# THE PRESSURE OF SATURATED WATER VAPOR IN THE RANGE 100° TO 374° C.

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ABSTRACT

The method and apparatus employed, and the measurements made in this determination of the vapor pressure of water are described, and the results obtained are given and formulated.

The method used was the "static method" in which the pressure is determined at the stationary boundary between the liquid and the vapor in equilibrium at a contant temperature in a closed container.

The container for the water sample was a calorimeter specially built for high pressure work. Pressures were measured by a precision piston gauge which balances the pressure by the gravitational force on a piston loaded with weights. Temperatures were measured by platinum resistance thermometers supplemented by thermoelements.

A total of 394 measurements were made at 38 temperatures so distributed as to facilitate formulation of the pressure-temperature relation.

The formulation was made by using an empirical equation which was fitted to the results in two temperature ranges. Values of pressure and its derivative with respect to temperature are tabulated from this formulation in standard atmospheres, centibars, and kg/cm$^2$ at each degree centigrade, and in pounds per square inch at each degree Fahrenheit. This provides a mutually consistent group of vapor pressure tables in convenient form for practical working tables of fundamental steam data.

It is estimated that the results are reliable to 3 parts in 10,000.

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## I. INTRODUCTION

The relation between the temperature and the pressure of saturated water vapor is of prime importance in establishing the thermodynamic behavior of steam. This relation, commonly called the vapor pressure relation, is a characteristic property which can be observed directly. Moreover, its derivative is an essential factor in correlating other important thermodynamic properties. It is evident that adequate knowledge of this property is indispensable to the success of any systematic effort to determine and formulate the thermal properties of steam.

The vapor pressure measurements to be described here were made as a coordinate part of the larger and more formidable project of calorimetric measurement of the enthalpy (heat content) of saturated water and steam. Since pressure and temperature of saturated vapor are definitely related, measurements of other thermal properties may be referred to either temperature or pressure as an independent variable, depending on which is the more expedient. This characteristic was utilized in planning a new high pressure calorimetric [1] apparatus for surveying the bahavior of saturated steam. As a refinement in technique, provision was made for observing both the temperature and the pressure of a water sample in the calorimeter. The arrangements for control and measurement of temperature, and for transmission of pressure to the measuring gage, were perfected to a degree which permits the rapid and reliable measurement of saturation pressure in the range 100° to 374° C.

Measurements within this range have already been made in several laboratories in accordance with definitely specified, recognized standards, permitting reduction of the results to a common basis. The results of these independent determinations, differing considerably in method and technique, have been regarded as in virtual agreement for technical purposes. Nevertheless, close scrutiny disclosed discrepancies which seemed unnecessarily large, particularly in the derivative on which reliance must be placed for making thermodynamic correlations of other experimental data.

The equipment available in this laboratory provided a favorable opportunity for making vapor pressure measurements. These were undertaken prior to the calorimetric measurements with the object of further verifying the numerical values of this property.

To provide for trustworthy correlation of thermodynamic properties, it is necessary not only that the observations of the corresponding pressures and temperatures be adequate in number, distribution, and precision, but also that a formulation be used which yields reliable values of the derivative. This latter requirement has been met by the successful application of a type of empirical equation which conforms with remarkable fidelity to the observed behavior of saturated steam.

## II. METHOD AND APPARATUS

### 1. GENERAL DESCRIPTION

In the calorimetric equipment used in making the vapor pressure measurements, provision is made for observing temperature, pressure, mass of water sample, and the energy added. The arrangements provided for controlling the state of the fluid in the calorimetric experiments are also especially appropriate for the determination of vapor pressure. In this report, which concerns only the latter, the

[1] Mechanical engineering, vol. 54, No. 2, p. 118, 1932.

description is intended to record those features which are essential to the vapor pressure measurements.

A schematic diagram of the vapor pressure measuring equipment is shown in Figure 1. The metal calorimeter shell contains, besides the water sample, an electric heater and a system of radial silver plates for diffusing heat. This shell is suspended within a thermally controlled inclosure or envelope which shields it against heat exchange with the surroundings.

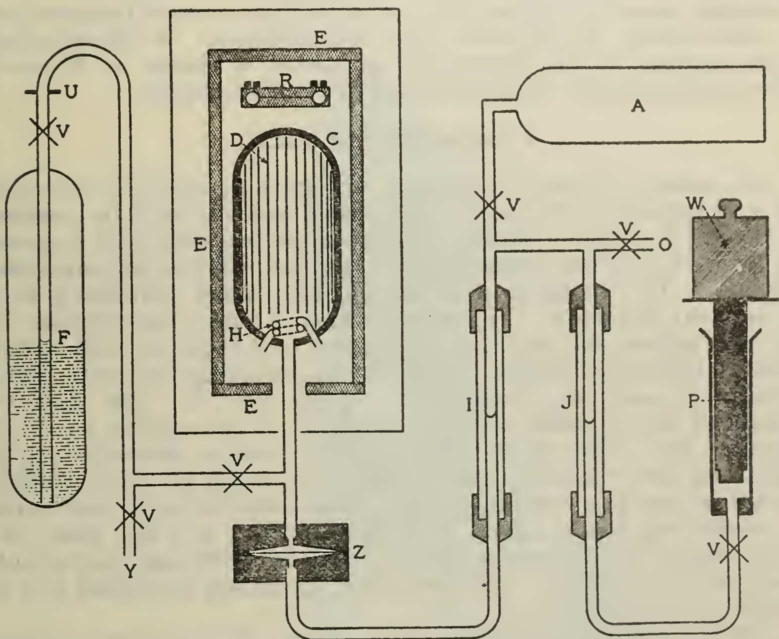


FIGURE 1.—*Schematic diagram of the vapor pressure measuring equipment*

*A*, high pressure air.
*C*, calorimeter shell (special steel).
*D*, heat diffusing system (silver).
*E*, envelope (silver).
*F*, water container (silver).
*H*, electric heater.
*I*, water indicator (glass capillary).
*J*, oil indicator (glass capillary).
*O*, air vent.
*P*, piston.
*R*, reference block (silver).
*U*, union.
*V*, valves.
*W*, weights.
*Y*, vacuum connection.
*Z*, pressure transmission cell.

The pressure in the calorimeter is transmitted directly through a tube from the bottom of the calorimeter shell to a cell with a thin elastic metal diaphragm which readily transmits pressure, yet prevents escape of the water sample. The pressure in the calorimeter is thus transmitted through this sensitive diaphragm to a column of water, and through this column to a balancing artificial atmosphere of air. The meniscus between the water and air is visible in a glass capillary, and serves to indicate balance between the air pressure and the pressure in the calorimeter. The pressure of the artificial atmosphere which is subject to very delicate manual control, is transmitted to the measuring piston gage through an oil column. The air-oil meniscus is visible in another glass capillary and is used as an indicator to show when the piston is properly loaded.

The temperature of the water sample, which is observed after the load on the piston has been properly adjusted, is obtained by the combined use of platinum resistance thermometers and thermoelements. Resistance thermometers located in a reference block of thick silver, yield the temperature of the block according to the international temperature scale. The thermoelements, with principal junctions distributed on the shell and reference junctions located on the reference block, indicate the small differences which exist between the calorimeter and the reference temperature. The thermoelements can be used in series to indicate average temperatures, or individually to indicate local temperatures. A diagrammatic scale drawing of the assembled apparatus is shown in Figure 2. The principal parts will be described in detail forthwith.

### 2. CALORIMETER SHELL

The calorimeter shell shown at *C* in Figure 2 provides a receptacle for the sample of water so that its thermal behavior may be observed. It has the shape of a cylinder with hemispherical ends and, as assembled with the various accessory parts in place, will hold approximately 320 $cm^3$. The material is a special alloy steel containing about 19 per cent chromium, 7.5 per cent nickel, 4.5 per cent tungsten, 1.3 per cent silicon, 0.5 per cent manganese, and 0.46 per cent carbon. This material was chosen because of its resistance to creep and to attack by water at temperatures up to 400° C. The shell was machined from a solid bar and was made in two similar parts held together on a thin silver gasket by the tension developed in the right and left threaded band which is screwed on with powerful wrenches engaging machined lugs. This annular joint was formed by machining one member to a plane surface and the other to a blunt angled edge, giving a contact with the silver gasket of about a half millimeter width. All parts were accurately machined and the surfaces well polished.

The shell, having a thickness of 0.125 inch (3.2 mm), was designed to stand steam pressures up to the critical without permanent deformation. Actually in hydraulic proof tests, it showed no permanent stretch for an internal pressure of 4,500 lbs./$inch^2$. After carrying a charge of water at 350° C., the inner surface showed on examination no sign of attack by the water other than the formation of a very thin film of light-straw color similar to that formed on the outside where in contact with air.

### 3. CALORIMETER HEATER

The electric heater in the calorimeter shell, shown at *H*1 (fig. 2) is an insulated resistor encased in a metal tubular coil sealed hermetically to the shell. It consists of about 10 ohms of calido wire, 0.2 mm in diameter, with gold leads. This resistor was wound in helical form, 0.6 mm outside diameter, and embedded in magnesia for insulation. It was sheathed in a platinum tube drawn down tightly on the magnesia to an outside diameter of about 2 mm. This sheathed resistor was then bent into the form of a helical coil 12 mm outside diameter, the resistor occupying about two turns. Each projecting end of this heater was put through a threaded plug of silver-palladium alloy and sealed by soldering with gold. To

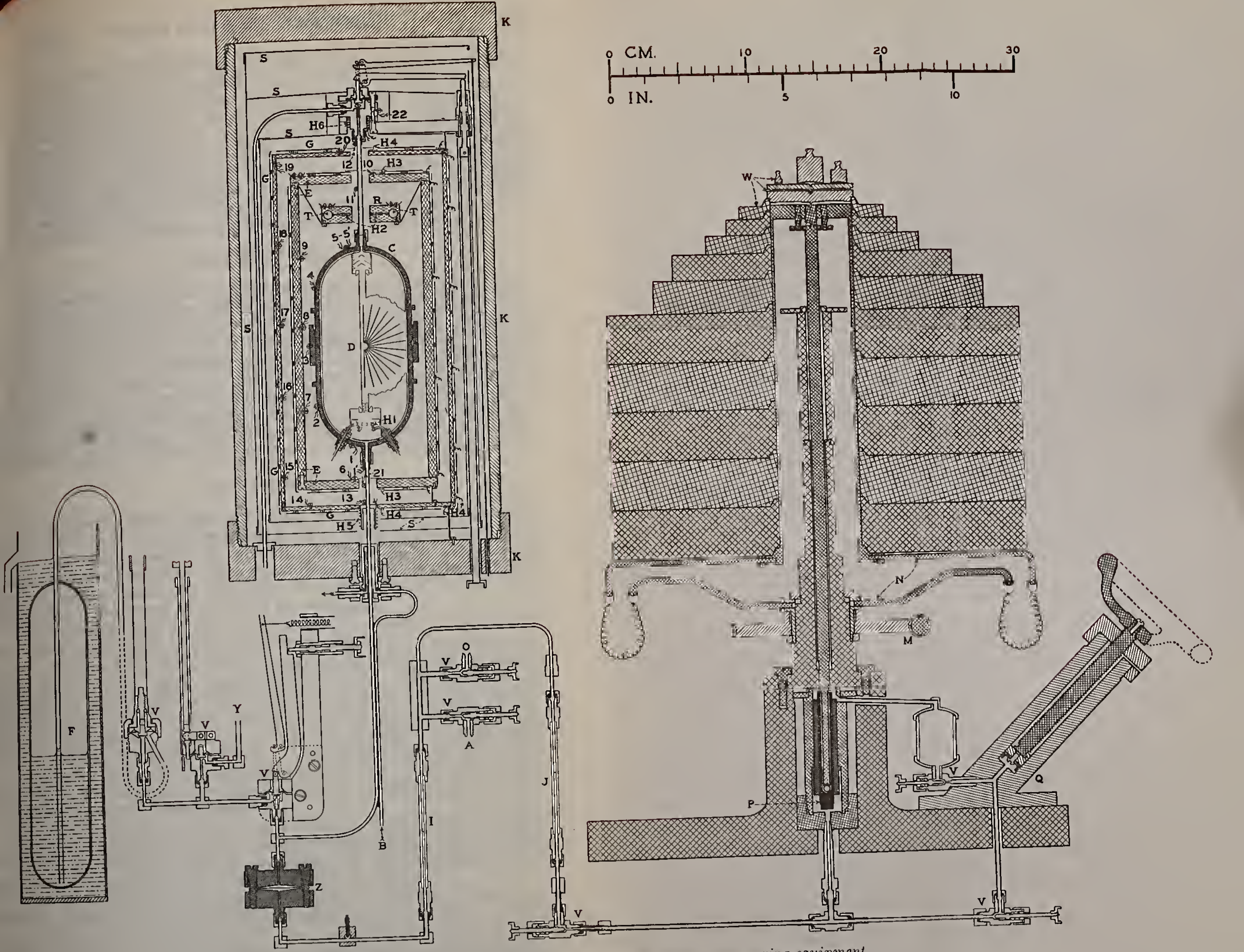


FIGURE 2.—*Sectional scale drawing of vapor pressure measuring equipment*

(NOTE.—This is not a true section but shows sections of important parts projected on a plane.)

*A*, high pressure air inlet.
*B*, cooling water.
*C*, calorimeter shell (special steel).
*D*, heat diffusing system (silver).
*E*, envelope (silver).
*F*, water container (silver).
*G*, guard (silver).
$H_1$, $H_2$, etc., electric heaters.
*I*, water indicator (glass capillary).
*J*, oil indicator (glass capillary).
*K*, casing (brass).
*M*, gear drive.
*N*, rotating arms.
*O*, air vent.
*P*, piston.
*Q*, oil pump.
*R*, reference block (silver).
*S*, shields (aluminum).
*T*, platinum resistance thermometers.
*V*, valves.
*W*, weights.
*Y*, vacuum connection.
*Z*, pressure transmission cell.
*1*, *2*, etc., principal junctions of thermoelements.

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complete the seal, the shoulders of these plugs were drawn tightly on thin silver gaskets by threaded nuts outside the shell.

The design of this heater was chosen with regard to influence on the calorimetric performance of the instrument. The heater surface has been made small with three objects in view, namely, to avoid unnecessary heat capacity, to permit operation with small amounts of liquid, and to avoid excessive accumulation of energy as superheat in the liquid. The characteristics of the heater have relatively little to do with the technique of pressure measurements since it is used only for bringing the water sample to a desired temperature.

### 4. HEAT DIFFUSER

For promoting temperature equalization in the calorimeter shell, a system of heat-conducting plates is provided. This heat-diffusing system consists of 30 flat plates of silver 0.5 mm thick, shaped to conform to the vertical profile of the shell and held radially in two slotted hubs so as to penetrate and interconnect the space within the shell with a good heat conductor. The chief function of this arrangement is to hasten the equalization of temperature after a period of change. This feature is important in both the calorimetric and the pressure measurements, and to some extent compensates for the lack of positive circulation by mechanical means.

### 5. ENVELOPE

The principal purpose of the envelope which surrounds the calorimeter shell is to provide protection from fortuitous exchanges of heat. This feature, which is vital to the energy accounting in calorimetry, contributes to the suitability of the instrument for pressure measurements by favoring the attainment of thermal equilibrium of the water sample and its container.

This protecting envelope is a double-walled inclosure formed of two coaxial cylindrical silver shells with flat ends, the inner one 6.3 mm thick and the outer one 3.2 mm thick, which will be designated as "envelope" and "guard" respectively. Electric heating elements are distributed over the outer surfaces of these shells. Subdivision of these heaters provides for meeting various local thermal requirements. The heater on the envelope is used only when its temperature is being raised. The guard may also be heated at a controlled rate, or its temperature may be maintained automatically at any desired value by a sensitive thermoregulator using a platinum resistance thermometer.

At a steady temperature the guard heater supplies the heat loss to the outside while the envelope temperature remains fixed. Such conditions are favorable for the establishment and maintenance of temperature equality of the calorimeter and its contents.

In the space outside the guard two thin aluminum shields are placed to impede the loss of heat by radiation and convection. These light shields, 0.05 mm thick, furnish effective thermal insulation and prevent excessive heat loss without introducing any considerable thermal lag. The whole is inclosed in a heavy brass casing which serves not only as a cover but also as protection in case of an explosive failure.

### 6. CONNECTIONS TO THE CALORIMETER SHELL

The calorimeter shell is held in place by two tubes of silver-palladium alloy. The one at the top bears the weight of the shell and the one at the bottom centers it. Besides furnishing firm, thermally resistant support for the shell, these tubes serve also for the transfer of fluid to or from the calorimeter. The upper tube is intended for a vapor outlet to be used in calorimetric measurements of heat of vaporization and was temporarily closed during the pressure measurements by a disk in the union at the top of the shell. This suspension tube reaches from the body of the vapor valve which is carried on a light but firm support from the guard shell.

The lower tube is used as a connection to transfer liquid to or from the calorimeter, and also to transmit pressure from within to the auxiliary measuring equipment outside. A cylindrical brass cell for cooling water surrounds this tube where it passes through the outer brass casing. Where the tube passes through the outer silver guard shell it bears an electric heater mounted on a silver support attached to the tube. There is a free length of about 2.6 cm between this heater and the union at the shell. The purpose of the heater is to control the thermal gradient in this section of the tube as indicated by thermoelements installed for that purpose. Similarly, the gradients on the upper tube are controlled by a heater on the vapor valve body.

The lower tube is always filled with liquid while observing saturation behavior in the calorimeter. From a union just below the cooling cell at the bottom, connection is made through a copper-nickel tube to the liquid valve and the pressure transmission cell. Beyond the liquid valve the line extends to a union by which the water receiver with its valve is connected. A side connection leads through a valve to a vacuum pump to permit evacuation of the calorimeter and its connecting lines.

### 7. PRESSURE CONNECTIONS AND AUXILIARY INDICATORS

Pressure is transmitted from the free surface of the liquid in the calorimeter through a continuous column of liquid water to the elastic diaphragm of the pressure transmission cell to be described forthwith. The purpose of this cell is to allow the pressure in the calorimeter system to be communicated to the pressure measuring gage, while at the same time interposing a barrier to the escape of water from the system through the gage line. A limited amount of inward and outward movement is allowed the water column by the necessary flexibility of the transmitting device, but this movement is restricted to the small volume displacement of 0.04 cm$^3$ required for observation. In this transmitting cell, a circular diaphragm of thin silver about 3 cm in diameter is held under slight tension between the two parts of the cell which clamp the diaphragm tightly near the edge. Small pressure changes suffice to move the diaphragm back and forth across the space between the two parts. The inner cell walls are shaped to conform approximately to the figure of the distended diaphragm. The delicate diaphragm must encounter support from the cell walls to avoid deformation beyond its elastic limit when the pressures are far out of balance.

The cell is made of two disks of stainless steel, each about 5 cm in diameter and about 1.4 cm thick, provided with 12 screws to draw them tightly together on the silver diaphragm. The two parts have nipples with unions for making connections with the lines as shown. The apertures to the inner cell are made only 0.035 cm in diameter to avoid too large an unsupported area of the thin silver diaphragm. This diaphragm is a vital part of the device, and its characteristics determine the limit of sensitivity of the transmitting cell. It is of rolled sheet silver about 0.06 mm thick. The diaphragm and cell were put together at a temperature of about 150° C. in order to produce sufficient tension, when cooled, to flatten out the slight unevenness of the sheet which otherwise would interfere with the freedom of motion between the cell walls. This procedure left enough flexibility to give a satisfactory sensitivity to pressure change.

On the measuring or gage side of the diaphragm a continuous column of liquid water extends and transmits pressure to air at the meniscus boundary in a glass capillary indicator. The volume of this water column is small. The meniscus is a reliable indicator of the position of the diaphragm and is used as a null device to tell when the pressures on the two sides are balanced to bring the diaphragm to a chosen zero position near the neutral. The air column extends to the end of an oil column in a second glass capillary indicator, whence the pressure is transmitted through the oil directly to the piston of the measuring gage. Sensitive needle valves permit fine adjustment of the pressure in the air line to balance the pressure in the calorimeter. When these pressures are balanced and the piston gage is also balanced by weights, the vapor pressure in the calorimeter may be found from the pressure measured at the piston by taking into account the fluid columns between the piston and the free surface in the calorimeter and whatever pressure difference the diaphragm may support.

The fluid columns to be accounted for are the oil, air, and water columns. The oil-column correction is constant and is easily measured. The air-column correction depends on the pressure and is almost negligible. The correction for the water column is somewhat more complicated due to the variation of the position of each end. The position of the meniscus in the glass capillary is directly observed and easily corrected for in each measurement. From a reference point on this capillary to a point near the calorimeter there is a constant pressure correction which is computed from the difference in height. From this latter point to the free surface the pressure correction varies both with the filling in the calorimeter and with its temperature, and was computed for the conditions of each measurement.

The correction for pressure difference supported by the diaphragm is small, but arises because the chosen zero position is not necessarily the neutral or unstrained position. It was determined by making a vapor pressure measurement near 100° C. with the air column open to the atmosphere instead of being connected to the piston gage. Since the vapor pressure of water is one standard atmosphere at 100° C. by definition of the international temperature scale, and its temperature variation there is well known, the difference between the computed pressure at the open end and the observed barometric pressure gives the desired diaphragm zero correction. This correction was determined occasionally during the progress of measurement.

This method of calibration connects the scale of pressure with the standard unit at the one atmosphere fixed point and in effect includes that point in the range of the observations.

A preliminary calibration of the assembled diaphragm with its capillary indicator was made at atmospheric pressure to determine its sensitivity to pressure differences. This showed the diaphragm displacement to be nearly proportional to the pressure difference over a considerable portion of the middle range. Within this linear range a pressure difference of 0.001 atmosphere was found to correspond to about 0.6 mm on the capillary indicator. This sensitivity calibration is merely an index of the limit of precision to be expected when the diaphragm is set to a chosen zero position and does not enter into the reduction of the observations.

### 8. PRESSURE GAGE

The pressure-measuring gage used in these determinations was one of a group of piston gages whose construction and calibration have been described previously.[2] These gages were designed and built at this bureau to meet a need for precision pressure-measuring instruments in determining thermodynamic properties of fluids. They have been studied with great care to determine their reliability as standard instruments.

This type of gage employs a loaded rotating piston which is supported in a vertically mounted, closely fitting cylinder by oil under the pressure to be measured. A balancing load of weights on the piston is borne axially above it on a carrier which engages the piston. A horizontal couple applied to the carrier by motor-driven arms produces a slow continuous rotation which is transmitted through it to the piston. Thus the entire load consisting of piston, carrier, and weights is rotated without introducing any appreciable vertical component of driving force. The rotation of the piston maintains a lubricating film of oil between it and the closely fitting cylinder. This provides greater freedom for vertical motion of the loaded piston in case of unbalance, by preventing direct contact between the piston and cylinder.

The gage chosen for the present work and shown in Figure 2 has a piston area of about 1 $cm^2$. It was designed for the range from about 3 to 100 atmospheres pressure. As it was desired to cover the range of steam pressures from 1 atmosphere to 218 atmospheres, it was necessary to make some modification to provide for this extension of the range. This was done by substituting for the original weight carrier two special ones, the first very light to permit a small load on the piston, and the second a larger carrier to accommodate the extra weights for the high pressures. This gage is provided with a set of weights in units ranging from 20 to 0.1 kg, specially built to stack on the carrier with proper stability. Standard laboratory weights were used for the range 100 to 1 g. The weights were calibrated at the time of their use in these measurements, and corrections were applied where significant.

The effective piston area had been determined in 1928 by a series of calibrations using a multiple-column mercury manometer as the fundamental standard. Direct comparisons with this standard

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[2] Meyers and Jessup, B. S. Jour. Research, vol. 6, (p. 324), June, 1931.

manometer were made at a pressure of 15 atmospheres. In addition to these, comparisons were made at pressures up to 75 atmospheres, using another gage to step up from the 15-atmosphere limit of the manometer to the higher pressures. These calibrations all gave a value of 0.9961 cm$^2$ at 20° C. for the effective piston area at that time.

During the course of the present pressure measurements a comparison was made with two other similar standard piston gages, and with the vapor pressure of a standard sample of carbon dioxide as a precaution against any significant change in the effective piston area which might have occurred since its 1928 calibration. The results of these comparisons gave the same value of 0.9961 cm$^2$.

## 9. THERMOMETRIC INSTALLATION

The thermometric installation used in the control and measurement of the temperature of the water sample includes platinum resistance thermometers and thermoelements. Thermoelements alone suffice for the survey of temperature distribution. For determining the actual temperature of the water sample, certain of the thermoelements are used to supplement the indications of platinum resistance thermometers.

### (a) REFERENCE BLOCK

A silver reference block located in the space above the calorimeter shell serves as an isothermal union between the resistance thermometers and the reference junctions of the thermoelements. Thus the thermometers measure the temperature of the reference junctions, while the thermoelements indicate the small additional differences between this reference temperature and those of chosen points where the principal junctions are located.

The reference block is made of two similar rectangular pieces of pure silver, each 5.6 by 3.8 by 0.63 cm, held together flatwise by screws. It is suspended horizontally from the top of the envelope by four slender straps of stainless steel. A pair of electric heaters and two resistance thermometers fit in receptacles machined across the horizontal midsection. A hole 12.7 mm in diameter in the vertical axis accommodates the small tube which suspends the calorimeter shell. This well-conducting block of silver is designed to keep the reference junctions at the same temperature as the resistance thermometers.

### (b) THERMOELEMENTS

The temperature-measuring system includes thermoelements with 38 principal junctions. These thermoelements are connected in groups to economize leads and to permit combinations for surveying temperature distribution, for indicating average temperature differences of surfaces, and for determining the temperature of the water sample. These combinations are completed at the option of the observer by the use of specially built distributing switches with all-copper circuits.

The thermoelements which are used to indicate the temperature of the water are a group of five with principal junctions located on the calorimeter shell at points selected as representative. These chosen points lie in one vertical element of the shell. The five junctions, designated as 1, 2, 3, 4, and 5, are spaced as shown in Figure 2. The indications of these five junctions may be observed individually, giving the temperature difference between any zone and the reference block, or all five may be observed in series to give a composite of the temperatures of the five zones. The single junctions may also be observed differentially against junction No. 5 at the top of the calorimeter to show directly the vertical distribution of temperature on the shell. The ability to make such a temperature survey enables the observer to follow the approach to equilibrium and make due allowance of time to assure a reliable temperature determination.

Each thermoelement is made of one wire of "chromel P," 0.127 mm in diameter, and two wires of "copel," 0.10 mm in diameter, the latter twisted together. For insulation and support, these wires are threaded through thin strips of mica which are assembled with mica separators and covers into sturdy but light and flexible bundles carrying groups of thermoelements.

Each principal junction of chromel to copel is made by silver soldering the wires to a tiny gold terminal which is used to attach the junction in the desired place. The reference junctions, two to each element, are made similarly by attaching gold terminals to the chromel and copel wires. These gold terminals make electrical connection to gold lead wires and provide for attachment of the reference junctions to the reference block.

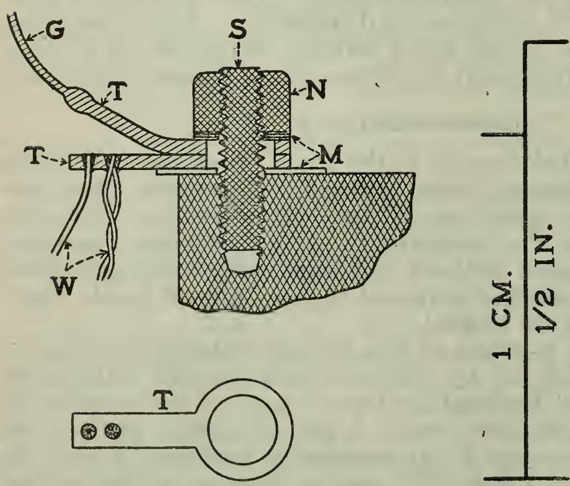


FIGURE 3.—*Details of thermojunction attachment*

*G*, gold wire.
*M*, mica insulation.
*N*, nut.
*S*, stud.
*T*, gold terminal.
*W*, thermoelement wires.

Figure 3 shows how the terminals are installed to secure good thermal union, electrical insulation, and electrical connection where desired. They are held firmly under nuts on threaded studs which are screwed into the metal at the desired places. The terminals are insulated electrically from above and below by mica washers, and from the stud by centering. Additional thermal attachments of the gold lead wires are made in a similar manner at the reference block and at the bottom of the envelope to prevent thermal lead conduction from directly affecting the reference junctions and thus causing erroneous temperature indications.

Gold wires, insulated with mica as described above, are brought out in a bundle from the reference junctions within the heated space to an accessible place at the temperature of the room. Here an isothermal attachment on copper blocks is provided for the junctions between these gold wires and the copper wires which lead across to the observing station.

The electromotive forces of the thermoelements, amounting in nearly all cases to less than 20 mv, are measured on a Wolff poten-

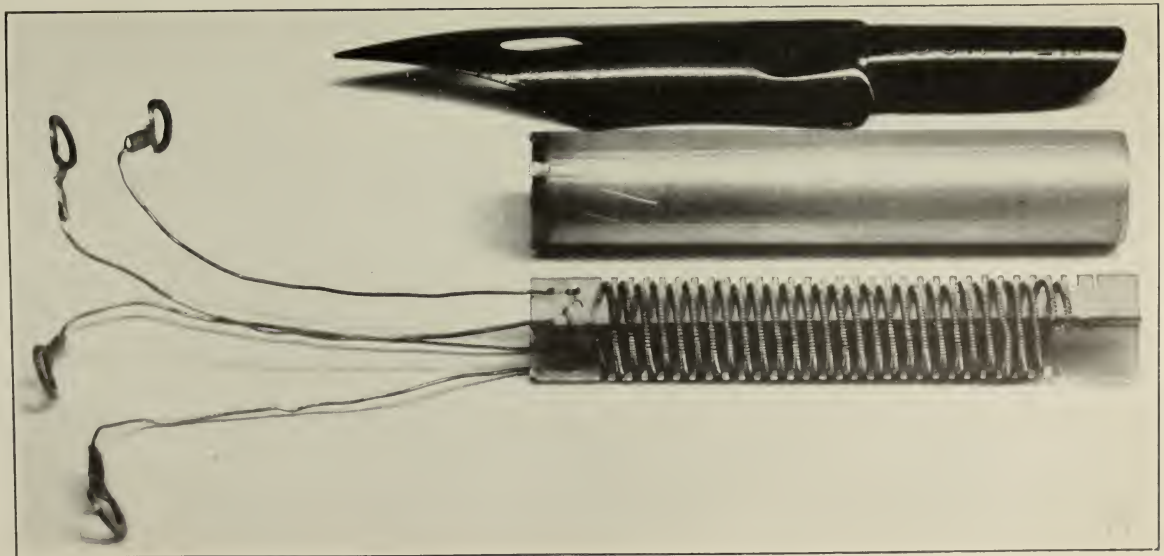

Figure 4.—*Platinum resistance thermometer and sheath, pen point for comparison of size*

tiometer designed by F. Wenner. Calibration of this instrument showed its corrections to be negligible. When the temperature of the calorimeter is being observed by means of the five thermoelements in series, a scale deflection of 1 mm corresponds to about 0.001° C.

The five thermoelements which are used in the measurement of water temperature were calibrated in place against a resistance thermometer in the reference block by the following procedure: With the block at nearly the same temperature as the calorimeter, a small emf is indicated on the thermoelements. When the block is heated the thermoelement reference junctions are heated by the same amount as the resistance thermometer. Therefore, the change in thermoelement emf is equivalent to the change in temperature as indicated by the thermometer. Calibrations were made at every temperature where pressure observations were made.

### (c) RESISTANCE THERMOMETERS

Two specially constructed platinum resistance thermometers were used as working standards for the temperature measurements. These are of the 4-lead potential-terminal type. They were made small and compact to fit into the receptacles in the reference block. The windings were made of highly refined platinum which showed at 100° C. a resistance as high as 1.392 times that at 0° C. The platinum wire, 0.1 mm in diameter, was first wound in helical form 0.45 mm in diameter, and again wound in a second helical form 4.8 mm in diameter upon a mica cross with the edges notched to carry the winding, yet leave it free from mechanical constraint. Initial strains were relieved by annealing the completed thermometer at 660° C. Each thermometer is mounted in a cylindrical silver case which fits the receptacle in the reference block. Figure 4 shows the construction of one of these thermometers.

This type of thermometer winding has been described by C. H. Meyers [3] and is particularly adapted to use where large size is objectionable. The question as to whether a platinum winding of this compact double-helical type will define the same temperature scale between the fixed points as a winding of the customary strain-free type, has been studied by making a direct comparison between one of the thermometers of this apparatus and one of the earlier standard thermometers of this laboratory. In the interval from 200° to 320° C., the maximum observed difference in indication was at 270° and amounted to 0.013° C., which is not more than that attributable to the uncertainty of reproduction of the scale itself.

The two thermometers used (M–22 and M–26) were selected from a group of eight by consideration of their characteristics and behavior over a period of time. They were calibrated according to the specifications of the international temperature scale, [4] which uses the fixed points of ice, steam, and boiling sulphur as 0, 100, and 444.6°, respectively. The thermometers were calibrated before and during the progress of the pressure measurements and showed no significant changes. The thermometer No. M–22, which was used in all the experiments, had the constants $R_0=27.6637$, $R_{100}=38.5158$, $\delta=1.496$, which were used in the Callendar formula given later for the tem-

[3] B. S. Jour. Research, vol. 9 (RP508), December, 1932.
[4] Burgess, G. K., B. S. Jour. Research, vol. 1 (RP22), p. 635, October, 1928.

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perature computation. The thermometer No. M–26, which was used only occasionally to check the other thermometer, had the constants $R_0=27.7640$, $R_{100}=38.6555$, $\delta=1.496$.

The resistances of the thermometers are measured with a Mueller [5] bridge built by O. Wolff. The bridge coils are immersed in a thermostated oil bath. A separate commutator switch permits the observation of either thermometer. The bridge coils were recalibrated several times during this investigation. A bridge current of 4.5 milliamperes was used both in the calibration and in the measurements of temperature. A galvanometer scale deflection of 1 mm corresponded approximately to 0.0001 ohm, or about 0.001° C. for the thermometers used.

## III. EXPERIMENTAL PROCEDURE

The first step in a vapor pressure determination is the introduction of a chosen amount of pure air-free water into the calorimeter. The water used in these measurements was prepared from distilled water by continuous low-pressure distillation in a special apparatus. The air was removed by pumping from the condenser a small fraction of the vapor which carried with it all but a trace of the air dissolved in the original water. This purification was found adequate to avoid any measurable partial pressure of air in the steam. A measured sample of the purified water is transferred without contact with air from the distilling apparatus to a special container, With this container attached to the evacuated calorimeter system, the water is driven into the calorimeter shell by heating the container. Weighing the container before and after this operation checks the amount transferred to the calorimeter. This must be known in order to compute the correction for the height of the liquid at any time.

The calorimeter with its charge of water is next brought to the desired temperature by adding heat electrically. At the same time the envelope, guard, reference block, and connecting tubes are all heated in a similar manner and at about the same rate. Their temperatures are finally adjusted by successive approximations while the calorimeter with its contents approaches the desired uniform stationary temperature. As this chosen temperature is approached, the automatic temperature control of the guard shell is put into operation.

The behavior of the fluid in the calorimeter varies appreciably in the temperature range covered by these experiments. At temperatures below 350° C., thermal gradients produced by heating the fluid, diminish quickly, leaving only small persistent gradients. As the critical region is approached, however, the gradients become larger. The procedure used to hasten favorable conditions for observing pressure at these high temperatures is first to heat the water above the desired temperature and then to cool by lowering the envelope temperature. This produces condensation on the upper calorimeter walls, bathing them with liquid which tends to bring them nearer the effective saturation temperature.

As equilibrium is approached, successive approximations are made to the adjustments necessary for a pressure measurement. The calorimeter pressure is balanced by the air pressure which in turn is balanced by the load on the piston. If the temperature and pressure

[5] Mueller, B. S. Bull., vol. 13, p. 547, October, 1916.

in the calorimeter were stationary and the measuring apparatus adjusted to proper balance, the diaphragm of the pressure cell would be at rest in its zero position, the two capillary indicators stationary, and the loaded rotating piston of the gage neither rising nor falling. This ideal condition of absolute constancy is not necessary to a satisfactory measurement. After close control and adjustment have been obtained, they are held over a period of about two minutes while a series of temperature readings is taken. The definitive value of the load is that at the mid-point of this period. The pressure observation includes the balancing load on the piston, temperature of the piston, barometric pressure, and height of fluid columns in the capillary indicators. The balancing load could always be determined to the nearest gram, and at low pressures it was possible to estimate fractions of a gram. At the higher steam pressures it is unnecessary to determine the load more closely than to 1 g in order to have the precision of the pressure measurement correspond with that of the temperature.

For determining the effective saturation temperature, four successive temperature readings are made at equal time intervals. Each temperature reading consists of simultaneous observations of resistance thermometer and thermoelements. The above method of reading several successive temperatures is desirable for several reasons. First, the 4-lead potential-thermal resistance thermometer requires at least two observations to eliminate the lead resistance from the measurement. Second, increasing the number of readings decreases the accidental error of observation. Third, a regular schedule of readings takes account of slight drift of temperatures. Fourth, the schedule permits the observation of local temperatures during the measurement.

The best selection of thermoelements to determine the temperature of the free surface of the water depends on the temperature distribution and the location of the liquid level in the calorimeter. In the range of temperature below 350° C., the water and calorimeter reach a steady state promptly. Below 200° C. this steady state was a uniform temperature, as indicated by surveys. All five thermoelements were therefore taken to indicate the saturation temperature up to 200° C.

Between 200° and 350° C., after the steady state was reached, the bottom of the shell showed a small persistent depression of temperature and the top a small elevation due to inability to control the surroundings perfectly. In this range the three intermediate thermoelements, Nos. 2, 3, and 4, were used.

Above 350° C. a difference in the behavior of the fluid was observed. The steady state was reached more slowly and thermal gradients were larger over the entire shell. The saturation temperature was estimated from the indication of a single thermo-element located in the vicinity of the liquid level in the calorimeter. If the quantity of water in the calorimeter is checked as previously described, the location of the liquid level is reliably known at temperatures below 370° C. Near the critical region, a comparatively small difference in the water sample determines whether saturated vapor, superheated vapor, or compressed liquid is present. Experiments were therefore made to indicate the state of the water in the calorimeter. These experiments started with the calorimeter supposed to be full of liquid water. After the pressure was observed, a chosen small amount of liquid was with-drawn and the pressure again observed. This procedure was repeated until the observed pressure, when reduced to a given temperature, showed a constant value indicating existence of the saturation state.

During the progress of the vapor-pressure measurements, two types of experiments were made to prove the absence of an appreciable amount of permanent gas in the calorimeter. In the first type, pressures were measured before and after the withdrawal of liquid, which increased the vapor space in the calorimeter. In the second type, the presence of gas in the calorimeter was tested by a McLeod gage after removal of the liquid. These tests gave no indication of enough gas to affect the vapor-pressure results.

## IV. RESULTS OF MEASUREMENTS

The results of the entire series of measurements have been assembled in Table 1, which includes each measured temperature, reduced to degrees of the international temperature scale of 1927 [6] and the corresponding measured pressure reduced to international standard atmospheres.[7] This table also contains the reduction of the observed pressures to values corresponding to even temperatures to permit comparison of the individual determinations and to facilitate the formulation of the entire group of results.

Each measured temperature is computed from the observed data, consisting of four readings of the bridge when balanced with the platinum resistance thermometer in circuit, and the four simultaneous readings of the potentiometer when balanced against the thermoelements, as described above in Section III, Experimental Procedure.

Each measured pressure is computed from the following observed quantities: The load on the piston gage, temperature of gage, position of water meniscus and oil meniscus, amount of water in the calorimeter, and barometer reading, including its temperature.

The auxiliary data used in these reductions include the densities of water and of oil, value of gravity at the Bureau of Standards, the relative elevation of gage and barometer from the gravity bench mark, the results of calibrations of the bridge, resistance thermometers, thermoelements, and the piston gage with its connecting lines and weights.

The mean of the four bridge readings corrected for the bridge calibration gives the resistance of the platinum thermometer ($R_\theta$) at the mean temperature of the series. The temperature, $\theta$, is computed from this resistance by use of the Callendar formula

$$\theta = 100\ (R_\theta - R_0)/(R_{100} - R_0 + 0.01\ \theta(0.01\ \theta - 1)\ \delta$$

The constants $R_0$, $R_{100}$, and $\delta$ are determined by the calibration previously described.

The mean of the four thermoelement observations is reduced from microvolts to degrees temperature difference by use of the calibration factor determined as previously described. By combining this mean temperature difference between the water and the reference block

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[6] Burgess, G. K., B. S. Jour. Research, (RP 22) p. 635, October, 1928.

[7] Standard atmospheric pressure is defined as the pressure due to a column of mercury 760 mm high, having a mass of 13.5951 g/cm³, subject to a gravitational acceleration of 980.665 cm/sec.² and is equal to 1,013,250 dynes/cm², B. S. Jour. Research, October, 1928, p. 637.

and the mean temperature of the block as determined by the thermometer, the temperature of the water, $\theta_w$, is obtained.

The pressure observation, made at the middle of the series of temperature readings, corresponds with the water temperature determined as above. In reducing the pressure observation, the effective weight of the entire load supported by the oil acting on the effective piston area was computed as the sum of the masses of the weights, weight carrier, and the piston, corrected for calibration and air buoyancy. From this total mass the resultant pressure was computed by use of the value of gravity at this laboratory (980.09 cm/sec.$^2$) relative to the standard value of gravity (980.665 cm/sec.$^2$) and the effective piston area, corrected for the effect of thermal expansion. To this component of pressure due to the load was added the observed barometric pressure corrected for temperature, difference in level, and for gravity, thus giving the total pressure at the bottom of the piston. From this pressure at the gage, the pressure at the level of the liquid in the calorimeter was found by applying the following corrections for the intermediate fluid columns: The oil column between the piston and the oil meniscus, the air column between oil and water, the water column between the water meniscus and the water level in the calorimeter, and the correction for the diaphragm position determined by the calibration at atmospheric pressure. The pressure contributed by the liquid water column in the calorimeter was calculated from the mass of water in the calorimeter, the dimensions of the calorimeter and the specific volumes of vapor and liquid water determined by Keyes and Smith.[8]

The total correction for fluid columns in the transmission line did not exceed 0.04 atmosphere and was estimated to 0.0001 atmosphere. The accuracy of this estimation may have limited the precision attainable at the lowest pressures measured. At the higher pressures, it was of less importance in comparison with several other factors.

TABLE 1.—*Observed pressure of saturated water vapor*

| Date | Observed quantities | | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | Temperature $\theta_w$ | Pressure $P_w$ | | | |
| | °C. (*Int.*) | | *Standard atmospheres (Int.)* | | |
| | 110.027 | 1.4146 | −0.0013 | 1.4133 | −0.0010 |
| | 110.018 | 1.4152 | −.0009 | 1.4143 | .0000 |
| July 20, 1932 | 110.003 | 1.4149 | −.0001 | 1.4148 | +.0005 |
| | 110.019 | 1.4156 | −.0009 | 1.4147 | +.0004 |
| | 110.011 | 1.4148 | −.0005 | 1.4143 | .0000 |
| | 109.994 | 1.4138 | +.0003 | 1.4141 | −.0002 |
| July 21, 1932 | 110.008 | 1.4146 | −.0004 | 1.4142 | −.0001 |
| | 110.027 | 1.4156 | −.0013 | 1.4143 | .0000 |
| Even temperature 110°. | Mean value of pressure at 110 $=P_m=$1.4143 atm. | | | | |
| | 119.975 | 1.9579 | +0.0015 | 1.9594 | −0.0004 |
| | 119.991 | 1.9587 | +.0006 | 1.9593 | −.0005 |
| July 20, 1932 | 119.981 | 1.9587 | +.0012 | 1.9599 | +.0001 |
| | 120.010 | 1.9608 | −.0006 | 1.9602 | +.0004 |
| | 119.982 | 1.9590 | +.0011 | 1.9601 | +.0003 |
| | 119.956 | 1.9564 | +.0027 | 1.9591 | −.0007 |
| July 21, 1932 | 120.004 | 1.9604 | −.0003 | 1.9601 | +.0003 |
| | 119.988 | 1.9596 | +.0007 | 1.9603 | +.0005 |
| Even temperature 120°. | Mean value of pressure at 120° $=P_m=$1.9598 atm. | | | | |

[8] Mechanical Engineering, vol. 53, No. 2 ,p. 133, 1931.

TABLE 1.—*Observed pressure of saturated water vapor*—Continued

| Date | Observed quantities: Temperature $\theta_w$ | Observed quantities: Pressure $P_w$ | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | °C. (*Int.*) | *Standard atmospheres (Int.)* | | | |
| April 2, 1932 | 129.965 | 2.6624 | +0.0028 | 2.6652 | −0.0006 |
| | 129.965 | 2.6635 | +.0028 | 2.6663 | +.0005 |
| | 129.965 | 2.6636 | +.0028 | 2.6664 | +.0006 |
| April 5, 1932 | 130.014 | 2.6656 | −.0011 | 2.6645 | −.0013 |
| April 7, 1932 | 130.008 | 2.6644 | −.0006 | 2.6638 | −.0020 |
| April 8, 1932 | 129.996 | 2.6641 | +.0003 | 2.6644 | −.0014 |
| July 2, 1932 | 129.990 | 2.6652 | +.0007 | 2.6659 | +.0001 |
| | 129.971 | 2.6636 | +.0023 | 2.6659 | +.0001 |
| | 130.000 | 2.6660 | .0000 | 2.6660 | +.0002 |
| July 7, 1932 | 130.046 | 2.6692 | −.0037 | 2.6655 | −.0003 |
| July 21, 1932 | 129.998 | 2.6665 | +.0002 | 2.6667 | +.0009 |
| | 129.976 | 2.6649 | +.0019 | 2.6668 | +.0010 |
| | 130.003 | 2.6670 | −.0002 | 2.6668 | +.0010 |
| | 130.023 | 2.6686 | −.0018 | 2.6668 | +.0010 |
| Even temperature 130°. | Mean value of pressure at 130° = $P_m$ = 2.6658 atm. | | | | |
| April 2, 1932 | 140.370 | 3.6027 | −0.0373 | 3.5654 | −0.0007 |
| | 140.371 | 3.6028 | −.0374 | 3.5654 | −.0007 |
| | 140.371 | 3.6028 | −.0374 | 3.5654 | −.0007 |
| April 5, 1932 | 140.023 | 3.5682 | −.0023 | 3.5659 | −.0002 |
| April 7, 1932 | 139.980 | 3.5614 | +.0020 | 3.5634 | −.0027 |
| April 8, 1932 | 139.983 | 3.5625 | +.0017 | 3.5642 | −.0019 |
| July 2, 1932 | 139.984 | 3.5653 | +.0016 | 3.5669 | +.0008 |
| | 139.968 | 3.5634 | +.0032 | 3.5666 | +.0005 |
| | 140.005 | 3.5675 | −.0005 | 3.5670 | +.0009 |
| July 7, 1932 | 140.004 | 3.5665 | −.0004 | 3.5661 | .0000 |
| July 21, 1932 | 139.975 | 3.5654 | +.0025 | 3.5679 | +.0018 |
| | 139.987 | 3.5662 | + 0012 | 3.5674 | +.0013 |
| | 140.021 | 3.5694 | −.0021 | 3.5673 | +.0012 |
| Even temperature 140°. | Mean value of pressure at 140° = $P_m$ = 3.5661 atm. | | | | |
| March 25, 1932 | 149.879 | 4.6802 | +0.0152 | 4.6954 | −0.0015 |
| March 28, 1932 | 149.911 | 4.6849 | +.0112 | 4.6961 | −.0008 |
| March 29, 1932 | 149.868 | 4.6789 | +.0166 | 4.6955 | −.0014 |
| March 30, 1932 | 150.032 | 4.7018 | −.0040 | 4.6978 | +.0009 |
| April 1, 1932 | 149.998 | 4.6970 | +.0002 | 4.6972 | +.0003 |
| April 7, 1932 | 149.984 | 4.6922 | +.0020 | 4.6942 | −.0027 |
| April 8, 1932 | 150.004 | 4.6964 | −.0005 | 4.6959 | −.0010 |
| July 7, 1932 | 150.035 | 4.7017 | −.0044 | 4.6973 | +.0004 |
| July 21, 1932 | 149.985 | 4.6971 | +.0019 | 4.6990 | +.0021 |
| | 150.004 | 4.6994 | −.0005 | 4.6989 | +.0020 |
| | 150.025 | 4.7019 | −.0031 | 4.6988 | +.0019 |
| Even temperature 150°. | Mean value of pressure at 150° = $P_m$ = 4.6969 atm. | | | | |
| April 2, 1932 | 160.067 | 6.1101 | −0.0104 | 6.0997 | −0.0001 |
| | 160.068 | 6.1102 | −.0106 | 6.0996 | −.0002 |
| | 160.068 | 6.1102 | −.0106 | 6.0996 | −.0002 |
| April 7, 1932 | 160.027 | 6.1028 | −.0042 | 6.0986 | −.0012 |
| April 8, 1932 | 159.990 | 6.0972 | +.0016 | 6.0988 | −.0010 |
| July 2, 1932 | 160.016 | 6.1031 | −.0025 | 6.1006 | +.0008 |
| | 159.999 | 6.0996 | +.0002 | 6.0998 | .0000 |
| | 160.022 | 6.1036 | −.0034 | 6.1002 | +.0004 |
| July 7, 1932 | 160.016 | 6.1023 | −.0025 | 6.0998 | .0000 |
| July 21, 1932 | 159.965 | 6.0956 | +.0054 | 6.1010 | +.0012 |
| | 159.978 | 6.0950 | +.0034 | 6.0984 | −.0014 |
| | 159.997 | 6.1008 | +.0005 | 6.1013 | +.0015 |
| Even temperature 160°. | Mean value of pressure at 160° = $P_m$ = 6.0998 atm. | | | | |
| April 2, 1932 | 169.994 | 7.8182 | +0.0011 | 7.8193 | +0.0015 |
| | 169.993 | 7.8182 | +.0013 | 7.8195 | +.0017 |
| | 169.994 | 7.8182 | +.0011 | 7.8193 | +.0015 |
| April 5, 1932 | 170.016 | 7.8183 | −.0030 | 7.8153 | −.0025 |
| April 7, 1932 | 169.993 | 7.8147 | +.0013 | 7.8160 | −.0018 |
| April 8, 1932 | 169.992 | 7.8140 | +.0015 | 7.8155 | −.0023 |
| July 2, 1932 | 169.991 | 7.8159 | +.0017 | 7.8176 | −.0002 |
| | 169.981 | 7.8140 | +.0036 | 7.8176 | −.0002 |
| | 169.996 | 7.8168 | +.0008 | 7.8176 | −.0002 |
| July 7, 1932 | 170.002 | 7.8174 | −.0004 | 7.8170 | −.0008 |
| July 21, 1932 | 169.978 | 7.8148 | +.0042 | 7.8190 | +.0012 |
| | 169.996 | 7.8182 | +.0008 | 7.8190 | +.0012 |
| | 170.014 | 7.8216 | −.0026 | 7.8190 | +.0012 |
| Even temperature 170°. | Mean value of pressure at 170° = $P_m$ = 7.8178 atm. | | | | |

TABLE 1.—*Observed pressure of saturated water vapor*—Continued

| Date | Observed quantities: Temperature $\theta_w$ | Observed quantities: Pressure $P_w$ | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | °C. (Int.) | Standard atmospheres (Int.) | | | |
| April 2, 1932 | 180.024 | 9.9023 | −0.0055 | 9.8968 | +0.0010 |
| | 180.022 | 9.9011 | −.0050 | 9.8961 | +.0003 |
| | 180.022 | 9.9017 | −.0050 | 9.8967 | +.0009 |
| April 5, 1932 | 180.014 | 9.8990 | −.0032 | 9.8958 | .0000 |
| April 7, 1932 | 180.001 | 9.8966 | −.0002 | 9.8964 | +.0006 |
| April 8, 1932 | 179.999 | 9.8918 | +.0002 | 9.8920 | −.0038 |
| July 7, 1932 | 179.982 | 9.8926 | +.0041 | 9.8967 | +.0005 |
| | 179.969 | 9.8887 | +.0071 | 9.8958 | .0000 |
| | 179.996 | 9.8953 | +.0009 | 9.8962 | +.0004 |
| Even temperature 180°. | Mean value of pressure at 180° = $P_m$ = 9.8958 atm. | | | | |
| April 2, 1932 | 190.001 | 12.3913 | −0.0003 | 12.3910 | +0.0023 |
| | 190.002 | 12.3904 | −.0005 | 12.3899 | +.0012 |
| | 190.002 | 12.3905 | −.0005 | 12.3900 | +.0013 |
| April 5, 1932 | 190.005 | 12.3890 | −.0014 | 12.3876 | −.0011 |
| April 7, 1932 | 190.010 | 12.3908 | −.0027 | 12.3881 | −.0006 |
| April 8, 1932 | 190.010 | 12.3898 | −.0027 | 12.3871 | −.0016 |
| July 7, 1932 | 190.010 | 12.3908 | −.0027 | 12.3881 | −.0006 |
| | 189.998 | 12.3871 | +.0005 | 12.3876 | −.0011 |
| | 190.012 | 12.3918 | −.0033 | 12.3885 | −.0002 |
| Even temperature 190°. | Mean value of pressure at 190° = $P_m$ = 12.3887 atm. | | | | |
| March 25, 1932 | 200.141 | 15.3920 | −0.0453 | 15.3467 | −0.0005 |
| March 28, 1932 | 199.957 | 15.3332 | +.0138 | 15.3470 | −.0002 |
| March 29, 1932 | 200.037 | 15.3576 | −.0119 | 15.3457 | −.0015 |
| March 30, 1932 | 199.700 | 15.2530 | +.0963 | 15.3493 | +.0021 |
| April 1, 1932 | 199.935 | 15.3264 | +.0209 | 15.3473 | +.0001 |
| April 7, 1932 | 199.990 | 15.3443 | +.0032 | 15.3475 | +.0003 |
| April 8, 1932 | 199.712 | 15.2535 | +.0924 | 15.3459 | −.0013 |
| July 7, 1932 | 199.996 | 15.3463 | +.0013 | 15.3476 | +.0004 |
| | 199.976 | 15.3395 | +.0077 | 15.3472 | .0000 |
| | 199.987 | 15.3440 | +.0042 | 15.3482 | +.0010 |
| Even temperature 200°. | Mean value of pressure at 200° = $P_m$ = 15.3472 atm. | | | | |
| April 4, 1932 | 209.991 | 18.8256 | +0.0034 | 18.8290 | −0.0010 |
| April 5, 1932 | 210.026 | 18.8393 | −.0098 | 18.8295 | −.0005 |
| April 7, 1932 | 210.006 | 18.8314 | −.0023 | 18.8291 | −.0009 |
| April 8, 1932 | 210.030 | 18.8424 | −.0113 | 18.8311 | +.0011 |
| April 29, 1932 | 209.979 | 18.8245 | +.0079 | 18.8324 | +.0024 |
| July 7, 1932 | 209.979 | 18.8213 | +.0079 | 18.8292 | −.0008 |
| | 209.957 | 18.8133 | +.0162 | 18.8295 | −.0005 |
| | 209.994 | 18.8277 | +.0023 | 18.8300 | .0000 |
| Even temperature 210°. | Mean value of pressure at 210° = $P_m$ = 18.8300 atm. | | | | |
| April 4, 1932 | 219.998 | 22.8960 | +0.0009 | 22.8969 | +0.0005 |
| April 5, 1932 | 220.002 | 22.8963 | −.0009 | 22.8954 | −.0010 |
| April 7, 1932 | 220.003 | 22.8960 | −.0013 | 22.8947 | −.0017 |
| April 8, 1932 | 220.013 | 22.9006 | −.0057 | 22.8949 | −.0015 |
| April 29, 1932 | 219.993 | 22.8948 | +.0031 | 22.8979 | +.0015 |
| July 7, 1932 | 219.999 | 22.8963 | +.0004 | 22.8967 | +.0003 |
| | 219.977 | 22.8867 | +.0101 | 22.8968 | +.0004 |
| | 219.996 | 22.8960 | +.0018 | 22.8978 | +.0014 |
| Even temperature 220°. | Mean value of pressure at 220° = $P_m$ = 22.8964 atm. | | | | |
| April 4, 1932 | 230.007 | 27.6156 | −0.0036 | 27.6120 | +0.0003 |
| April 5, 1932 | 230.019 | 27.6187 | −.0096 | 27.6091 | −.0026 |
| April 7, 1932 | 230.015 | 27.6208 | −.0076 | 27.6132 | +.0015 |
| April 8, 1932 | 230.010 | 27.6137 | −.0051 | 27.6086 | −.0031 |
| April 29, 1932 | 230.006 | 27.6160 | −.0030 | 27.6130 | +.0013 |
| July 7, 1932 | 229.986 | 27.6055 | +.0071 | 27.6126 | +.0009 |
| | 229.951 | 27.5883 | +.0248 | 27.6131 | +.0014 |
| | 229.999 | 27.6115 | +.0005 | 27.6120 | +.0003 |
| Even temperature 230°. | Mean value of pressure at 230° = $P_m$ = 27.6117 atm. | | | | |
| April 4, 1932 | 240.014 | 33.0550 | −0.0081 | 33.0469 | +0.0053 |
| April 5, 1932 | 240.060 | 33.0706 | −.0349 | 33.0357 | −.0059 |
| April 7, 1932 | 240.015 | 33.0474 | −.0087 | 33.0387 | −.0029 |
| April 8, 1932 | 240.021 | 33.0499 | −.0122 | 33.0377 | −.0039 |
| April 29, 1932 | 240.026 | 33.0575 | −.0151 | 33.0424 | +.0008 |
| July 8, 1932 | 239.976 | 33.0307 | +.0139 | 33.0446 | +.0030 |
| | 239.955 | 33.0188 | +.0261 | 33.0449 | +.0033 |
| Even temperature 240°. | Mean value of pressure at 240° − $P_m$ − 33.0146 atm. | | | | |

TABLE 1.—*Observed pressure of saturated water vapor*—Continued

| Date | Observed quantities: Temperature $\theta_w$ | Observed quantities: Pressure $P_w$ | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | °C. (Int.) | Standard atmospheres (Int.) | | | |
| March 25, 1932 | 250.186 | 39.3760 | −0.1233 | 39.2527 | −0.0039 |
| March 28, 1932 | 250.026 | 39.2729 | −.0172 | 39.2557 | −.0009 |
| March 29, 1932 | 249.968 | 39.2340 | +.0212 | 39.2552 | −.0014 |
| March 30, 1932 | 249.832 | 39.1476 | +.1114 | 39.2590 | +.0024 |
| April 1, 1932 | 250.131 | 39.3401 | −.0869 | 39.2532 | −.0034 |
| April 7, 1932 | 250.030 | 39.2729 | −.0199 | 39.2530 | −.0036 |
| April 8, 1932 | 250.005 | 39.2660 | −.0033 | 39.2627 | +.0061 |
| July 8, 1932 | 249.977 | 39.2403 | +.0153 | 39.2556 | −.0010 |
| | 249.933 | 39.2148 | +.0444 | 39.2592 | +.0026 |
| | 249.985 | 39.2497 | +.0099 | 39.2596 | +.0030 |
| Even temperature 250°. | Mean value of pressure at 250° = $P_m$ = 39.2566 atm. | | | | |
| March 28, 1932 | 259.991 | 46.3170 | +0.0068 | 46.3238 | −0.0048 |
| April 4, 1932 | 259.999 | 46.3287 | +.0008 | 46.3295 | +.0009 |
| April 5, 1932 | 260.011 | 46.3334 | −.0083 | 46.3251 | −.0035 |
| April 7, 1932 | 260.010 | 46.3326 | −.0075 | 46.3251 | −.0035 |
| April 8, 1932 | 260.005 | 46.3367 | −.0038 | 46.3329 | +.0043 |
| April 29, 1932 | 259.998 | 46.3244 | +.0015 | 46.3259 | −.0027 |
| July 8, 1932 | 259.986 | 46.3200 | +.0105 | 46.3305 | +.0019 |
| | 259.970 | 46.3086 | +.0226 | 46.3312 | +.0026 |
| | 259.997 | 46.3310 | +.0023 | 46.3333 | +.0047 |
| Even temperature 260°. | Mean value of pressure at 260° = $P_m$ = 46.3286 atm. | | | | |
| March 28, 1932 | 269.996 | 54.3349 | +0.0034 | 54.3383 | +0.0050 |
| April 4, 1932 | 270.000 | 54.3318 | .0000 | 54.3318 | −.0015 |
| April 5, 1932 | 270.030 | 54.3533 | −.0255 | 54.3278 | −.0065 |
| April 7, 1932 | 270.018 | 54.3454 | −.0153 | 54.3301 | −.0032 |
| April 8, 1932 | 269.986 | 54.3193 | +.0119 | 54.3312 | −.0021 |
| April 26, 1932 | 269.994 | 54.3305 | +.0051 | 54.3356 | +.0023 |
| | 270.002 | 54.3337 | −.0017 | 54.3320 | −.0013 |
| April 28, 1932 | 269.990 | 54.3245 | +.0085 | 54.3330 | −.0003 |
| | 270.002 | 54.3325 | −.0017 | 54.3308 | −.0025 |
| April 29, 1932 | 269.994 | 54.3303 | +.0051 | 54.3354 | +.0021 |
| July 8, 1932 | 269.990 | 54.3286 | +.0085 | 54.3371 | +.0038 |
| | 269.975 | 54.3138 | +.0213 | 54.3351 | +.0018 |
| | 269.995 | 54.3302 | +.0043 | 54.3345 | +.0012 |
| Even temperature 270°. | Mean value of pressure at 270° = $P_m$ = 54.3333 atm. | | | | |
| April 4, 1932 | 275.059 | 58.7648 | −0.0532 | 58.7116 | −0.0009 |
| April 5, 1932 | 275.415 | 59.0855 | −.3756 | 58.7099 | −.0026 |
| April 7, 1932 | 275.015 | 58.7218 | −.0135 | 58.7083 | −.0042 |
| April 8, 1932 | 275.669 | 59.3127 | −.6041 | 58.7086 | −.0039 |
| July 8, 1932 | 274.990 | 58.7073 | +.0090 | 58.7163 | +.0038 |
| | 274.968 | 58.6857 | +.0289 | 58.7146 | +.0021 |
| | 274.963 | 58.6820 | +.0334 | 58.7154 | +.0029 |
| | 274.998 | 58.7132 | +.0018 | 58.7150 | +.0025 |
| Even temperature 275°. | Mean value of pressure at 275° = $P_m$ = 58.7125 atm. | | | | |
| March 28, 1932 | 280.015 | 63.3688 | −0.0143 | 63.3545 | −0.0013 |
| April 4, 1932 | 280.009 | 63.3635 | −.0086 | 63.3545 | −.0013 |
| April 5, 1932 | 280.219 | 63.5622 | −.2093 | 63.3529 | −.0029 |
| April 7, 1932 | 280.054 | 63.4020 | −.0516 | 63.3504 | −.0054 |
| April 8, 1932 | 279.996 | 63.3651 | +.0038 | 63.3689 | +.0131 |
| April 26, 1932 | 280.098 | 63.4445 | −.0937 | 63.3508 | −.0050 |
| April 29, 1932 | 280.005 | 63.3602 | −.0048 | 63.3554 | −.0004 |
| July 8, 1932 | 279.988 | 63.3444 | +.0115 | 63.3559 | +.0001 |
| | 279.962 | 63.3214 | +.0363 | 63.3577 | +.0019 |
| | 279.988 | 63.3458 | +.0115 | 63.3573 | +.0015 |
| Even temperature 280°. | Mean value of pressure at 280° = $P_m$ = 63.3558 atm. | | | | |
| March 28, 1932 | 290.406 | 73.9146 | −0.4351 | 73.4795 | +0.0016 |
| April 4, 1932 | 290.027 | 73.5075 | −.0289 | 73.4786 | +.0007 |
| April 5, 1932 | 290.027 | 73.5066 | −.0289 | 73.4777 | −.0002 |
| April 7, 1932 | 290.001 | 73.4771 | −.0011 | 73.4760 | −.0019 |
| April 8, 1932 | 290.009 | 73.4944 | −.0096 | 73.4848 | +.0069 |
| April 26, 1932 | 290.014 | 73.4824 | −.0150 | 73.4674 | −.0105 |
| | 290.023 | 73.4963 | −.0246 | 73.4717 | −.0062 |
| April 29, 1932 | 290.040 | 73.5189 | −.0428 | 73.4761 | −.0018 |
| July 8, 1932 | 289.986 | 73.4657 | +.0150 | 73.4807 | +.0028 |
| | 289.949 | 73.4254 | +.0546 | 73.4800 | +.0021 |
| | 289.996 | 73.4796 | +.0043 | 73.4839 | +.0060 |
| Even temperature 290°. | Mean value of pressure at 290° = $P_m$ = 73.4779 atm. | | | | |

TABLE 1.—*Observed pressure of saturated water vapor*—Continued

| Date | Observed quantities | | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | Temperature $\theta_w$ | Pressure $P_w$ | | | |
| | °C. (Int.) | *Standard atmospheres (Int.)* | | | |
| March 25, 1932 | 300.129 | 84.9464 | −0.1546 | 84.7918 | −0.0051 |
| March 28, 1932 | 300.005 | 84.8075 | −.0060 | 84.8015 | +.0046 |
| March 29, 1932 | 299.970 | 84.7592 | +.0358 | 84.7950 | −.0019 |
| March 30, 1932 | 299.953 | 84.7475 | +.0561 | 84.8036 | +.0067 |
| April 1, 1932 | 300.048 | 84.8578 | −.0573 | 84.8005 | +.0036 |
| April 7, 1932 | 300.047 | 84.8492 | −.0561 | 84.7931 | −.0038 |
| April 8, 1932 | 300.025 | 84.8232 | −.0299 | 84.7933 | −.0036 |
| June 30, 1932 | 299.609 | 84.3244 | +.4665 | 84.7909 | −.0060 |
| | 299.954 | 84.7441 | +.0549 | 84.7990 | +.0021 |
| | 299.813 | 84.5766 | +.2234 | 84.8000 | +.0031 |
| July 1, 1932 | 299.654 | 84.3803 | +.4128 | 84.7931 | −.0038 |
| July 8, 1932 | 300.009 | 84.8095 | −.0107 | 84.7988 | +.0019 |
| | 299.974 | 84.7671 | +.0311 | 84.7982 | +.0013 |
| | 299.973 | 84.7662 | +.0322 | 84.7984 | +.0015 |
| | 300.012 | 84.8111 | −.0143 | 84.7968 | −.0001 |
| Even temperature 300°. | Mean value of pressure at 300° = $P_m$ = 84.7969 atm. | | | | |
| March 28, 1932 | 310.019 | 97.4298 | −0.0253 | 97.4045 | −0.0017 |
| April 4, 1932 | 310.039 | 97.4615 | −.0518 | 97.4097 | +.0035 |
| April 5, 1932 | 310.036 | 97.4503 | −.0478 | 97.4025 | −.0037 |
| April 7, 1932 | 309.980 | 97.3822 | +.0266 | 97.4088 | +.0026 |
| April 8, 1932 | 309.902 | 97.2816 | +.1302 | 97.4118 | +.0056 |
| April 25, 1932 | 310.015 | 97.4259 | −.0199 | 97.4060 | −.0002 |
| | 310.015 | 97.4246 | −.0199 | 97.4047 | −.0015 |
| | 310.017 | 97.4264 | −.0226 | 97.4038 | −.0024 |
| April 29, 1932 | 310.030 | 97.4361 | −.0399 | 97.3962 | −.0100 |
| July 1, 1932 | 309.975 | 97.3685 | +.0332 | 97.4017 | −.0035 |
| July 11, 1932 | 309.993 | 97.4006 | +.0093 | 97.4099 | +.0037 |
| | 309.973 | 97.3753 | +.0359 | 97.4112 | +.0050 |
| | 309.989 | 97.3949 | +.0146 | 97.4095 | +.0033 |
| Even temperature 310°. | Mean value of pressure at 310° = $P_m$ = 97.4062 atm. | | | | |
| April 4, 1932 | 320.070 | 111.524 | −0.103 | 111.421 | +0.003 |
| April 5, 1932 | 320.032 | 111.473 | −.047 | 111.426 | +.008 |
| April 7, 1932 | 320.045 | 111.493 | −.066 | 111.427 | +.009 |
| April 8, 1932 | 320.020 | 111.460 | −.030 | 111.430 | +.012 |
| April 29, 1932 | 320.017 | 111.447 | −.025 | 111.422 | +.004 |
| July 1, 1932 | 320.007 | 111.426 | −.010 | 111.416 | −.002 |
| | 320.007 | 111.422 | −.010 | 111.412 | −.006 |
| | 319.957 | 111.333 | +.063 | 111.396 | −.022 |
| | 320.012 | 111.418 | −.018 | 111.400 | −.018 |
| July 11, 1932 | 320.017 | 111.446 | −.025 | 111.421 | +.003 |
| | 319,994 | 111.415 | +.009 | 111.424 | +.006 |
| | 320.003 | 111.425 | −.004 | 111.421 | +.003 |
| Even temperature 320°. | Mean value of pressure at 320° = $P_m$ = 111.418 atm. | | | | |
| April 4, 1932 | 325.025 | 119.033 | −0.039 | 118.994 | +0.006 |
| April 5, 1932 | 325.033 | 119.043 | −.051 | 118.992 | +.004 |
| April 7, 1932 | 325.004 | 118.994 | −.006 | 118.988 | .000 |
| April 8, 1932 | 325.004 | 118.998 | −.006 | 118.992 | +.004 |
| July 1, 1932 | 324.968 | 118.920 | +.050 | 118.970 | −.018 |
| | 324.923 | 118.854 | +.120 | 118.974 | −.014 |
| July 11, 1932 | 325.005 | 119.004 | −.008 | 118.996 | +.008 |
| | 324.997 | 119.986 | +.005 | 118.991 | +.003 |
| | 325.038 | 119.052 | −.060 | 118.992 | +.004 |
| Even temperature 325°. | Mean value of pressure at 325° = $P_m$ = 118.988 atm. | | | | |
| April 4, 1932 | 330.020 | 126.994 | −0.033 | 126.961 | +0.001 |
| April 5, 1932 | 330.010 | 126.980 | −.016 | 126.964 | +.004 |
| April 7, 1932 | 330.009 | 126.983 | −.015 | 126.968 | +.008 |
| April 8, 1932 | 330.012 | 126.988 | −.020 | 126.968 | +.008 |
| April 26, 1932 | 330.020 | 126.990 | −.033 | 126.957 | −.003 |
| | 330.033 | 127.008 | −.054 | 126.954 | −.006 |
| | 330.038 | 127.012 | −.062 | 126.950 | −.010 |
| April 29, 1932 | 330.043 | 127.030 | −.070 | 126.960 | .000 |
| July 11, 1932 | 330.026 | 127.002 | −.042 | 126.960 | .000 |
| | 330.014 | 127.982 | −.023 | 126.959 | −.001 |
| | 330.032 | 127.005 | −.052 | 126.953 | −.007 |
| | 330.025 | 127.004 | −.041 | 126.963 | +.003 |
| Even temperature 330°. | Mean value of pressure at 330° = $P_m$ = 126.960 atm. | | | | |

TABLE 1.—*Observed pressure of saturated water vapor*—Continued

| Date | Observed quantities | | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | Temperature $\theta_w$ | Pressure $P_w$ | | | |
| | °C. (*Int.*) | *Standard atmospheres (Int.)* | | | |
| April 4, 1932 | 340.035 | 144.229 | −0.063 | 144.166 | −0.001 |
| April 5, 1932 | 340.040 | 144.243 | −.072 | 144.171 | +.004 |
| April 7, 1932 | 340.041 | 144.231 | −.074 | 144.157 | −.010 |
| April 8, 1932 | 340.015 | 144.197 | −.027 | 144.170 | +.003 |
| April 28, 1932 | 340.021 | 144.208 | −.038 | 144.170 | +.003 |
| | 340.025 | 144.204 | −.045 | 144.159 | −.008 |
| April 29, 1932 | 340.028 | 144.213 | −.051 | 144.162 | −.005 |
| July 11, 1932 | 340.026 | 144.216 | −.047 | 144.169 | +.002 |
| | 340.023 | 144.211 | −.042 | 144.169 | +.002 |
| | 339.994 | 144.161 | +.011 | 144.172 | +.005 |
| | 340.028 | 144.222 | −.051 | 144.171 | +.004 |
| Even temperature 340°. | Mean value of pressure at 340° = $P_m$ = 144.167 atm. | | | | |
| March 29, 1932 | 349.998 | 163.208 | +0.004 | 163.212 | +.007 |
| March 29, 1932 | 349.996 | 163.209 | +.008 | 163.217 | +.012 |
| March 30, 1932 | 349.989 | 163.183 | +.022 | 163.205 | .000 |
| | 350.110 | 163.421 | −.220 | 163.201 | −.004 |
| April 1, 1932 | 350.089 | 163.382 | −.178 | 163.204 | −.001 |
| April 5, 1932 | 350.057 | 163.324 | −.114 | 163.210 | +.005 |
| April 7, 1932 | 349.999 | 163.198 | +.002 | 163.200 | −.005 |
| April 8, 1932 | 350.026 | 163.254 | −.052 | 163.202 | −.003 |
| | 350.043 | 163.282 | −.086 | 163.196 | −.009 |
| | 350.060 | 163.332 | −.120 | 163.212 | +.007 |
| April 27, 1932 | 350.001 | 163.215 | −.002 | 163.213 | +.008 |
| | 350.018 | 163.225 | −.036 | 163.189 | −.016 |
| July 11, 1932 | 350.027 | 163.262 | −.054 | 163.208 | +.003 |
| | 350.009 | 163.218 | −.018 | 163.200 | −.005 |
| | 350.020 | 163.246 | −.040 | 163.206 | +.001 |
| July 12, 1932 | 350.025 | 163.254 | −.050 | 163.204 | −.001 |
| | 349.995 | 163.197 | +.010 | 163.207 | +.002 |
| | 350.006 | 163.214 | −.012 | 163.202 | −.003 |
| Even temperature 350°. | Mean value of pressure at 350° = $P_m$ = 163.205 atm. | | | | |
| July 12, 1932 | 355.037 | 173.552 | −0.078 | 173.474 | +0.001 |
| | 355.006 | 173.475 | −.013 | 173.462 | −.011 |
| | 355.022 | 173.521 | −.046 | 173.475 | +.002 |
| July 13, 1932 | 354.988 | 173.449 | +.025 | 173.474 | +.001 |
| | 354.966 | 173.402 | +.072 | 173.474 | +.001 |
| | 355.013 | 173.507 | −.027 | 173.480 | +.007 |
| Even temperature 355°. | Mean value of pressure at 355° = $P_m$ = 173.473 atm. | | | | |
| April 29, 1932 | 360.008 | 184.311 | −0.018 | 184.293 | −0.004 |
| July 12, 1932 | 360.029 | 184.365 | −.064 | 184.301 | +.004 |
| | 359.996 | 184.291 | +.009 | 184.300 | +.003 |
| | 360.004 | 184.308 | −.009 | 184.299 | +.002 |
| July 13, 1932 | 359.976 | 184.241 | +.053 | 184.294 | −.003 |
| | 359.959 | 184.208 | +.091 | 184.299 | +.002 |
| | 359.996 | 184.285 | +.009 | 184.294 | −.003 |
| Even temperature 360°. | Mean value of pressure at 360° = $P_m$ = 184.297 atm. | | | | |
| July 12, 1932 | 361.993 | 188.770 | +0.016 | 188.786 | −0.001 |
| | 361.990 | 188.765 | +.023 | 188.788 | +.001 |
| | 361.973 | 188.729 | +.061 | 188.790 | +.003 |
| | 362.007 | 188.803 | −.016 | 188.787 | .000 |
| July 13, 1932 | 361.981 | 188.741 | +.043 | 188.784 | −.003 |
| | 361.965 | 188.708 | +.079 | 188.787 | .000 |
| | 361.992 | 188.770 | +.018 | 188.788 | +.001 |
| Even temperature 362°. | Mean value of pressure at 362° = $P_m$ = 188.787 atm. | | | | |
| July 12, 1932 | 363.996 | 193.367 | +0.009 | 193.376 | −0.002 |
| | 363.978 | 193.323 | +.051 | 193.374 | −.004 |
| | 364.009 | 193.401 | −.021 | 193.380 | +.002 |
| July 13, 1932 | 363.972 | 193.314 | +.065 | 193.379 | +.001 |
| | 363.958 | 193.282 | +.097 | 193.379 | +.001 |
| | 363.981 | 193.338 | +.044 | 193.382 | +.004 |
| Even temperature 364°. | Mean value of pressure at 364° = $P_m$ = 193.378 atm. | | | | |

TABLE 1.—*Observed pressure of saturated water vapor*—Continued.

| Date | Observed quantities: Temperature $\theta_w$ | Observed quantities: Pressure $P_w$ | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | °*C. (Int.)* | *Standard atmospheres (Int.)* | | | |
| | 366.019 | 198.110 | −0.045 | 198.065 | +0.001 |
| | 365.992 | 198.038 | +.019 | 198.057 | −.007 |
| July 12, 1932 | 366.032 | 198.139 | −.076 | 198.063 | −.001 |
| | 366.034 | 198.143 | −.081 | 198.062 | −.002 |
| | 366.022 | 198.119 | −.052 | 198.067 | +.003 |
| | 365.951 | 197.949 | +.116 | 198.065 | +.001 |
| July 13, 1932 | 365,938 | 197.917 | +.147 | 198.064 | .000 |
| | 366.004 | 198.078 | −.009 | 198.069 | +.005 |
| Even temperature 366°. | Mean value of pressure at 366° = $P_m$ = 198.064 atm. | | | | |
| | 368.009 | 202.876 | −0.022 | 202.854 | −0.003 |
| July 13, 1932 | 367.988 | 202,831 | +.029 | 202.860 | +.003 |
| | 368.030 | 202.938 | −.073 | 202.865 | +.008 |
| | 368.047 | 202.972 | −.114 | 202.858 | +.001 |
| July 14, 1932 | 368.040 | 202.947 | −.097 | 202.850 | −.007 |
| | 368.018 | 202.899 | −.044 | 202.855 | −.002 |
| Even temperature 368°. | Mean value of pressure at 368° = $P_m$ = 202.857 atm. | | | | |
| | 370.014 | 207.801 | −0.035 | 207.766 | −0.005 |
| | 370.009 | 207.788 | −.022 | 207.766 | −.005 |
| Apr. 29 1932 | 370.010 | 207.792 | −.025 | 207.767 | −.004 |
| | 370.020 | 207.820 | −.049 | 207.771 | .000 |
| | 370.035 | 207.857 | −.087 | 207.770 | −.001 |
| | 369.959 | 207.667 | +.101 | 207.768 | −.003 |
| | 370.017 | 207.829 | −.042 | 207.787 | +.016 |
| | 370.034 | 207.862 | −.084 | 207.778 | +.007 |
| | 370.013 | 207.810 | −.032 | 207.778 | +.007 |
| July 13, 1932 | 370.056 | 207.924 | −.138 | 207.786 | +.015 |
| | 370.041 | 207.870 | −.101 | 207.769 | −.002 |
| | 370.012 | 207.804 | −.030 | 207.774 | +.003 |
| | 370.006 | 207.795 | −.015 | 207.780 | +.009 |
| | 369.983 | 207.723 | +.042 | 207.765 | −.006 |
| | 370.016 | 207.812 | −.040 | 207.772 | +.001 |
| | 370.010 | 207.789 | −.025 | 207.764 | −.007 |
| July 14, 1932 | 369.986 | 207.726 | +.035 | 207.761 | −.010 |
| | 370.017 | 207.808 | −.042 | 207.766 | −.005 |
| | 370.001 | 207.766 | −.002 | 207.764 | −.007 |
| Even temperature 370°. | Mean value of pressure at 370° = $P_m$ = 207.771 atm. | | | | |
| | 370.952 | 210.147 | +0.120 | 210.267 | −0.003 |
| | 370.966 | 201.182 | +.085 | 210.267 | −.003 |
| | 371,091 | 210.511 | −.227 | 210.284 | +.014 |
| | 371,082 | 210.480 | −.205 | 210.275 | +.005 |
| July 14, 1932 | 371.046 | 210.389 | −.115 | 210.274 | +.004 |
| | 371.038 | 210.360 | −.095 | 210.265 | −.005 |
| | 371.015 | 210.315 | −.037 | 210.278 | +.008 |
| | 371.011 | 210.297 | −.027 | 210.270 | .000 |
| | 370.953 | 210.149 | +.117 | 210.266 | −.004 |
| | 370.914 | 210.047 | +.215 | 210.262 | −.008 |
| July 15, 1932 | 370.900 | 210.022 | +.250 | 210.272 | +.002 |
| | 370.892 | 209.987 | +.270 | 210.257 | −.013 |
| Even temperature 371°. | Mean value of pressure at 371° = $P_m$ = 210.270 atm. | | | | |
| | 371.993 | 212.780 | +0.018 | 212.798 | +0.003 |
| | 372.004 | 212.806 | −.010 | 212.796 | +.001 |
| | 372.027 | 212.866 | −.068 | 212.798 | +.003 |
| July 15, 1932 | 372.014 | 212.831 | −.035 | 212.796 | +.001 |
| | 372.020 | 212.848 | −.051 | 212.797 | +.002 |
| | 372.016 | 212.846 | −.040 | 212.806 | +.011 |
| | 372.070 | 212.966 | −.177 | 212.789 | −.006 |
| July 22, 1932 | 372.072 | 213.074 | −.182 | 212.792 | −.003 |
| | 372.098 | 213.033 | −.248 | 212.785 | −.010 |
| Even temperature 372°. | Mean value of pressure at 372° = $P_m$ = 212.795 atm. | | | | |
| | 373.012 | 215.393 | −0.031 | 215.362 | −0.001 |
| | 373.012 | 215.391 | −.031 | 215.360 | −.003 |
| | 373.003 | 215.373 | −.008 | 215.365 | +.002 |
| | 373.005 | 215.367 | −.013 | 215.354 | −.009 |
| July 15, 1932 | 372.987 | 215.330 | +.033 | 215.363 | .000 |
| | 372.983 | 215.318 | +.043 | 215.361 | −.002 |
| | 372.974 | 215.294 | +.066 | 215.360 | −.003 |
| | 372.974 | 215.299 | +.066 | 215.365 | +.002 |
| | 372.996 | 215.361 | +.010 | 215.371 | +.008 |
| | 373.059 | 215.515 | −.151 | 215.364 | +.001 |
| July 22, 1932 | 373.029 | 215.447 | −.074 | 215.373 | +.010 |
| | 373.008 | 215.381 | −.020 | 215.361 | −.002 |
| Even temperature 373°. | Mean value of pressure at 373° = $P_m$ = 215.363 atm. | | | | |

TABLE 1.—*Observed pressure of saturated water vapor*—Continued

| Date | Observed quantities: Temperature $\theta_w$ | Observed quantities: Pressure $P_w$ | Reduction to even temperature | Vapor pressure at even temperature $P$ | Residual $P-P_m$ |
|---|---|---|---|---|---|
| | °C. (Int.) | Standard atmospheres (Int.) | | | |
| July 22, 1932 | 374.001 | 217.985 | −0.003 | 217.982 | −0.003 |
| | 373.998 | 217.980 | +.005 | 217.985 | .000 |
| | 373.992 | 217.956 | +.021 | 217.977 | −.008 |
| | 373.999 | 217.971 | +.003 | 217.974 | −.011 |
| | 373.978 | 217.913 | +.057 | 217.970 | −.015 |
| | 373.957 | 217.859 | +.111 | 217.970 | −.015 |
| July 25, 1932 | 374.039 | 218.091 | −.101 | 217.990 | +.005 |
| | 373.971 | 217.912 | +.078 | 217.990 | +.005 |
| | 373.948 | 217.855 | +.134 | 217.989 | +.004 |
| | 374.037 | 218.090 | −.096 | 217.994 | +.009 |
| | 374.052 | 218.135 | −.134 | 218.001 | +.016 |
| | 374.044 | 218.106 | −.114 | 217.992 | +.007 |
| | 374.069 | 218.169 | −.178 | 217.991 | +.006 |

Even temperature 374°. Mean value of pressure at 374° = $P_m$ = 217.985 atm.

## V. FORMULATION OF RESULTS

Proceeding with the mean values of vapor pressure corresponding to even temperatures assembled in Table 1 as described above, the next step was to express the aggregate result of the entire series by

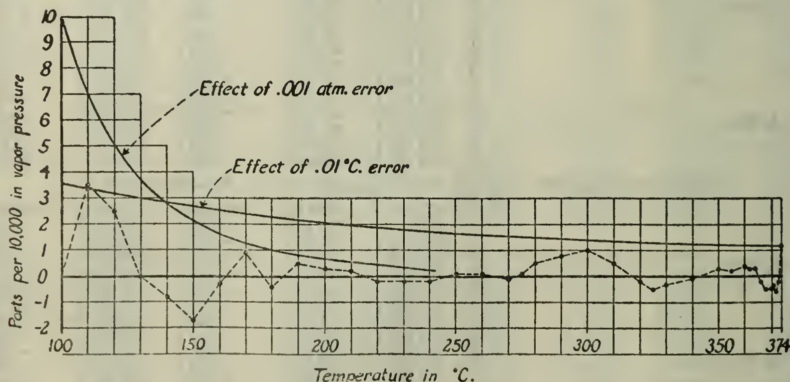


FIGURE 5.—*Deviation of mean observed pressures from the Bureau of Standards formulation*

means of a formula in order to smooth out irregularities caused by accidental errors of observation, and to provide a trustworthy method for interpolating intermediate values and for obtaining the derivative. The results of this formulation are given in Table 2. The constants of the empirical equation were determined by the method of least squares. Since the pressure at the 100° point is fixed by definition, the formula was made to give the value of exactly 1 atmosphere at this point. It was found necessary to apply the formula over two overlapping temperature ranges in order to secure a satisfactory fit.

The agreement of the formula with observation is shown by the differences in columns 4 and 5 and graphically in Figure 5. Since these differences in no case exceed the amount which experimental errors might cause, the formula is taken as a reliable representation of the aggregate results of the complete series of measurements. This formulation is the basis of a mutually consistent group of tables suitable for use as actual working tables. They are expressed in various appropriate units and arranged in convenient form to provide for intercomparison of current steam tables. The number of significant figures retained may be more than corresponds to the absolute accuracy of measurement, yet was determined by considerations of consistency and precision of formulation, calculation, conversion of units, and comparisons. The derivative is included because this factor is important for making thermodynamic correlations and for interpolating intermediate values.

For the units which involve the value of the intensity of gravity the internationally accepted value of 980.665 cm/sec.$^2$ or its equivalent in the English system (32.174 ft./sec.$^2$) has been used. Obviously it would be undesirable to complicate the tabulation further by taking into account the difference of gravity in different localities. It may be regarded as unfortunate that existing engineering practice still retains pressure units which involve local values of gravity, particularly since the difference is usually so small that the change to standard gravity could be made painlessly.

It should not be overlooked that the temperatures given in this group of tables are expressed either on the international centigrade scale or on the Fahrenheit scale derived from it. For correlations involving the second law of thermodynamics, the departure of this temperature scale from the absolute or thermodynamic scale must be taken into account if it should be found to be significant.

Table 3 contains the values of the pressure of saturated water vapor and the derivative with respect to temperature at each ° C. from 100° to 374°. Values are given in each of the three units of pressure which are ordinarily used with the centigrade scale. The standard atmosphere is the standard international unit which has been used as the basis of reduction of the measurements. The centibar is a decimal subdivision of an internationally recognized unit of pressure.[9] This unit possesses several advantages for use as a practical working standard. It is derived directly from the fundamental units of length, mass, and time independently of the properties of any substance or of the intensity of gravity. It may therefore be used in thermodynamic calculations with other current cgs units without requiring a conversion factor, a property possessed by no system of thermodynamic units used in current steam tables. This unit is of convenient size for practical use and has a convenient and unequivocal name, which is a unique combination.

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[9] The bar, equal to $10^6$ dynes/cm$^2$ was approved as a unit of pressure by the International Meteorological Commission, Rome, 1913.

TABLE 2.—*Saturation pressure of water vapor*

[Results and formulation of observations]

| Temperature | Saturation pressure | | Deviations | | Derivative [2] |
|---|---|---|---|---|---|
| $\theta$ | Mean observed $P_m$ | Calculated [1] $P$ | $P_m-P$ | $\frac{P_m-P}{P}\times 10^4$ | Calculated $dP/d\theta$ |
| ° *C.* | *Standard atmospheres (Int.)* | | | *Parts in 10,000* | *Atm./° C.* |
| 100 | ---------- | ---------- | ---------- | ---------- | 0.03569 |
| 110 | 1.4143 | 1.4138 | +0.0005 | +3.5 | .04750 |
| 120 | 1.9598 | 1.9593 | +.0005 | +2.5 | .06208 |
| 130 | 2.6658 | 2.6658 | .0000 | .0 | .07978 |
| 140 | 3.5661 | 3.5664 | −.0003 | −.8 | .10095 |
| 150 | 4.6969 | 4.6977 | −.0008 | −1.7 | .12598 |
| 160 | 6.0998 | 6.1000 | −.0002 | −.3 | .15521 |
| 170 | 7.8178 | 7.8171 | +.0007 | +.9 | .18899 |
| 180 | 9.8958 | 9.8962 | −.0004 | −.4 | .22768 |
| 190 | 12.3887 | 12.3881 | +.0006 | +.5 | .27161 |
| 200 | 15.3472 | 15.3468 | +.0004 | +.3 | .32110 |
| 210 | 18.8300 | 18.8296 | +.0004 | +.2 | .37647 |
| 220 | 22.8964 | 22.8969 | −.0005 | −.2 | .43805 |
| 230 | 27.6117 | 27.6122 | −.0005 | −.2 | .5061 |
| 240 | 33.0416 | 33.0421 | −.0005 | −.2 | .5810 |
| 250 | 39.2566 | 39.2563 | +.0003 | +.1 | .6630 |
| 260 | 46.3286 | 46.3280 | +.0006 | +.1 | .7526 |
| 270 | 54.3333 | 54.3339 | −.0006 | −.1 | .8500 |
| 275 | 58.7125 | 58.7122 | +.0003 | +.1 | .9016 |
| 280 | 63.3558 | 63.3529 | +.0029 | +.5 | .9553 |
| 290 | 73.4779 | 73.4723 | +.0056 | +.8 | 1.0701 |
| 300 | 84.7969 | 84.7881 | +.0088 | +1.0 | 1.1947 |
| 310 | 97.4062 | 97.4015 | +.0047 | +.5 | 1.3297 |
| 320 | 111.418 | 111.420 | −.002 | −.2 | 1.4760 |
| 325 | 118.988 | 118.994 | −.006 | −.5 | 1.5538 |
| 330 | 126.960 | 126.964 | −.004 | −.3 | 1.6349 |
| 340 | 144.167 | 144.168 | −.001 | −.1 | 1.8086 |
| 350 | 163.205 | 163.200 | +.005 | +.3 | 2.0016 |
| 355 | 173.473 | 173.470 | +.003 | +.2 | 2.1076 |
| 360 | 184.297 | 184.290 | +.007 | +.4 | 2.2220 |
| 362 | 188.787 | 188.782 | +.005 | +.3 | 2.2705 |
| 364 | 193.378 | 193.373 | +.005 | +.3 | 2.3208 |
| 366 | 198.064 | 198.067 | −.003 | −.2 | 2.3732 |
| 368 | 202.857 | 202.867 | −.010 | −.5 | 2.4277 |
| 370 | 207.771 | 207.781 | −.010 | −.5 | 2.4846 |
| 371 | 210.270 | 210.279 | −.009 | −.4 | 2.5141 |
| 372 | 212.795 | 212.808 | −.013 | −.6 | 2.5442 |
| 373 | 215.363 | 215.367 | −.004 | −.2 | 2.5751 |
| 374 | 217.985 | 217.958 | +.027 | +1.2 | 2.6068 |

[1] Calculated from the equation

$$\Theta \log_{10} P = a\Theta + b + cx^3 + dx^5 + ex^6$$

where $a$, $b$, $c$, $d$, and $e$ are constants given in the table below for the two temperature ranges, $\Theta = (273.1 + \theta)$, and $x = \left(\frac{\Theta^2}{298{,}000} - 1\right)$.

[2] Calculated from the equation

$$\frac{dP}{d\Theta} = 2.302585P\left(\frac{a - \log_{10}P}{\Theta} + 6cx^2 + 10dx^4 + 12ex^5\right)$$

which is the derivative of the above equation, using the same notation and constants.

*Table of constants*

| | Range 100°–275° C. | Range 275°–374° C. |
|---|---|---|
| $a=$ | +5.4247285 | +5.4231165 |
| $b=$ | −2003.853 | −2002.971 |
| $c=$ | +87.880 | +109.54 |
| $d=$ | +107.35 | −608.22 |
| $e=$ | −96.252 | +1399.0 |

TABLE 3.—*Pressure of saturated water vapor*

[1 standard atmosphere=101.325 centibars[1]=1.033228 kg/cm $^2$.][2]

| Temperature θ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Temperature θ |
|---|---|---|---|---|---|---|---|
| °C. (Int.) | Std. Atm. | Std. Atm. per °C. | Centibars | Centibars per °C. | kg/cm $^2$ | kg/cm $^2$ per °C. | °C. (Int.) |
| 100 | 1.0000 | 0.03569 | 101.325 | 3.616 | 1.03323 | 0.03688 | 100 |
| 101 | 1.0362 | .03676 | 104.99 | 3.725 | 1.0706 | .03798 | 101 |
| 102 | 1.0735 | .03785 | 108.77 | 3.835 | 1.1092 | .03911 | 102 |
| 103 | 1.1119 | .03896 | 112.66 | 3.948 | 1.1488 | .04025 | 103 |
| 104 | 1.1515 | .04011 | 116.68 | 4.064 | 1.1898 | .04144 | 104 |
| 105 | 1.1922 | .04128 | 120.80 | 4.183 | 1.23188 | .04265 | 105 |
| 106 | 1.2341 | .04247 | 125.05 | 4.303 | 1.2751 | .04388 | 106 |
| 107 | 1.2771 | .04369 | 129.40 | 4.427 | 1.3195 | .04514 | 107 |
| 108 | 1.3214 | .04493 | 133.89 | 4.553 | 1.3653 | .04642 | 108 |
| 109 | 1.3670 | .04621 | 138.51 | 4.682 | 1.4124 | .04775 | 109 |
| 110 | 1.4138 | .04750 | 143.25 | 4.813 | 1.4608 | .04908 | 110 |
| 111 | 1.4620 | .04883 | 148.14 | 4.948 | 1.5106 | .05045 | 111 |
| 112 | 1.5115 | .05019 | 153.15 | 5.086 | 1.5617 | .05186 | 112 |
| 113 | 1.5624 | .05157 | 158.31 | 5.225 | 1.6143 | .05328 | 113 |
| 114 | 1.6146 | .05298 | 163.60 | 5.368 | 1.6682 | .05474 | 114 |
| 115 | 1.6683 | .05442 | 169.04 | 5.514 | 1.7237 | .05623 | 115 |
| 116 | 1.7235 | .05590 | 174.63 | 5.664 | 1.7808 | .05776 | 116 |
| 117 | 1.7802 | .05740 | 180.38 | 5.816 | 1.8394 | .05931 | 117 |
| 118 | 1.8383 | .05893 | 186.27 | 5.971 | 1.8994 | .06089 | 118 |
| 119 | 1.8980 | .06049 | 192.31 | 6.129 | 1.9611 | .06250 | 119 |
| 120 | 1.9593 | .06208 | 198.53 | 6.290 | 2.0244 | .06414 | 120 |
| 121 | 2.0222 | .06370 | 204.90 | 6.454 | 2.0894 | .06582 | 121 |
| 122 | 2.0867 | .06536 | 211.43 | 6.623 | 2.1560 | .06753 | 122 |
| 123 | 2.1529 | .06704 | 218.14 | 6.793 | 2.2214 | .06927 | 123 |
| 124 | 2.2208 | .06876 | 225.02 | 6.967 | 2.2946 | .07104 | 124 |
| 125 | 2.2904 | .07051 | 232.07 | 7.144 | 2.3665 | .07285 | 125 |
| 126 | 2.3619 | .07230 | 239.32 | 7.326 | 2.4404 | .07470 | 126 |
| 127 | 2.4351 | .07412 | 246.74 | 7.510 | 2.5160 | .07658 | 127 |
| 128 | 2.5101 | .07597 | 254.34 | 7.698 | 2.5935 | .07849 | 128 |
| 129 | 2.5870 | .07786 | 262.13 | 7.889 | 2.6730 | .08045 | 129 |
| 130 | 2.6658 | .07978 | 270.11 | 8.084 | 2.7544 | .08243 | 130 |
| 131 | 2.7466 | .08173 | 278.30 | 8.281 | 2.8379 | .08445 | 131 |
| 132 | 2.8293 | .08372 | 286.68 | 8.483 | 2.9233 | .08650 | 132 |
| 133 | 2.9140 | .08575 | 295.26 | 8.689 | 3.0108 | .08860 | 133 |
| 134 | 3.0008 | .08781 | 304.06 | 8.897 | 3.1005 | .09073 | 134 |
| 135 | 3.0897 | .08991 | 313.06 | 9.110 | 3.1924 | .09290 | 135 |
| 136 | 3.1806 | .09204 | 322.27 | 9.326 | 3.2863 | .09510 | 136 |
| 137 | 3.2738 | .09421 | 331.72 | 9.546 | 3.3826 | .09734 | 137 |
| 138 | 3.3691 | .09642 | 341.37 | 9.770 | 3.4810 | .09962 | 138 |
| 139 | 3.4666 | .09867 | 351.25 | 9.998 | 3.5818 | .10195 | 139 |
| 140 | 3.5664 | .10095 | 361.37 | 10.229 | 3.6849 | .10430 | 140 |
| 141 | 3.6686 | .10328 | 371.72 | 10.465 | 3.7905 | .10671 | 141 |
| 142 | 3.7730 | .10564 | 382.30 | 10.704 | 3.8984 | .10915 | 142 |
| 143 | 3.8798 | .10804 | 393.12 | 10.947 | 4.0087 | .11163 | 143 |
| 144 | 3.9891 | .11048 | 404.20 | 11.194 | 4.1216 | .11415 | 144 |
| 145 | 4.1008 | .11296 | 415.51 | 11.446 | 4.2371 | .11671 | 145 |
| 146 | 4.2150 | .11548 | 427.08 | 11.701 | 4.3551 | .11932 | 146 |
| 147 | 4.3318 | .11805 | 438.92 | 11.961 | 4.4757 | .12197 | 147 |
| 148 | 4.4511 | .12065 | 451.01 | 12.225 | 4.5990 | .12466 | 148 |
| 149 | 4.5731 | .12329 | 463.37 | 12.492 | 4.7251 | .12739 | 149 |
| 150 | 4.6977 | .12598 | 475.99 | 12.765 | 4.8538 | .13017 | 150 |
| 151 | 4.8251 | .12871 | 488.90 | 13.042 | 4.9854 | .13299 | 151 |
| 152 | 4.9552 | .13148 | 502.09 | 13.322 | 5.1199 | .13585 | 152 |
| 153 | 5.0880 | .13429 | 515.54 | 13.607 | 5.2571 | .13875 | 153 |
| 154 | 5.2238 | .13714 | 529.30 | 13.896 | 5.3974 | .14170 | 154 |

1 1 centibar=10,000 dyn/cm $^2$.

2 Standard gravity=980.665 cm/sec. $^2$

TABLE 3.—*Pressure of saturated water vapor*—Continued

| Temperature θ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Temperature θ |
|---|---|---|---|---|---|---|---|
| °C. (*Int.*) | *Std. Atm.* | *Std. Atm. per °C.* | *Centibars* | *Centibars per °C.* | *kg/cm²* | *kg/cm² per °C.* | °C. (*Int.*) |
| 155 | 5.3623 | .14004 | 543.34 | 14.190 | 5.5405 | .14469 | 155 |
| 156 | 5.5039 | .14298 | 557.68 | 14.487 | 5.6868 | .14773 | 156 |
| 157 | 5.6483 | .14597 | 572.31 | 14.790 | 5.8360 | .15082 | 157 |
| 158 | 5.7959 | .14901 | 587.27 | 15.098 | 5.9885 | .15396 | 158 |
| 159 | 5.9464 | .15209 | 602.52 | 15.411 | 6.1440 | .15714 | 159 |
| 160 | 6.1000 | .15521 | 618.08 | 15.727 | 6.3027 | .16037 | 160 |
| 161 | 6.2568 | .15837 | 633.97 | 16.047 | 6.4647 | .16363 | 161 |
| 162 | 6.4168 | .16159 | 650.18 | 16.373 | 6.6300 | .16696 | 162 |
| 163 | 6.5800 | .16485 | 666.72 | 16.703 | 6.7986 | .17033 | 163 |
| 164 | 6.7465 | .16816 | 683.59 | 17.039 | 6.9707 | .17375 | 164 |
| 165 | 6.9163 | .17151 | 700.79 | 17.378 | 7.1461 | .17721 | 165 |
| 166 | 7.0895 | .17491 | 718.34 | 17.723 | 7.3251 | .18072 | 166 |
| 167 | 7.2661 | .17836 | 736.24 | 18.072 | 7.5075 | .18429 | 167 |
| 168 | 7.4462 | .18185 | 754.49 | 18.426 | 7.6936 | .18789 | 168 |
| 169 | 7.6298 | .18540 | 773.09 | 18.786 | 7.8833 | .19156 | 169 |
| 170 | 7.8171 | .18899 | 792.07 | 19.149 | 8.0768 | .19527 | 170 |
| 171 | 8.0079 | .19263 | 811.40 | 19.518 | 8.2740 | .19903 | 171 |
| 172 | 8.2023 | .19632 | 831.10 | 19.892 | 8.4748 | .20284 | 172 |
| 173 | 8.4005 | .20007 | 851.18 | 20.272 | 8.6796 | .20672 | 173 |
| 174 | 8.6025 | .20386 | 871.65 | 20.656 | 8.8883 | .21063 | 174 |
| 175 | 8.8083 | .20770 | 892.50 | 21.045 | 9.1010 | .21460 | 175 |
| 176 | 9.0179 | .21159 | 913.74 | 21.439 | 9.3175 | .21862 | 176 |
| 177 | 9.2315 | .21554 | 935.38 | 21.840 | 9.5382 | .22270 | 177 |
| 178 | 9.4490 | .21953 | 957.42 | 22.244 | 9.7630 | .22682 | 178 |
| 179 | 9.6705 | .22357 | 979.86 | 22.653 | 9.9918 | .23100 | 179 |
| 180 | 9.8962 | .22768 | 1,002.7 | 23.070 | 10.225 | .23525 | 180 |
| 181 | 10.126 | .23183 | 1,026.0 | 23.490 | 10.462 | .23953 | 181 |
| 182 | 10.360 | .23604 | 1,049.7 | 23.917 | 10.704 | .24388 | 182 |
| 183 | 10.598 | .24029 | 1,073.8 | 24.347 | 10.950 | .24827 | 183 |
| 184 | 10.840 | .24460 | 1,098.4 | 24.784 | 11.200 | .25273 | 184 |
| 185 | 11.087 | .24896 | 1,123.4 | 25.226 | 11.455 | .25723 | 185 |
| 186 | 11.338 | .25338 | 1,148.8 | 25.674 | 11.715 | .26180 | 186 |
| 187 | 11.594 | .25786 | 1,174.8 | 26.128 | 11.979 | .26643 | 187 |
| 188 | 11.854 | .26238 | 1,201.1 | 26.586 | 12.248 | .27110 | 188 |
| 189 | 12.119 | .26697 | 1,228.0 | 27.051 | 12.522 | .27584 | 189 |
| 190 | 12.388 | .27161 | 1,255.2 | 27.521 | 12.800 | .28064 | 190 |
| 191 | 12.662 | .27630 | 1,283.0 | 27.996 | 13.083 | .28548 | 191 |
| 192 | 12.941 | .28105 | 1,311.2 | 28.477 | 13.371 | .29039 | 192 |
| 193 | 13.224 | .28585 | 1,339.9 | 28.964 | 13.663 | .29535 | 913 |
| 194 | 13.512 | .29071 | 1,369.1 | 29.456 | 13.961 | .30037 | 194 |
| 195 | 13.806 | .29564 | 1,398.9 | 29.956 | 14.265 | .30546 | 195 |
| 196 | 14.104 | .30061 | 1,429.1 | 30.459 | 14.573 | .31060 | 196 |
| 197 | 14.407 | .30564 | 1,459.8 | 30.969 | 14.886 | .31580 | 197 |
| 198 | 14.715 | .31074 | 1,491.0 | 31.486 | 15.204 | .32107 | 198 |
| 199 | 15.028 | .31589 | 1,522.7 | 32.008 | 15.527 | .32639 | 199 |
| 200 | 15.347 | .32110 | 1,555.0 | 32.535 | 15.857 | .33177 | 200 |
| 201 | 15.671 | .32637 | 1,587.9 | 33.069 | 16.192 | .33721 | 201 |
| 202 | 16.000 | .33169 | 1,621.2 | 33.608 | 16.532 | .34271 | 202 |
| 203 | 16.334 | .33708 | 1,655.0 | 34.155 | 16.877 | .34828 | 203 |
| 204 | 16.674 | .34252 | 1,689.5 | 34.706 | 17.228 | .35390 | 204 |
| 205 | 17.019 | .34803 | 1,724.5 | 35.264 | 17.585 | .35959 | 205 |
| 206 | 17.370 | .35360 | 1,760.0 | 35.829 | 17.947 | .36535 | 206 |
| 207 | 17.726 | .35922 | 1,796.1 | 36.398 | 18.315 | .37116 | 207 |
| 208 | 18.088 | .36491 | 1,832.8 | 36.975 | 18.689 | .37704 | 208 |
| 209 | 18.456 | .37066 | 1,870.1 | 37.557 | 19.069 | .38298 | 209 |
| 210 | 18.830 | .37647 | 1,907.9 | 38.146 | 19.456 | .38898 | 210 |
| 211 | 19.209 | .38235 | 1,946.4 | 38.742 | 19.847 | .39505 | 211 |
| 212 | 19.594 | .38828 | 1,985.4 | 39.342 | 20.245 | .40118 | 212 |
| 213 | 19.986 | .39428 | 2,025.1 | 39.950 | 20.650 | .40738 | 213 |
| 214 | 20.383 | .40034 | 2,065.3 | 40.564 | 21.060 | .41364 | 214 |
| 215 | 20.786 | .40646 | 2,106.1 | 41.185 | 21.477 | .41997 | 215 |
| 216 | 21.196 | .41265 | 2,147.7 | 41.812 | 21.900 | .42636 | 216 |
| 217 | 21.612 | .41890 | 2,189.8 | 42.445 | 22.330 | .43282 | 217 |
| 218 | 22.034 | .42522 | 2,232.6 | 43.085 | 22.766 | .43935 | 218 |
| 219 | 22.462 | .43160 | 2,276.0 | 43.732 | 23.208 | .44594 | 219 |

TABLE 3.—*Pressure of saturated water vapor*—Continued

| Temperature θ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Temperature θ |
|---|---|---|---|---|---|---|---|
| °C. (Int.) | Std. Atm. | Std. Atm. per °C. | Centibars | Centibars per °C. | kg/cm² | kg/cm² per °C. | °C. (Int.) |
| 220 | 22.897 | .43805 | 2,320.0 | 44.385 | 23.658 | .45261 | 220 |
| 221 | 23.338 | .44455 | 2,364.7 | 45.044 | 24.113 | .45932 | 221 |
| 222 | 23.786 | .45113 | 2,410.1 | 45.711 | 24.576 | .46612 | 222 |
| 223 | 24.240 | .45777 | 2,456.1 | 46.384 | 25.045 | .47298 | 223 |
| 224 | 24.702 | .46448 | 2,502.9 | 47.063 | 25.523 | .47991 | 224 |
| 225 | 25.170 | .47125 | 2,550.4 | 47.749 | 26.006 | .48691 | 225 |
| 226 | 25.644 | .47809 | 2,598.4 | 48.442 | 26.496 | .49398 | 226 |
| 227 | 26.126 | .48500 | 2,647.2 | 49.143 | 26.994 | .5011 | 227 |
| 228 | 26.614 | .49197 | 2,696.7 | 49.849 | 27.498 | .5083 | 228 |
| 229 | 27.110 | .49901 | 2,746.9 | 50.56 | 28,011 | .5156 | 229 |
| 230 | 27.612 | .5061 | 2,797.8 | 51.28 | 28.529 | .5229 | 230 |
| 231 | 28.122 | .5133 | 2,849.5 | 52.01 | 29.056 | .5304 | 231 |
| 232 | 28.639 | .5205 | 2,901.8 | 52.74 | 29.591 | .5378 | 232 |
| 233 | 29.163 | .5279 | 2,954.9 | 53.48 | 30.132 | .5454 | 233 |
| 234 | 29.695 | .5352 | 3,008.8 | 54.23 | 30.682 | .5530 | 234 |
| 235 | 30.234 | .5427 | 3063.5 | 54.99 | 31.239 | .5607 | 235 |
| 236 | 30.780 | .5502 | 3118.8 | 55.75 | 31.803 | .5685 | 236 |
| 237 | 31.334 | .5578 | 3174.9 | 56.52 | 32.375 | .5763 | 237 |
| 238 | 31.896 | .5655 | 3231.9 | 57.30 | 32.956 | .5843 | 238 |
| 239 | 32.465 | .5732 | 3289.5 | 58.08 | 33.544 | .5923 | 239 |
| 240 | 33.042 | .5810 | 3348.0 | 58.87 | 34.140 | .6003 | 240 |
| 241 | 33.627 | .5889 | 3407.3 | 59.67 | 34.744 | .6085 | 241 |
| 242 | 34.220 | .5968 | 3467.3 | 60.47 | 35.357 | .6167 | 242 |
| 243 | 34.821 | .6049 | 3528.2 | 61.29 | 35.978 | .6250 | 243 |
| 244 | 35.430 | .6130 | 3589.9 | 62.11 | 36.607 | .6333 | 244 |
| 245 | 36.047 | .6211 | 3652.5 | 62.93 | 37.245 | .6418 | 245 |
| 246 | 36.672 | .6293 | 3715.8 | 63.77 | 37.891 | .6503 | 246 |
| 247 | 37.305 | .6377 | 3779.9 | 64.61 | 38.545 | .6589 | 247 |
| 248 | 37.947 | .6460 | 3845.0 | 65.46 | 39.208 | .6675 | 248 |
| 249 | 38.598 | .6545 | 3910.9 | 66.32 | 39.881 | .6763 | 249 |
| 250 | 39.256 | .6630 | 3977.6 | 67.18 | 40.560 | .6851 | 250 |
| 251 | 39.924 | .6717 | 4045.3 | 68.06 | 41.251 | .6940 | 251 |
| 252 | 40.600 | .6803 | 4113.8 | 68.93 | 41.949 | .7029 | 252 |
| 253 | 41.284 | .6891 | 4183.1 | 69.82 | 42.656 | .7120 | 253 |
| 254 | 41.978 | .6979 | 4253.4 | 70.72 | 43.373 | .7211 | 254 |
| 255 | 42.680 | .7068 | 4324.6 | 71.62 | 44.098 | .7303 | 255 |
| 256 | 43.392 | .7158 | 4396.7 | 72.53 | 44.834 | .7396 | 256 |
| 257 | 44.112 | .7249 | 4469.6 | 73.45 | 45.578 | .7490 | 257 |
| 258 | 44.841 | .7340 | 4543.5 | 74.38 | 46.331 | .7584 | 258 |
| 259 | 45.580 | .7433 | 4618.4 | 75.31 | 47.095 | .7680 | 259 |
| 260 | 46.328 | .7526 | 4694.2 | 76.25 | 47.867 | .7776 | 260 |
| 261 | 47.085 | .7619 | 4770.9 | 77.20 | 48.650 | .7873 | 261 |
| 262 | 47.852 | .7714 | 4848.6 | 78.16 | 49.442 | .7970 | 262 |
| 263 | 48.628 | .7809 | 4927.2 | 79.13 | 50.244 | .8069 | 263 |
| 264 | 49.414 | .7906 | 5006.9 | 80.10 | 51.056 | .8168 | 264 |
| 265 | 50.209 | .8002 | 5087.4 | 81.08 | 51.877 | .8268 | 265 |
| 266 | 51.014 | .8100 | 5169.0 | 82.08 | 52.709 | .8369 | 266 |
| 267 | 51.829 | .8199 | 5251.6 | 83.08 | 53.551 | .8471 | 267 |
| 268 | 52.654 | .8298 | 5335.2 | 84.08 | 54.404 | .8574 | 268 |
| 269 | 53.489 | .8399 | 5419.8 | 85.10 | 55.266 | .8678 | 269 |
| 270 | 54.334 | .8500 | 5505.4 | 86.12 | 56.139 | .8782 | 270 |
| 271 | 55.189 | .8602 | 5592.0 | 87.16 | 57.023 | .8887 | 271 |
| 272 | 56.054 | .8704 | 5679.7 | 88.20 | 57.917 | .8994 | 272 |
| 273 | 56.930 | .8808 | 5768.4 | 89.25 | 58.822 | .9101 | 273 |
| 274 | 57.816 | .8912 | 5858.2 | 90.31 | 59.737 | .9209 | 274 |
| 275 | 58.712 | .9018 | 5949.0 | 91.37 | 60.663 | .9317 | 275 |
| 276 | 59.619 | .9120 | 6040.9 | 92.41 | 61.600 | .9423 | 276 |
| 277 | 60.536 | .9227 | 6133.8 | 93.49 | 62.547 | .9533 | 277 |
| 278 | 61.464 | .9335 | 6227.8 | 94.58 | 63.506 | .9645 | 278 |
| 279 | 62.403 | .9444 | 6323.0 | 95.69 | 64.477 | .9757 | 279 |
| 280 | 63.353 | .9553 | 6419.2 | 96.80 | 65.458 | .9871 | 280 |
| 281 | 64.314 | .9664 | 6516.6 | 97.92 | 66.451 | .9985 | 281 |
| 282 | 65.286 | .9775 | 6615.1 | 99.05 | 67.455 | 1.0100 | 282 |
| 283 | 66.269 | .9888 | 6714.7 | 100.19 | 68.471 | 1.0216 | 283 |
| 284 | 67.263 | 1.0001 | 6815.4 | 101.34 | 69.498 | 1.0333 | 284 |

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TABLE 3.—*Pressure of saturated water vapor*—Continued

| Temperature $\theta$ | Pressure $P$ | Derivative $dP/d\theta$ | Pressure $P$ | Derivative $dP/d\theta$ | Pressure $P$ | Derivative $dP/d\theta$ | Temperature $\theta$ |
|---|---|---|---|---|---|---|---|
| °C. (*Int.*) | *Std. Atm.* | *Std. Atm. per °C.* | *Centibars* | *Centibars per °C.* | *kg/cm²* | *kg/cm² per °C.* | °C. (*Int.*) |
| 285 | 68.269 | 1.0116 | 6917.4 | 102.50 | 70.537 | 1.0452 | 285 |
| 286 | 69.286 | 1.0231 | 7020.4 | 103.67 | 71.588 | 1.0571 | 286 |
| 287 | 70.315 | 1.0347 | 7124.7 | 104.84 | 72.651 | 1.0691 | 287 |
| 288 | 71.356 | 1.0464 | 7230.1 | 106.03 | 73.727 | 1.0812 | 288 |
| 289 | 72.408 | 1.0582 | 7336.7 | 107.22 | 74.814 | 1.0934 | 289 |
| 290 | 73.472 | 1.0701 | 7444.6 | 108.43 | 75.913 | 1.1057 | 290 |
| 291 | 74.548 | 1.0821 | 7553.6 | 109.64 | 77.025 | 1.1181 | 291 |
| 292 | 75.637 | 1.0942 | 7663.9 | 110.87 | 78.150 | 1.1306 | 292 |
| 293 | 76.737 | 1.1064 | 7775.4 | 112.11 | 79.287 | 1.1432 | 293 |
| 294 | 77.850 | 1.1188 | 7888.2 | 113.36 | 80.437 | 1.1560 | 294 |
| 295 | 78.974 | 1.1312 | 8002.0 | 114.62 | 81.598 | 1.1688 | 295 |
| 296 | 80.112 | 1.1437 | 8117.3 | 115.89 | 82.774 | 1.1817 | 296 |
| 297 | 81.262 | 1.1563 | 8233.9 | 117.16 | 83.962 | 1.1947 | 297 |
| 298 | 82.424 | 1.1690 | 8351.6 | 118.45 | 85.163 | 1.2078 | 298 |
| 299 | 83.600 | 1.1818 | 8470.8 | 119.75 | 86.378 | 1.2211 | 299 |
| 300 | 84.788 | 1.1947 | 8591.1 | 121.05 | 87.605 | 1.2344 | 300 |
| 301 | 85.989 | 1.2077 | 8712.8 | 122.37 | 88.846 | 1.2478 | 301 |
| 302 | 87.204 | 1.2209 | 8835.9 | 123.71 | 90.102 | 1.2615 | 302 |
| 303 | 88.431 | 1.2341 | 8960.3 | 125.05 | 91.369 | 1.2751 | 303 |
| 304 | 89.672 | 1.2474 | 9086.0 | 126.39 | 92.652 | 1.2888 | 304 |
| 305 | 90.926 | 1.2609 | 9,213.1 | 127.76 | 93.947 | 1.3028 | 305 |
| 306 | 92.194 | 1.2744 | 9,341.6 | 129.13 | 95.257 | 1.3167 | 306 |
| 307 | 93.475 | 1.2881 | 9,471.4 | 130.52 | 96.581 | 1.3309 | 307 |
| 308 | 94.770 | 1.3019 | 9,602.6 | 131.92 | 97.919 | 1.3452 | 308 |
| 309 | 96.079 | 1.3157 | 9,735.2 | 133.31 | 99.272 | 1.3594 | 309 |
| 310 | 97.402 | 1.3297 | 9,869.3 | 134.73 | 100.64 | 1.3739 | 310 |
| 311 | 98.738 | 1.3438 | 10,005 | 136.16 | 102.02 | 1.3885 | 311 |
| 312 | 100.09 | 1.3581 | 10,142 | 137.61 | 103.42 | 1.4032 | 312 |
| 313 | 101.45 | 1.3724 | 10,279 | 139.06 | 104.82 | 1.4180 | 313 |
| 314 | 102.83 | 1.3868 | 10,419 | 140.52 | 106.24 | 1.4329 | 314 |
| 315 | 104.23 | 1.4014 | 10,561 | 142.00 | 107.69 | 1.4480 | 315 |
| 316 | 105.64 | 1.4161 | 10,704 | 143.49 | 109.15 | 1.4632 | 316 |
| 317 | 107.06 | 1.4309 | 10,848 | 144.99 | 110.62 | 1.4784 | 317 |
| 318 | 108.50 | 1.4458 | 10,994 | 146.50 | 112.11 | 1.4938 | 318 |
| 319 | 109.95 | 1.4609 | 11,141 | 148.03 | 113.60 | 1.5094 | 319 |
| 320 | 111.42 | 1.4760 | 11,290 | 149.56 | 115.12 | 1.5250 | 320 |
| 321 | 112.90 | 1.4913 | 11,440 | 151.11 | 116.65 | 1.5409 | 321 |
| 322 | 114.40 | 1.5068 | 11,592 | 152.68 | 118.20 | 1.5569 | 322 |
| 323 | 115.92 | 1.5223 | 11,746 | 154.25 | 119.77 | 1.5729 | 323 |
| 324 | 117.45 | 1.5380 | 11,901 | 155.84 | 121.35 | 1.5891 | 324 |
| 325 | 118.99 | 1.5538 | 12,057 | 157.44 | 122.94 | 1.6054 | 325 |
| 326 | 120.55 | 1.5697 | 12,215 | 159.05 | 124.56 | 1.6219 | 326 |
| 327 | 122.13 | 1.5858 | 12,375 | 160.68 | 126.19 | 1.6385 | 327 |
| 328 | 123.73 | 1.6020 | 12,537 | 162.32 | 127.84 | 1.6552 | 328 |
| 329 | 125.34 | 1.6184 | 12,700 | 163.98 | 129.50 | 1,6722 | 329 |
| 330 | 126.96 | 1.6349 | 12,864 | 165.66 | 131.18 | 1.6892 | 330 |
| 331 | 128.61 | 1.6516 | 13,031 | 167.35 | 132.88 | 1.7065 | 331 |
| 332 | 130.27 | 1.6684 | 13,200 | 169.05 | 134.60 | 1.7238 | 332 |
| 333 | 131.94 | 1.6853 | 13,369 | 170.76 | 136.32 | 1.7413 | 333 |
| 334 | 133.64 | 1.7024 | 13,541 | 172.50 | 138.08 | 1.7590 | 334 |
| 335 | 135.35 | 1.7197 | 13,714 | 174.25 | 139.85 | 1.7768 | 335 |
| 336 | 137.08 | 1.7371 | 13,890 | 176.01 | 141.63 | 1.7948 | 336 |
| 337 | 138.82 | 1,7547 | 14,066 | 177.80 | 143.43 | 1.8130 | 337 |
| 338 | 140.59 | 1.7724 | 14,245 | 179.59 | 145.26 | 1.8313 | 338 |
| 339 | 142.37 | 1.7905 | 14,426 | 181.42 | 147.10 | 1,8500 | 339 |
| 340 | 144.17 | 1.8086 | 14,608 | 183.26 | 148.96 | 1.8687 | 340 |
| 341 | 145.98 | 1.8269 | 14,791 | 185.11 | 150.83 | 1.8876 | 341 |
| 342 | 147.82 | 1.8455 | 14,978 | 187.00 | 152.73 | 1.9068 | 342 |
| 343 | 149.68 | 1.8642 | 15,166 | 188.89 | 154.65 | 1.9261 | 343 |
| 344 | 151.55 | 1.8831 | 15,356 | 190.81 | 156.59 | 1.9457 | 344 |
| 345 | 153.44 | 1.9023 | 15,547 | 192.75 | 158.54 | 1.9655 | 345 |
| 346 | 155.36 | 1.9217 | 15,742 | 194.72 | 160.52 | 1.9856 | 346 |
| 347 | 157.29 | 1.9413 | 15,937 | 196.70 | 162.52 | 2.0058 | 347 |
| 348 | 159.24 | 1.9611 | 16,135 | 198.71 | 164.53 | 2.0263 | 348 |
| 349 | 161.21 | 1.9812 | 16,335 | 200.75 | 166.57 | 2.0470 | 349 |
| 350 | 163.20 | 2.0016 | 16,536 | 202.81 | 168.62 | 2.0681 | 350 |
| 351 | 165.21 | 2.0222 | 16,740 | 204.90 | 170.70 | 2.0894 | 351 |
| 352 | 167.24 | 2.0431 | 16,946 | 207.02 | 172.80 | 2.1110 | 352 |
| 353 | 169.30 | 2.0643 | 17,154 | 209.17 | 174.93 | 2.1329 | 353 |
| 354 | 171.37 | 2.0858 | 17,364 | 211.34 | 177.06 | 2.1551 | 354 |

TABLE 3.—*Pressure of saturated water vapor*—Continued

| Temperature θ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Pressure P | Derivative dP/dθ | Temperature θ |
|---|---|---|---|---|---|---|---|
| °C. (Int.) | Std. Atm. | Std. Atm. per °C. | Centibars | Centibars per °C. | kg/cm² | kg/cm² per °C. | °C. (Int.) |
| 355 | 173.47 | 2.1076 | 17,577 | 213.55 | 179.23 | 2.1776 | 355 |
| 356 | 175.59 | 2.1298 | 17,792 | 215.80 | 181.42 | 2.2006 | 356 |
| 357 | 177.73 | 2.1523 | 18,008 | 218.08 | 183.64 | 2.2238 | 357 |
| 358 | 179.89 | 2.1751 | 18,227 | 220.39 | 185.87 | 2.2474 | 358 |
| 359 | 182.08 | 2.1984 | 18,449 | 222.75 | 188.13 | 2.2714 | 359 |
| 360 | 184.29 | 2.2220 | 18,673 | 225.14 | 190.41 | 2.2958 | 360 |
| 361 | 186.52 | 2.2460 | 18,899 | 227.58 | 192.72 | 2.3206 | 361 |
| 362 | 188.78 | 2.2705 | 19,128 | 230.06 | 195.05 | 2.3459 | 362 |
| 363 | 191.06 | 2.2954 | 19,359 | 232.58 | 197.41 | 2.3717 | 363 |
| 364 | 193.37 | 2.3208 | 19,593 | 235.16 | 199.80 | 2.3979 | 364 |
| 365 | 195.71 | 2.3467 | 19,830 | 237.78 | 202.21 | 2.4247 | 365 |
| 366 | 198.07 | 2.3732 | 20,069 | 240.46 | 204.65 | 2.4521 | 366 |
| 367 | 200.45 | 2.4001 | 20,311 | 243.19 | 207.11 | 2.4799 | 367 |
| 368 | 202.87 | 2.4277 | 20,556 | 245.99 | 209.61 | 2.5084 | 368 |
| 369 | 205.31 | 2.4558 | 20,803 | 248.83 | 212.13 | 2.5374 | 369 |
| 370 | 207.78 | 2.4846 | 21,053 | 251.75 | 214.68 | 2.5672 | 370 |
| 371 | 210.28 | 2.5141 | 21,307 | 254.74 | 217.27 | 2.5976 | 371 |
| 372 | 212.81 | 2.5442 | 21,563 | 257.79 | 219.88 | 2.6287 | 372 |
| 373 | 215.37 | 2.5751 | 21,822 | 260.92 | 222.53 | 2.6607 | 373 |
| 374 | 217.96 | 2.6068 | 22,085 | 264.13 | 225.20 | 2.6934 | 374 |

The kilogram per square centimeter has a wide usage, particularly abroad and in scientific circles. Its chief disadvantage is that the intensity of gravity must be specified to make the unit definite. A second is that, lacking a name, it has frequently been confused with the atmosphere, having approximately the same value. The three units are used coordinately in this table to facilitate their use interchangeably and give the user a choice of unit appropriate for his purpose.

Table 4 contains values of the pressure of saturated steam in pounds per square inch at each degree Fahrenheit. This pressure unit, like the kg/cm² is indefinite unless the intensity of gravity is specified. Table 5 contains values of the derivative in the corresponding units.

TABLE 4.—*Pressure of saturated water vapor*

[Pounds [1] per square inch]

| Temperature °F. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| ϑ | Pressure | | | | | | | | | |
| | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² | Lbs./in.² |
| 210 | --------- | --------- | 14.696 | 14.990 | 15.288 | 15.592 | 15.900 | 16.213 | 16.532 | 16.857 |
| 220 | 17.186 | 17.521 | 17.862 | 18.206 | 18.556 | 18.911 | 19.273 | 19.640 | 20.014 | 20.393 |
| 230 | 20.777 | 21.167 | 21.565 | 21.969 | 22.377 | 22.793 | 23.215 | 23.642 | 24.076 | 24.518 |
| 240 | 24.966 | 25.420 | 25.882 | 26.349 | 26.824 | 27.305 | 27.795 | 28.290 | 28.794 | 29.305 |
| 250 | 29.823 | 30.348 | 30.877 | 31.420 | 31.969 | 32.525 | 33.088 | 33.660 | 34.243 | 34.829 |
| 260 | 35.425 | 36.028 | 36.641 | 37.262 | 37.892 | 38.530 | 39.177 | 39.834 | 40.498 | 41.172 |
| 270 | 41.853 | 42.545 | 43.246 | 43.957 | 44.677 | 45.406 | 46.144 | 46.892 | 47.651 | 48.419 |
| 280 | 49.198 | 49.986 | 50.784 | 51.593 | 52.412 | 53.243 | 54.083 | 54.933 | 55.793 | 56.665 |
| 290 | 57.549 | 58.444 | 59.349 | 60.266 | 61.194 | 62.133 | 63.085 | 64.046 | 65.020 | 66.006 |
| 300 | 67.006 | 68.015 | 69.038 | 70.074 | 71.120 | 72.181 | 73.251 | 74.336 | 75.433 | 76.546 |
| 310 | 77.669 | 78.805 | 79.957 | 81.119 | 82.296 | 83.484 | 84.691 | 85.909 | 87.141 | 88.386 |
| 320 | 89.646 | 90.922 | 92.209 | 93.514 | 94.829 | 96.162 | 97.510 | 98.873 | 100.25 | 101.64 |
| 330 | 103.05 | 104.47 | 105.91 | 107.36 | 108.84 | 110.32 | 111.83 | 113.34 | 114.88 | 116.43 |
| 340 | 118.00 | 119.58 | 121.18 | 122.80 | 124.44 | 126.09 | 127.76 | 129.45 | 131.15 | 132.87 |
| 350 | 134.62 | 136.37 | 138.15 | 139.94 | 141.75 | 143.58 | 145.44 | 147.31 | 149.19 | 151.10 |

[1] Standard gravity=32.174 ft./sec.²

TABLE 4.—*Pressure of saturated water vapor*—Continued

| Temperature ° F. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| θ | Pressure | | | | | | | | | |
| | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² | *Lbs./in.*² |
| 360 | 153.02 | 154.97 | 156.93 | 158.91 | 160.91 | 162.94 | 164.98 | 167.04 | 169.13 | 171.23 |
| 370 | 173.35 | 175.50 | 177.67 | 179.85 | 182.06 | 184.29 | 186.53 | 188.81 | 191.10 | 193.41 |
| 380 | 195.74 | 198.10 | 200.48 | 202.89 | 205.32 | 207.76 | 210.24 | 212.72 | 215.24 | 217.78 |
| 390 | 220.34 | 222.92 | 225.54 | 228.18 | 230.84 | 233.50 | 236.21 | 238.95 | 241.70 | 244.48 |
| 400 | 247.29 | 250.11 | 252.97 | 255.85 | 258.75 | 261.67 | 264.63 | 267.61 | 270.63 | 273.66 |
| 410 | 276.73 | 279.81 | 282.92 | 286.05 | 289.22 | 292.43 | 295.65 | 298.90 | 302.16 | 305.47 |
| 420 | 308.82 | 312.17 | 315.56 | 318.98 | 322.43 | 325.89 | 329.40 | 332.93 | 336.50 | 340.09 |
| 430 | 343.70 | 347.35 | 351.03 | 354.74 | 358.47 | 362.25 | 366.06 | 369.90 | 373.76 | 377.65 |
| 440 | 381.58 | 385.53 | 389.52 | 393.53 | 397.60 | 401.68 | 405.79 | 409.94 | 414.12 | 418.33 |
| 450 | 422.57 | 426.86 | 431.17 | 435.53 | 439.90 | 444.32 | 448.77 | 453.24 | 457.76 | 462.31 |
| 460 | 466.90 | 471.51 | 476.17 | 480.86 | 485.59 | 490.35 | 495.15 | 499.98 | 504.85 | 509.76 |
| 470 | 514.69 | 519.68 | 424.69 | 529.76 | 534.84 | 539.96 | 545.12 | 550.32 | 555.57 | 560.86 |
| 480 | 566.17 | 571.52 | 576.91 | 582.36 | 587.83 | 593.33 | 598.88 | 604.46 | 610.08 | 615.77 |
| 490 | 621.48 | 627.23 | 633.03 | 638.86 | 644.72 | 650.63 | 656.59 | 662.60 | 668.64 | 674.72 |
| 500 | 680.84 | 687.01 | 693.21 | 699.46 | 705.76 | 712.09 | 718.47 | 724.90 | 731.36 | 737.88 |
| 510 | 744.44 | 751.03 | 757.67 | 764.35 | 771.10 | 777.87 | 784.71 | 791.57 | 798.50 | 805.46 |
| 520 | 812.46 | 819.52 | 826.62 | 833.77 | 840.96 | 848.20 | 855.50 | 862.84 | 870.23 | 877.66 |
| 530 | 885.12 | 892.65 | 900.23 | 907.85 | 915.54 | 923.26 | 931.04 | 938.87 | 946.74 | 954.68 |
| 540 | 962.64 | 970.67 | 978.74 | 986.87 | 995.04 | 1.003.3 | 1,011.6 | 1,019.9 | 1,028.3 | 1,036.7 |
| 550 | 1,045.2 | 1,053.8 | 1,062.4 | 1,071.0 | 1,079.7 | 1,088.5 | 1,097.3 | 1,106.2 | 1,115.1 | 1,124.1 |
| 560 | 1,133.2 | 1,142.3 | 1,151.4 | 1,160.6 | 1,169.9 | 1,179.2 | 1,188.6 | 1,198.0 | 1,207.5 | 1,217.0 |
| 570 | 1,226.6 | 1,236.3 | 1,246.0 | 1,255.8 | 1,265.7 | 1,275.6 | 1,285.5 | 1,295.5 | 1,305.6 | 1,315.8 |
| 580 | 1,326.0 | 1,336.3 | 1,346.6 | 1,357.0 | 1,367.4 | 1,377.9 | 1,388.5 | 1,399.1 | 1,409.8 | 1,420.6 |
| 590 | 1,431.4 | 1,442.3 | 1,453.3 | 1,464.3 | 1,475.3 | 1,486.4 | 1,497.6 | 1,508.9 | 1,520.3 | 1,531.8 |
| 600 | 1,543.3 | 1,554.8 | 1,566.4 | 1,578.1 | 1,589.8 | 1,601.6 | 1,613.4 | 1,625.4 | 1,637.4 | 1,649.5 |
| 610 | 1,661.6 | 1,673.8 | 1,686.1 | 1,698.6 | 1,711.1 | 1,723.6 | 1,736.2 | 1,748.8 | 1,761.4 | 1,774.2 |
| 620 | 1,787.0 | 1,800.0 | 1,813.1 | 1,826.2 | 1,839.4 | 1,852.6 | 1,865.9 | 1,879.3 | 1,892.8 | 1,906.3 |
| 630 | 1,919.9 | 1,933.5 | 1,947.3 | 1,961.2 | 1,975.1 | 1,989.1 | 2,003.2 | 2,017.3 | 2,031.5 | 2,045.8 |
| 640 | 2,060.2 | 2,074.7 | 2,089.3 | 2,104.0 | 2,118.7 | 2,133.4 | 2,148.3 | 2,163.4 | 2,178.4 | 2,193.6 |
| 650 | 2,208.8 | 2,224.1 | 2,239.5 | 2,255.0 | 2,270.6 | 2,286.3 | 2,302.0 | 2,317.8 | 2,333.8 | 2,349.8 |
| 660 | 2,366.0 | 2,382.2 | 2,398.4 | 2,414.7 | 2,431.2 | 2,447.8 | 2,464.5 | 2,481.3 | 2,498.1 | 2,515.1 |
| 670 | 2,532.1 | 2,549.3 | 2,566.6 | 2,584.0 | 2,601.4 | 2,618.9 | 2,636.6 | 2,654.3 | 2,672.3 | 2,690.3 |
| 680 | 2,708.3 | 2,726.5 | 2,744.8 | 2,763.2 | 2,781.7 | 2,800.3 | 2,819.0 | 2,838.0 | 2,857.0 | 2,876.2 |
| 690 | 2,895.5 | 2,914.8 | 2,934.1 | 2,953.6 | 2,973.4 | 2,993.3 | 3,013.3 | 3,033.4 | 3,053.6 | 3,073.9 |
| 700 | 3,094.4 | 3,115.0 | 3,135.8 | 3,156.7 | 3,177.7 | 3,198.9 | -------- | -------- | -------- | -------- |

TABLE 5.—*Derivative of the pressure of saturated water vapor* (*dP/d*)

[Pounds [1] per square inch per degree Fahrenheit]

| Temperature θ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Derivative | | | | | | | | | |
| ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* | *Lbs./in.*² ° *F.* |
| 210 | -------- | -------- | 0.2914 | 0.2962 | 0.3011 | 0.3061 | 0.3111 | 0.3161 | 0.3212 | 0.3264 |
| 220 | 0.3317 | 0.3370 | .3424 | .3478 | .3534 | .3590 | .3646 | .3703 | .3761 | .3819 |
| 230 | .3878 | .3938 | .3999 | .4061 | .4123 | .4186 | .4249 | .4313 | .4378 | .4443 |
| 240 | .4511 | .4578 | .4646 | .4714 | .4783 | .4854 | .4924 | .4996 | .5068 | .5142 |
| 250 | .5216 | .5291 | .5367 | .5443 | .5520 | .5598 | .5677 | .5757 | .5833 | .5919 |
| 260 | .6002 | .6085 | .6169 | .6254 | .6339 | .6427 | .6514 | .6602 | .6691 | .6781 |
| 270 | .6872 | .6964 | .7057 | .7151 | .7246 | .7341 | .7437 | .7534 | .7633 | .7732 |
| 280 | .7832 | .7933 | .8036 | .8139 | .8242 | .8348 | .8454 | .8561 | .8668 | .8778 |
| 290 | .8887 | .8998 | .9110 | .9223 | .9337 | .9452 | .9568 | .9686 | .9803 | .9922 |
| 300 | 1.0042 | 1.0163 | 1.0286 | 1.0409 | 1.0533 | 1.0659 | 1.0786 | 1.0913 | 1.1042 | 1.1171 |
| 310 | 1.1302 | 1.1433 | 1.1568 | 1.1702 | 1.1837 | 1.1973 | 1.2111 | 1.2250 | 1.2389 | 1.2531 |
| 320 | 1.2672 | 1.2816 | 1.2959 | 1.3105 | 1.3252 | 1.3400 | 1.3549 | 1.3699 | 1.3851 | 1.4003 |
| 330 | 1.4157 | 1.4312 | 1.4468 | 1.4626 | 1.4784 | 1.4944 | 1.5105 | 1.5267 | 1.5430 | 1.5595 |
| 340 | 1.5761 | 1.5928 | 1.6096 | 1.6267 | 1.6437 | 1.6609 | 1.6783 | 1.6958 | 1.7134 | 1.7311 |
| 350 | 1.7491 | 1.7670 | 1.7851 | 1.8033 | 1.8217 | 1.8402 | 1.8589 | 1.8777 | 1.8966 | 1.9157 |
| 360 | 1.9349 | 1.9541 | 1.9736 | 1.9932 | 2.0128 | 2.0326 | 2.0527 | 2.0728 | 2.0931 | 2.1135 |
| 370 | 2.1340 | 2.1547 | 2.1755 | 2.1965 | 2.2176 | 2.2388 | 2.2601 | 2.2817 | 2.3033 | 2.3251 |
| 380 | 2.3471 | 2.3691 | 2.3914 | 2.4138 | 2.4363 | 2.4589 | 2.4817 | 2.5046 | 2.5278 | 2.5511 |
| 390 | 2.5744 | 2.5980 | 2.6216 | 2.6456 | 2.6695 | 2.6936 | 2.7178 | 2.7423 | 2.7669 | 2.7916 |
| 400 | 2.8165 | 2.8415 | 2.8668 | 2.8921 | 2.9176 | 2.9432 | 2.9690 | 2.9949 | 3.0211 | 3.0473 |

[1] Standard gravity=32.174 ft./sec.²

TABLE 5.—*Derivative of the pressure of saturated water vapor (dP/d)*—Continued

| Temperature θ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Derivative | | | | | | | | | |
| ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. | Lbs./in.² ° F. |
| 410 | 3.0737 | 3.1004 | 3.1271 | 3.1540 | 3.1810 | 3.2082 | 3.2355 | 3.2631 | 3.2908 | 3.3186 |
| 420 | 3.3466 | 3.3747 | 3.4031 | 3.4316 | 3.4603 | 3.4891 | 3.5180 | 3.5472 | 3.5764 | 3.6060 |
| 430 | 3.6355 | 3.6654 | 3.6953 | 3.7254 | 3.7557 | 3.7862 | 3.8168 | 3.8475 | 3.8786 | 3.9097 |
| 440 | 3.9410 | 3.9724 | 4.0041 | 4.0358 | 4.0678 | 4.0999 | 4.1322 | 4.1648 | 4.1974 | 4.2303 |
| 450 | 4.2633 | 4.2965 | 4.3298 | 4.3633 | 4.3969 | 4.4308 | 4.4649 | 4.4992 | 4.5336 | 4.5681 |
| 460 | 4.6030 | 4.6379 | 4.6730 | 4.7083 | 4.7437 | 4.7794 | 4.8152 | 4.8513 | 4.8874 | 4.9238 |
| 470 | 4.9604 | 4.9971 | 5.034 | 5.071 | 5.108 | 5.146 | 5.184 | 5.221 | 5.259 | 5.298 |
| 480 | 5.336 | 5.375 | 5.413 | 5.453 | 5.492 | 5.531 | 5.571 | 5.610 | 5.650 | 5.691 |
| 490 | 5.731 | 5.771 | 5.812 | 5.853 | 5.894 | 5.935 | 5.977 | 6.018 | 6.060 | 6.102 |
| 500 | 6.144 | 6.187 | 6.230 | 6.273 | 6.316 | 6.359 | 6.402 | 6.446 | 6.489 | 6.534 |
| 510 | 6.578 | 6.622 | 6.667 | 6.712 | 6.757 | 6.803 | 6.848 | 6.894 | 6.939 | 6.986 |
| 520 | 7.032 | 7.079 | 7.126 | 7.172 | 7.219 | 7.267 | 7.315 | 7.363 | 7.411 | 7.458 |
| 530 | 7.506 | 7.554 | 7.602 | 7.651 | 7.700 | 7.750 | 7.800 | 7.850 | 7.900 | 7.951 |
| 540 | 8.002 | 8.053 | 8.104 | 8.155 | 8.207 | 8.259 | 8.312 | 8.364 | 8.416 | 8.469 |
| 550 | 8.522 | 8.575 | 8.629 | 8.683 | 8.737 | 8.791 | 8.846 | 8.901 | 8.956 | 9.011 |
| 560 | 9.067 | 9.123 | 9.179 | 9.236 | 9.292 | 9.349 | 9.407 | 9.464 | 9.521 | 9.579 |
| 570 | 9.637 | 9.695 | 9.754 | 9.813 | 9.872 | 9.932 | 9.992 | 10.052 | 10.112 | 10.172 |
| 580 | 10.233 | 10.294 | 10.355 | 10.417 | 10.479 | 10.541 | 10.604 | 10.667 | 10.730 | 10.793 |
| 590 | 10.856 | 10.920 | 10.984 | 11.049 | 11.114 | 11.179 | 11.244 | 11.310 | 11.376 | 11.442 |
| 600 | 11.508 | 11.575 | 11.642 | 11.710 | 11.778 | 11.846 | 11.914 | 11.982 | 12.051 | 12.120 |
| 610 | 12.190 | 12.260 | 12.330 | 12.401 | 12.472 | 12.543 | 12.614 | 12.686 | 12.758 | 12.830 |
| 620 | 12.903 | 12.976 | 13.050 | 13.124 | 13.198 | 13.273 | 13.348 | 13.424 | 13.500 | 13.576 |
| 630 | 13.652 | 13.729 | 13.806 | 13.884 | 13.962 | 14.041 | 14.120 | 14.199 | 14.278 | 14.358 |
| 640 | 14.439 | 14.520 | 14.602 | 14.684 | 14.766 | 14.849 | 14.933 | 15.017 | 15.102 | 15.187 |
| 650 | 15.272 | 15.357 | 15.444 | 15.531 | 15.619 | 15.707 | 15.796 | 15.886 | 15.976 | 16.066 |
| 660 | 16.157 | 16.249 | 16.342 | 16.435 | 16.529 | 16.624 | 16.719 | 16.815 | 16.912 | 17.010 |
| 670 | 17.109 | 17.208 | 17.308 | 17.409 | 17.511 | 17.613 | 17.717 | 17.822 | 17.928 | 18.034 |
| 680 | 18.142 | 18.251 | 18.361 | 18.471 | 18.582 | 18.696 | 18.810 | 18.925 | 19.042 | 19.159 |
| 690 | 19.280 | 19.401 | 19.522 | 19.646 | 19.771 | 19.898 | 20.025 | 20.155 | 20.286 | 20.419 |
| 700 | 20.553 | 20.690 | 20.828 | 20.968 | 21.111 | 21.254 | --------- | --------- | --------- | --------- |

Tables 6 and 7 are reciprocal to Tables 3 and 4 and express the same relation of vapor pressure to temperature arranged to indicate temperatures corresponding to integral values of saturation pressures.

TABLE 6.—*Pressure of saturated water vapor*

[Even pressures in pounds [1] per square inch with corresponding temperatures in degrees Fahrenheit]

| Pressure P | Temp. θ | Pressure P | Temp. θ | Pressure P | Temp. θ | Pressure P | Temp. θ |
|---|---|---|---|---|---|---|---|
| Lbs./in.² | °F. | Lbs./in.² | °F. | Lbs./in.² | °F. | Lbs./in.² | °F. |
| 15 | 213.034 | 30 | 250.340 | 45 | 274.444 | 60 | 292.711 |
| 16 | 216.321 | 31 | 252.224 | 46 | 275.806 | 61 | 293.792 |
| 17 | 219.436 | 32 | 254.056 | 47 | 277.143 | 62 | 294.859 |
| 18 | 222.405 | 33 | 255.841 | 48 | 278.456 | 63 | 295.911 |
| 19 | 225.247 | 34 | 257.584 | 49 | 279.747 | 64 | 296.953 |
| 20 | 227.963 | 35 | 259.288 | 50 | 281.018 | 65 | 297.980 |
| 21 | 230.572 | 36 | 260.954 | 51 | 282.268 | 66 | 298.994 |
| 22 | 233.076 | 37 | 262.580 | 52 | 283.499 | 67 | 299.994 |
| 23 | 235.493 | 38 | 264.170 | 53 | 284.708 | 68 | 300.985 |
| 24 | 237.826 | 39 | 265.728 | 54 | 285.902 | 69 | 301.963 |
| 25 | 240.075 | 40 | 267.251 | 55 | 287.078 | 70 | 302.929 |
| 26 | 242.253 | 41 | 268.746 | 56 | 288.238 | 71 | 303.886 |
| 27 | 244.367 | 42 | 270.214 | 57 | 289.381 | 72 | 304.830 |
| 28 | 246.415 | 43 | 271.650 | 58 | 290.505 | 73 | 305.767 |
| 29 | 248.405 | 44 | 273.060 | 59 | 291.616 | 74 | 306.692 |

[1] Standard gravity=32.174 ft./sec.²

TABLE 6.—*Pressure of saturated water vapor*—Continued

| Pressure *P* | Temp. *θ* | Pressure *P* | Temp. *θ* | Pressure *P* | Temp. *θ* | Pressure *P* | Temp. *θ* |
|---|---|---|---|---|---|---|---|
| *Lbs./in.*² | °*F.* | *Lbs./in.*² | °*F.* | *Lbs./in.*² | °*F.* | *Lbs./in.*² | °*F.* |
| 75 | 307.607 | 180 | 373.067 | 475 | 461.749 | 1,200 | 567.211 |
| 76 | 308.509 | 182 | 373.973 | 480 | 462.817 | 1,220 | 569.309 |
| 77 | 309.405 | 184 | 374.872 | 485 | 463.875 | 1,240 | 571.381 |
| 78 | 310.293 | 186 | 375.763 | 490 | 464.927 | 1,260 | 573.428 |
| 79 | 311.170 | 188 | 376.647 | 495 | 565.969 | 1,280 | 575.449 |
| 80 | 312.037 | 190 | 377.522 | 500 | 467.004 | 1,300 | 577.444 |
| 81 | 312.898 | 192 | 378.390 | 510 | 469.049 | 1,320 | 579.414 |
| 82 | 313.749 | 194 | 379.253 | 520 | 471.064 | 1,340 | 581.362 |
| 83 | 314.595 | 196 | 380.110 | 530 | 473.049 | 1,360 | 583.290 |
| 84 | 315.429 | 198 | 380.958 | 540 | 475.008 | 1,380 | 585.197 |
| 85 | 316.255 | 200 | 381.799 | 550 | 476.939 | 1,400 | 587.082 |
| 86 | 317.074 | 205 | 383.868 | 560 | 478.841 | 1,420 | 588.946 |
| 87 | 317.886 | 210 | 385.903 | 570 | 480.717 | 1,440 | 590.789 |
| 88 | 318.691 | 215 | 387.905 | 580 | 482.566 | 1,460 | 592.615 |
| 89 | 319.488 | 220 | 389.868 | 590 | 484.395 | 1,480 | 594.421 |
| 90 | 320.279 | 225 | 391.794 | 600 | 486.201 | 1,500 | 596.208 |
| 91 | 321.061 | 230 | 393.687 | 610 | 487.983 | 1,520 | 597.972 |
| 92 | 321.838 | 235 | 395.549 | 620 | 489.742 | 1,540 | 599.718 |
| 93 | 322.607 | 240 | 397.382 | 630 | 491.479 | 1,560 | 601.446 |
| 94 | 323.370 | 245 | 399.186 | 640 | 493.195 | 1,580 | 603.162 |
| 95 | 324.129 | 250 | 400.961 | 650 | 494.892 | 1,600 | 604.863 |
| 96 | 324.879 | 255 | 402.708 | 660 | 496.568 | 1,620 | 606.546 |
| 97 | 325.623 | 260 | 404.428 | 670 | 498.224 | 1,640 | 608.215 |
| 98 | 326.361 | 265 | 406.123 | 680 | 499.863 | 1,660 | 609.866 |
| 99 | 327.093 | 270 | 407.793 | 690 | 501.482 | 1,680 | 611.499 |
| 100 | 327.819 | 275 | 409.439 | 700 | 503.086 | 1,700 | 613.114 |
| 102 | 329.257 | 280 | 411.061 | 710 | 504.671 | 1,720 | 614.716 |
| 104 | 330.671 | 285 | 412.662 | 720 | 506.239 | 1,740 | 616.307 |
| 106 | 332.062 | 290 | 414.240 | 730 | 507.790 | 1,760 | 617.885 |
| 108 | 333.434 | 295 | 415.799 | 740 | 509.324 | 1,780 | 619.450 |
| 110 | 334.786 | 300 | 417.337 | 750 | 510.844 | 1,800 | 621.000 |
| 112 | 336.118 | 305 | 418.855 | 760 | 512.349 | 1,820 | 622.529 |
| 114 | 337.431 | 310 | 420.354 | 770 | 513.837 | 1,840 | 624.047 |
| 116 | 338.725 | 315 | 421.835 | 780 | 515.313 | 1,860 | 625.556 |
| 118 | 340.002 | 320 | 423.297 | 790 | 516.772 | 1,880 | 627.052 |
| 120 | 341.263 | 325 | 424.742 | 800 | 518.216 | 1,900 | 628.535 |
| 122 | 342.507 | 330 | 426.170 | 810 | 519.650 | 1,920 | 630, 007 |
| 124 | 343.734 | 335 | 427.580 | 820 | 521.068 | 1,940 | 631.468 |
| 126 | 344.946 | 340 | 428.975 | 830 | 522.474 | 1,960 | 632.918 |
| 128 | 346.143 | 345 | 430.357 | 840 | 523.867 | 1,980 | 634.351 |
| 130 | 347.326 | 350 | 431.721 | 850 | 525.248 | 2,000 | 635.773 |
| 132 | 348.495 | 355 | 433.070 | 860 | 526.614 | 2,050 | 639.286 |
| 134 | 349.649 | 360 | 434.404 | 870 | 527.969 | 2,100 | 642.730 |
| 136 | 350.790 | 365 | 435.722 | 880 | 529.313 | 2,150 | 646.108 |
| 138 | 351.917 | 370 | 437.026 | 890 | 530.649 | 2,200 | 649.423 |
| 140 | 353.033 | 375 | 438.319 | 900 | 531.970 | 2,250 | 652.678 |
| 142 | 354.137 | 380 | 439.599 | 910 | 533.281 | 2,300 | 655.873 |
| 144 | 355.228 | 385 | 440.866 | 920 | 534.579 | 2,350 | 659.013 |
| 146 | 356.304 | 390 | 442.120 | 930 | 565.857 | 2,400 | 662.098 |
| 148 | 357.370 | 395 | 443.362 | 940 | 537.144 | 2,450 | 665.132 |
| 150 | 358.426 | 400 | 444.590 | 950 | 538.412 | 2,500 | 668.112 |
| 152 | 359.469 | 405 | 445.808 | 960 | 539.670 | 2,550 | 671.041 |
| 154 | 360.504 | 410 | 447.014 | 970 | 540.917 | 2,600 | 673.922 |
| 156 | 361.528 | 415 | 448.209 | 980 | 542.155 | 2,650 | 676.755 |
| 158 | 362.542 | 420 | 449.394 | 990 | 543.383 | 2,700 | 679.542 |
| 160 | 363.545 | 425 | 450.566 | 1,000 | 544.600 | 2,750 | 682.283 |
| 162 | 364.538 | 430 | 451.729 | 1,020 | 547.012 | 2,800 | 684.981 |
| 164 | 365.521 | 435 | 452.881 | 1,040 | 549.386 | 2,850 | 687.632 |
| 166 | 366.496 | 440 | 454.023 | 1,060 | 551.726 | 2,900 | 690.241 |
| 168 | 367.462 | 445 | 455.153 | 1,080 | 554.033 | 2,950 | 692.810 |
| 170 | 368.417 | 450 | 456.275 | 1,100 | 556.305 | 3,000 | 695.336 |
| 172 | 369.364 | 455 | 457.388 | 1,120 | 558.544 | 3,050 | 697.822 |
| 174 | 370.303 | 460 | 458.493 | 1,140 | 560.753 | 3,100 | 700.272 |
| 176 | 371.232 | 465 | 459.588 | 1,160 | 562.935 | 3,150 | 702.679 |
| 178 | 372.153 | 470 | 460.674 | 1,180 | 565.086 | 3,200 | 705.052 |

TABLE 7.—*Pressure of saturated water vapor*

[Even pressures in kilograms [1] per square centimeter with corresponding temperatures in degrees centigrade]

| Pressure P | Temperature θ | Pressure P | Temperature θ | Pressure P | Temperature θ | Pressure P | Temperature θ |
|---|---|---|---|---|---|---|---|
| Kg/cm² | °C. | Kg/cm² | °C. | Kg/cm² | °C. | Kg/cm² | °C. |
| 1.0 | 99.072 | 8.0 | 169.605 | 55 | 268.693 | 120 | 323.148 |
| 1.1 | 101.764 | 8.2 | 170.626 | 56 | 269.842 | 122 | 324.408 |
| 1.2 | 104.246 | 8.4 | 171.629 | 57 | 270.974 | 124 | 325.654 |
| 1.3 | 106.565 | 8.6 | 172.613 | 58 | 272.092 | 126 | 326.884 |
| 1.4 | 108.739 | 8.8 | 173.579 | 59 | 273.195 | 128 | 328.098 |
| 1.5 | 110.789 | 9.0 | 174.526 | 60 | 274.285 | 130 | 329.298 |
| 1.6 | 112.730 | 9.2 | 175.458 | 61 | 275.361 | 132 | 330.484 |
| 1.7 | 114.575 | 9.4 | 176.375 | 62 | 276.423 | 134 | 331.657 |
| 1.8 | 116.331 | 9.6 | 177.276 | 63 | 277.472 | 136 | 332.816 |
| 1.9 | 118.010 | 9.8 | 178.163 | 64 | 278.509 | 138 | 333.958 |
| 2.0 | 119.617 | 10 | 179.035 | 65 | 279.534 | 140 | 335.088 |
| 2.1 | 121.161 | 11 | 183.201 | 66 | 280.547 | 142 | 336.206 |
| 2.2 | 122.646 | 12 | 187.079 | 67 | 281.548 | 144 | 337.312 |
| 2.3 | 124.076 | 13 | 190.708 | 68 | 282.537 | 146 | 338.406 |
| 2.4 | 125.457 | 14 | 194.130 | 69 | 283.517 | 148 | 339.488 |
| 2.5 | 126.790 | 15 | 197.360 | 70 | 284.485 | 150 | 340.559 |
| 2.6 | 128.083 | 16 | 200.429 | 71 | 285.441 | 152 | 341.616 |
| 2.7 | 129.335 | 17 | 203.351 | 72 | 286.388 | 154 | 342.661 |
| 2.8 | 130.549 | 18 | 206.145 | 73 | 287.326 | 156 | 343.696 |
| 2.9 | 131.730 | 19 | 208.819 | 74 | 288.252 | 158 | 344.722 |
| 3.0 | 132.878 | 20 | 211.385 | 75 | 289.170 | 160 | 345.737 |
| 3.1 | 133.994 | 21 | 213.855 | 76 | 290.079 | 162 | 346.742 |
| 3.2 | 135.082 | 22 | 216.234 | 77 | 290.978 | 164 | 347.738 |
| 3.3 | 136.143 | 23 | 218.530 | 78 | 291.867 | 166 | 348.723 |
| 3.4 | 137.178 | 24 | 220.753 | 79 | 292.748 | 168 | 349.699 |
| 3.5 | 138.188 | 25 | 222.905 | 80 | 293.621 | 170 | 350.664 |
| 3.6 | 139.178 | 26 | 224.988 | 81 | 294.486 | 172 | 351.620 |
| 3.7 | 140.144 | 27 | 227.012 | 82 | 295.343 | 174 | 352.565 |
| 3.8 | 141.089 | 28 | 228.979 | 83 | 296.191 | 176 | 353.502 |
| 3.9 | 142.015 | 29 | 230.894 | 84 | 297.032 | 178 | 354.432 |
| 4.0 | 142.922 | 30 | 232.757 | 85 | 297.865 | 180 | 355.353 |
| 4.1 | 143.810 | 31 | 234.572 | 86 | 298.690 | 182 | 356.263 |
| 4.2 | 144.680 | 32 | 236.345 | 87 | 299.508 | 184 | 357.165 |
| 4.3 | 145.534 | 33 | 238.075 | 88 | 300.319 | 186 | 358.058 |
| 4.4 | 146.374 | 34 | 239.766 | 89 | 301.123 | 188 | 358.943 |
| 4.5 | 147.200 | 35 | 241.419 | 90 | 301.919 | 190 | 359.821 |
| 4.6 | 148.008 | 36 | 243.035 | 91 | 302.710 | 192 | 360.689 |
| 4.7 | 148.802 | 37 | 244.617 | 92 | 303.493 | 194 | 361.551 |
| 4.8 | 149.584 | 38 | 246.167 | 93 | 304.270 | 196 | 362.404 |
| 4.9 | 150.354 | 39 | 247.687 | 94 | 305.041 | 198 | 363.248 |
| 5.0 | 151.110 | 40 | 249.176 | 95 | 305.804 | 200 | 364.084 |
| 5.2 | 152.586 | 41 | 250.637 | 96 | 306.562 | 202 | 364.913 |
| 5.4 | 154.018 | 42 | 252.073 | 97 | 307.314 | 204 | 365.734 |
| 5.6 | 155.409 | 43 | 253.483 | 98 | 308.060 | 206 | 366.550 |
| 5.8 | 156.760 | 44 | 254.866 | 99 | 308.799 | 208 | 367.358 |
| 6.0 | 158.075 | 45 | 256.224 | 100 | 309.533 | 210 | 368.157 |
| 6.2 | 159.354 | 46 | 257.562 | 102 | 310.986 | 212 | 368.949 |
| 6.4 | 160.602 | 47 | 258.876 | 104 | 312.418 | 214 | 369.734 |
| 6.6 | 161.820 | 48 | 260.171 | 106 | 313.828 | 216 | 370.511 |
| 6.8 | 163.008 | 49 | 261.443 | 108 | 315.214 | 218 | 371.280 |
| 7.0 | 164.168 | 50 | 262.697 | 110 | 316.580 | 220 | 372.042 |
| 7.2 | 165.303 | 51 | 263.931 | 112 | 317.930 | 222 | 372.800 |
| 7.4 | 166.412 | 52 | 265.149 | 114 | 319.264 | 224 | 373.553 |
| 7.6 | 167.497 | 53 | 266.347 | 116 | 320.577 | 225 | 373.926 |
| 7.8 | 168.563 | 54 | 267.527 | 118 | 321.871 | | |

[1] Standard gravity=980.665 cm/sec.²

## VI. ESTIMATION OF ACCURACY

Numerical values of physical quantities derived from measurements are never in exact accord with the true values. No matter how skillful and diligent the experimenter, there is a limit to the precision attained in each separate element of measurement and in the final result. The practical use of physical data is similarly subject to limitations of accuracy. The compiler of tables of properties of steam for practical use is obliged to choose from available experimental sources the definitive values which are to be used as a basis for formulation. This selection may be aided by the experimenter if in addition to the record of methods, standards, and units used in his measurements, he includes also a judicious appraisal of the accuracy of the results.

By careful study of all the factors which enter into the measurements, an estimate may be made of the magnitude of the systematic error which may still remain in each factor after all known corrections for standards and calibrations have been applied. Having made these preliminary estimates, they may be used in a final estimate of the amount by which the results of the measurements might differ from the truth. Such an analysis has been made for the results of the present investigation by considering every apparent source of error, both systematic and accidental.

The sources of systematic error which have been found significant, include the calibration of the piston gage, the determination of the pressure corrections for the connecting line between the water sample and the gage, the difference of the scale of the thermometer used from the ideal international standard temperature scale, and the determination of the actual temperature of the free surface of the water sample relative to the thermometer. Each of these factors has been discussed earlier in its proper place. The magnitude of the accidental errors of measurement was deduced from the actual differences in the individual results.

Obviously, the final appraisal of accuracy can be only approximate. If the facts were known on which an exact estimate of the systematic errors could be based, corrections could be applied for them and their effect eliminated. The element of judgment must enter in the figure which is deduced to indicate the uncertainty remaining after all known corrections have been applied. As such an approximate appraisal, it is believed that the values formulated for the pressure of saturated water vapor do not differ from the truth by more than 3 parts in 10,000, with the possible exception of the region near the critical, where the rapidly changing properties of water make the measurements somewhat less trustworthy.

## VII. ACKNOWLEDGMENT

The work presented in this report marks a further step in the effort to establish reliability and accord in steam tables, a project which has been promoted by the American Society of Mechanical Engineers through the material support of the steam power industries. It is hoped that the results here given may prove an aid in attaining that object.

WASHINGTON, October 15, 1932.