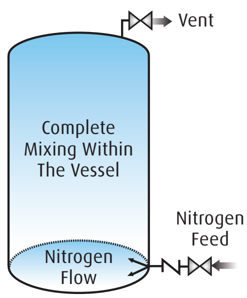
Nitrogen Purging and Inerting

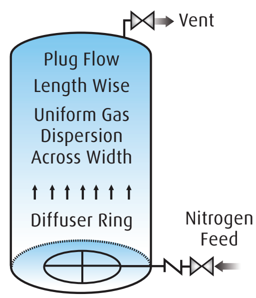
Industrial gases such as nitrogen, argon and carbon dioxide are commonly used to protect materials from contact with atmospheric oxygen, moisture and environmental contaminants. For most applications, pure, dry gaseous nitrogen offers the optimum combination of low reactivity with good economy.

Nitrogen atmospheres are used to address a range of needs such as: preventing formation of flammable or explosive vapors in piping, process equipment, storage vessels and transport vehicles; protecting materials from degradation by contact with atmospheric moisture or oxygen; facilitating vapor recovery (reducing emissions); removing dissolved contaminants or by-products from liquids; enabling the safe transfer of hazardous materials between vessels, and many other situations.

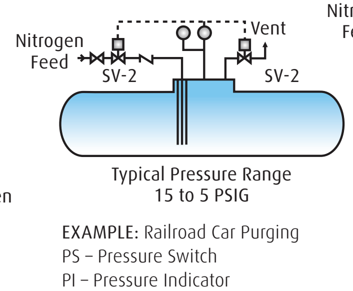
Dilution Purging



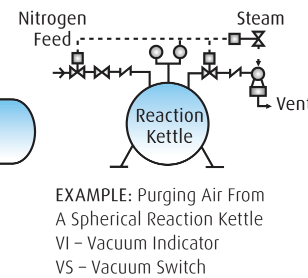
Displacement Purging



Pressure Purging



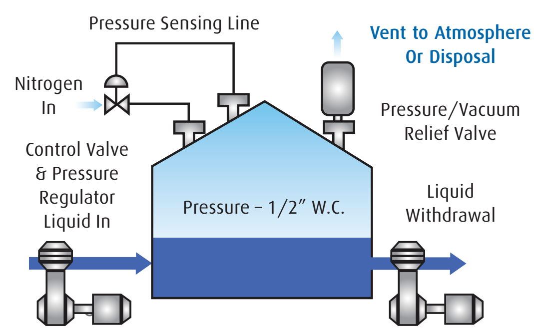
Vacuum Purging



Purging creates an inert atmosphere in vessels or piping systems by displacing the gases already present (frequently air). There are four general types of purging:

- **Dilution Purging** – the most common and simplest approach, this involves letting the inert gas mix with and dilute the gases present in the vessel.
- **Displacement Purging** – a more efficient approach where the inert gas ideally displaces an equal volume of the gas to be purged, such as in pipe or plug flow.
- **Pressure Purging** – where the vessel can safely withstand moderate pressure (5-15 psig) to enhance mixing and displacement. This can be effective for unusual geometries such as railcars.
- **Vacuum Purging** – The headspace gas is withdrawn under vacuum and replaced by inert gas. It is very efficient in terms of inert gas use, but the vessel must be capable of low pressure operation.

Tank Blanketing involves feeding nitrogen gas into the vapor space of a fixed roof tank. The nitrogen flow may be continuous (e.g. simple continuous purge) or the system can be designed for intermittent nitrogen flow that is regulated by the headspace pressure, the headspace oxygen concentration, or both.



Total Nitrogen Requirement = In-Breathing Requirement + Liquid Withdrawal

Pressure Transfer is similar to pressure purging, however here the objective is to use an inert gas to propel a solid or liquid product from one vessel to another. For example, nitrogen pressure transfer of solvents from railcars is a safe and reliable method that eliminates the need for mechanical pumps and has the added benefit of providing a blanketing gas in the destination vessel.

Nitrogen Stripping involves using a high velocity flow of inert gas to desorb contaminants or dissolved gases from a liquid medium. A common application is the use of nitrogen to deodorize and remove dissolved oxygen from edible oils. Inert gas stripping is also used to remove volatile residues such as monomers or solvents from reaction masses.

A reliable source of nitrogen is of paramount importance to ensuring a safe and productive facility. As the largest industrial gases company in North and South America, Linde can precisely engineer a nitrogen supply system for any purpose and at any scale.

Compressed Gaseous and Liquid Nitrogen Storage Systems are located at the customer's plant and supplied from Linde's extensive network of cryogenic air separation plants. These systems deliver high purity nitrogen (greater than 99.999%) and can be engineered to accommodate very dynamic flow patterns, for example in autoclave applications. Also, because, nitrogen is stored at or above typical use pressures, additional compression equipment is frequently unnecessary. An important feature of these systems is that nitrogen supply can be maintained even in the event of a power failure.

Dedicated Onsite Nitrogen Generators can provide higher nitrogen flow rates very economically in applications where the demand is fairly uniform. Linde's technology portfolio in this category includes systems based on membrane, pressure swing adsorption (PSA) and cryogenic air separation that can provide nitrogen flow rates up to 500,000 cfh and higher, Ar purities from 95% to over 99.999%. Linde works with customers to first determine the most appropriate technology and then constructs, operates and maintains a Linde system at the customer's site. Onsite systems may also be configured with liquid nitrogen back-up where the reliability is required.

Comparison of Nitrogen Supply Modes

Supply Mode	Typical Supply Rate (cfh)	Comment
Gas & Liquid Cylinders	0-200	Better for lower volumes and intermittent uses
Bulk Liquid Tank	100-10,000	Excellent flexibility and reliability. Tanks are supplied via truck delivery
Dedicated Onsite Plant:	Membrane 1,000 - 200,000 PSA 1,000 - 200,000 Cryogenic 10,000 - 1,000,000+	Better for larger and regular flows. Considerations include required purity and pressure as well as power costs. Systems are owned and operated by Linde under long-term supply arrangement.
Pipeline	5,000 - 1,000,000+	Excellent capability for large and highly variable flows for sites near to pipeline network

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