Steam and Water Analysis System (SWAS)
An Overview
Today in power plants, high pressure boilers and steam turbines are under constant attack from erosive and corrosive elements such as Silica, Sodium, Dissolved Oxygen, Calcium, Chloride and Phosphates. Without accurate measurement and monitoring, the plant may suffer heavy mechanical damages that can be caused due to imbalance of turbines, reduced efficiency, deposition on turbine blades, corrosion of steam pipe work and so on.

Our Steam and Water Analysis System (SWAS) is designed to keep you in power. SWAS assures the safety of your boiler and turbines, by taking along and analysing up to a dozen samples from all the water and steam circuits. In today’s supercritical power plants, sample conditions as high as 600 Degree C and 300 bars are quite common. The Forbes Marshall SWAS can easily take care of these samples. To protect your equipment our SWAS works in two stages:

1. Sample Conditioning
2. Sample Analysis

1. Sample Conditioning

   The first section of any SWAS is the Sample Conditioning section or the Wet Panel

   Here the sample is first cooled in Sample Coolers, de-pressurised in pressure regulators and then fed to various analyzers while keeping the flow characteristic constant by means of a back pressure regulating device. There are several safety equipment provided in wet panels, so that the operators feel safe while working with these systems.
The schematic diagram here shows how this happens:

**NOTE:**
1. SAMPLE TUBING: 1/4" OD, 16 SWG, ASTM A 213, TP-316, SEAMLESS TUBE
2. BLOWDOWN HEADER (DEFAULT): 2" NB, ASTM A106, GR.B, SCH-80, PIPE FLANGED TO 2" NB, ANSI B16.5, CLASS 300 R/F
3. COOLING WATER HEADERS (DEFAULT): 2"NB, ASTM A106, GR.B, SCH.40, PIPE FLANGED TO 2"NB, ANSI B16.5 CLASS 150 R/F
4. WASTE DRAIN HEADER (DEFAULT): 2"NB, ASTM A106,GR.B, SCH. 40 C.S PIPE FLANGED TO 2"NB, ANSI B16.5, CLASS 150 RF
5. COOLING WATER PIPING: 3/4"NB, SS304 PIPING
6. SAMPLE INLET CONNECTIONS: BULKHEAD UNION FOR SR.NO.27
Some important components of Sampling Systems (Wet Rack)

Sample Cooler

Forbes Marshall Sample Coolers are coil-in-shell type contra-flow heat exchangers. Validated by a premier institute like IIT, we are one of the few sample cooler manufacturers in the world offering a guaranteed performance. With in-house test set-up for performance testing, world-class manufacturing and welding facilities, we offer one of the most trusted sample coolers in the power sector. Various options of coil materials such as Stainless Steel AISI 316, Monel 400, and Inconel 625 etc are available.

High Pressure Regulator

Forbes Marshall offers piston type High Pressure Regulators. These are used in primary conditioning where sample pressures are higher than 100 Kg/cm². As these are piston type Pressure Regulators, there is no fear of diaphragm rupture etc.

For lower pressure / temperature rating, Forbes Marshall offers spring loaded diaphragm type Pressure Regulator. To offer safety against a remote possibility of diaphragm rupture, an in-built safety valve is a regular feature.

Back Pressure Regulator

Forbes Marshall offers Back Pressure Regulators (BPR) to avoid low flow (or fluctuating flow) conditions to analyzers in case of grab sample valve operations. In the absence of such a device, the sample would flow to the grab sample line when the grab sample valve is opened. This can create low flow alarm conditions in samples going to analyzers.

A Pressure Regulator and Back Pressure Regulator combination provides very stable pressure and flow conditions, thereby ensuring reliable, efficient and accurate analysis.
Sight Glass

Forbes Marshall offers Sample Flow Indicator (Sight Glass) to view the sample flow inside the sample line. A rotating wheel indicates presence of cooling water. The sight glass is made of high grade stainless steel.

Sample Filters

Forbes Marshall also manufactures filters required to ensure particle-free samples. Particles of size up to 40 microns size can be filtered out. Forged stainless steel body and hexagonal cap help easy cleaning of the filter element.

Pressure Relief Valves

Forbes Marshall Pressure Relief Valves comes fitted with Sample Cooler. A Pressure Relief Valve is important as it protects the Sample Cooler in case the coil fails. This is also important for human safety as the pressurized cooler may burst due to full sample pressure under coil failure conditions.
High Temperature Isolation Valves

These valves are easy to operate and can be used for most high pressure and temperature applications. The unique plug/seat geometry and stuffing box design allow these valves to operate for extended periods of time without gland leakage and passing. Valves are designed for PN 500 (Class 2500) and are offered for all ratings up to PN 500 and Class 2500. Body seat integral stellite is hard faced by a special Automatic welding process. Unique non-rotating single piece spindle plug design guarantees long seat life as grinding between plug and seat is eliminated.

Cooling Water Isolation Valve

Cooling Water Isolation Valve is a ball valve. Its stainless steel body makes it corrosion resistant and light weight. A long handle makes it easy to operate. Ball valve type design ensures full flow at open condition.

Cation Column

The duplex type Cation Conductivity Column is a field proven Forbes Marshall design. Cation conductivity measurements are considered to be more reliable than ordinary conductivity measurements, as this method ensures elimination of masking effects of desired chemicals used in treating the water. This provides a more realistic picture of dissolved impurities in the sample. The Forbes Marshall Cation Column is easy to operate, regenerate and maintain.
Significance and importance of boiler parameters

Thermal Power Plant Steam and Water in-line Analytics

Nuclear cycle measurement
pH Analyzer

- **pH**: The steam which goes to the turbines has to be ultra pure. The pH value of the feed water gives direct indication of alkalinity or acidity of this water. The ultra pure water has pH value of 7. In a steam circuit, it is a normal practice to keep the pH value of feed water at slightly alkaline levels. This helps in preventing the corrosion of pipe work and other equipment. Typically dedicated pH analyzers are recommended at following locations in a steam circuit: high pressure heaters, DM make-up mater, condensate extraction pump discharge.

**Features:**

- Dedicated pH analyzer in each line ensure that pH is maintained in a specified band
- Two wire Aquamon Smartpro series plus model is the simplest pH and ORP transmitter. These analyzers are directly loop powered by +24V DC supply from DCS and PLC
- Also direct 110-230 V AC powered Aquamon 4000 transmitter is available if alarm contacts are required along with 4-20 mA output. For pH measurement both low and high pH alarm contacts can be used to control dosing for chemicals. Separate PT-100 sensor input can be used for temperature compensation for pH measurement.

Conductivity Analyzer

- **Conductivity**: Conductivity is an important parameter for detecting any contamination of steam in the boiler circuit. Conductivity of pure water is almost zero (1-2 $\mu$ Siemens). Ingress of any kind of dissolved impurity will raise conductivity instantly. Thus conductivity is an important parameter for the detection of leakages.

Typical points in the steam circuit where conductivity should be monitored are: superheated steam, drum water, high pressure heaters, low pressure heaters, condenser, plant effluent, D.M. plant, make-up water to D.M. plant.

**Features:**

- Like pH Analyzers, Aquamon smart pro series is also available for conductivity measurement. This is loop powered through 24VDC power supply. Both 24V DC loop powered and AC powered options are available for this measurement
- These conductivity transmitters can be used with cells with different cell constant. PT-100 temperature sensor in conductivity cell helps to get a compensated reading for conductivity measurement
• **Silica**: The presence of Silica in the steam and water circuits of a power generation plant is associated with a number of problems both in the super heater and turbine sections.

The solubility of silica in steam increases with pressure. Hence there are chances of silica carryover. The presence of silica in steam can lead to deposition in superheated tubes and on the turbine blades which may lead to loss of efficiency and turbine blade failure. For proper working of turbines, continuous monitoring of silica is highly recommended.

Similarly, the monitoring of anion and mixed bed ion exchanges safeguards and optimizes the operation of the demineralization plant.

Thus the typical points in steam circuits where silica analysis is required are Low Level Silica Measurement in: high pressure and low pressure turbines, steam, drum (saturated) steam, CEP discharge, make-up water, D M makeup water and high level Silica measurement in drum water.

**Features:**

- Predictive diagnostic tools, including Hach's proprietary Prognosys technology.
- PROGNOSYS is now available to provide confidence in instrument readings. PROGNOSYS will monitor and display the reliability of instrument measurement values and identify when upcoming maintenance tasks are due in an easy-to-read color display.
- Grab Sample In and Out features allow quick analysis of a grab sample poured into the analyzer, and facilitate easily taking a sample out of the analyzer to verify in a lab test.
- The industry’s only pressurised reagent delivery system eliminates the frequent maintenance associated with pumps.
- 5.7” color screen with intuitive user interface and predictive diagnostics
- 90 days of continuous runtime.
• **Dissolved Oxygen**: At elevated temperature, dissolved oxygen causes corrosion which may cause puncturing and failure of piping and components respectively. Dissolved oxygen also promotes electrolytic action between dissimilar metals causing corrosion and leakage at joints and gaskets. Mechanical deaeration and chemicals scavenger additives are used to remove the dissolved oxygen. An analytical check of process efficiency, therefore, is essential. Dissolved oxygen monitoring is imperative in power stations using neutral or combined operating conditions (pH 7.0-7.5 or 8.0-8.5). The typical points in steam circuit where dissolved oxygen monitoring is required are deaerator inlet and outlet.

**Features:**
- Measurement in ppb range
- Better response time 1-40 ppb :< 30 sec.
- Built-in temperature sensor for temperature easy compensation
- Sensors can be directly connected to the transmitter through a detachable cable for an easy maintenance
- Output with HART / RS-485 / PROFIBUS-DP available optionally.

• **Hydrazine**: Hydrazine is used as oxygen scavenger. So it also maintains feed water alkalinity to prevent acidic corrosion. It prevents frothing in the boiler and minimizes deposits on metal surfaces. Hydrazine also helps in maintaining a protective magnetite layer over steel surfaces. Under dosing of hydrazine leads to increased corrosion and overdosing represents a costly waste. Therefore hydrazine monitoring is extremely important. The typical points in a steam circuit where hydrazine monitoring is required are: re-heaters, economizer inlet and L.P. heaters.

**Features:**
- A response time lower than 60 seconds
- Reference electrode with pre-pressurized gel electrolyte which facilitates maintenance.
- Provision for grab sample analysis- A feature very useful for PLANT CHEMIST
- No moving parts such as pumps or valves that are used to force gases, making the analyzer the most reliable one.
- Output with HART / RS-485 / PROFIBUS-DP available optionally.
• **Sodium:** The presence of Sodium signals contamination with potentially corrosive anions, e.g. chlorides, sulfates etc. Under conditions of high pressure and temperature, neutral sodium salts exhibit considerable steam solubility. NaCl and NaOH, in particular, are known to be associated with “Stress Corrosion Cracking” of boiler and superheater tubes. The ubiquitous character of sodium in the environment makes it a useful indication to reveal possible “Leak conditions” within the circuit, particularly in the condenser section where the measurement of sodium detects cooling-water leaks with a much higher sensitivity than conductivity measurements. The typical points in a steam circuit where sodium monitoring is required are: D.M. plant make up water, condensate pump discharge, condenser, drum (saturated) steam.

**Features:**

- Unmatched accuracy with 0.01 ppb detection unit
- Provision of grab Sampling, a feature very useful for plant chemists
- Wide range of measurement from 0 to 10,000ppb. Freely programmable
- Use of non-hazardous chemicals for automatic reactivation of electrodes
- Fast Response. Even in multichannel measurement auto-adapted rinsing sequence to reach accuracy in a minimized cycle time (possible 10 minutes)
- A reproducibility <1.5% of reading or <±0.02 ppb, whichever is greater within 10°C
- An accuracy <5% of the reading or <±0.1 ppb, whichever is greater
- Users can choose the freely programmable “FULLY AUTOMATIC CALIBRATION SEQUENCE” as an option
Chiller

**Chilled Package**

Chilled water is required when the cooling water available at site is incapable of cooling the sample to the temperature required by the analyzers.

If cooling water temperature exceeds 400 Deg C, the sample temperature would exceed 450 Deg C, which is higher than the temperature required by the analyzers. To bring down the temperature of the sample, chilled water is required.

A Chiller Package is also required when a sample is to be cooled at 25 Deg C. Forbes Marshall manufactures these in our factory and are the only SWAS manufacturers having this capability.

**Lab Sampling Module**

Forbes Marshall offers the Lab Sampling Module for laboratory analysis of steam in process boilers which is designed as per international standards. Its small and compact size and light weight design makes it suitable for continuous lab sample collection. It is easy to operate and can be fitted easily on site.

Wherever there is a Boiler, a Lab Sampling Module is required.
Photo Gallery
Forbes Marshall is the only SWAS manufacturer with a unique expertise in both Steam Engineering & Control Instrumentation

All power majors deal with us

- Alstom
- Siemens
- Doosan
- AES Power Machines
- ABB
- Power Machine
- BHEL
- NTPC
- Yokogawa
- Honeywell Automation
- Lanco Group
- Jindal Group
- Essar Group
- Tata Group
- Reliance Industries Ltd.
- Reliance Energy Ltd.
- Larsen & Toubro
- Thermax
- Bechtel
- and many more...

Presence in all continents
Everything about steam and water analysis