



Of Peltier's phenomenon in liquids

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Properly to treat this subject, and to bring Thomson's investigations into connection with the older ones, we must no longer adopt the ordinary mechanical treatment, but must have recourse to general thermodynamical methods. The considerations arising from this point of view form the contents of the present research.

It is first of all shown, that for a system of bodies touching each other we are not to seek the potential at a fixed temperature, but the thermodynamical potential, which contains the changes of energy for varying temperature. The only assumption made is that the densities and the actions of the molecular forces of bodies vary only in infinitely thin layers at the surfaces.

It is seen that this supposition is sufficient to prove that the thermodynamical potential consists of two parts, one of which is a linear function of the content of the various bodies, the other a linear function of the surface in contact. This easily furnishes a proof of the admissibility of the older view. From the formulæ obtained, the laws of Gauss and Laplace for the shape of the surfaces are explicitly deduced; the same formulæ render it possible to investigate the capillary changes which occur in thermal changes. New results are thus not obtained, but the old ones are brought into connection with each other.

The general equations are then applied to the two special processes of evaporation and supersaturation.—*Ann. Ecole Normale* [3] ii. p. 217 (1885); *Beiblätter der Physik*, vol. x. p. 330.

OF PELTIER'S PHENOMENON IN LIQUIDS.

BY E. NACCARI AND A. BATTELLI.

Two glass cylinders, 16 centim. in width, were placed near each other in a vessel of water, and a paper disk fastened in each half way up. At the bottom of each cylinder was a copper disk 13 centim. in diameter. Solution of blue vitriol was poured in up to the disk, and on this solution of zinc sulphate; in each of these solutions a zinc plate perforated in the centre was suspended. Both zinc plates were connected by a copper wire and a current passed through the apparatus, the intensity of which was determined by a reflecting-galvanometer, one division of the scale of which represented an ampere. A very thin perforated glass plate was brought in the centre of each of the paper disks. In this aperture was accurately fitted the bulb of a thermometer, which was surrounded by a caoutchouc tube as far as the part in the aperture. The current of one or two Bunsen elements was sent through the apparatus in either direction, and the course of the thermometer observed every minute. If i and i_1 are the intensities of the current, y and y_1 the corresponding thermal effects, the magnitude of the Peltier phenomenon is given by the formula

$$h = (yi_1^2 - yi^2) / (ii_1^2 + i_1i^2).$$

Only those experiments were taken into consideration in which i and i_1 were not greatly different from each other. With the

following intensities were obtained :—

i	63	123	148	187
$10^6 h$	71	64	72	67

The value of h is therefore almost independent of i , and thus Peltier's phenomenon proportional to the intensity of the current.

If when solutions of Glauber's salts of various concentration were superposed on each other, and the bulb of the thermometer was not at the surface of separation of the liquids, or if the same liquid was above and below the diaphragm, no appreciable value was obtained for h , so that the above results are not limited by other influences of heat.

From the experiments as a whole, the value of h is obtained when solutions of the following sulphates are combined with solution of CuSO_4 of specific gravity s , and in like manner the solutions of the chlorides with solution of cupric chloride of sp. gr. 1.10. The values of h are positive, when the greater heating effect takes place, *i. e.* when the current passes from the lower and more concentrated solution to the one above it.

Formula.	s .	h .	Formula.	s .	h .
N			NiCl_2	1.115	—60
NiSO_4	1.13	—49	HCl	1.029	—46
$\text{Ni}(\text{NH}_4)_2\text{SO}_4$. . .	1.07	12	MgCl_2	1.12	—36
CuSO_4	1.13	29	ZnCl_2	1.19	—23
$(\text{NH}_4)_2\text{SO}_4$	1.06	29	MCl_2	1.29	+14
Na_2SO_4	1.057	52	KCl	1.08	24
MnSO_4	1.1	64	NaCl	1.068	27
MgSO_4	1.09	74	CaCl_2	1.15	38
K_2SO_4	1.07	91	MnCl_2	1.167	38
ZnSO_4	1.137	101	NH_4Cl	1.026	52
FeSO_4	1.12	106			
H_2SO_4	1.05	120			

The series do not agree with each other. With solutions of various strengths, apart from H_2SO_4 and HCl , h is always positive.

If the entire apparatus was filled with water, and the thermometer was surrounded by a semicircle which was half of iron and half of zinc wire, and the current was passed through, the mean of ten experiments was found to be $h=18$; so that the Peltier phenomenon between liquids is not of a less order of magnitude than between metals. As according to Bellati the electromotive force between zinc and iron is 0.0024 volt, the absolute value of Peltier's phenomenon may be calculated from this for the liquids investigated.—*Atti della R. Acc. di Torino*, vol. xx. 1885; *Beiblätter der Physik*, vol. x. p. 118.