AQUARIUS
TECHNOLOGIES PTY LTD
WATER QUALITY CONTROL

Quality System

Quality Endorsed Company ISO 9001

Lic. No. 5403

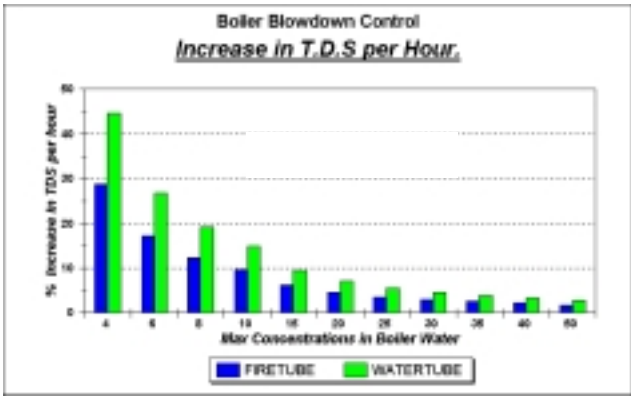
Aquarius Technical Bulletin - No. 02

Design Considerations for Automatic Blowdown on Steaming Boilers

Modern designed Steaming Boilers are very efficient generators of steam, having a high evaporation rate, and small or compact volume. Firetube boilers have a ratio 0.6 to 0.75, evaporation rate in Kgs/hr. compared to the Boiler working volume in Kgs of water, - Watertube boilers have a ratio of 1.0 to 1.3.

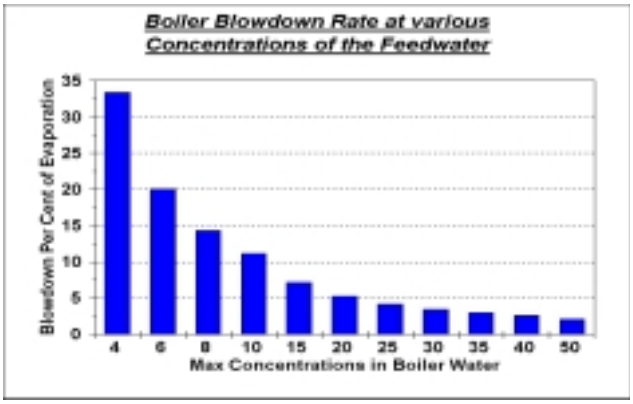
High evaporation rates versus volume, result in a rapid increase in concentrations, or T.D.S, with-in the boiler water, and the need for frequent "blowdowns" to maintain the Boiler Manufacturers recommended T.D.S. limits, and also to prevent carry over, scaling etc. and other problems associated with high T.D.S. levels

The rate of increase of T.D.S. within the boiler is affected by the T.D.S. of feedwater and high T.D.S. feedwater leads to very rapid increases in boiler T.D.S. - **see Graph 1 below.**



The majority of small steaming boilers are either legally unattended boilers, or the boiler man has many additional duties as well as the boiler to attend to, thus many boilers are not blown down as frequently as they should be, resulting in poor water treatment control, carry over and contamination of process steam, and shock to the boiler if large blowdowns are replaced with cold or cool feedwater.

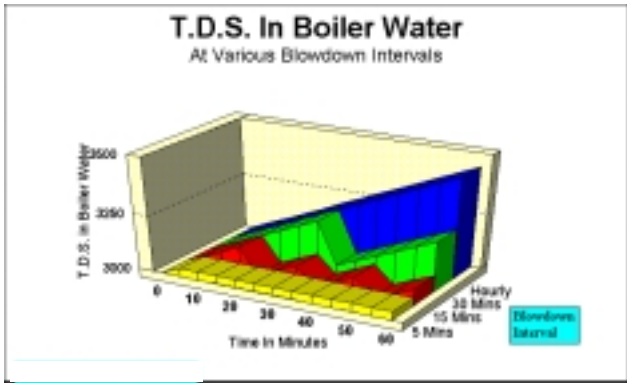
As will be shown from **Graph 3** on following pages, small and frequent blowdowns are very desirable from both a water treatment and control of T.D.S. point of view, and will result in longer boiler life, increased economy, a cleaner boiler, good steam purity, however the current economy can no longer afford a full time boiler attendant to carry out the frequent blowdowns required to maintain the recommended T.D.S. limits.



Let us consider the following example, - A watertube boiler of 1500 Kw operating at full load, and that 10 concentrations of feedwater will result in a boiler T.D.S. of 3000 ppm. Evaporation rate is 2395 Kgs/hr. and the boiler working volume is 1789 lts. (Taken from actual Manufacturers figures)

The boiler blowdown required is calculated as 11.1% of evaporation or 2395 x 0.111 = 265.8 Kgs/hr., - if only 1 blowdown per hour is normally given to this boiler, then 265.8 Kgs must be removed by blowdown, or 14.8% of the boiler volume would require to be removed per blowdown and replaced with cold or cool feedwater. Also the T.D.S. would have risen by 14.8% to now be 3444 ppm

Obviously this boiler should be blown down a lot more frequently than hourly, perhaps every 5 to 10 mins, necessitating some kind of automatic blowdown device. - See Graph 3 below.



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Aquarius Technical Bulletin - No. 02 - Automatic Boiler Blowdown

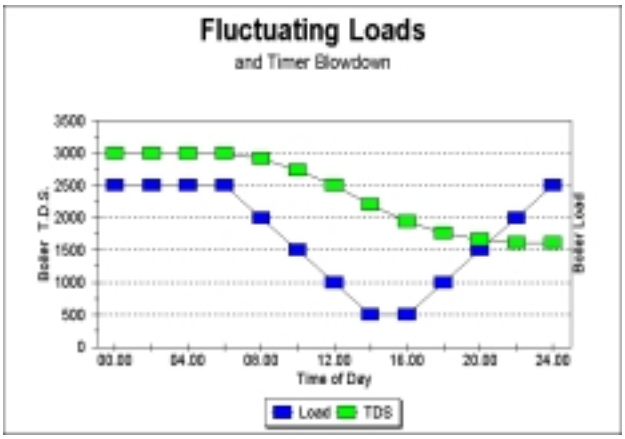
Most Boiler Manufacturers, have fitted "Timer Blowdowns" to these type of boilers to ensure frequent small blowdowns are automatically provided. This is normally accomplished by means of an adjustable repeat cycle timer set to open a 0.5" solenoid for say 60 seconds with an adjustable delay period of say 3 -15 mins.

On the above type of Timer Blowdown we can calculate than the solenoid valve will blowdown approx. 40 lts/minute @ 1000 Kpa and if on for 60 seconds will deliver 40 lts of blowdown, - the delay period can be calculated as follows:-

Blowdown required per minute = 265.8/60 = 4.42 lts/min, and the solenoid valve delivers 40.0 lts/min when open, then the delay or shut period = 40.0/4.42 = 9.04 minutes delay.

If the boiler has a constant steaming rate this type of blowdown will provide good control on T.D.S. levels, however if the steaming load varies from day to day then the delay period on the timer needs to be adjusted daily, or worse still if the load varies from hour to hour, the delay period would need to be adjusted hourly, and practically, it is virtually impossible to control T.D.S. with this technique on a boiler with a fluctuating load cycle.

Take the example of a mushroom grower, where the steam load is required to maintain temperature in the growing rooms, - with cool nights, the boiler may be at 100% load at night time, but only at 20 -30% of load during the hotter daytime hours. With the Timer Blowdown as above the T.D.S. will be maintained during the night time, but at 30% load only 88.6 lts/hr. blowdown is required and T.D.S. will drop as blowdown is set for 265.8 lts/hr. to approx. 1000 ppm T.D.S. with resulting wastage of hot water and chemicals. - **See Graph 4.**



Even worse if the Boiler Water analysis were carried out in the afternoon, the analysis indications are of excessive blowdown, and if the delay period is reset to 33% of that previously set to allow the T.D.S. to built up to the desired 3000 ppm. level, then the T.D.S. at night will be greatly excessive of the desired levels, with consequences as previously outlined.

Boiler Conductivity Control units, especially those units where the conductivity sensor probe cannot be installed directly in the boiler water, normally have a repeat cycle timer similar to that described above, which is used to open a solenoid valve to allow a sample of boiler water to pass by the conductivity probe or sensor for a short period, and if the measured conductivity at the end of this period, is above the set point, the solenoid continues to be held open until sufficient blowdown from the boiler has reduced the boiler water conductivity to the Set Point value on the controller.

However even these type of boiler conductivity controllers have difficulty where fluctuating loads are encountered, - either the time delay period for sampling is too short when on low load, resulting in excessive blowdown, and low ppm T.D.S., or the time delay period is too long when the boiler is on close to full load conditions allowing for excessive build up of T.D.S. before sampling and subsequent blowdown.

From a series of computer spreadsheet calculations it was clearly demonstrated to us that the blowdown sampling period required the following to maintain the desired level of T.D.S. under fluctuating load conditions - which incidentally are the majority of small boilers.!!

The conditions required are as follows:-

(a) The delay period should be proportional to evaporation rate and thus should modulate with evaporation rate.!

(b) The delay period should be as small as possible to allow for the minimum increase in T.D.S. between blowdown periods.!

(c) The sample period should be small but long enough to allow for boiler water temperatures to be experienced by the probe before conductivity takes over

(d) Conductivity measurement should be included to take over at end of sample period to automatically blowdown to the Set Point level.

From the previous data and thinking the **Aquarius 950BW** series of controllers have been designed, which allows for:-

(a) a signal to be taken from the ON/OFF feed pump to modulate the blowdown sampling rate, in direct proportion to the evaporation rate, and
(b) conductivity sensing and control on each sample as an override to maintain the desired levels of T.D.S. independent of load, or varying feedwater characteristics.

Design of a manifold to house, solenoid blowdown valve, y - strainer, probe housing, isolation valves, and with an orifice to limit blowdown rates to less than 500 lts/hr. was necessary to cover the huge range of small boiler capacities, and the range of amounts of blowdown required on the various water supplies