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Flow Measurement and Average Demand

Proper equipment design begins with a thorough understanding of your process requirements. All design engineers are concerned with the quality of a particular air delivery solution, but many have not adequately modeled the problem. Sometimes the end result is a quality system that when placed into operation is not at all suited for the real world application.

Consider the application of mixing a tank through diffused aeration. Mixing is a volume dependent application where fluid displacement to achieve a homogonous mixture is the goal. At the point where the desired mixture is attained any excess air put into the system is wasted. Since mixing through diffused aeration is a costly and an ongoing expense, any reduction you can make will save money continuously over the lifespan of the equipment.

We recommend use of volumetric flow (ACFM or m^3/min) measurement versus a mass flow (SCFM or Nm^3) measurement for this volume dependent application. A mass flow measurement will result in a higher volume and excess fluid displacement when temperature and elevation increase above the standard volume's defined point (this is typically defined in the US as the amount of air in one cubic foot at 68F, 36% RH and sea level).

Consider the two following examples where the actual mixing requirement is independent of site conditions yet mass flow was incorrectly specified. As a result, the system must be oversized and electrical costs are significantly increased.

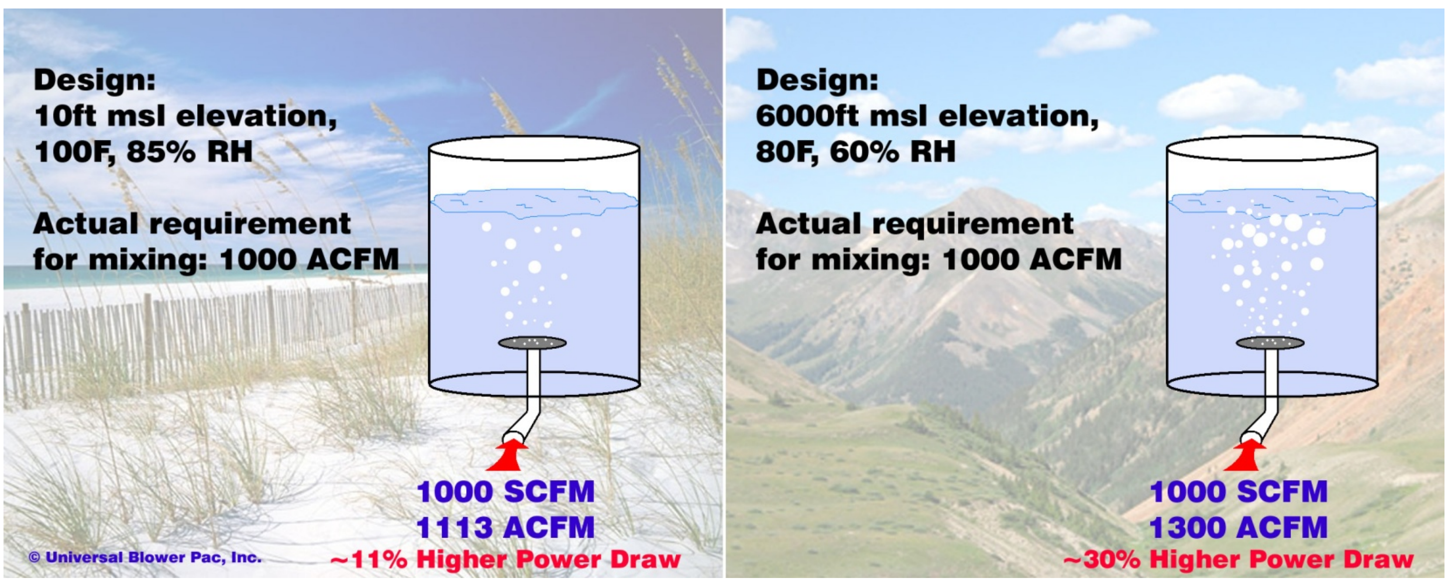

Figure 1: Mass & Volume Flows at Different Locations

Proper flow use will save money in operating expense. Volume flow measurement should be used versus mass flow measurement in any situation where the concern is fluid displacement or flow speed. This includes mixing, scour, backwash, and pneumatic conveying applications.

Another potential improvement is to focus design on your average system demand. Typically, variable demand systems are designed for a peak flow and pressure requirement that is much higher than the average demand. Oftentimes, especially in wastewater treatment, this average demand is only 50% of the peak. The oversight for not considering the operating schedule and power draws under the average demand can be significant.

For example, a consultant engineer has an application which requires 6000 SCFM for a peak demand sometime in the future. The engineer requires a maximum turndown to 30% or 1800 SCFM and will have an average demand of 4000 SCFM or 67% turndown. This engineer is concerned with power draw, but hasn't mapped the operating schedule or quantified the total lifecycle costs of differing potential configurations. Since two duty and one common standby unit should meet their client's existing building space they decide that soliciting bids for the lowest operating expense at peak demand under this configuration will provide an adequate result. They end up with the following.

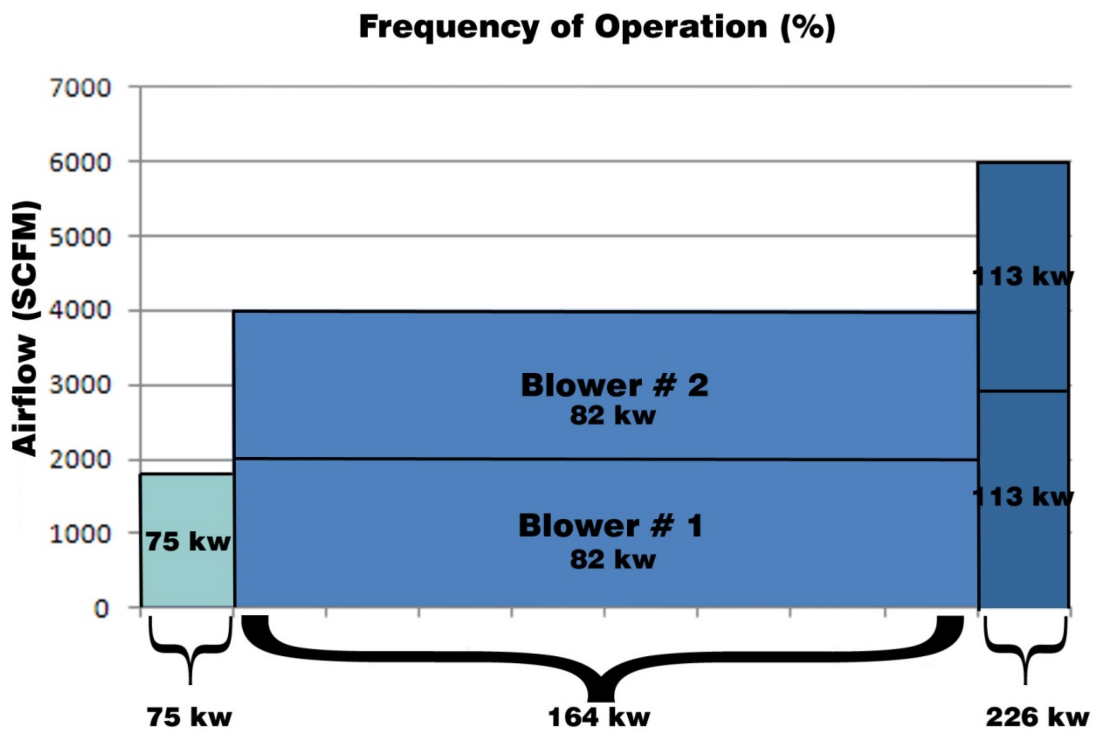

Figure 2: Operating Scheme 1, Two Duty One Standby

This configuration has a low total power draw of 226 kW at peak demand, but suffers an efficiency drop when the demand is lowered. The resulting weighted power draw is 161.3 kW. This resolves to a current yearly operation cost of $92,800 at the current US industrial average power cost.[1]

If the average power and operating scheme were considered instead of the peak demand performances the following schedule would be more applicable.

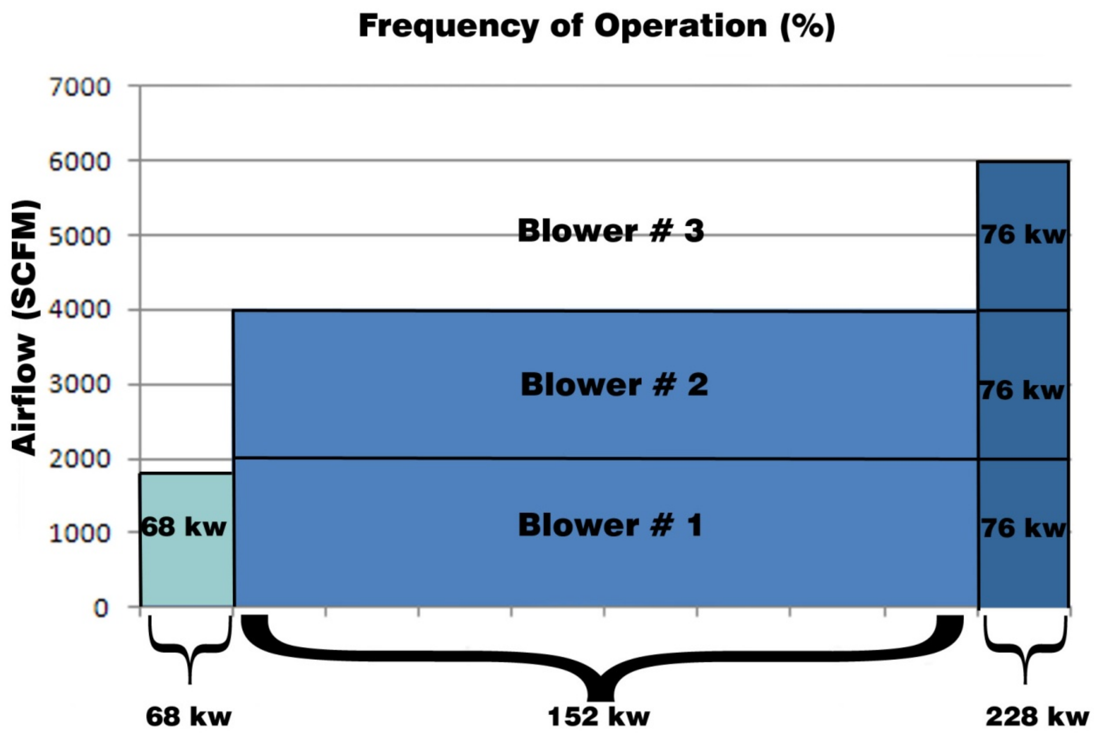

Figure 3: Operating Scheme 2, Three Duty One Standby

This scheme has a higher peak demand cost of 228 kW, but a significantly lower weighted power draw of 151.2 kW. Its peak efficiency point is much closer to the average demand. The total cost to operate this configuration is $87,000 at the current US industrial power average cost.[1] In comparison with Operating Scheme 1, this configuration will cost $5,800 less per year to operate. Further consideration can be given to the potential change in maintenance and difference in initial capital costs. Also differences in electrical service, conduit requirement, and spatial constraints will factor into identification of the best solution. However, the focus on average demand and operating scheme allows for a much more informed decision, especially when the cumulative difference in operating cost is significant.

Think of the last few applications you've encountered. Could equipment design have been significantly improved by a thorough review of the process requirements and better modeling of the application? Proper flow measurement and optimizing for average demands are two simple considerations that can result in better solutions that provide ongoing cost savings.

[1] April 2010 US National Industrial Average Power Cost- DOE, 7/20/10, http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html