

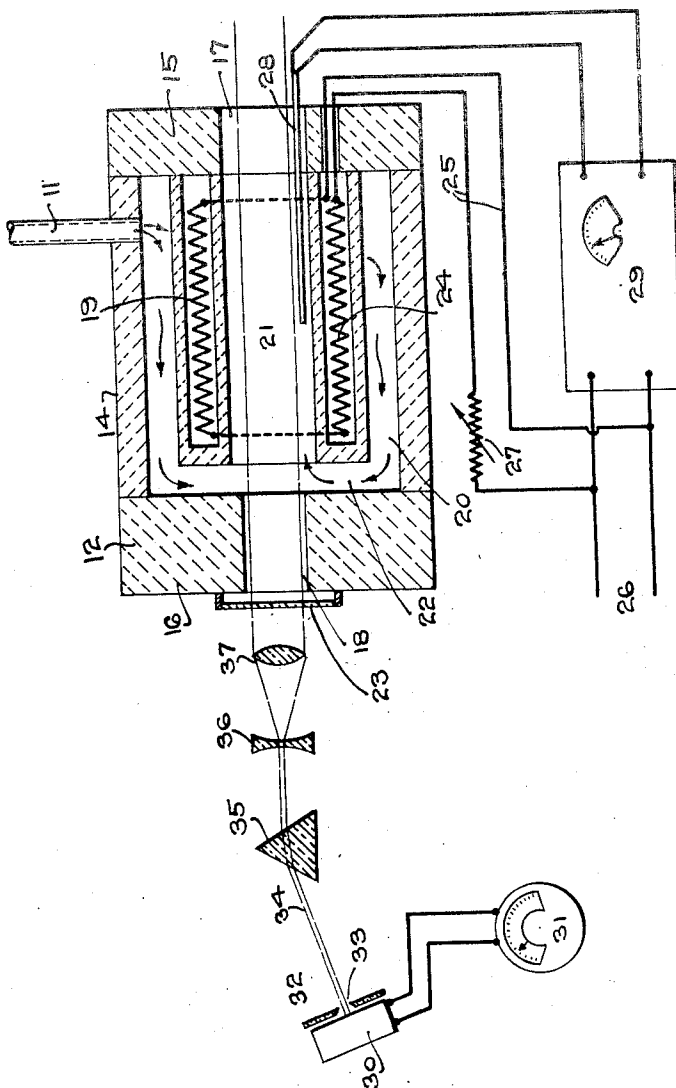
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GAS ANALYSIS

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GAS ANALYSIS

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The present invention relates generally to methods for spectrum analysis or for what is otherwise called spectro-chemical analysis. While the present method may be employed for the analysis of a variety of substances under a variety of conditions, it is in the present instance more particularly designed for the analysis of gases and specifically for the facile and rapid determination of the percentage or proportion of solids dispersed through a gas. The present process may be employed with a varying degree of accuracy for the determination of the solid contents of a large variety of gases, and where the percentage of solid content may even be substantial. The present process is, however, particularly applicable and operates with a satisfactory degree of accuracy when the solids are dispersed through the gases with a volumetric precision approaching or approximating that of a solution. In industrial operations a large variety of circumstances arise which approximate the conditions set forth herein, namely, in which it is desired rapidly to determine the solid content of a gas and where the solids are so finely dispersed throughout the gas that they may be said to approximate the conditions existing in a solution in that the solids are distributed uniformly throughout the gas, and the proportion of solids is minute. Thus it is frequently desired to determine the percentage content of the solids suspended in steam. The occurrence of solids in steam fits the present circumstances for the reason that such solids are highly dispersed and finely suspended. In the further and more detailed description of the present invention, therefore, it will be described as being applied to the spectrum analysis of steam for the purpose of determining the solid content of such steam.

One of the objects of the present invention is to conduct the analysis of the steam sample under suitable and standard conditions so that the results obtained may be properly comparative with each other or with any desired standards. In this respect the present process differs from the commonly employed spark and arc spectroscopic methods for the reason that in the latter methods no effort is made to control the temperature and concentration of the substances being analyzed in the zone of radiation. One of the objects of the present invention, therefore, is to provide a method wherein the temperature conditions may be closely regulated and controlled so that the analysis is conducted under predetermined suitable and standardized temperature conditions.

Referring again more specifically to the deter-

mination of solids content in steam, the methods employed hitherto involved the measurement of the electrical conductivity of the steam condensate. Such steams, however, very frequently include small quantities of ammonia and sometimes carbon dioxide and other gaseous impurities which affect the conductivity measurements of the condensate and introduce unpredictable errors in the determinations. It is, therefore, one object of the present invention to eliminate such sources of error by subjecting a sample of the steam to a predetermined temperature so that the characteristic spectral radiations of the gaseous elements to be analyzed will correspond to the selected temperature and will vary in intensity with the percentage contents of the solids in the sample.

For any given boiler installation, sodium normally constitutes a substantially constant portion of the total solids in the steam generated by such installation. The present method, therefore, takes advantage of this by measuring the intensity of the characteristic D-line of the sodium spectrum. The intensity of this radiation is, therefore, a function of the sodium concentration in the gas and of the total solids present in the steam.

In order to accomplish the object set forth above, the present invention contemplates the employment of a suitable electric furnace and bypassing the continuously flowing sample of steam through the furnace. The steam displaces the air from the furnace, is heated to desired predetermined temperature and the radiation of the D-line is measured by any desired apparatus such as a spectroscope or any other suitable devices.

The present invention is described in greater detail in the following specification and the apparatus is illustrated in the accompanying drawing. It will be understood, however, that the specific embodiment of the present invention may be varied by persons skilled in the art without departing from the scope of the invention as defined in the appended claims.

As shown in the drawing, a sample of the gas to be analyzed, for example steam, is drawn from the main line (not shown) into a bleeder pipe 11 leading to the heating furnace 12. A valve (not shown) in the bleeder pipe 11, is opened when it is desired to subject the steam to test. The heating furnace may be of any suitable type, but it is preferred that such furnace be so constructed that it shall permit the continuous flow of steam through the furnace during the time when the steam is subjected to observation or

test. In the present instance, the furnace is so constructed that the steam from the bleeder pipe 11 may flow into and out of the furnace as long as the valve to the bleeder is open. In this wise, the air, or other gases in the furnace, is displaced and the furnace is continuously filled by a sample of steam. The rate of flow of this steam may be regulated by the control of the valve, the rate being such that under conditions of operation of the furnace the steam will be heated to the desired temperature so as to bring the entire steam sample up to the desired temperature and particularly the solid particles thereof to the desired degree of incandescence.

For this purpose the furnace shown herein is preferably of cylindrical form having an outer cylindrical wall 14 and end walls 15 and 16, the end walls having concentric openings 17 and 18. A cylindrical heater element 19 is mounted on the back wall 15, this heater element having a length somewhat shorter than the distance between the walls 15 and 16. By this construction, therefore, the furnace is provided with an outer annular chamber 20 and a central radiating zone 21 and a passage 22 establishing communication between the two zones. The opening 18 in the wall 16 of the furnace is provided with a transparent window 23 of any suitable material. The heater element 19 carries the resistance heater element 24 which is connected by wires 25 to the source of electric current 26. A rheostat 27 may be interposed in the wiring 25 so as to permit of the control and regulation of the amount of current flowing through the resistance element 24. A pyrometer for the observation of the temperature in the furnace is provided, the pyrometer having a thermo-couple 28 placed in the radiating zone 21 of the furnace and connected to the temperature indicator 29.

In the conduct of a test, the valve is opened, thus permitting a sample of the steam to flow from the main steam line through the bleeder pipe 11 into the heating zone 20 of the furnace, through the passage 22 and through the radiating zone 21 and out of the furnace. The steam is permitted to flow so as to displace the air from the furnace and fill the same with steam under continuous flow. The heater current and rate of flow of steam through the furnace are regulated and controlled with relation to each other so as to maintain a constant and continuous flow of steam through the furnace and also to heat the steam in the furnace to the desired temperature as indicated by the pyrometer 29. These conditions are permitted to remain for a period long enough to establish relatively stable conditions.

In order to determine the percentage solid contents of the steam, the radiation of the sodium is determined by measuring the intensity of the D-line. For this purpose any suitable spectroscopic device or apparatus may be employed. Such device or apparatus would be positioned to measure the radiation of the sodium in the radiating zone 21 and which is transmitted through the window 23. For purposes of illustration and as indicated, a photoelectric cell 30 together with a millivolt meter 31 associated therewith are employed for measuring the intensity of such radiation. The photoelectric cell which may be of the type now available on the market known as Weston Photronic cell is provided with a shield 32 having an aperture 33. This shield and cell are so disposed in the path of the spectrum 34

formed by the prism 35 that only the D-line of the spectrum is intercepted by the photoelectric cell. The lenses 36 and 37 are of any suitable type for the purpose of concentrating the radiations of the radiating zone 21 upon the prism 35.

If desired, the spectroscopic apparatus including elements 36 to 37, inclusive, may be designed and constructed into a unitary piece of apparatus which may be readily positioned against or directly in front of the window 23 of the furnace 12. Under some conditions where it may be desirable to conduct a large number of such tests at frequent intervals the electric furnace 12 and the spectroscopic apparatus may be organized into a single structural arrangement.

The apparatus may be calibrated by any desirable or suitable method so that the indication of the millivolt meter 31 may be converted into percentages of solids, present in the gas, or, if desired, after such calibration the scale on the millivolt meter may be graduated in percentage of solid content so that such reading may be obtained directly.

While in the foregoing specification the invention has been described in its application particularly to the determination of the presence of sodium in steam, it will be understood that the principles of the present invention are applicable as well to the determination of the presence of other elements in gaseous mediums, such as copper, lithium, potassium, strontium and other elements that may be thermally excited to produce a characteristic spectral radiation. The characteristic spectral radiation of any one of such elements is subjected to the spectroscopic analysis in substantially the same manner as has been described hereinbefore, it being only necessary to adjust the spectroscopic apparatus in order to subject the photoelectric cell to the characteristic radiation emitted by the element under analysis.

Having thus described my invention with reference to a specific embodiment thereof, it will be understood that the same may be varied without departing from the scope of the appended claims.

What is claimed as new and useful is:

1. The method of determining the solid content in a gaseous medium of elements which are thermally excitable to their spectral radiation which consists in continuously flowing the medium containing such elements through a confined chamber, in heating the interior of said chamber to and maintaining it at such predetermined constant temperature that, as such medium flows through the chamber, said elements dispersed in such medium are thermally excited to their characteristic radiation, and in observing and measuring the intensity of such radiation.

2. The method of determining the sodium content of a gaseous medium, such as steam, which consists in continuously flowing a sample of the medium through a confined heated chamber, in maintaining the interior of said chamber at a constant temperature sufficient to excite the sodium content to its characteristic spectral radiation, in directing said radiation toward a point of observation, and in measuring the intensity of such radiation at said point of observation.

3. The method of determining the sodium content of a gaseous dispersion comprising the steps of flowing a sample of the dispersion through a heating zone of such predetermined constant

temperature as is sufficient to excite radiation of the sodium content thereof, and thereafter measuring the intensity of radiation of the characteristic D-line.

4. The method of determining the sodium content of a gaseous dispersion comprising the steps of continuously flowing a sample of the dispersion through a heating zone of a predetermined constant temperature sufficient to excite the sodium content of the dispersion to its characteristic radiation, and thereafter measuring the intensity of the radiation of the sodium D-line.

5. The method of determining the presence in a gaseous medium of elements which are thermally excitable to their spectral radiation comprising the steps of continuously flowing a sample of such medium through a heating zone, heating and subjecting such sample during its pas-

sage through such zone to a predetermined constant temperature sufficient to excite spectral radiation, and thereafter measuring the intensity of such radiation of a preselected zone in the spectrum.

6. The method of determining the sodium content of a gaseous dispersion comprising the steps of flowing a sample of such dispersion through an enveloping heating zone the temperature of which is maintained at a predetermined constant value, continuously flowing such sample through said zone at a rate sufficient to insure that the entire sample is subjected to said predetermined temperature whereby to uniformly excite the sodium content of the dispersion to its characteristic radiation, and thereafter measuring the intensity of radiation of the sodium D-line.

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