require in the stream. Also, one must check the motive flow rate of the booster pump required to ensure proper dosing and suction of ozone as per the venturi selected. Also, the material of construction of the Venturi and Booster pump need to confirmed.</p> | YES/NO |
| 7 | Ozone Safety Features | <p>High Voltage Protection, Low Voltage Protection, Short Circuit Protection, Over current Protection, Door Interlock, Over Temperature Interlock, Flap Trap Arrangement or safety valves to protect ozone electrode from improper suction or to prevent any backflow.</p>  <p>OZONE INJECTION SYSTEM</p> <p>Ozone Leak Detector: Considering safety norms, all large scale ozone generators must be purchased with ozone leak detectors. The ozone</p> | YES/NO |

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| | | <p>leak detector immediately shuts down the system as soon as it detects ozone concentration above a certain limit.</p> | |
| 8 | Ozone Electrode Cooling Arrangement | The cooling water flow and temperature must be known for proper cooling of the electrode which ensures longer operational time. | YES/NO |
| 9 | Power Consumption | In quest for low power consuming ozone generators, some ozone generator manufacturers don't reveal the detailed breakup of the power consumption. Also, single phase power supply drives more current than three phase power supply in large units. A Smart buyer must know that in an ozone generator system, power will be consumed by the ozone generator, feed gas preparation unit, booster pump, chiller, chilling pump etc. Never fall in the trap of just going by the low power consumption unless they have mentioned the detailed power consumption of the auxiliaries as well. | YES/NO |
| 10 | After Sales Service | The buyer must have a detailed conversation regarding how the ozone generator manufacturer will be providing his services. Ozone Generators do require periodic maintenance in terms of electrode cleaning etc. | YES/NO |
| 11 | How long they have been in business and their credentials? | If they haven't been in business for at least 10 years then it is risky to purchase from them unless the equipment comes from a reputable ozone supplier, there is a very good chance that they will go out of business before they reach 5 years and then you will have trouble getting support or replacement parts. Remember, it is a well known fact that most small businesses do not last 5 years. The credentials given by the vendor need to be checked and verified by the purchase department. | YES/NO |