SYNRAD Technical Bulletin

0015

Technical Issue: The Importance of Purge Gas for Firestar f201/f400 Lasers

Date: 30 June 2008

Description:

This Technical Bulletin describes how to prevent condensation or optics damage to your Firestar f201 or f400 laser by using an appropriate purge gas.

This Bulletin covers the following topics:

- Importance of purge gas
- Recommended purge gases and specifications
- Proper conditioning of compressed air
- Connecting purge gas to the laser
- Summary

Importance of purge gas

Purge gas is important because it protects against two important sources of laser damage—condensation and particulate matter. Condensation and particulates can cause catastrophic (and expensive) damage to your laser that is not covered under warranty.

Purge gas creates a slight positive pressure inside the laser housing that prevents particulate matter such as dust and debris from accumulating on optical surfaces and electronic circuit boards. In condensing atmospheres, purge gas reduces the potential for condensation because a nitrogen or oil-free, dried air purge displaces moisture-laden environmental air from the laser housing.

Condensation

Condensation forms when the laser's coolant temperature is lower (cooler) than the dew point of the surrounding air. Water vapor in the surrounding warm, moist air condenses into liquid water onto cooler surfaces of the laser, including internal and external coolant lines, electronic circuit boards, and optical components.

Liquid water on circuit boards, especially on high-power RF boards, causes catastrophic board damage, requiring replacement of the RF pan and associated electronic assemblies. Water droplets or moisture on optical surfaces leads to spotting, which increases power absorption and ultimately, optics failure. In an enclosed beam path, failed optics tend to release particulates that quickly coat other optics, causing a cascade effect that could lead to complete tube failure.

Particulate matter

Particulate contamination like the dust, dirt, debris, and vapor produced by laser material processing is a problem when it coats optical surfaces in the beam path or when it accumulates on circuit boards, especially if the material is conductive.

Circuit elements coated with particulates lose their ability to transfer heat, which leads to shortened component lifetimes and premature part failure. At the high voltages and currents produced by RF circuitry, conductive dust may cause short circuits and catastrophic circuit board damage. Dust, dirt, or vapor deposited on optical components leads to increased power absorption that causes optics failure and the potential of a cascade effect that may damage multiple optics up to, and including, the laser tube.

Recommended purge gases and specifications

SYNRAD recommends only two types of gas for purging the laser or external beam delivery optics—nitrogen (N_2) or air. If air is used, it can be breathing grade (available in bottled gas cylinders) or oil- and water-free, dry air provided by an on-site air compressor.

Caution: You must not use any other type of inert gas, including argon (Ar) as a purge gas. Using inert gases other than nitrogen will damage RF boards and other electrical components.

Table 1 lists purity specifications for acceptable types of purge gas.

Table 1 Purge gas specifications

Purge Gas	Type	Specification
Nitrogen	High Purity Grade	99.9500% purity or better
Air	Breathing Grade	99.9996% purity or better
Air	Compressed	99.9950% purity or better, water-free; oil filtered to 5mg/m^3 or better; particulate filtered to < 1.0 micron; dried to lower dew point below coolant temperature setpoint

Important Note: As specified above, on-site compressed air **must** be filtered to remove water and oil, which are by-products of the compression process. Depending on the environment, it may be necessary to dry the filtered air before it reaches the laser. The dew point temperature of the filtered air must be lower than the laser’s inlet cooling fluid temperature.

Proper conditioning of compressed air

Important Note: The integrator or end-user must provide a purge gas that meets the requirements described above in Table 1. Using a purge gas that does not meet specifications (or a lack of purge gas) will void the laser warranty and may lead to catastrophic and expensive laser damage.

Compressed air is widely available in most facilities, however it is usually contaminated by oil and water vapor during the compression process. These contaminants must be removed before they reach the laser. Figure 1 illustrates the accepted method for plumbing a compressed air drop to your laser. The subsections below describe how to choose filtering and drying components necessary to condition compressed air for use as a laser purge gas. The callout numbers in Figure 1 correspond to the item numbers in the subsections below.

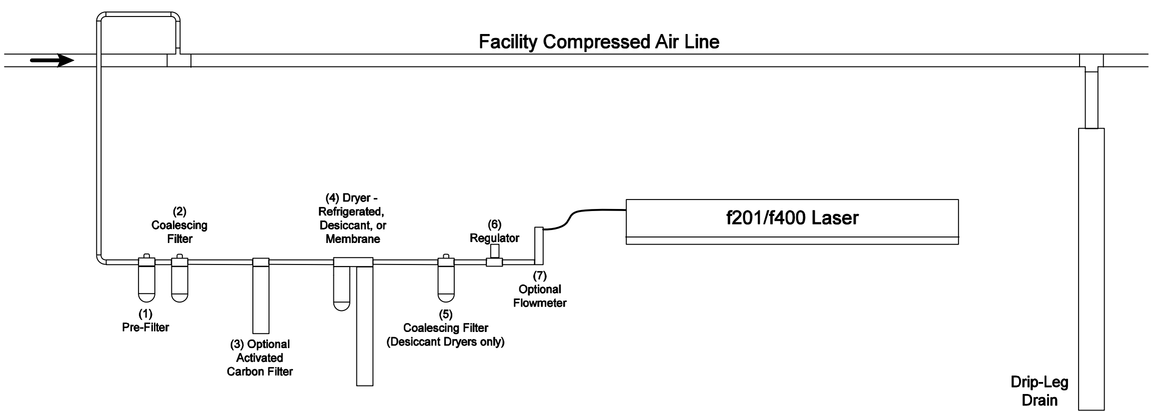

Figure 1 Plumbing an air drop for laser purge

Oilless air compressors

Although oilless air compressors are not generally used to provide compressed air throughout an entire facility, oilless compressors are a good choice when used as a dedicated supply for one or more lasers or other equipment that requires instrument-grade compressed air. Oilless compressors are designed using diaphragms or non-metallic seals, allowing them to compress air without the need to lubricate rotating and reciprocating parts. This design eliminates oil vapor from the compressed air stream. Oilless compressors are available in many sizes depending upon capacity. Several manufacturers build units small enough to fit within an electronics enclosure.

Note: When using an oilless compressor, you must still install both a pre-filter (standard filter) and a coalescing filter (commonly called a two-stage filter system) upstream of the laser; however, an adsorbent (activated charcoal) cartridge filter is not required. Depending on the dew point of the air from the oilless compressor, you may also need to install a dryer.

Filtering

Compressed air filtering should be done using a two-stage system—a pre-filter, to remove particulate contamination and eliminate water, and a coalescing filter, to remove liquid aerosols (water vapor) and hydrocarbons (oil vapor) from the air stream.

Note: Filter assemblies with automatic drains are highly recommended. See the Maintenance section for details.

Item 1 A pre-filter should be installed as the first component of a two-stage system at the point-of-use air line drop. The pre-filter should have an ISO Class 1 or Class 2 element rated to remove 93% of particles less than one (1) micron in size.

Item 2 The second-stage coalescing filter is installed downstream of the pre-filter. It should have an ISO Class 1 or Class 2 element rated to remove 99.995% of 0.01-micron particles or droplets.

Item 3 (optional) When shop air is provided by a standard (oil-lubricated) compressor, you should consider installing an adsorbing filter containing activated carbon. This type of filter provides maximum protection against oil vapor. The carbon filter is always installed downstream of the coalescing filter.

Item 5 If a desiccant dryer is used, then install a coalescing filter with an ISO Class 1or Class 2 element downstream of the dryer. This filter is required to remove any abrasive particles that escape from the desiccant dryer.

Drying

Item 4 A dryer (refrigerated, desiccant, or membrane type) is required in situations where the dew point of the filtered air is higher than the dew point of the laser coolant. A dryer at point-of-use removes all remaining water vapor from the air stream while lowering the compressed air dew point to –40 °C, which is well below the dew point of the laser coolant. Some dryers are manufactured with a built-in coalescing filter that eliminates the need for Item 2.

Regulating (pressure and flow)

Item 6 A pressure regulator is needed to reduce facility air line pressure, typically 80–120 PSI (5.5–8.3 Bar), down to between 2–5 PSI (0.14–0.34 Bar), which is the laser's recommended purge pressure.

Caution: Do not exceed a gas purge pressure of 5 PSI (0.34 Bar). Excessive pressure may damage the purge assembly or other internal laser components.

Item 7 (optional) A flowmeter helps minimize air consumption by allowing you to fine-tune purge gas delivery based on actual flow through the laser and any mounted beam delivery components. The flowmeter should be accurate for an airflow rate between 30–60 Standard Cubic Feet per Hour (SCFH) or 14–28 liters/minute.

Maintenance

Daily/Weekly– If your filters (Items 1, 2, and 5) do not have an automatic drain feature, you should inspect and drain the filter bowls daily or weekly depending on the amount of water trapped by your system. If the water level in the filter bowl becomes too high, then water is passed through the filter(s) into downstream components (carbon filter, dryer, laser), leading to expensive repair or replacement.

Yearly– Replace all filter elements every 12 months; sooner if the pressure drop across an element exceeds 10 PSI (0.7 Bar).

Connecting purge gas to the laser

To connect purge gas to the *Gas Purge* port on a Firestar f201 or f400 laser, perform the following steps:

Important Note: The *Gas Purge* port must be connected to a source of nitrogen or oil- and water-free, dried air. Do not use any other gases for purging as this will damage internal components inside the laser housing.

1 Connect your nitrogen or oil- and water-free dried air source to the *Gas Purge* port using 1/4-inch (6.4 mm) O.D. plastic tubing.

2 Push the tubing completely into the fitting and then lightly pull the tubing to verify it is locked into the fitting.

Note: To disconnect gas purge tubing, first push and hold the tubing slightly into the fitting. Next push the white fitting ring evenly towards the fitting and then pull the tubing free.

3 Set a purge pressure between 2–5 PSI (0.14–0.34 Bar). If a flowmeter is available, set a flow rate of 30–60 Standard Cubic Feet per Hour—SCFH (14–28 liters/minute) at a pressure not to exceed 5 PSI (0.34 Bar).

Caution: Do not exceed a gas purge pressure of 5 PSI (0.34 Bar). Excessive pressure may damage the purge assembly or other internal laser components.

Summary

The use of an appropriate purge gas can improve the reliability and operation of your Firestar f201/f400 laser by reducing the volume of moisture and particulates inside the laser housing. The most important factor is purge gas purity. SYNRAD highly recommends high-purity grade (99.9500%) nitrogen or breathing grade (99.9996%) bottled air for your laser purge gas. An alternative is compressed air; HOWEVER, it must be oil- and water-free (99.9950%) and dried to prevent any trace of oil or water vapor from contaminating laser optics or electronics.

For further information, contact SYNRAD, Inc. at 1.800.796.7231; outside the U.S., dial +1.425.349.3500 or fax us at +1.425.349.3667.