Argon or Nitrogen. Which is Best for Your Application?

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Gas Generation Team

Argon and nitrogen are quite similar in inertness, but are vastly different in cost, both economic and environmental.

Argon, the noble gas

Argon is the most common gas in the atmosphere besides Nitrogen and Oxygen. Argon is a noble gas (like helium) which means that it is completely inert. Argon will not readily react with any other substance. Thinking back to your chemistry classes you'll recall that the noble gases are unreactive because they have a full outer shell of electrons. Those electrons are tightly held and won't be shared with other compounds. That makes Argon a good choice for blanketing of items like wine and sensitive chemicals but at a high cost.

Although argon is the third most common gas, it only makes up about 0.9% of the atmosphere. Commercially it is available as a by-product of industrial air separation. This is the only commercial source of Argon. Since it is such a small percentage of the atmosphere Argon is many times more expensive than Nitrogen.

Nitrogen, the unreactive gas

On the other hand, nitrogen is not a noble gas. Two nitrogen atoms make up the nitrogen molecule (N_2), so it has no free electrons like Argon and thus the same properties of a noble gas under nearly all uses. Indeed, nitrogen, which makes up 79.1% of our atmosphere, is very unreactive. Therefore, the relatively commonplace nitrogen exhibits the same properties of argon but at much less cost. Nitrogen is 88 times more abundant than argon. That means that the energy to produce a pound of nitrogen is 88 times less than the energy to produce a pound of argon. Argon production and distribution creates a large carbon footprint.

For most users of nitrogen gas, on site air separation using pressure swing adsorption or hollow fiber membranes reduces the cost of nitrogen even more than relying on an air separation factory. On site gas generation also minimizes CO_2 emissions by eliminating diesel truck deliveries of bottled or liquid nitrogen.

Argon versus Nitrogen

One advantage of argon is its heavy weight. Argon has a density of 0.1 lb/ft^3 and nitrogen is 0.07 lb/ft^3 or about 40% heavier per cubic foot than nitrogen. Therefore, argon will tend to sit on top of a liquid column and not readily diffuse with air. For **blanketing** applications, determining how long a blanket of argon will stay in place is not a trivial task as it depends on temperature and movement of air above the blanket. Also argon is invisible so the user cannot easily determine when to replenish the blanket. Therefore, nitrogen is used because its low cost allows for continuous purging that would be uneconomical with argon.

There are two instances where argon is superior to nitrogen. **Arc welding,** where nitrogen becomes reactive in the presence of the electric arc, and in **window insulation** where argon has a much lower thermal conductivity than nitrogen. In almost all other uses of the gases, nitrogen is the better choice.

For more information, please visit our Parker Balston website.

This post was contributed by David Connaughton, product manager, Nitrogen Generation Systems, and Jennifer Fiorello, Gas Generation Technology Blog Team Member - Parker Hannifin

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