HIGH PURITY WATER AND STEAM FOR POWER GENERATION AND ASSOCIATED PROCESSES

Introduction

High purity water and steam is used for electricity generation in conventional and combined cycle thermal power plants and in process plants such as diary factories. High purity steam is also used in geothermal power plants after the steam is separated from the geothermal fluids. The heat to produce the steam can be from a variety of sources; geothermal, natural gas, coal, etc., and is produced in a variety of boiler and heat recovery steam generator designs.

Corrosion and Deposition

Water to be used for high purity steam production must be very pure, to minimise corrosion and deposition within the boiler plant and any steam turbine blades or process equipment that the steam later interacts with, such as shown in Figure 1. Unexpected corrosion and deposition failures within boilers and steam turbines can result in extremely expensive repairs and downtime, also with loss of production costs which can be significant.

Figure 1: Steam turbine blade corrosion (left) and boiler tube hydrogen damage failure (right) both caused by corrosive impurities present in the steam and boiler water left unchecked

High Purity Water

High purity water is produced in a water treatment plant where raw surface or bore waters are treated with a variety of water treatment technologies such as ion exchange and reverse osmosis to remove suspended and dissolved solids and gases to leave high purity water.

An alternative use of high purity water in some combustion turbine power plants is via injection into the combustion turbine for emissions control and power augmentation as per the type of power plant shown in Figures 2 and 3. Similar corrosion and deposition risks exist for this application of high purity water as per for conventional, combined cycle and geothermal power plants.

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Figure 2: Combustion turbines that utilise high purity water injection

Figure 3: Combined cycle power plant utilising high purity water for high purity steam product for a process

Testing of High Purity Water

High purity water can be tested for a variety of reasons;

- To determine the purity of the steam being produced
- To determine the purity of the boiler water from which steam produced
- To determine the purity of the feedwater being supplied to the boiler
- To determine the purity of the make up water (outlet of the water treatment plant) being supplied to the feed system
- To determine the purity of injection water being supplied to the combustion turbine
- To monitor for corrosion by-products in feedwater and boiler water (eg iron, copper)
- To monitor the effectiveness of the water treatment system at various stages in the process

Note that the raw feed water for the water treatment plant can also be tested, but must NOT be done using the codes for Steam Turbine Water due to the raw feedwater having very high suspended and dissolved solids contents. More information on high purity water can be found here – www.iapws.org.

Table 1: Analytes

Anions	MDL ($g.m^{-3}$, ppm)	MDL ($\mu g.m^{-3}$, ppb)	Code	Cost ($)	Method
Filtration for anions	-		**Filtmg**	10.20	0.45um, Cellulose acetate
Cl	0.002	2	Clicu	75.00	IC
SO4	0.002	2	SO4u	75.00	IC
DRP	0.002 [DRP] 0.006 [PO4]	2 [DRP] 6 [PO4]	DRPt PO4	18.00	FIA Calculated from DRP, n/c
NOxN	0.002	2	NOxNt	18.00	FIA
Organic acids (acetate, formate) #			*[Under development]*	150.00	IC
Cations					
Digest for metals	-		TuDig	25.00	Hot nitric acid digestion.
Na	0.002	2	NaTup	75.00	ICPMS, nitric preserved, after digestion
Mg	0.002	2	MgTup	75.00	ICPMS, nitric preserved, after digestion
Ca	0.002	2	CaTxup	75.00	ICPMS, nitric preserved, after digestion
K	0.002	2	K_Txup	75.00	ICPMS, nitric preserved, after digestion
Fe	0.001	1	FeTxup	75.00	ICPMS, nitric preserved, after digestion
Cu	0.001	1	CuTxup	75.00	ICPMS, nitric preserved, after digestion
Other					
NPOC #	0.02	*20*	*[Under development]*	100.00	TOC Analyser (Waiting on new instrument)
Silicon, Silica #	0.002 [Si] 0.004 [SiO2]	2 [Si] 4 [SiO2]	SiZu, SiO2z *[Under development]*	50.00	ICPMS, as received SiO2 calculated from Silica, n/c

Sample type = “SteamTurbineWater” [Env.L.Aq.A1.BW.SteamTurb]

Profiles

Profile	Cost	Code
Anions [Cl, SO4, NOxN, DRP/PO4, includes filtration]	$162.20	BWTurbAn
Cations [Ca, Mg, Na, K, Fe, Cu, includes digest]	$229.00	BWTurbCat
Corrosion metals only [Fe, Cu]	$150.00	STCorrMet

Turnaround

Normal Turnaround is aimed at 10 working days.

Faster turnaround may be available if pre-arranged with the laboratory and at extra cost (100% loading for ASAP Urgent)

References [Hill Laboratories Internal References]

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Q53135 Quote template

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David Addison, Thermal Chemistry Ltd, Hamilton, who stimulated us to develop these tests and provided photos and comments for this Technote.

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