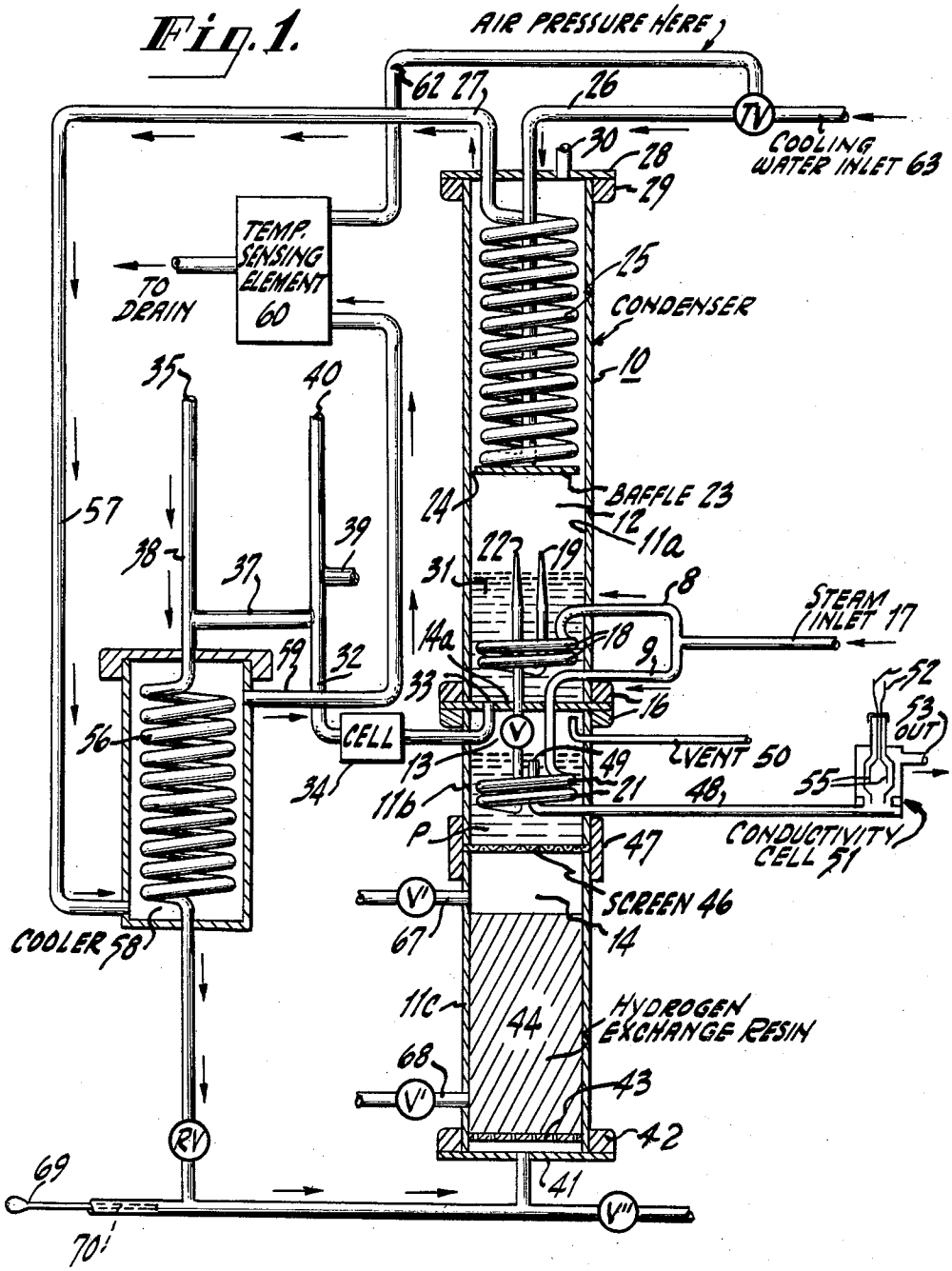
Nov. 24, 1964 T. E. LARSON ETAL 3,158,444

APPARATUS AND METHOD FOR DETERMINING STEAM PURITY

Filed Sept. 13, 1961 2 Sheets-Sheet 1

Fig. 1.

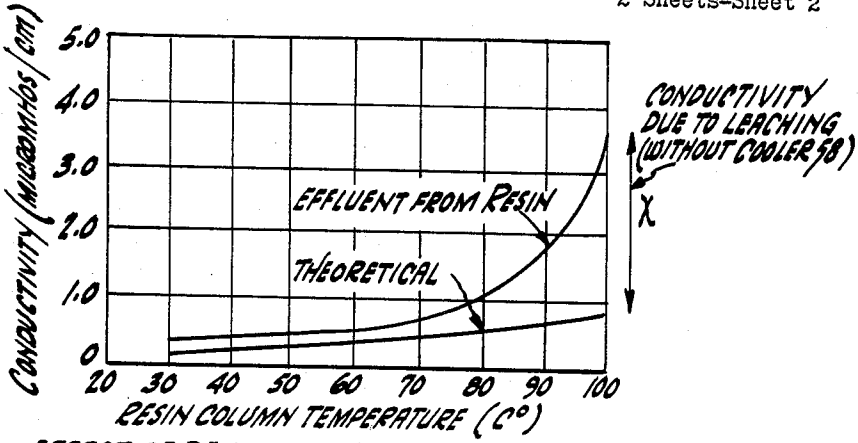


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EFFECT OF DEIONIZED WATER TEMPERATURE ON LEACHING OF HYDROGEN EXCHANGE RESIN

Fig. 2.

CONDUCTIVITY OF 1 PPM SALT SOLUTIONS (MICROMHOS/CM)

		CONVERTED TO ACID BY HYDROGEN EXCHANGER	
SALTS	SPECIFIC CONDUCTANCE AT 25 C	CONDUCTIVITY MEASURED AT 98.5 C, CORRECTED TO 25C	CONDUCTIVITY MEASURED AND RECORDED AT 98.5 C
NaCL	2.16	4.18	11.15
Na_2SO_4	1.83	3.76	10.03
$NaNO_3$	1.44	2.94	7.84
Na_3PO_4	1.44	1.36	3.62
	COL. 1	COL. 2	COL. 3	COL. 4

Fig. 3.

AVERAGE RATE OF CONDUCTIVITY INCREASE PER 100 PPB ANION IN ACID FORM (MICROMHO/CM)

ANION	MEASURED AT 98.5 C	MEASURED AT 98.5C CORRECTED TO 25C
CHLORIDE	2.54 - 0.84* = 1.70	0.97 - 0.05* = 0.92
SULFATE	2.20 - 0.84 = 1.36	0.84 - 0.05 = 0.79
NITRATE	1.80 - 0.84 = 0.96	0.69 - 0.05 = 0.64
PHOSPHATE	1.32 - 0.84 = 0.48	0.50 - 0.05 = 0.45

*CONDUCTIVITY OF PURE WATER

Fig. 4.

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APPARATUS AND METHOD FOR DETERMINING STEAM PURITY

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10 Claims. (Cl. 23—230)

This invention relates to a method of and apparatus for increasing the sensitivity of the conductivity measurement in the determination of the purity of steam or steam condensate, and is an improvement over the apparatus and method disclosed in our U.S. Patent, 2,832,673, granted April 29, 1958.

The steam purity analyzer disclosed in our Patent 2,832,673 has been widely used to measure steam purity in the presence of ammonia and/or amines by combining hydrogen exchange and degasification processes with measurement of conductivity at atmospheric boiling temperature. Essentially, the method employed in our patent consists in condensing steam at atmospheric boiling water temperature, passing it through a hydrogen exchanger to remove ammonia and/or amines and to convert boiler water salts to acids, and measuring the conductivity at boiling water temperature. The recording in the past has been at 25° C. (a lower temperature) by using an empirical correction factor. While it is recognized that the conductivity of hydroxide and carbonate is lost by the ion exchange and reboil processes, the increased conductivity of other boiler water solids by conversion to the acid form materially increases the conductivity value in most cases. The method of our patent was designed primarily to record deviations from a normal recording of conductivity. Because the limits of impurities have not been completely or quantitatively defined in the past, this method of measurement has proven satisfactory in many plants. Stated in other words, such method has been concerned with gross impurities in the steam of the order of 1 to 20 micromhos/cm. as recorded for 25° C. by the conductivity measurement.

At the higher steam pressures and temperatures which are required in many present day plants, however, the purity requirements have become more stringent and better defined, and the need for greater sensitivity and precision for the determination of the absolute value for solids in the steam has become essential. It has been reported by J. K. Rice in his article entitled "Steam Quality Measurements by Flame Photometer," Proc. Ann. Water Conf. Eng. Sec. of W. Pa., 17, 89–101 (1956), that sodium concentrations as low as .01 to 0.03 p.p.m. (parts per million) may cause deposits in turbines and that the current conductivity techniques were insufficiently sensitive for such detection. Such sodium concentrations require conductivity recordings corrected to 25° C., which are sensitive and accurate to 0.1 to 0.3 micromho/cm. The foregoing known method of measuring steam purity by conductivity cannot achieve such sensitivity and accuracy and has given rise to the belief that conductivity measurements for steam purity are invalid below a level of one micromho per cm.

The present invention refutes such belief and enables the measurement of conductivities as low as 0.1 microhmo/cm. at 98.5° C. equivalent to 0.008 p.p.m. sodium—and the sensitive and accurate recording of such low values.

It is, therefore, an object of the invention to provide a more sensitive and accurate method of and apparatus for the determination of steam purity.

Among the features of the present invention which cooperatively combine to achieve the higher degree of sensitivity and accuracy of measurement are: A cooling device located between the output from the vented condenser and the cation exchange bed (hydrogen exchange resin) which in combination with an automatically operated temperature control system achieves the dual purpose of (*a*) furnishing water (condensed steam) of constant and relatively low temperature to the cation exchange bed, as compared to the temperature of boiling water, and (*b*) assuring a constant and uniform regulation of the temperature in the reboil steam chamber; a manually adjustable value at the specific location between the reboil steam chamber and the vented condenser for obtaining greater reboil or increased heat transfer capacity from the steam condensed in the reboil coil; the method which includes the recording as well as measuring the conductivity of the steam sample subjected to ion exchange at a controlled temperature near 98.5° C.; and, an arrangement of valves for enabling the fast replacement of the hydrogen exchange resin by flowing the resin in and out of the steam purity analyzer, thereby eliminating the need to dismantle the equipment during resin replacement.

Other objects and features will appear from a reading of the detailed description of the invention which is given in conjunction with a drawing, wherein:

FIGURE 1 is a vertical sectional view of the apparatus of the invention suitable for carrying out our method for testing the purity of steam;

FIGURE 2 is a graphical representation of the effect of the temperature of deionized water on the leaching of hydrogen exchange resin material;

FIGURE 3 is a table showing the conductivity of different 1 p.p.m. (part per million) salt solutions in micromhos/cm., as measured and recorded at 98.5° C.; and

FIGURE 4 is a table showing the 98.5° C. degree conductivity of the acids formed by the reaction of the hydrogen exchanger with several added salt solutions, by the apparatus of the invention.

The method of our invention as applied to testing steam is best carried out in equipment such as that shown in FIGURE 1, in which the reference numeral **10** indicates generally an elongated tubular housing, formed of a number of sections **11***a*, **11***b* and **11***c* of brass or stainless steel tube, the sections preferably being all of the same diameter and adapted to be coupled together. The elongated housing **10** is divided into an upper compartment **12** and intermediate and lower compartments **13** and **14**, respectively, by means of an imperforate partition **14***a* between the upper and intermediate sections of tube, **11***a* and **11***b*. The partition **14***a* may suitably be clamped between collars **16** and secured to the lower and upper ends, respectively, of the sections **11***a* and **11***b*.

A valved steam inlet pipe, or tube, **17** extending from the boiler is coupled to a T or divider arrangement **8**, **9** as a result of which the steam in the tube **17** divides into two parts and flows through tubes **8** and **9**. The tube **8** extends into the lower portion of the upper compartment **12** and is there provided with a few coils **18**, or turns, terminating in an upwardly directed steam discharge nozzle **19**. The tube **9** extends into the lower portion of the upper compartment **12** and downwardly through the partition **14***a* into the intermedate compartment or reboil steam chamber **11***b*. The tube **9** is there provided with a few coils, or turns, **21** from which the tubing extends upwardly to form a steam discharge nozzle **22** that projects through the partition **14***a* and continues through the loop of the coils **18** to terminate

at substantially the same level as the discharge nozzle 19. This upwardly extending tubing terminating in discharge nozzle 22 is provided with a manually controllable valve V the purpose of which will be described in detail later. Valve V is provided with a control handle, not shown, extending externally of the section 11*b*.

The two nozzles 19 and 22, when the device 10 is in its intended position, extend parallel to each other and generally centrally of the tubular housing 10 for discharging their steam jets vertically upwardly. An impingement baffle plate 23 of stainless steel is mounted above the discharge ends of the nozzles 19 and 22, in spaced relation thereto, and nests within and is supported by the bottom turn of condenser or cooling coil 25. The impingement baffle 23 is slightly spaced from the wall of the tubular casing 11*a* as at 24, to permit the upward flow of the discharged steam around the peripheral edge of said baffle. Above the baffle and within the upper compartment 12 there is mounted a condenser 25 which may suitably take the form of a multi-turn copper cooling coil having an intake 26 for cooling water and an outlet 27 for the discharge of the water from the cooling coil. In practice, the nozzles are only open-ended tubes which are directed to the baffle plate in order to avoid impingement of the steam on the copper cooling coil. The condenser 25 is suitably suspended from a closure 28 attached to a collar 29, or the like, at the open upper end of the tubular section 11*a*. Closure 28 is provided with a vent 30 for the release of any non-condensable gases separated from the steam, or the condensate formed therefrom.

As the steam condenses in the upper portion of the upper compartment 12, due to the presence there of the condenser 25, the condensate falls down by gravity and collects on the partition 14*a* to provide a pond 31 of condensate over the partition 14*a*. A pipe 32 has an open end at the bottom of the pond 31. As shown in the drawing, this pipe passes through partition 14*a* and extends outwardly through the wall of the tubular section 11*b* and is in flow communication with a cell 34, which may be an electrode for measuring the conductivity of the condensate, or may be a pH electrode for measuring the hydrogen ion concentration of the condensate, or may be any other instrument or device for determining or measuring a characteristic of the condensate related to its purity. Because the cell 34 is similar to conductivity cell 51 shown at the output of the steam purity analyzer of the invention and contains similar parts, a description of the details of cell 51 will only be given. The cell 34, like cell 51, houses a pair of electrodes 55 from which wires 52 lead to a recorder (not shown) for indicating and recording the conductivity of the condensate in the cell. The electrodes and wires of cell 34 have not been illustrated as they have been in cell 51 in order not to detract from the clarity of the drawing.

From the cell 34, the tested condensate passes to a vertical length of tubing 32 and through a short length of tubing 37 to a vertical length of tubing 38. Any excess may overflow through a branch outlet 39. Overflow outlet 39 is at the same level as the level of the water in pond 31 in vented condenser 12. The uppermost end of the tubing 32 is open to the atmosphere, as indicated at 40.

Also connected to tubing 38 is a section of tubing 35 which serves as a thermometer well and a syphon breaker.

The vertical tubing 38 conducts the condensate from the upper compartment 12 into the upper end of a coiled tube 56 contained within cooler 58. The lower end of coil 56 conducts the water which has been cooled within the cooler into the lower closed end of the lower compartment 14. A closure cap 41 is provided at said lower end and is suitably secured to a collar 42 mounted thereon. A distributor plate 43 is positioned in the lower end of the compartment 14 in closely spaced relationship to the closure 41. The distributor plate 43 serves not only for the upward flow of the condensate into the compartment 14 thereabove, but also for supporting a bed 44 of ion exchange material, i.e., hydrogen exchange resin. For this purpose, the distributor plate 43 is perforated. A manually controllable needle-type valve RV is used to regulate the flow of water through the hydrogen exchange resin unit. A manually controlled open and shut valve V'' may be used to bleed off a sample of water entering the closed end of lower compartment 14. A thermometer 69 is permanently located in a thermometer well 70 in the tubing leading to cap 41.

The cooler 58 is supplied with cooling water from the discharge outlet 27 connected to the condenser 25 via tubing 57. The outlet 59 from the cooler 58 is connected to a temperature regulator or sensing element 60 which, in turn, controls the extent of the opening of the throttling valve TV by means of the air pressure within tube or duct 62. Throttling valve TV is provided with a large diaphragm, not shown, which is responsive to the degree of air of pressure within tube 62 to automatically control the amount of cooling water supplied over inlet 63. Hence, this valve is adjusted automatically to respond to the temperature of the cooling water from the cooler 58 as determined by the temperature regulator or sensing element 60. In other words, the temperature sensing element 60 responds to the water which passes through it to affect the air pressure in tube 62 and thereby control throttling valve TV. A suitable temperature regulator and a suitable throttling valve are commercially marketed by Powers Regulator Company of Skokie, Illinois. Other equivalent devices may be employed; and the air pressure control system may be replaced by an electrically equivalent system.

The bed 44 is preferably formed of a cation exchange resin and is of suitable depth to insure substantially complete exchange of the cations in the condensate for hydrogen.

Above the resin bed 44 there is mounted a screen 46 that serves to prevent any particles from the resin bed from rising in the effluent therefrom beyond the level of said screen into the intermediate compartment 13. The screen is suitably clamped between adjacent sections 11*c* and 11*b* of the tubular housing, as by means of a coupling 47.

An overflow pipe 48, having an open upper end 49 limits the level to which the effluent in pond P from the resin bed may flow. It will be noted that the coils 21 are normally immersed in the pond P, and that these coils enclose the upturned end of the overflow pipe 48. A vent 50 is formed in the upper portion of the intermediate compartment 13 above the level of the pond P. This vent is for the same purpose as the vent 30, namely, to permit the escape of any non-condensable gases released by the reboiling of the condensate, or by the heating thereof to substantially the boiling point.

The overflow pipe 48 is connected to a second cell, or unit, 51, which is similar to the unit 34, and which has wires 52 leading to a recorder (not shown). The contents of the unit 51 are allowed to overflow through a discharge connection 53 at a level the same as the upper end 49 of overflow pipe 48.

In the apparatus just described, the steam coils 18 provide the heat necessary to drive off substantially all of the carbon dioxide that may be dissolved in the condensate, and the vent 30 permits the escape of such released carbon dioxide, or other non-condensable gases. The residual carbon dioxide released from carbonate or bicarbonate ions by passage through the resin bed 44 is driven off by the steam coils 21 which provide the heat necessary to bring the temperature of pond P to the atmospheric boiling point under more favorable pH conditions, due to amine removal. Thus, the present equipment also embodies degasifier units such as have been used previously in testing the purity of steam.

The upper compartment 12 constitutes the condensing compartment for steam introduced through the inlet 17 and discharged through the nozzles 19 and 22.

The hydrogen exchange resin or cation exchange bed 44 serves to remove the cations resulting from any ammonia or amines dissolved in the steam condensate. This involves a replacement of the ammonium or the amine radicals by hydrogen ions, which combine with bicarbonate or carbonate ions to form water plus carbon dioxide.

The location of the valve V in the steam outlet or exit line from the reboil chamber 13 to the discharge nozzle 22, is important in achieving an increased heat transfer capacity from the steam condensed in reboil coil 21, as compared to that obtained from the non-condensed steam in the same reboil coil if an attempt were made to control or regulate the steam in inlet 17. In the absence of valve V, the steam from the reboil coil 21 would pass directly and unhindered into the vented chamber 12. The valve V enables the operator to take maximum advantage of the latent heat of condensation generated by converting steam in the coil 21 to liquid. This partially condensed steam liquid in coil 21 passes out to the vented condenser 12 through the discharge nozzle 22. The manually controlled valve V, in effect, permits a greater or lesser amount of steam to pass through the reboil chamber 13 at the expense of steam passing into the vented condenser because of the T-shaped divider connection between steam inlet 17 and tubes 8 and 9.

The combination of the cooler 58 and the thermostatic temperature control of the cooling water by the use of the temperature regulator 60 provides a water flow into the cation exchange bed 44 of substantially constant temperature (of magnitude in the range of 30° C. to 40° C.) and which is appreciably lower than boiling water temperature, and also a constant and uniform regulation of the temperature of the water in the reboil chamber 13 with the aid of the valve V. Both the heat input regulated by valve V and the temperature and rate of flow from the cooler 58 must be constant and balanced to maintain the atmospheric boiling point of pond P. The cooler 58 is necessary to lower the temperature of the water from the vented condenser in order to minimize leaching of the resin in bed 44.

Leaching is known as the solubilizing and/or degrading or disintegration effect on the hydrogen exchange resin by contact with the water at or near the boiling temperature. This solubilizing effect has been shown to decrease with lower temperatures of the water. Where there is appreciable leaching there are chemicals placed in the water by the leaching process which are recorded as conductivity in the recording instrument. The degree of leaching is affected (1) by the rate of flow of water through the resin bed, (2) the temperature of the water flowing through the resin, and (3) the composition of the resin and the regeneration technique in the preparation of the resin. Hence, variations in any of these factors may result in a variability in the recorded conductivity. By lowering the degree of leaching, the greater will be the reliability and sensitivity for detection of impurities, and this principle is utilized in the practice of the invention.

The foregoing combination of elements assures a constant minimum leaching of the resin as is evidenced by the graphical representation of FIG. 2. In FIG. 2, the limits identified by X indicate the wide range of conductivity due to the leaching effect caused by the water flowing at high temperatures through the resin bed. The use of the cooler 58 in the present invention reduces the temperature of the water flowing into the resin bed to a range of 30°–40° C. and enables the attainment of a recording of conductivity of pure steam condensate closer to that of the theoretical conductivity of pure water, assuming that there are no impurities in the steam. Although the reduction in temperature of the water flowing into the resin bed provides nearly maximum results in the range of 30°–40° C., it will be apparent from an inspection of the curves of FIG. 2, that a markedly significant improvement in reducing resin leaching occurs at temperatures of 65° C. and lower.

The foregoing combination of elements in the apparatus of the invention also simplifies the control of the reboil steam valve (V) adjustment. Since there are two heat inputs to the reboil chamber 13, viz, the steam inlet through duct 9 and coil 21, and the water from exchange resin bed 44—both at different temperatures—it is important that the difference in temperature between the two heat inputs be balanced so that the water in the reboil chamber 13 be at the atmospheric boiling point at all times.

The two valves V′ and the tubing 67 and 68 associated therewith and connected to the interior of the lower compartment 14 are for the purpose of fast removal and replacement of the resin by means of water flow. The resin material 44 is in granulated form and can be removed or flushed out of the lower compartment 44 by opening both valves V′ and forcing water through the upper tubing 67. The resin can be replaced by closing the lower valve V′ and flushing new resin into the upper tube 67. A great advantage of this arrangement for removal and replacement of the resin is that it is fast and the operation may be performed while the instrument is still at least partially in operation and is recording at conductivity cell 34. Heretofore, the replacement of the resin 44 has required dismantling the apparatus with a consequent appreciable loss of time in the use of the apparatus during resin replacement.

Another important advantage of the invention is that it permits both measuring and recording the conductivity at 98.5° C., as contrasted to prior procedures of measuring at 98.5° C. and recording at 25° C. by means of an empirical correction factor. The prior procedure introduced errors and decreased the accuracy and sensitivity of the instrument because the different acids in the water at conductivity cell 51 have different temperature coefficients.

The table of FIG. 3 shows that the sensitivity measurements are increased at the higher level temperatures (evidenced by a comparison of column 4 versus column 2) and that the accuracy of measurement is also increased, because the different ionic components have different temperature coefficients (evidenced by a comparison of column 3 versus column 2). For example, in column 4 the acid equivalent of sodium chloride (NaCl) records a conductivity of 11.15 micromhos/cm. at 98.5° C. whereas at 25° C. (column 2) the equivalent conductivity is 2.16 micromhos per cm.—a five-fold increase in conductivity. When the empirical temperature coefficient which is used for all ions is employed, the 25° C. empirical recorded conductivity in column 3 is 4.18 micromhos/cm. rather than 2.16 as in column 2.

The temperature of 98.5° C. is mentioned herein because the atmospheric boiling point of water has been found to be 99.5° C. and there is a one degree C. drop which occurs between the reboil chamber and the electrode where conductivity is measured. An investigation of the influence of variations of barometric pressure at an elevation of 700 feet on the temperature of atmospheric boiling of water indicates that there is a variation of 99 to 99.9° C.—a difference which has been shown to have a negligible effect on conductivity values.

The recording of accurate conductivity at 98.5° C. has an additional advantage that the calculation of carryover (i.e., the mineral impurities in the steam) may be obtained from the recorder conductivity and the composition of the boiler water solids. The table of FIG. 4 lists the conductivity of various acids formed in passing through the steam purity analyzer. Using the data in FIG. 4 on the conductivity of the acids it is now possible to calculate the mechanical and possibly vaporous carryover in the steam from the specific conductance of the

steam (micromhos/cm. at 98.5° C.) and the boiler water anion concentrations, from the following formula.

Calculation of Carryover From Recorder Conductivity and Boiler Water Dissolved Solids

$$\text{Carryover (p.p.b.)} = \frac{1000(A)(DS)}{17\ Cl^- + 13.6\ SO_4^{=} + 9.6\ NO_3^- + 4.8\ PO_4^{\equiv}}$$

where

A=recorder conductivity at 98.5° C. minus 0.84 micromho/cm. (theoretical conductivity of pure water at 98.5° C.)
DS=p.p.m. boiler water dissolved solids content
Cl^-=p.p.m. chloride in boiler water
$SO_4^{=}$=p.p.m. sulfate in boiler water
NO_3^-=p.p.m. nitrate in boiler water
$PO_4^{\equiv}$=p.p.m. phosphate in boiler water

In summation, the apparatus and method of invention constitute, very briefly, a technique which employs a cation exchanger that removes ammonia and amine interferences, reduces resin leaching (or blank) to a minimum, and provides recording of the true conductivity value at the temperature of measurement, the temperature of atmospheric boiling water. The invention now makes possible the detection of 5 to 8 p.p.b. (parts per billion) chloride or sulfate which is equivalent to approximately 3 p.p.b. sodium (0.003 p.p.m.).

Previous practice has been to report the conductivity at 25° C. by applying an empirical temperature coefficient to the measurement at any other temperature. This reduces the conductivity value several-fold and introduces serious errors since five or six ionic components, having different temperature coefficients, may be present.

What is claimed is:

1. Apparatus for determining the purity of water, steam and condensate likely to be contaminated with dissolved ammonia and its derivatives, which comprises an elongated casing having a partition dividing the same into upper and lower compartments, means for introducing steam into the upper compartment and discharging a jet thereof upwardly, a baffle against which such discharged jet of steam can impinge, a cooling coil for condensing steam in said upper compartment for collection of the condensate on said partition, a bed of ion exchange material in said lower compartment, means for conducting condensate from said upper compartment to said lower compartment for passage through said bed, said last means including a cooling device for reducing the temperature of said condensate by at least half before the condensate is introduced into said lower compartment, means between said bed and said partition for heating the effluent from said bed to substantially its boiling point, means for venting non-condensable gases eliminated during such heating, and means for determining a characteristic of the so-treated condensate dependent upon the ionization of said condensate.

2. Apparatus for determining the purity of water, steam and condensate likely to be contaminated with dissolved ammonia and its derivatives, which comprises an elongated casing having a partition dividing the same into upper and lower compartments, means for introducing steam into the upper compartment and discharging a jet thereof upwardly, a baffle against which such discharged jet of steam can impinge, a cooling coil for condensing steam in said upper compartment for collection of the condensate on said partition, a bed of ion exchange material in said lower compartment, means for conducting condensate from said upper compartment to said lower compartment for passage through said bed, said last means including a cooling system for materially reducing the temperature of said condensate before the condensate is introduced into said lower compartment, means between said bed and said partition for heating the effluent from said bed to substantially its boiling point, means for venting non-condensable gases eliminated during such heating, and means for measuring and also recording the conductivity of the so-treated condensate at or near atmospheric boiling point temperature.

3. Apparatus for determining the purity of water, steam and condensate likely to be contaminated with dissolved ammonia and its derivatives, which comprises an elongated casing having a partition dividing the same into upper and lower compartments, an intermediate compartment between said upper and lower compartments, means for introducing steam into said upper and intermediate compartments and discharging a jet from each of said compartments upwardly through separate nozzles, said means including coils in both said upper and intermediate compartments on opposite sides of said partition, a steam inlet pipe and a T connection for dividing the steam in said pipe between said coils, a multi-turn cooling coil in said upper compartment for condensing steam in said upper compartment for collection of the condensate on said partition, a baffle within and supported by the lowest turn of said cooling coil against which the discharged jets of steam from said upper and intermediate compartments can impinge, said coil in the upper compartment serving to heat the condensate collected therein to the boiling point, a vent for non-condensable gases released from said condensate, a bed of ion exchange material in said lower compartment, a pipe for conducting away said condensate from said upper compartment, a cooling system for materially cooling the condensate conducted away from said upper compartment by said pipe and for conducting the cooled condensate to said lower compartment for passage through said bed, said coil in said intermediate compartment serving to heat the effluent from said bed to substantially its boiling point, an adjustable valve in the nozzle discharge path of said intermediate compartment and located between the coil in said intermediate compartment and the associated nozzle, means for venting non-condensable gases eliminated during the heating of said effluent in said intermediate compartment, and means for measuring and also recording a characteristic of the so-treated condensate at a temperature approximately equal to the atmospheric boiling point thereof.

4. In a method of determining the purity of steam in which a steam sample is condensed and held at the boiling point to eliminate carbon dioxide, the improvement which comprises subjecting said sample at a controlled temperature below half the boiling point temperature to ion exchange sufficient to remove cations derived from ammonia and amines, reboiling the so-treated sample, and then measuring and recording the conductivity of the reboiled treated sample at approximately 98.5° C.

5. The method of determining steam purity of a steam having a sufficient concentration of ammonium ions or amines to give an erroneous solids concentration determination when subjected to an electrical conductivity test which comprises condensing a sample of the steam, maintaining the resulting condensate at substantially its boiling point to eliminate carbon dioxide, passing the condensate at a temperature of 65° C. or less through a bed of cation exchange material capable of exchanging hydrogen ions for said ammonium ions and amines to remove substantially all of said ammonium ions and amines, and thereafter subjecting the ammonium ion free sample to an electrical conductivity measurement at approximately 98.5° C. and recording said measurement at said same 98.5° C. temperature.

6. In the method of determining the purity of a condensate of steam in a steam generating and condensing system wherein said condensate in said system has cations derived from the group consisting of ammonia and amines and alkali metal and alkaline earth metal compounds derived from boiler water carryover, said cations derived from ammonia and amines being in a concentration sufficient to give an erroneous solids concentration determination when subjected to an electrical conductivity test, the steps which comprise cooling a sample of condensate of said steam to a temperature of 65° C. or less, and then

subjecting said cooled sample to cation exchange material capable of exchanging hydrogen ions for cations derived from said group to remove substantially all of said cations from said sample, and thereafter recording as well as measuring the conductivity of the resulting treated sample at approximately atmospheric boiling point temperature.

7. In a steam purity analyzer in which the purity of the steam is determined by first condensing a steam sample, passing the sample through a bed of hydrogen exchange resin, and then subjecting the resulting sample to an electrical conductivity measurement, the method of operation which comprises reducing the temperature of the condensate to 65° C. or less before it is passed along to the bed of hydrogen exchange resin thereby avoiding leaching of the resin.

8. Apparatus in accordance with claim 3 in which a water cooling inlet supplies water through a throttling valve to one end of said multi-turn coil, and said cooling system includes a cooler having an inlet coupled to the other end of said multi-turn coil for receiving water from said multi-turn coil and an outlet coupled to a temperature sensing device, said temperature sensing device responding to the water passing to it from said cooler to control said throttling valve.

9. Apparatus for determining the purity of water, steam and condensate likely to be contaminated with dissolved ammonia and its derivatives, which comprises an elongated casing having a partition dividing the same into upper and lower compartments, means for introducing steam into the upper compartment and discharging a jet thereof upwardly, a baffle against which such discharged jet of steam can impinge, a condenser having a multi-turn cooling coil for condensing steam in said upper compartment for collection of the condensate on said partition, an inlet for said cooling coil, a throttling valve controlling the amount of water passing through said inlet, an outlet for said cooling coil, a bed of ion exchange material in said lower compartment, a cooler comprising an enclosed housing having therein a coil, said housing having an inlet and an outlet, means for conducting condensate from said upper compartment through the coil of said cooler to said lower compartment for passage through said bed, a pipe connecting the outlet of said condensing cooling coil and the inlet of said housing of said cooler, a temperature sensing element, and a pipe coupling the outlet of said housing and said temperature sensing element for supplying water from said cooler housing thereto, said sensing element having means for automatically controlling the throttling valve in accordance with the temperature of the water supplied to said sensing element, a coil between said bed and said partition for heating the effluent from said bed to substantially its boiling point, a manually controllable valve in the outlet connection from said last coil, means for venting non-condensable gases eliminated during such heating, and means for determining a characteristic of the so-treated condensate dependent upon the ionization of said condensate.

10. Apparatus for determining the purity of water, steam and condensate likely to be contaminated with dissolved ammonia and its derivatives, which comprises an elongated casing having a partition dividing the same into two compartments, means for introducing steam into one of said compartments and discharging a jet of said steam, a baffle against which such discharged jet of steam can impinge, a cooling coil for condensing steam in said one compartment for collection of the condensate in said compartment, a bed of ion exchange material in said other compartment, means for conducting condensate from said one compartment to said other compartment for passage through said bed, said last means including a cooling device for reducing the temperature of said condensate to 65° C. or less before the condensate is introduced into said other compartment, means between said bed and said partition for heating the effluent from said bed to substantially its boiling point, means for venting non-condensable gases eliminated during such heating, and means for measuring the conductivity of the so-treated condensate at near atmospheric boiling point temperature.

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