SPECIFIC HEATS OF ACETONE, METHYL—, ETHYL—, AND n-PROPYL-ALCOHOLS AT LOW TEMPERATURES.[2]

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In the ordinary calorimetric works, the environment in which the calorimeter is placed has a constant temperature, but at low temperatures, it is very difficult to get such one which is so constant enough as to enable one to do the accurate thermal measurement. It is not difficult, however, to get an environment whose temperature is rising regularly. The present authors, therefore, used the latter as the environment of the calorimeter with which the specific heats of acetone, methyl-, ethyl-, and n-propyl-alcohols at low temperatures were measured.

The schematic diagram of the apparatus is shown in Fig. 1. M is the Dewar vessel containing petroleum ether in which the whole system of the calorimeter is imbedded. A is a brass cylinder, and B the calorimeter proper which is suspended in A. J is the platinum resistance thermometer for measuring the temperature of the calorimeter, and E the manganin wire wounded around B, through which the electric current for the heating of the latter is passed.

The liquid air contained in another Dewar vessel of flask-like shape is forced to go through the syphone H and the copper tube K, so that the

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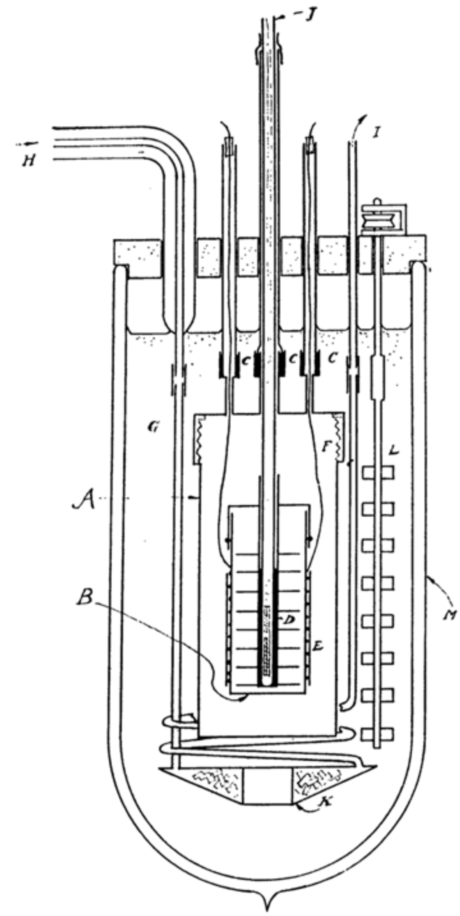

Fig. 1.

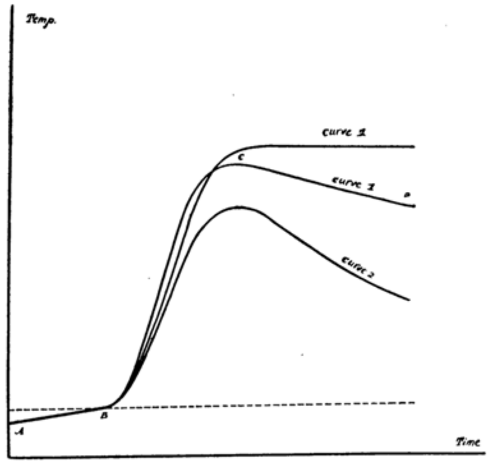

Fig. 2.

temperature in A goes down. When the temperature becomes low enough, the circulation of the liquid air is stopped, and then, being left in this state, the whole system in M finally takes the stationary state in which the temperature is rising regularly. At this time, electric current, which is measured with a potentiometer and a standard resistance, is supplied to the calorimeter for a proper interval of time, while the temperature of the calorimeter is measured at regular intervals.

The time-temperature curve thus obtained has the form shown by the curve 1 in Fig. 2, in which the part B C shows the region where electric current is passed in the calorimeter, while A B and C D show the regions before and after the passage of electric current.

Now, if the temperature of the environment is assumed to be constant throughout the measurement, the curve 1 must take the form shown by the curve 2 in the same figure. The curve 2 can be obtained from the curve 1, when, from each value of the temperature on the latter, the product of the time and the rate of rise of the temperature is substracted. From the curve 2, the curve 3 can be obtained, when the ordinary correction for the heat loss of the calorimeter is applied. With the value of the temperature rise obtained from the curve 3, the electric energy supplied to the calorimeter and the amount of the sample used, the specific heat of the sample can be calculated, if the heat capacity of the calorimeter is known. The last mentioned quantity is able to be measured in the same way as stated above, if the experiment is conducted with the empty calorimeter.

Table 1.

Specific Heats of Acetone

Absolute temp.	Specific heats
204.8	0.481
209.6	0.482
209.7	0.479
211.5	0.472
214.3	0.482
215.4	0.479
217.4	0.480
225.6	0.486
229.2	0.486
229.8	0.489
232.9	0.493
235.7	0.499
236.8	0.494
240.8	0.499
243.3	0.504
246.6	0.501
246.6	0.495
247.3	0.508
247.5	0.497
249.7	0.497
251.0	0.504
253.8	0.499
254.2	0.507
256.3	0.510

Table 2.

Specific Heats of Methyl-alcohol

Absolute temp.	Specific heats
190.5	0.524
192.0	0.537
198.3	0.536
198.7	0.535
204.6	0.541
208.9	0.539
211.5	0.557
214.0	0.540
220.5	0.544
225.9	0.559
238.7	0.566
242.0	0.571
246.6	0.580
249.9	0.582
254.7	0.570
258.4	0.584
262.4	0.582
264.8	0.577

Table 3.

Specific Heats of Ethyl-alcohol.

Absolute temp.	Specific heats	Absolute temp.	Specific heats
184.4	0.471	234.4	0.517
188.7	0.471	234.7	0.521
193.6	0.477	238.7	0.512
198.0	0.490	242.7	0.523
199.1	0.490	254.0	0.538
204.7	0.492	256.0	0.542
208.6	0.491	259.6	0.538
214.1	0.493	263.3	0.539
219.0	0.514	264.8	0.547
221.0	0.500	264.9	0.553
224.3	0.510	266.9	0.547
226.9	0.513	268.8	0.552
230.8	0.515		

Table 4.

Specific Heats of Normal-propyl-alcohol

Absolute temp.	Specific heats	Absolute temp.	Specific heats
162.8	0.422	233.6	0.497
168.0	0.433	234.3	0.504
170.7	0.423	236.9	0.491
176.0	0.444	237.1	0.500
182.0	0.445	243.3	0.510
192.3	0.464	244.7	0.504
192.3	0.466	246.4	0.510
196.8	0.468	248.3	0.507
202.5	0.471	250.7	0.506
207.6	0.473	254.5	0.517
209.6	0.475	257.3	0.520
215.5	0.480	259.2	0.523
222.5	0.495	266.0	0.533
222.9	0.493	268.3	0.551
226.5	0.486	269.8	0.550
228.6	4.495	270.5	0.540
230.7	0.489	274.4	0.545
231.1	0.500		

Table 5.

Abs. Temp.	Specific heats			
	Acetone	Methyl-al.	Ethyl-al.	n-Propyl-al.
170.	—	—	—	0.432
180.	—	—	—	0.449
190.	—	0.533	0.476	0.460
200.	0.470	0.539	0.488	0.469
210.	0.476	0.546	0.498	0.476
220.	0.482	0.551	0.505	0.484
230.	0.488	0.558	0.512	0.493
240.	0.496	0.564	0.519	0.502
250.	0.503	0.571	0.523	0.512
260.	0.511	0.577	0.539	0.525
270.	—	0.583	0.552	0.541

The results of the experiments were shown in Tables 1 to 4, and graphically represented in Fig. 3. The values of the specific heats shown in the Table 5 are those obtained from the curves in Fig. 3.

These values are not much different from those obtained by Parks and his co-workers(1) with the so-called Nernst method, but perhaps the former values have less errors.

(1) G. S. Parks, *J. Am. Chem. Soc.*, **47** (1925), 338; **48** (1926), 2788 and K. K. Kelley, *J. Am. Chem. Soc.*, **47** (1925), 2089.

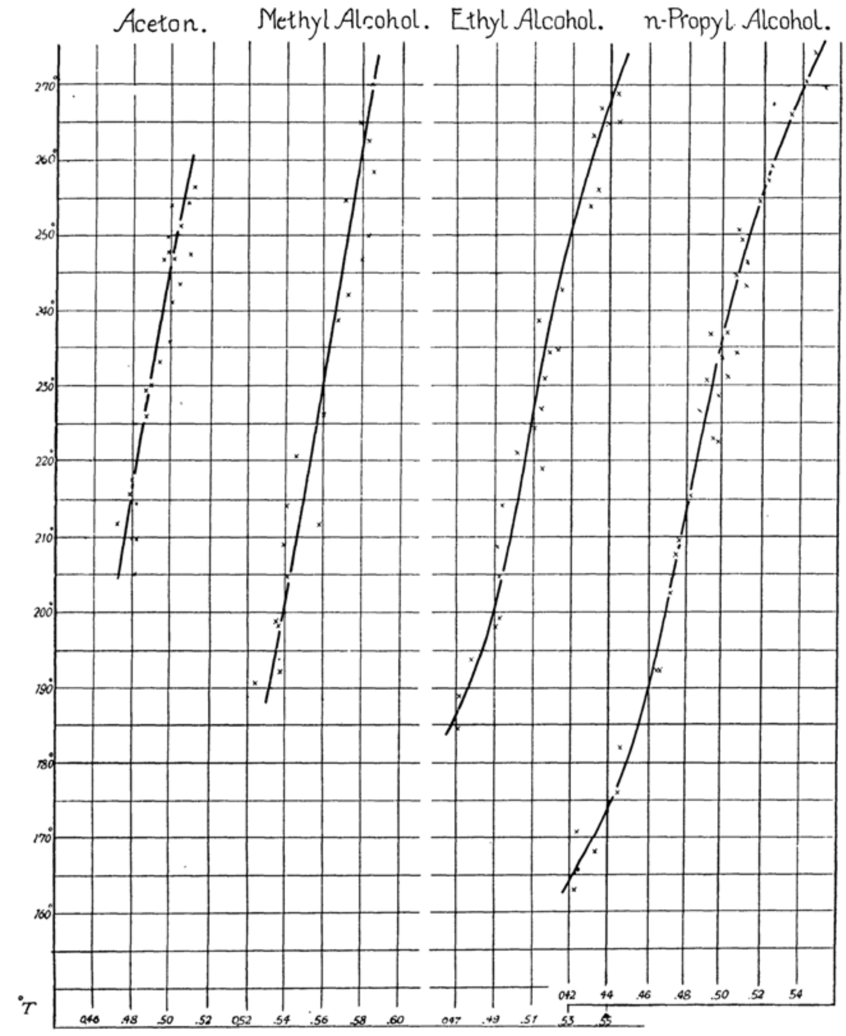

Fig. 3.

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