Portable Steam Turbine Continuous Performance Measurement

Pressure Measurement

Scanivalve

General Description

Steam Turbine efficiency, reliability, and service condition must be accurately measured for a power plant to provide higher unit outputs. The benefit of improved steam turbine efficiency is more affordable energy and fewer greenhouse gases. This application note describes a pressure measurement system using relatively inexpensive piezoresistive sensors and safety purge valves to continuously measure turbine pressures while the turbine is operating under normal loads. This system will provide gapless data at very high accuracy. The safety purge valves, described in Scanivalve Application Note No. 6, protect the pressure sensors from the potentially harmful steam pressure media. This data may be used to determine turbine efficiency, indicate possible compressor blade tip erosion, or other performance problems.

Continuous Purge Measurement System

This system utilizes intelligent DSA3218 pressure scanners, incorporating relatively inexpensive piezoresistive sensors, to measure pressures in steam turbines. These sensors normally could not be used to measure liquid or high temperature steam media pressures. However, this system has a continuous purge feature that isolates the sensors from the harsh media without affecting the accuracy (+/- .05% full scale) of the pressure measurement.
Wet steam source from a low pressure steam turbine (LPMT) is connected to the cabinet input panel. This line is connected to a safety purge valve and the DSA3218 within the cabinet. Steam from the test article is likely to travel up the pressure measurement lines and form condensate inside the equipment. For this reason, measurement points are supplied with a constant purge source adjusted approximately 20% greater than the measurement input pressure. A precision needle metering valve and flow meter allows the user to adjust the purge pressure to apply a small amount of flow to each measurement line. A shutoff ball valve disables the purge line when not in use, conserving purge pressure for other lines. The measurement portion of the system is the DSA3218. It is connected to the continuous purge source measuring pressure changes caused by changes in back pressure during a test. The DSA3218 modules are mounted at the top of the cabinet with measurement inputs pointing down towards a set of safety purge valves.
During non-measurement periods, an Ethernet Control Pressure Module (ENETCPM) configures valves to introduce high pressure, high flow purge air to each pressure line to remove any water and dry the tubing. This is called the Safety Purge Mode which overrides the continuous purge measurement mode. In Safety Purge Mode, the DSA modules are isolated from the test article and two purge paths are applied. Path #1 is called “cabinet purge” applying pressure from the DSA module to atmosphere without resistance or back-pressure. Path #2 is called “turbine purge” applying pressure from the Safety Purge Valve to the test article. Refer to application note #6 for more details on the safety purge mode.

Measurement mode: Turbine measurement lines and continuous purge pressures are connected to the pressure scanners. This mode is used for continuous data to be collected.

Continuous purge Zero Calibrate mode: This is an optional mode where the zero point of every pressure sensor is recalibrated. This calibration point is valid as long as the needle valve isn’t adjusted or the system supply pressure isn’t changed.

Safety purge mode: All lines are purged directing purge air to the steam turbine as well as the drain lines. Purge pressure is used to prevent moisture from making contact with the sensors. If electrical power is lost, the system will default to this mode. No data can be taken during safety-purge mode.

Dormant mode: Measurement lines are closed and the system is placed in the safe mode.

Calibrate and Validate mode: A key function of this pressure measuring system is its ability to perform a system calibration or validate individual sensors “on demand. ” Pressure sensor validation or calibration is accomplished in this mode by applying precision calibration pressures thru the CAL port during static engine-off conditions only.

SYSTEM INSTALLATION AND OPERATION

Figure 1 shows the pneumatic logic of a typical system layout. The pressure measurement cabinet should be located above the measurement points. Gravity thus assists in keeping condensation from the pressure sensors.

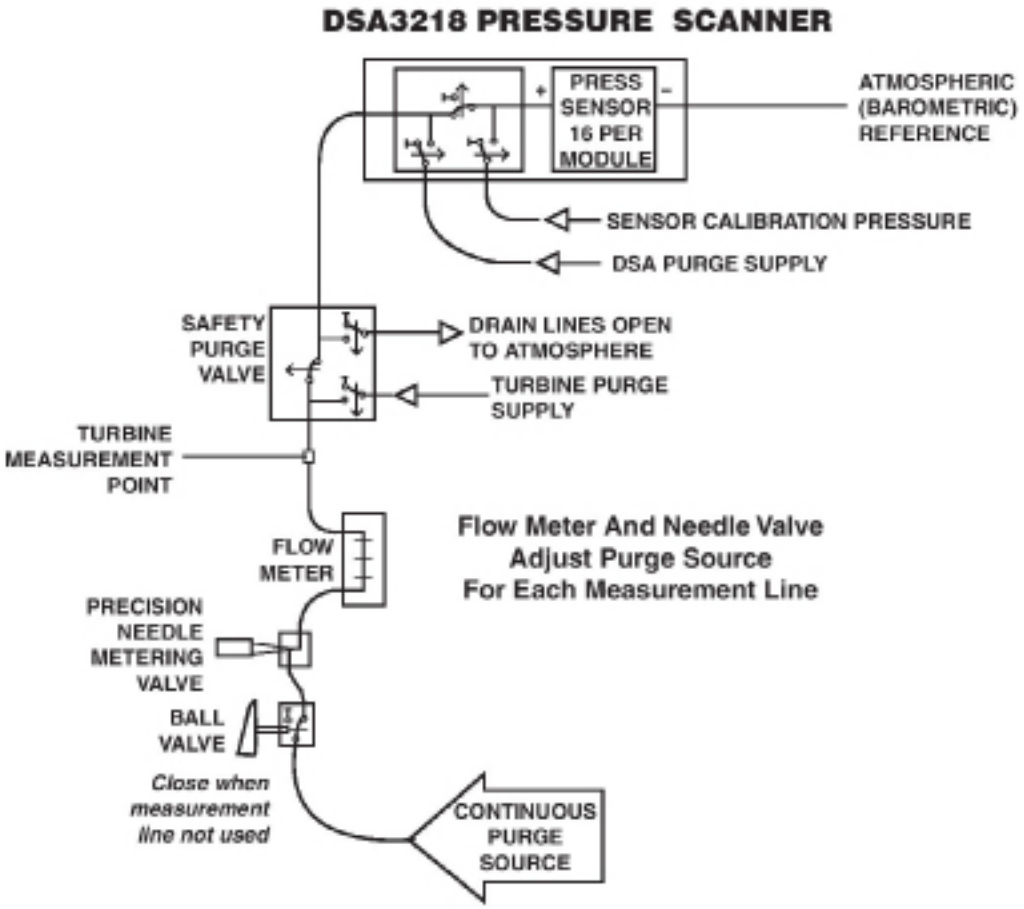

FIGURE 1 - PURGE/MEASUREMENT LOGIC DIAGRAM

Purge Flow Requirements

A customer supplied purge air or nitrogen source is required that is capable of providing purge pressures 20% greater than the maximum test pressure. The needle valves are used to adjust the continuous purge pressure slightly greater than the measurement input pressure. The purge pressure will move any condensate that might form in the pressure input lines back to the turbine.

Portability

The system does not have to be permanently installed in a development test cell. This continuous purge system cabinet is portable and used for performance testing several turbines at a power plant. The cabinet has wheels and eyebolts for transportability. Turbines could be monitored more frequently thus improving overall plant efficiency. A typical portable continuous purge system is shown below utilizing 2 each Scanivalve DSA3218 16 channel pressure scanners (32 pressure measurements).

Alternate System

The pressure measurement system described in this application note includes the safety purge system plus the optional capability for continuous purging that provides gapless data during purging.
Also available is the basic system which only includes the safety purge system, described in Scanivalve Application Note #6, that protects the pressure sensors from the potentially harmful steam pressure media. Turbine pressures are measured only during non-purging times in the safety purge system.

Communication

The DSA3218 intelligent pressure modules communicate through industry proven Ethernet TCP/IP or UDP. Data is output in Engineering Units (EU). A system may be monitored from any PC or plant network connection using Telnet, Hyperterminal, LabView, an OPC server, or our free ScanTel software.

Typical DSA3218 Continuous Purge System for Steam Turbine Performance Testing

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