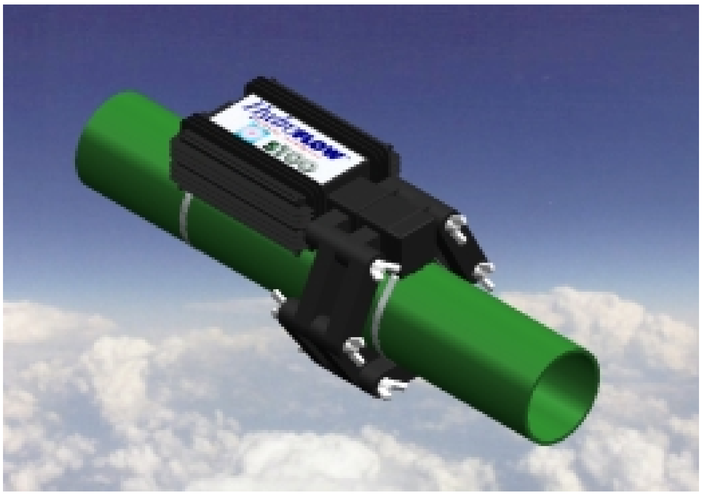
Use of HydroFLOW technology with Boilers

By D. Stefanini May 2002



Steam Boiler also called STEAM GENERATOR, apparatus designed to convert a liquid to vapor. In a conventional steam power plant, a boiler consists of a furnace in which fuel is burned, surfaces to transmit heat from the combustion products to the water, and a space where steam can form and collect. A conventional boiler has a furnace that burns a fossil fuel or, in some installations, wastes fuels. A nuclear reactor can also serve as a source of heat for generating steam under pressure.

Modern boilers are made of alloy steel to withstand high pressures and extremely high temperatures. Most conventional steam boilers are classed as either fire-tube or water tube types. In the fire-tube type, the water surrounds the steel tubes through which hot gases from the furnace flow. The steam generated collects above the water level in a cylindrically shaped drum. A safety valve is set to allow escape of steam at pressures above normal operating pressure; this device is necessary on all boilers, because continued addition of heat to water in a closed vessel without means of steam escape results in a rise in pressure and, ultimately, in explosion of the boiler. Fire-tube boilers have the advantage of being easy to install and operate. They are widely used in small installations to heat buildings and to provide power for factory processes. Fire-tube boilers are also used in steam locomotives. In the water tube boiler, the water is inside tubes with the hot furnace gases circulating outside the tubes.

Modern water tube boilers were developed in response to the demand for large quantities of steam at pressures and temperatures far exceeding those possible with fire-tube boilers. The tubes are outside the steam drum, which has no heating surface and is much smaller than in the fire-tube boiler. For this reason, the drum of the water tube boiler is better able to withstand higher pressures and temperatures. A wide variety of sizes and designs of water tube boilers are used in ships and factories. The express boiler is designed with small water tubes for quick generation of steam. The flash boiler may not require a steam drum, because the tubes operate at such high temperatures that the feed water flashes into steam and superheats before leaving the tubes. The largest units are found in the central-station power plants of public utilities. Units of substantial size are used in steel mills, paper mills, oil refineries, chemical plants, and other large manufacturing plants.

The theory of producing steam

Water and steam are used as heat carriers in heating systems. It is well known that water boils and evaporates at 100°C under atmospheric pressure. By higher pressure, water evaporates at higher temperature - e.g. a pressure of 10 bars equals an evaporation temperature of 184°C. During the evaporation process, pressure and temperature are constant, and a substantial amount of heat are use for bringing the water from liquid to vapour phase. When all the water is evaporated, the steam is called dry saturated. In this condition the steam contains a large amount of latent heat, corresponding the heat that was led to the process under constant pressure and temperature. So despite temperature and pressure is the same for the liquid and the vapour, the amount of heat is much higher in vapour compare to the liquid. This latent heat in the dry saturated steam can efficiently be utilised to different processes requiring heat. The steam boiler or steam generator is connected to the consumers through the steam and condensate piping. When steam is supplied to the consumers, it condenses. It can then be returned to the feed water tank, from where it again is pumped to the steam boiler / steam generator. In some applications the steam is used up in the process, (e.g. Garment factories steam used for ironing) In other applications the condensate is not fully or partly recycled, and then a make-up of fresh and pre-treated feed water is established. This preheating is effected in a heat exchanger that recovers the heat from the condensate and transfers it to the feed water.

Steam generator versus steam boiler

Opposite the principle of the steam boilers, the water in the steam generators evaporates inside the tube waned up into serial connected tube coils. The feed water is heated up to the evaporation temperature and then evaporated. The intensity of the heat, the feed water flow and the size/length of the tube are adapted, so that the water is exactly fully evaporated at the exit of the tube. This ensures a very small water and steam volume (content of the pressure vessel). Thus there are no buffers in a steam generator, and is it temporary overloaded i.e. beyond its nominal steam capacity - a separate buffer tank should be provided. The advantages using a steam generator compare to conventional steam boilers:

- Easy to operate - normally no requirement for boiler authorisation
- Rapid start-up and establishing full steam pressure
- Compact and easy to adapt in the existing machinery arrangement
- Price attractive - especially at low steam rates.

Steam Generator Design
Steam generators can be delivered in horizontal execution (with low height), or in vertical execution (occupying limited floor space). Like the steam boilers they are delivered insulated with stainless steel cover sheets and complete with burner, armatures, instrumentation, safeties and a control panel - and with full documentation including necessary certificates.

The steam generators heaters are made with coils made of seamless tubes, where the feed water is preheated and evaporated during the flow through these. The heat is transferred to the water/steam mixture as radiant heat in the combustion chamber, where the inner cylindrical tube coil and a flat tube coil forms the chamber wall and the bottom respectively. Consequently refractory concrete is avoided. The combustion gasses are hereafter cooled in the outer convection part, as the gasses pass the space between the two tube coils. The thermal design ensures a modest volume of steam relative to the size of the heater, and allows unlimited thermal expansion due to the high temperatures. All TT Boilers steam generators and steam boilers are designed and equipped according to German TRD boiler regulations and Danish AT boiler regulations (and corresponding ratified EN-norms).

Beside the standard execution the steam generators can be delivered in e.g. following variations:

- Electrical heated, including EX-design if required
- Material in stainless steel
- Complete skid-mounted with tanks and pre-treatment equipment.
- Build in a container.

Exhaust Gas Boilers · Economizers
Steam can be produced not only by oil or gas-fired burners, but also by utilizing the substantial amount of waste heat in hot flue gasses or exhaust air. The steam evaporation is done like the steam generators, and are gives therefore a rapid acting and compact unit.

Boiler examples

TT BOILERS · 3-PASS STEAM BOILERS · type DJ / DJM

TT BOILERS, type DJ

The larger DJ steam boiler is a modern and efficient 3-pass fire tube boiler. It offers a reliable design with no compromises - especially for industrial heating.

The boilers are equipped with high quality burner for light oil, gas, heavy fuel oil or combinations hereof.

- High efficiency : Up to **90 - 91%**
- **320 - 6000 kg/h** steam at 1 bar up to 16 bar.
- Easy to access for inspection and cleaning.
- Blow-down during operation

Finish with stainless steel cover sheets

<u>TABLE VALUES · Presumptions</u>:
The below stated values for heat capacity and fuel consumptions are based on 60°C feed water temperature, 5 bar steam pressure, 90% efficiency and normal European quality light fuel oil (Hi=42.300 kJ/kg) and natural gas (Hi=39.600 kJ/Nm³).

TT BOILERS, type DJM

The smaller DJM offers the same advantages as the DJ, including a full 3-pass design. This type is an alternative to the steam generator dedicated those who prefer the classic steam boiler with a good steam buffer facility for varying operations. The DJM is less sensible to lack of feed water treatment compare to steam generators, and it has a slightly higher efficiency also.

- High efficiency : Up to **90 - 91%**
- **125 - 400 kg/h** steam at 0,5 barg up to 20 barg.
- Easy to access for inspection and cleaning.
- Blow-down during operation
- Finish with stainless steel cover sheets

- Steam Generators

TT BOILERS · STEAM GENERATORS · type DT

Steam Generator - Vertical type

INTRODUCTION
Opposite conventional steam boilers, the water in the steam generators contains a very small water and steam volume (content of the pressure vessel). This gives a lot of advantages:

- Easy to operate - normally no requirement for boiler authorisation

- Rapid start-up and establishing full steam pressure
- Compact and easy to adapt in the existing machinery arrangement
- Price attractive - especially at low steam rates.
- Approved for industry, marine and offshore.

The steam generators are delivered in the range **150 - 5,000 kg/h** steam at **1 bar** all the way up to **190 bar** (for special applications). These complete units are easy to install and does not require any special foundation, but can be place directly on concrete floor. Rapid start-up down to **2 - 3 minutes** on the smaller sizes.

All DT steam generators are carefully checked, controlled and function tested prior to dispatch from the workshop. **EXTENT OF DELIVERY**

DT steam generators can be delivered in horizontal execution (with low height), or in vertical execution (occupying limited floor space). They are delivered insulated with stainless steel cover sheets and complete with burner, armatures, instrumentation, safeties and a control panel - and with full documentation including necessary certificates.

Making the Steam Generators

CONSTRUCTION

The steam generators heaters are made with coils made of seamless tubes, where the feed water is preheated and evaporated during the flow through these. The heat is transferred to the water/steam mixture as radiant heat in the combustion chamber, where the inner cylindrical tube coil and a flat tube coil forms the chamber wall and the bottom respectively. Consequently refractory concrete is avoided. The combustion gasses are hereafter cooled in the outer convection part, as the gasses pass the space between the two tube coils. The thermal design ensures a modest volume of steam relative to the size of the heater, and allows unlimited thermal expansion due to the high temperatures. All TT Boilers steam generators and steam boilers are designed and equipped according to German TRD boiler regulations and Danish AT boiler regulations (and corresponding ratified EN-norms).

DT steam generators are made in carbon steel and different grades of stainless steel.

TECHNICAL DATA

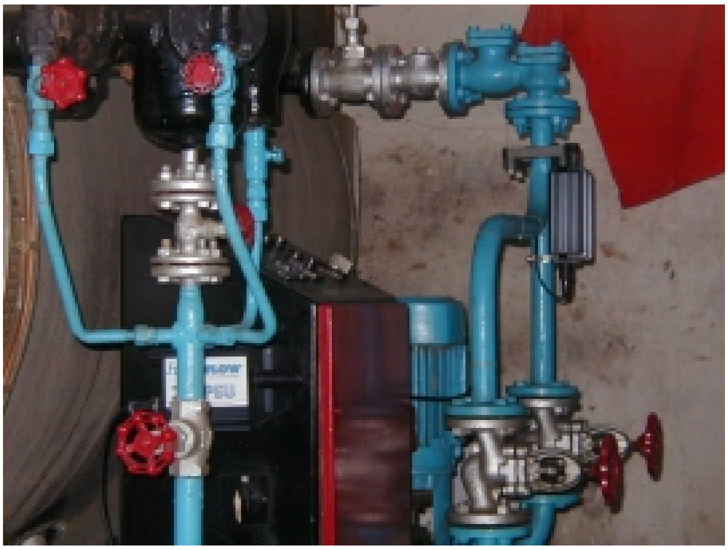
Capacities	**80 - 5.000** kg/hour
Operating. Pressure	**0,5 - 190** bar gauge
Fuel	Gas, light oil, heavy fuel oil and combinations hereof.
Efficiencies	**87 - 90%**
Product Range	See table below
Dimensions	See table below

BURNERS
As standard the heaters are provided by international recognized and only high quality burner brands - for natural gas, light fuel oil, heavy fuel oil and combinations (dual fuel). Demands for special burner designs can be meet and adapted in the heater design.

SPECIAL DESIGNS
Beside the standard execution the DT steam generators can be delivered in e.g. following variations:

- Electrical heated, including EX-design if required
- Material in stainless steel
- Complete skid-mounted with tanks and pre-treatment equipment.
- Build in a container.

Water treatment



Water that contains salts of calcium and magnesium principally as bicarbonates, chlorides, and sulfates. Ferrous iron may also be present; oxidized to the ferric form, it appears as a reddish brown stain on washed fabrics and enameled surfaces. Water hardness that is caused by calcium bicarbonate is known as temporary, because boiling converts the bicarbonate to the insoluble carbonate; hardness from the other salts is called permanent. Calcium and magnesium ions in hard water react with the higher fatty acids of soap to form an insoluble gelatinous curd, thereby causing a waste of the soap. This objectionable reaction does not take place with modern detergents.
In Water used in steam boilers, the presence of metal ions is undesirable, as, for example, in water, in which calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions cause hardness. In such cases the undesirable effects of the metal ions frequently can be eliminated by "sequestering" the ions as harmless complexes through the addition of an appropriate complexing reagent. Ethylene-diamine-tetra-acetic acid (EDTA) forms very stable complexes and is widely used for this purpose. Its applications include water softening (by tying up Ca^{2+} and Mg^{2+}) and the preservation of organic substances, such as vegetable oils and rubber, in which case it combines with traces of transition metal ions that would catalyze oxidation of the organic substances.

In boilers, the calcium and magnesium in hard waters form a hard, adherent scale on the plates or tubes. As a result of the poor heat conductivity of the scale, fuel consumption is increased, and the boiler deteriorates rapidly through the external overheating of the plates and tubes. Sodium carbonate, if present, hydrolyzes to produce free alkali that causes caustic embrittlement and failure of the boilerplates and tubes. Water is softened on a small scale by the addition of ammonia, borax, or tri-sodium phosphate, together with sodium carbonate (washing soda). The latter precipitates the calcium as carbonate and the magnesium as hydroxide. Water is softened on a large scale by the addition of just enough lime to precipitate the calcium as carbonate and the magnesium as hydroxide, whereupon sodium carbonate is added to remove the remaining calcium salts. In areas where the water is hard, water softeners are used, making use of the properties of natural or artificial zeolite minerals and resins.

Water Softener is a device for removing calcium and magnesium from water; Water softeners usually consist of zeolite or an ion-exchange resin in a tank connected directly into the water system. The zeolite or resin contains sodium ions that change places with the calcium and magnesium ions dissolved in the water. When the zeolite or resin becomes exhausted (when most of its exchangeable sodium is replaced with calcium and magnesium), it can be regenerated by washing with a strong solution of common salt, which removes the calcium and magnesium and replaces them once again by sodium. This process generates pollution of the waterways by discharging large quantities of concentrated salt solution. Water so treated; in theory will not form insoluble scale in pipes and tanks. However in practice water softener are often allowed to operate long periods without regeneration or salts. The zeolite or resins require periodic replacement as their efficiency decline. Chemical water treatment requires expertise often unavailable in industrial and commercial applications. As a result even well maintained boilers are found; to be coated with scale that considerably reduce their efficiency. Calcium carbonate is not soluble and requires costly acid treatment to remove. The resumption of proper operation of the water softeners will not correct the problem; as the soft water is unable to dissolve the Calcium carbonate. The introduction of anti-scale chemicals will not correct the problem it can only prevent further deposits. Water treated by softeners becomes aggressive to metals and require to be treated with anti-corrosive chemicals, the introduction of ***Hydro*FLOW** technology in steam boiler system will dissolve existing scale, prevent new scale and improve efficiency by 30-50%.
Steam boiler operators are reluctant to change the water treatment methods that they have been trained to perform and will want to continue with softening and slowly reduce it to be safe.
This will be a mistake and will prevent ***Hydro*FLOW** technology from operating properly. The reasons are as follows:

1. Water treatment by softening is never perfect; as a result boilers experience scaling and anti-scaling chemicals are required.
2. Softened water is aggressive and requires anti-corrosion chemicals to be introduced to prevent corrosion damage to the boiler.
3. Soft water cannot dissolve carbonate deposits; as a result acid cleaning of the boiler is regularly required.
4. If **hard feed water** is used; ***Hydro*FLOW** technology will produce precipitation of all the calcium salts in solution, converting the bicarbonates to suspended carbonate crystals (see following text).
   $Ca(HCO_3)_2$ ------> $CaCO_3$ + H_2O + CO_2
   Calcium bicarbonate — Calcium carbonate deposits.
5. CO_2 under pressure in the boiler is converted to carbonic acid.

6. Carbonic acid will combine with existing carbonate deposits to form bicarbonates that are soluble and will dissolve in the water
 $CaCO_3 + H_2O + CO_2$ ------> $Ca (HCO_3)_2$.
7. ***Hydro*FLOW** technology precipitates the bicarbonates from solution to suspension by introducing clusters of ions in the water to act as seed for suspended crystallisation (see following text).
 $Ca (HCO_3)_2$ ------> $CaCO_3$ $+ H_2O + CO_2$
 Calcium bicarbonate Calcium carbonate suspended crystals.

8. The suspended crystals are removed from the boiler in the blow-down.
9. The existing carbonates deposits are gradually dissolved; improving heat transfer and efficiency of the boiler.
10. **The introduction of *Hydro*FLOW technology will only be effective if soft feed-water is replaced with hard feed-water.**

The introduction of ***Hydro*FLOW** technology in steam boiler system, to apply an electrical field to the feed water will eliminate scaling of the feed water condensers and the boiler tubes, thus enabling the use of untreated feed water, thus eliminating salt water and other chemical pollution of the environment.

In order to understand the way this electrical field is applied, it is necessary to understand the basic theory of electromagnetic waves; their generation and effects and basic theory of transformers. It is also necessary to understand the fundamental principles of Crystallisation, scale-forming mechanisms, and hardness of water. This understanding will help to prevent some misconceptions held by many, including academics not involved directly in the field of electronics.

FUNDAMENTAL PRINCIPLES.

CRYSTALLISATION.

Crystallisation normally occurs when a solution becomes supersaturated. A supersaturated solution is one that contains higher concentration of dissolved solute than its equilibrium concentration. However super saturation alone is not sufficient for a system to begin to crystallise. It is generally accepted that two steps are involved in the formation of microscopic crystals from supersaturated solutions: First, nuclei, minute crystalline entities of definite size must be formed (nucleation) ***Hydro*FLOW**

technology can perform this step as described below; and second, these nuclei must grow (crystal growth). There are many other variables, which influence the nucleation and growth of crystals such as: The presence of the impurities; the turbulence within the system; the nature and state of the surfaces in contact with the solution etc.
There are two basic nucleation mechanisms:

- Homogeneous nucleation where the nucleus is formed spontaneously from the mother solution; and
- Heterogeneous nucleation where a foreign substance, (such as an impurity), a metal surface or another nucleus acts as a seed for precipitation to occur.

Any crystallizing system is characterized by the generation of a spectrum of differently sized particles under conditions where new crystals, generated through nucleation, are being advanced in size by crystal growth and are interacting with existing crystals in a complex and unpredictable manner.

SCALE FORMING MECHANISMS.

Both homogeneous and heterogeneous nucleation are of interest in scale deposition mechanisms, although it is unlikely that homogeneous nucleation occurs very often in steam boilers (except when ***Hydro*FLOW** is installed). In fact, homogeneous nucleation only occurs in bulk solution away from surfaces when super-super saturation has been reached. There are many potential nucleation sites for heterogeneous precipitation: suspended particles in the solution, the walls of a pipe of the heat exchanger, welds and other stress points in metals, oxide films, fingerprints etc. Once nucleation has occurred, crystal growth on existing nuclei follows rapidly. If nucleation occurs on the pipe or vessel wall, scale growth would continue and the observed deposit is a hard encrusted layer. This type of scale requires aggressive techniques (acid washing or scraping) to dislodge. If, on the other hand, nucleation occurs on suspended particles in the body of the solution, scale growth would continue within the solution until the crystals are large enough to settle as sludge in the bottom of the heat exchangers. This type of scale is not encrusting and can be dislodged easily either by brushing or hosing under moderate pressures. If ***Hydro*FLOW** is installed, most of the scale is formed in the form of suspended crystals 10-50 micron in size and that are discharged in the blow down operation. The homogenous crystallization releases Carbon dioxide (CO_2) and water, under pressure these form Carbonic acid, reacting with Calcium carbonate coating the heat exchanger, the Carbonic acid reaction with calcium carbonate form calcium bicarbonate that is soluble in water. This process continues until the boiler is completely clear of scale. Testing the T.D.S. of the blow-down water can easily see this effect.

INDUCTION.

Induction is the creation of an electric current in a conductor moving across a magnetic field (hence the full name, electromagnetic induction).

ELECTRIC GENERATOR.

When a conductor, such as a wire, moves through the gap between the poles of a magnet, the negatively charged electrons in the wire will experience a force along the length of the wire and will accumulate at one end of it, leaving positively charged atomic nuclei, partially stripped of electrons, at the other end. This creates a potential difference, or voltage, between the ends of the wire. If a conductor connects the ends of the wire, a current will flow around the circuit. This is the principle behind the rotary electric power generator, in which a loop of wire is spun through a magnetic field so as to produce a voltage and generate a current in a closed circuit.

ELECTRIC TRANSFORMER.

Induction occurs only if the wire moves at right angles to the direction of the magnetic field. This motion is necessary for induction to occur, but it is a relative motion between the wire and the magnetic field. Thus, an expanding or collapsing magnetic field can induce a current in a stationary wire. Such a moving magnetic field can be created by a surge of current through a wire or electromagnet (the primary coil in the ***Hydro*FLOW** unit). As the current in the electromagnet rises and falls, its magnetic field grows and collapses (the coaxial magnetic lines. The lines of force move outwards, then inwards). The moving field can induce a current in a nearby stationary wire (the pipe and the feed water in it). Such induction without mechanical motion is the basis of the electric transformer. A transformer usually consists of two adjacent coils of wire wound over a single core of magnetic material (the ferrite ring). It is used to couple two or more AC circuits by employing the induction between the coils. When the current in a conductor varies, the resulting changing magnetic field cuts across the conductor itself (the feed water in the pipe) and induces a voltage in it. This self-induced voltage is opposite to the applied voltage and tends to limit or reverse the original current. Electric self-induction is thus analogous to mechanical inertia. An inductance coil, or choke, tends to smooth out a varying current, as a flywheel smoothes out the rotation of an engine.

- Hardness.

Salts of calcium are dissolved in the feed water. These take the form of bicarbonates of calcium.

- Temporary hardness-alkaline hardness.

Calcium decomposed by the action of heat, part of the carbon dioxide then being released:

$Ca(HCO_3)_2$ ------> $CaCO_3 + H_2O + CO_2$

Calcium bicarbonate Calcium carbonate.

Since the simple action of heating the feed water will remove bicarbonates the term "temporary" has been used, although this could be called "Alkaline hardness" as a precise distinction.

- Dissolved solids.

The mineral salts found in feed water. These substances do not exist in solution as definite compounds, but as "ions" - charged soluble particle of metal (known as cations) or as acid radicals (know as anions). The most commonly occurring cations are:

Calcium	Ca++

The most commonly occurring anions are:

Bicarbonate	HCO3-

The negative and positive signs indicate polarity of electron charge. The negative sign indicated electron gain, positive sign electron loss. Contaminants can be grouped according to polarity and magnitude of charge.

The ***Hydro*FLOW PATENTED TECHNOLOGY**

A unique and new approach to physical solute treatment
The most important feature of the ***Hydro*FLOW** technology that sets it apart from that of any competing technology is the efficient manner by which the electric field is directionally generated through the entire system.

This unique advantage protected by international patents singularly delivers consistently beneficial results in industrial, commercial, and domestic applications.

***Hydro*FLOW THEORY OF OPERATION**.

A feed water system must be regarded as an open circuit from the electrical point of view. It would be impractical and expensive to form a reliable circuit from a feed water system, whereby an electrical current flows through every section of the system.

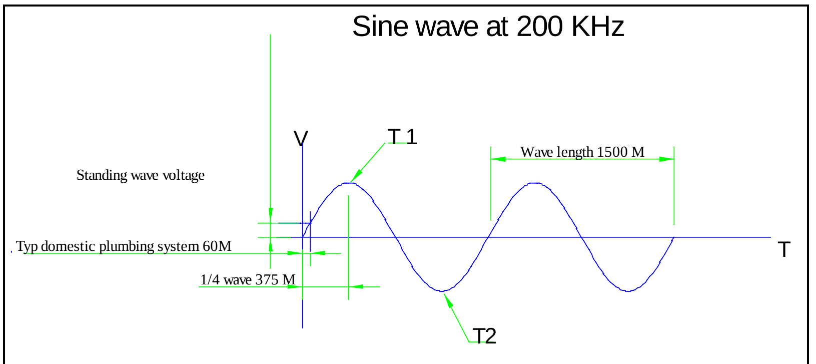


Fig. 5

To generate a reasonable flow of electrons in an open circuit conductor, it is necessary to provide a source of high frequency to a conductor that is long enough to generate a standing wave voltage over its length. Fig 5 shows a sign wave of 200 KHz. The wavelength is 1500 m;

the ¼ wavelength is 375 m. A feed water pip work in the relevant section is approximately 100 m. If the source is 29 V then the standing wave voltage will be [sin ((100/375)*90)]*29 = 11.79V between one end of the system and the other. This voltage difference between the extremities of the pipes is caused by a substantial flow of electrons from one end to the other of the system. Fig 6 represents the position at T 1 on Fig 5 and Fig 7 represent the position at T 2 on Fig5. To achieve this flow of electrons in the feed water system, a voltage must be generated in the water in the direction of the pipe. This is achieved by utilising a high frequency transformer. This transformer consists of a ferrite ring around the feed water pipe. A primary coil is wound around the ferrite ring. Any conductor, the feed water and the pipe (if it is a conductive material) will form parallel secondary windings of the transformer. The signal that is fed to the primary coil is a high frequency diminishing wave with random wait periods. This wave is designed to allow the formation of seed crystals for a variety of crystal forming ionised salts conditions that may be present in the feed water.

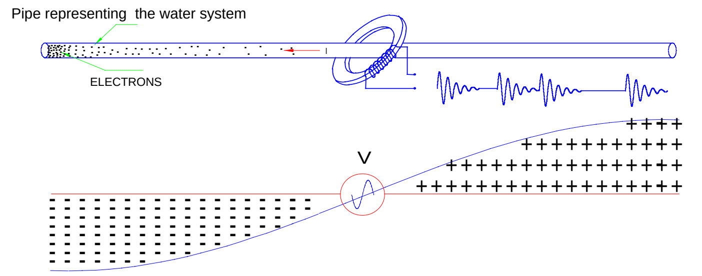


Fig. 6

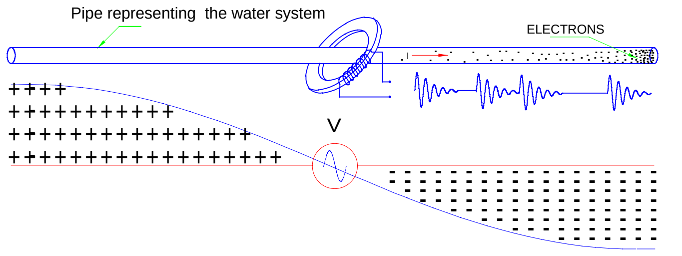


Fig. 7

marked T1 and T2 in Fig. 5, as Fig. 6 and Fig. 7 illustrate the diminishing wave and the voltage V over the feed water system at specific times as well as the position of the electrons, and the positively charged atoms in the conducting feed water (and pipe), at maximum voltage position. [V] Is the voltage generated by the ferrite ring and. [I] is the accelerated charge generated due to the standing wave.
It is this acceleration that forms the electromagnetic field. The electric component is responsible for the generation of nuclear clusters that act as seed crystals to prevent the formation of encrusting scale.

SCALE REMOVAL.

In a scaling system there are three processes that are at work: Heterogeneous crystallisation, homogeneous crystallisation and the return to solution of the scale when the solute has become unsaturated. Heterogeneous crystallisation occurs mainly on surfaces that are subject to increasing temperatures. Homogeneous crystallisation occurs in large vessels containing a large volume of solute with relatively small surface area, as the solute is being heated, the solution becomes supersaturated. The surface area is not sufficient to provide all the nucleation necessary. The solute reaches a critical condition. At this point any source of energy, like turbulence in the solute will cause homogeneous nucleation. A large number of small crystals are formed. These crystals have a high surface charge that causes them to adhere to all the surfaces. The fine crystals adhere to the surfaces and will become the nuclei for heterogeneous crystallisation in subsequent heating cycles. This process explains the reason for scale deposits on surfaces other than the ones being heated. The third process is the return to solution of the scale deposits. After the solute has become unsaturated due to the presence of carbonic acid and turbulence, a quantity of the deposits will be returned to solution. In addition some scale will return to solution when new unsaturated solute is introduced. If ***Hydro*FLOW** is installed, most of the scale is formed in the form of suspended crystals 10-50 micron in size and that are discharged in the blow down operation. The homogenous crystallization releases Carbon dioxide (CO_2) and water, under pressure these form Carbonic acid, reacting with Calcium carbonate coating the heat exchanger, the Carbonic acid reaction with calcium carbonate form calcium bicarbonate that is soluble in water. This process continues until the boiler is completely clear of scale. Testing the T.D.S. of the blow-down water, one can easily see this effect. Initially the T.D.S will show an increase due to the solution of the carbonate deposits. As the deposits are dissolved the T.D.S will show a reduction and later will stabilize, indicating that all the carbonic deposits have been dissolved.

In every system containing solute, there is a balance of scale-formation and scale-solution. In a system where the balance is in favour of scale-formation, the system will experience scaling. In a system where the balance is in favour of scale-solution, the system will remain free of scale in a steam boiler heat exchanger both conditions exist due to ***Hydro*FLOW** the scale solution prevail.

***Hydro*FLOW** simply tips the balance in favour of the scale-solution, by providing ion clusters to begin crystallisation in suspension and carbonic acid to dissolve calcium carbonate deposits to calcium bicarbonate that will be dissolved in the water. HF generated seed crystals will precipitate carbonates in suspension.
Inside heat exchanger pipes, a large quantity of unsaturated water is formed due to turbulence near the heat exchanger pipes walls, which with the aid of carbonic acid dissolve the existing scale. ***Hydro*FLOW** provide seed crystals to precipitate the dissolved solids in suspension. This occurs when the solution become super-saturated due to turbulence reduced pressure and increased heat. Since the heterogeneous crystallisation is replaced by homogeneous crystallisation. But in this case homogeneous crystallisation occurs in the middle of the heat exchanger pipe.

Steam Boiler Glossary

Dry steam, steam which does not contain water held in suspension mechanically; -- sometimes applied to superheated steam.

Exhaust steam. See under Exhaust.

High steam, or High-pressure steam, steam of which the pressure greatly exceeds that of the atmosphere.

Low steam, or Low-pressure steam, steam of which the pressure is less than, equal to, or not greatly above, that of the atmosphere.

Saturated steam, steam at the temperature of the boiling point which corresponds to its pressure; -- sometimes also applied to wet steam.

Superheated steam, steam heated to a temperature higher than the boiling point corresponding to its pressure. It can not exist in contact with water, nor contain water, and resembles a perfect gas; -- called also surcharged steam, anhydrous steam, and steam gas.

Wet steam, steam which contains water held in suspension mechanically; -- called also misty steam.

Note: Steam is often used adjectively, and in combination, to denote, produced by heat, or operated by power, derived from steam, in distinction from other sources of power; as in steam boiler or steam-boiler, steam dredger or steam-dredger, steam engine or steam-engine, steam heat, steam plow or steam-plow, etc.

Steam blower.
(a) A blower for producing a draught consisting of a jet or jets of steam in a chimney or under a fire.
(b) A fan blower driven directly by a steam engine.

Steam boiler, a boiler for producing steam. See Boiler, 3, and Note. In the illustration, the shell a of the boiler is partly in section, showing the tubes, or flues, which the hot gases, from the fire beneath the boiler, enter, after traversing the outside of the shell, and through which the gases are led to the smoke pipe d, which delivers them to the chimney; b is the manhole; c the dome; e the steam pipe; f the feed and blow-off pipe; g the safety value; hthe water gauge.

Steam car, a car driven by steam power, or drawn by a locomotive.

Steam carriage, a carriage upon wheels moved on common roads by steam.

Steam casing. See Steam jacket, under Jacket.

Steam chest, the box or chamber from which steam is distributed to the cylinder of a steam engine, steam pump, etc., and which usually contains one or more values; -- called also valve chest, and valve box. See Illust. of Slide valve, under Slide.

Steam chimney, an annular chamber around the chimney of a boiler furnace, for drying steam.

Steam coil, a coil of pipe, or collection of connected pipes, for containing steam; -- used for heating, drying, etc.

Steam colors (Calico Printing), colors in which the chemical reaction fixed the coloring matter in the fiber is produced by steam.

Steam cylinder, the cylinder of a steam engine, which contains the piston. See Illust. of Slide valve, under Slide.

Steam dome (Steam Boilers), a chamber upon the top of the boiler, from which steam is conduced to the engine. See Illust. of Steam boiler, above.

Steam fire engine, a fire engine consisting of a steam boiler and engine, and pump which is driven by the engine, combined and mounted on wheels. It is usually drawn by horses, but is sometimes made self-propelling.

Steam fitter, a fitter of steam pipes.

Steam fitting, the act or the occupation of a steam fitter; also, a pipe fitting for steam pipes.

Steam gas. See Superheated steam, above.

Steam gauge, an instrument for indicating the pressure of the steam in a boiler. The mercurial steam gauge is a bent tube partially filled with mercury, one end of which is connected with the boiler while the other is open to the air, so that the steam by its pressure raises the mercury in the long limb of the tume to a height proportioned to that pressure. A more common form, especially for high pressures, consists of a spring pressed upon by the steam, and connected with the pointer of a dial. The spring may be a flattened, bent tube, closed at one end, which the entering steam tends to straighten, or it may be a diaphragm of elastic metal, or a mass of confined air, etc.

Steam gun, a machine or contrivance from which projectiles may be thrown by the elastic force of steam.

Steam hammer, a hammer for forging, which is worked directly by steam; especially, a hammer which is guided vertically and operated by a vertical steam cylinder located directly over an anvil. In the variety known as Nasmyth's, the cylinder is fixed, and the hammer is attached to the piston rod. In that known as Condie's, the piston is fixed, and the hammer attached to the lower end of the cylinder.

Steam heater.
(a) A radiator heated by steam.
(b) An apparatus consisting of a steam boiler, radiator, piping, and fixures for warming a house by steam.

Steam jacket. See under Jacket.

Steam packet, a packet or vessel propelled by steam, and running periodically between certain ports.

Steam pipe, any pipe for conveying steam; specifically, a pipe through which steam is supplied to an engine.

Steam plow or plough, a plow, or gang of plows, moved by a steam engine.

Steam port, an opening for steam to pass through, as from the steam chest into the cylinder.

Steam power, the force or energy of steam applied to produce results; power derived from a steam engine.

Steam propeller. See Propeller.

Steam pump, a small pumping engine operated by steam. It is usually direct-acting.

Steam room (Steam Boilers), the space in the boiler above the water level, and in the dome, which contains steam.

Steam table, a table on which are dishes heated by steam for keeping food warm in the carving room of a hotel, restaurant, etc.

Steam trap, a self-acting device by means of which water that accumulates in a pipe or vessel containing steam will be discharged without permitting steam to escape.

Steam tug, a steam vessel used in towing or propelling ships.

Steam vessel, a vessel propelled by steam; a steamboat or steamship; -- a steamer.

Steam whistle, an apparatus attached to a steam boiler, as of a locomotive, through which steam is rapidly discharged, producing a loud whistle which serves as a warning signal. The steam issues from a narrow annular orifice around the upper edge of the lower cup or hemisphere, striking the thin edge of the bell above it, and producing sound in the manner of an organ pipe or a common whistle.

steam boiler
n : sealed vessel where water is converted to steam [syn: boiler]

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