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5-Minute Ozone Sizing

"Five quick rules of thumb to get a 'ballpark size' for your next ozone project."

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A week seldom goes by when we don't get a dozen questions concerning ozone system sizing or pricing. Fortunately, its fairly easy to develop a 'ballpark' size estimate with just a minimum of information. Although this method isn't intended for making a purchase decision, it is certainly sufficient to help determine if ozone is a potential fit for your next project. Provided below are five quick rules of thumb to help 'ballpark' the size of a given ozone system.

TIP #1 - Ballpark Ozone Dosing

Caveat Emptor: Given the complexity of the chemistry of ozone in water and the vast array of possible applications, it is absolutely impossible to provide a definitive set of rules for treatment. That being said, below are some extremely rough guidelines to estimate an ozone dose for the four most common applications.

APPLICATION	BALLPARK OZONE DOSE
Drinking Water Disinfection (only)	1-2 mg/l
Drinking Water TOC Removal	1-4 mg/l | *Use higher values if DOC fraction is high.
Wastewater Disinfection / EDC Destruction	4-8 mg/l
Industrial WW BOD / COD / TOC Removal	5-10 mg/l per 1 mg/l of TOC | *Impossible to estimate without test. Use 3-5 mg/l to see if ozone is within your budget.

Tip 2 - Ballpark Your Daily Ozone Demand

Ok, you have your dose, now you need to estimate your ozone demand. Overall, you need about 9 lbs of ozone per day for each 1 mg/l of ozone injected into 1 MGD of treatment volume. This very rough rule-of-thumb assumes a transfer efficiency of 90-95%, so adjust accordingly if your transfer efficiency is lower. While only approximately, this estimate will help you to determine the general size and scope of your ozone project.

Example:

So, a 10 MGD site needing an ozone dose of 2 mg/l will require about 180 lb/day of ozone (10 MGD x 2 mg/l x 9ppd/mg/l-MGD = 180 lb/d).

Tip 3 - Ballpark Your Oxygen Needs

If your daily ozone requirement is more than a few pounds per day, you should be looking at an oxygen-based design. Most modern ozone systems will be designed to operate at a minimum ozone concentration of 10% BW, which will require some type of oxygen supply. The 10% BW assumption also makes it simple to calculate the oxygen requirement as 10X the weight of ozone required. If you plan to use a higher or lower ozone concentration, you will need to adjust your estimate accordingly.

Example:
Continuing with our example from above, our 180 ppd ozone system is going to require around 1800 lb/day of oxygen. (O_3=180 ppd * 10 ppd O_2/ppd O_3 = 1800 ppd O_2)

Tip 4 - Ballpark Oxygen Flows

So far, so good, however, most commercial oxygen supplies are sized on a volume basis. As such, we need to do some quick conversions in order to talk about O_2 options.

a. LOX based systems are typically sized in terms of 100-scf/d (100 standard cubic feet per day). For estimating purpose, 1 standard cubic foot of O_2 weighs about 0.089 lb. Since we want a value in 100's of standard cubic feet, we can simply round up and divide our ozone requirement by 9, which happens to be especially convenient in our ballpark method.

Example:
For our example, the daily LOX requirement is 200 x100-scf/d. (1800 ppd O_2 / (9 lbO_2/100 scf O_2))

b. The reporting units for gas flow are different based on the applications. On-site VSA and PSA oxygen systems are typically sized in terms of standard cubic liters per minute – so we need to convert again. Each 100 standard cubic foot of gas contains 100 x 28.3 standard cubic liters. We also need to express our daily value in minutes which requires dividing by 1440 min/day. While you can do the math, the conversion nets out to a factor of about 2. So, in order to get your O_2 requirement in terms of slpm multiply your O_2 requirement from above by 2.

5-MINUTE BALLPARK OZONE SIZING CHEAT-SHEET

Ballpark Ozone Demand (in lb/day)		MGD * mg/l * 9 lb O_3 / (mg/l-MGD) = O_3 #/day
Ballpark Oxygen Demand (in lb/day) (at O_3=10% BW)		O_3 #/d * 10 = O_2 #/day
Ballpark Oxygen Flow		O_2 #/d ÷ 9 = O_2 100-scf/d O_2 scf/d * 2 = O_2 slpm
Ballpark Ozone Equipment Cost*		$750-$2,500 per O_3 ppd | *Higher values reflect larger equipment scope of supply.

Example:
(For our system, daily VSA/PSA flow requirement is 200 100-scf/d * 2 ≈ 400 slpm)

Tip 5 - Ballpark Your Ozone Costs

System capital and operating costs can vary significantly between the various ozone system manufacturers and your on-site power and oxygen costs. That being said, an extremely rough estimate of ozone system costs are:

Ozone equipment costs vary between manufacturers based on the technology selected and system options. This said, most equipment costs are in the range of $1,000 - $2,500 per lb of O_3 per day. Pricing can vary significantly depending on your actual project scope, but this number should get you somewhere in the ballpark. Operating costs also vary significantly depending on process conditions, the equipment selected, and local power cost. That being said, estimates of ozone equipment cost (capital or CAPEX) and operating cost (OPEX) are simple enough to estimate on an 'order-of- magnitude' scale.

Similarly, our ozone system should cost about $36-$50 per pound per day to operate. You can easily calculate annual cost by multiplying by the number of operating days (or fraction thereof) per year.

Example:
Almost done – for our example project we can expect an equipment cost of somewhere between $180k-$450k. Obviously, the higher pricing represents a more complete scope of supply.

Summary

So, there you have it - a simple 5-minute method to estimate the size and budget of your next potential ozone project. The method outlined here certainly won't win you any points on the next PE exam - and you should NOT use it to make any final engineering or financial decisions.

There are at least a dozen different variable that aren't even discussed here that can significantly impact your project. If you have any doubt, contact one of the many ozone vendors for help and guidance. With a little more time, information and effort you can easily develop a more accurate estimate that's worthy of your serious consideration.

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