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PRESSURE OF THE VAPOR OF WATER.

BY H. A. HAZEN.

ONE of the more important facts needed in meteorology is the pressure of the vapor of water, commonly called "vapor pressure" for short. Until very recently Regnault had obtained the best values for this element. His method was to introduce a capsule of distilled water, from which all air had been expelled, into the vacuum of a barometer and there liberate the water. It is well known that this vapor will diffuse itself and absolutely saturate the space above the mercury. Its pressure will be exactly dependent upon the temperature and can be ascertained approximately by comparing the barometer reading with a perfect barometer. It is easy to see that many elements of inaccuracy are introduced in such an apparatus. Most of these have been eliminated by a most beautiful apparatus, designed and constructed by Prof. C. F. Marvin, of the Weather Bureau. I have made thousands of readings with it, and it is one of the most satisfactory instruments to manipulate I have ever seen. In this, the two barometers are dispensed with, but there are two vertical tubes connected at the bottom and partly filled with mercury. A bulb is attached to one of the tubes, and afterward the air is exhausted and vapor liberated by breaking a capsule of water previously inserted in the bulb. The heights of the mercury columns are read by means of a vernier. I found no difficulty in repeating again and again, and day after day, readings within .03 to .04 of a millimetre (.0012 to .0016 in.). A full description of a perfected apparatus will be found in the Annual Report of the Chief Signal Officer for 1891, pp. 351–383.

In January, 1890, I carried the apparatus with great pains to Northfield, Minn., and there made a series of readings, the results of which were published in the Annual Report of the Chief Signal Officer, 1890, pp. 658–662. Perhaps the most interesting result obtained was a marked difference in vapor pressure when the temperature of the water was different from that of the vapor. This is best shown in a series of comparisons of water at freezing and a portion of the vapor above it at different temperatures, as follows:

Water 32°.	Vapor Temperature Fahr.	32	42	52	62	72	82	92	102	112
	Vapor pressure	4.60	4.57	4.55	4.53	4.50	4.48	4.44	4.39	4.33

Most of the vapor in these experiments was at the temperature of the liquid.

It should be noted, in passing, that Professor Marvin did not obtain any effect of this kind, and in his results it is ignored.

There has just come to hand a very interesting paper, by Prof. Geo. W. A. Kahlbaum, of Basel, Switzerland, in "Archives des Sciences Physiques et Naturelles," Geneva, vol. 31, p. 49. In this paper the author shows very clearly that there is a marked effect depending upon the difference in temperature between the liquid and the vapor above it. The only portion of this investigation needed for our purpose is that relating to the vapor of water. To present the facts in the best possible shape for comparison I have placed in the following table values of vapor pressure at different temperatures by various experimenters. In the first column is the temperature of the vapor in degrees Fahr., and in the succeeding columns the pressure in millimetres of mercury, as observed by Regnault, computed by Broch from Regnault's observations, observed by Kahlbaum, by Professor Marvin, by myself, and as determined by the Royal Society of England, probably from the results of various observers, but this is a mere inference.

VAPOR PRESSURE IN MILLIMETRES AT VARIOUS TEMPERATURES.

(1) Fahr.	(2) Reg.	(3) Broch.	(4) Kahl.	(5) Marvin.	(6) Hazen.	(7) Roy. Soc.
0	1.01	1.14		.97	1.11	1.30
5	1.32	1.44		1.25	1.38	
10	1.72	1.81		1.60	1.72	1.98*
15	2.18	2.25		2.06	2.18	
20	2.78	2.79		2.61	2.75	2.95
25	3.45	3.43		3.31	3.44	
30	4.25	4.22		4.17	4.25	4.37
35	5.17	5.15		[5.24]	5.17	
40	6.29	6.26			6.28	6.38
45	7.60	7.58			7.62	
50	9.16	9.14	9.36		9.15	9.17
55	11.00	10.97	10.97		10.91	
60	13.15	13.22	13.13		13.05	13.11
65	15.68	15.65	15.67		15.59	
70	18.62	18.59	18.47		18.53	18.36
75	22.04	22.01	21.76		21.96	
80	25.99	25.96	25.67		25.88	25.53
85	30.56	30.52	30.51		30.30	
90	35.81	35.76	36.12		35.41	35.05

A comparison of (2) and (3) shows a tendency to error at very low temperatures in the mathematically computed results. I do not see how we can go back of the original record in such case. The values in (4) agree fairly well with those in (2), except at 50°, 70, 75 and 80. It is possible there is a misprint, otherwise there would seem to be some error in the values. It would be very gratifying if we had the results at the lower temperatures. Column (5) gives results which are lower than those in (2), and as the observations were all at temperatures of 70° for some of the vapor, it would seem, according to the law determined by two independent observers, that these values are all too small. Perhaps Regnault's work was done at temperatures of water, or ice, and vapor approximately the same, and, if so, his results may be very nearly correct, so far as this point is concerned. In column (6) all the values are reduced to a common temperature of water and vapor. These agree remarkably with column (2) till we reach 85°, when there is a falling off. It was found rather difficult to manipulate the apparatus at this high temperature, and it is also probable that whatever errors existed in the apparatus were largely increased at these higher temperatures, so that I do not insist upon the absolute accuracy of the results in (6) above 85°. It is a little singular that there should be this rather rapid fall in my values as compared with Regnault's, and I am confident they are not due wholly to errors in (6). There is another point of great interest in this connection. Column (4) is supposed to have this effect entirely eliminated, but that has a very sharp fall as compared with (2) at 70° $-.15^{mm}$, 75° $-.28^{mm}$, 80° $-.32^{mm}$, then a rise at 90° $+.31^{mm}$. It seems very difficult to account for these jumps in (4), and it may be that there is some error at the highest temperature given. Column (7) is interesting as showing the extreme difficulty there is in securing reliable results in work of this kind. At the lowest temperature this gives $.29^{mm}$ higher than (2); at 50° they agree, and at 90° column (7) is $.76^{mm}$ lower than (2), and $.36^{mm}$ lower than (6). It seems to me the work has now been narrowed within pretty small limits, and but little more is needed to give us an absolute standard of values of this important element, which enters into so many discussions in meteorology. I hope shortly to obtain values from Professor Kahlbaum at very much lower temperatures.

CURIOUS IROQUOIS POTTERY.

BY W. M. BEAUCHAMP, BALDWINSVILLE, N. Y.

THE common earthenware of the North is well known, and its styles of ornament are simple. Incised lines, rows of dots, notches either pinched or cut, impressions of corn or grass, small circles made by a hollow bone, are among these, but there are others which are almost unique. Hough speaks of rude attempts at human faces in pottery along the St. Lawrence River, and these appear in a more distinct manner on some Mohawk and Onondaga sites. On these they occur from about A.D. 1600 to 1640, apparently reaching their proper territory at the time of the migration of these two nations, which may have been a little before the earlier date here given.

The earliest hint of such attempts which I have seen in New York is in the arrangement of three dots to represent the eyes and mouth. Such examples occur in Jefferson County, N. Y., and in one of these the elliptical and horizontal indentations are placed inside four lines, arranged as a diamond, at the lower angle of the vessel. The point of the diamond forms the chin. In a similar one the boundary lines form a pentagon, with the apex above. Still another has a horizontal line for the chin, as in the last, and mostly the same general form. About this are lines and notches, and the three circular impressions were formed by a hollow bone. I have a pottery rim much like these, said to be from a small burial mound near Columbus, Ohio. In this, however, the small elliptic indentations have their longest diameter vertical. There are no distinct bounding lines, though two lines run parallel with the notched rim, and the general decoration is of vertical and diagonal lines.

In the more advanced types the body and limbs, when present, are almost always made of raised bars of clay, which are crossed by grooves. Rarely these bars appear without human faces. In the Canadian Institute Report, 1891, fig. 2, is the representation of a fine vessel from Lanark County, Canada, which has several such bars symmetrically arranged. I picked up a rim on the Seneca River, N. Y., which had two such raised bars, placed vertically and rising so far above the rim as to be continued within. They are each two inches long.

On one of the two early Mohawk sites I know of no earthenware of this description, though the general style is very bold. On the other I found a fragment of the largest figure that I have yet seen. It was broken through part of the angle, and though the body was gone its impress remained. One arm is nearly perfect and is 3.5 inches long. The vessel was ornamented with lines and notches, and this was continued below the projection. Usually this class of pottery has no ornament on the lower part. I figured a very elaborate specimen from the same early site. The face reached the top of the angle, and the feet to the lower edge of the projecting top. The limbs were less conventional in arrangement than usual, and there were many parallel and intersecting lines. The figure was but slightly raised, and may not have been made like the others. No European articles have been found on this site except two long and cylindrical brass beads.

A site in a like elevated position near the same stream is a little more recent, containing iron articles, copper saws of Mohawk make, unfinished bone combs, etc., and it is several miles nearer the river. It yields fragments of many of these vessels. In one the angle is low, and the small face is close to the rim. There is a curious arrangement of dots and lines. Another has a large face, with general ornaments of lines and notches. The most curious one I have seen came from this spot. The figure is rather large, and while one extended arm has the left hand raised, the other has the right hand turned down. Fingers and toes are also represented, and the general surface has some incised lines. Another with a small face and body has circles for eyes, with a raised surface in the centre of each.

On a still later site a few miles east of this I found an angle of a vessel with a projecting head above the level of the rim. The face is round and flattened, with very wide eyes and mouth, suggesting an ape. The body forms a single bar with the usual cross indentations, and lines slope away from it on either side. I have seen nothing like it. In the same place I found another fragment, one arm and part of the body remaining, and on these were deeper notches than usual, of an elliptic form. The face was broken off from another. It was placed below a dotted angular rim, and the body was slight. In this one lines of dots represented the arms instead of bars. Still another preserved the face and body, the latter in two vertical lines, whereas it is usually in one. At a site not far from this the face at the angle of a broken vessel was broken off, and the legs reached only to the edge of the upper projection. The body of this was also double, and the arms were nearly perpendicular, but not symmetrically arranged. They had fingers. All these were from the north side of the river.

I have a figure of but one on the south side, and think the early clan there made few or none. This one had a curious face and body. Three circular dots represented the eyes, and the shoulders were distinctly rounded. Of a few Mohawk specimens I made no figures.

The Onondaga forms are remarkable in the frequent occurrence of the detached faces, especially on their earliest site. The range in time is about the same as the Mohawk, and all have been found within a distance of six miles except one specimen. The detached faces are of many sizes and features, but a broad, good natured face was quite a favorite. Usually the face is placed squarely on the vessel, but sometimes it has an oblique position. One has a large nose and projecting forehead, and this, like most of the others, is from the site occupied about 300 years ago. Excepting one already noted this has the only example of the perpendicular raised bars which I have seen here unconnected with heads. Among the Mohawk specimens the legs usually end with the projecting upper part. Here they often extend below. One of this kind has the arms represented by lines of dots. A face below a notched rim shows traces of arms but no body or legs. The parallel legs of another are over two inches long. One round face has a broad body, which has no lines across it, but they may have been worn away. Another body is very broad and has lines; the extremely short incurved legs end in long toes in this example.

Several miles southwest of this is the next site in point of time. One fragment has a very high angle, with the head, body and arms on the upper part, which is decorated with lines and dots. Two slender legs appear on the sharply receding lower part. Another has a twisted face