Condensation Coefficients of Various Substances

The ratio of the number of gas molecules *condensing* on a surface per second to the total number *incident* on the surface may be defined as the 'condensation coefficient' (f) of the gas at the surface. It has usually been assumed that this coefficient has the value unity; in other words, that every gas molecule striking the solid surface remains attached to it for some time before returning to the gas phase.

Some years ago, however, it was shown[1] that the condensation coefficient of water vapour at a liquid water surface and that of ethyl alcohol vapour at the corresponding liquid surface were considerably less than unity ($f = 0.036$ for water), and recently Lennard-Jones and Devonshire[2], having examined the problem of condensation at a crystal surface theoretically, have shown that values of f less than unity are sometimes to be expected.

I have now measured this coefficient for (a) iodine vapour at the surface of an iodine crystal, (b) naphthalene vapour at the surface of a naphthalene crystal, (c) camphor vapour at the surface of a camphor crystal, and (d) benzoic acid vapour at the surface of a benzoic acid crystal.

The results are shown in the accompanying table, which also includes the values of f for the liquids examined earlier and that for mercury as determined by Knudsen[3].

Substance	Condensation coefficient
Iodine	1.0
Naphthalene	1.0
Benzene	1.0
Carbon tetrachloride	1.0
Mercury	1.0
Synthetic camphor	0.17
Benzoic acid	0.29
Water	0.036
Ethyl alcohol	small

Owing to the powdery surface of the solid benzoic acid, the true surface area must be greater than the apparent area. In obtaining the value of f given above, no allowance was made for this, so that the true value of f must therefore be smaller than that given.

It will be seen that, while f is equal to unity for iodine and naphthalene, it is comparatively small for camphor and benzoic acid. It is also to be noted that all those substances examined the molecules of which have a zero dipole moment have a condensation coefficient of unity; on the other hand, the substances the molecules of which have large dipole moments have small values of the coefficient f.

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Jan. 28.

[1] Alty, *Proc. Roy. Soc.*, A, **131**, 553 (1931); A, **149**, 104 (1935).
[2] Lennard-Jones and Devonshire, *Proc. Roy. Soc.*, A, **156**, 6 (1936).
[3] Knudsen, *Ann. Phys.*, **47**, 697 (1915).

Molecular Distillation of Petroleum Lubricating Oils

In some preliminary distillations of lubricating oils carried out in this laboratory, we have encountered results quite contrary to those anticipated, and as we believe them to be unlike any results hitherto reported, we deem them worthy of notice, even at this early stage of our investigations.

So far, the distillation of two oils, a Scottish shale oil and a Persian oil, using a specially designed molecular still, has been carried out. This still is based on the principles set forth by Hickman and Sanford[1]. The temperature control, and to some extent the pressure regulation, were not very constant (the temperature varied $\pm 3°$ C.), but even so the results are consistent. The most striking result, allowing for the lack of good temperature control, to our minds, is the inversion that has taken place in the change in the physical properties as we go up the temperature scale. Thus, instead of the first fractions showing low refractive indices and densities, they actually gave figures higher than those of the original oil, with gradually descending values from fraction 4 as the temperature is raised. The accompanying table makes this clear.

MOLECULAR DISTILLATION OF SHALE OIL NO. 55
(ALL CHARACTERISTICS AT 25°)

Fraction	Density	Refractive Index	Refractivity	Viscosity (centipoises)	Temperature (approx.)
Original oil	0.8935	1.5039	0.5640	51.86	
1	0.8961	1.5092	0.5682		40
4	0.9070	1.5151	0.5679	33.29	59
6	0.9018	1.5109	0.5665		60
10	0.8929	1.5038	0.5642	50.21	65
15	0.8805	1.4950	0.5622	66.25	95
Residue	0.8996	1.5064	0.5629	228.6	

We, ourselves, are specially interested in the carcinogenicity of these molecular distillates as compared with the products obtained by use of solvents. For example, all samples of petroleum oils we have treated with alcohol have provided residues of lower carcinogenicity than the original oil, but while index and density were always lower, viscosity was sometimes higher than that of the original oil. All these experiments have a bearing on the important question of the interrelation of index and viscosity to activity on injection, and thereby carcinogenicity when applied to the skin.

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[1] *J. Phys. Chem.*, **34**, 637–653 (1930).

Variable Magnetic Moments of Cobaltous Compounds

In the course of an investigation on the magnetism of cobalt compounds, we have found a notable difference between the magnetic moments of the blue and violet forms of *bis*pyridylcobaltous chloride, ($Co2PyCl_2$). The violet form, which is stable at room temperature, was first prepared in 1894 by Reitzenstein[1]; the blue form was obtained in 1927 by Hantzsch and Schlegel[2] by dissolving the violet form in chloroform and precipitating the substance by dilution with ligroin. The blue form can also be prepared by heating the stable form to 120°; it is unstable at room temperature and reverts to the violet form in a few days. Much work has been done on the absorption spectra, molecular weight, and conductivity of these substances[3].

Fahlenbrach[4] measured the susceptibility of solutions of cobaltous chloride ($CoCl_2$) in pyridine; below $-20°$ the $1/\chi$,T curves were linear and gave $\mu_{eff.} = 5.0$ Bohr magnetons over a range of dilutions. These red solutions probably contain $[Co6Py]^{++}$. From $-20°$ to $+35°$ the solutions were violet and the $1/\chi$,T curve was not linear. Above 35° the solution was blue but the slope of the $1/\chi$,T curve varied with