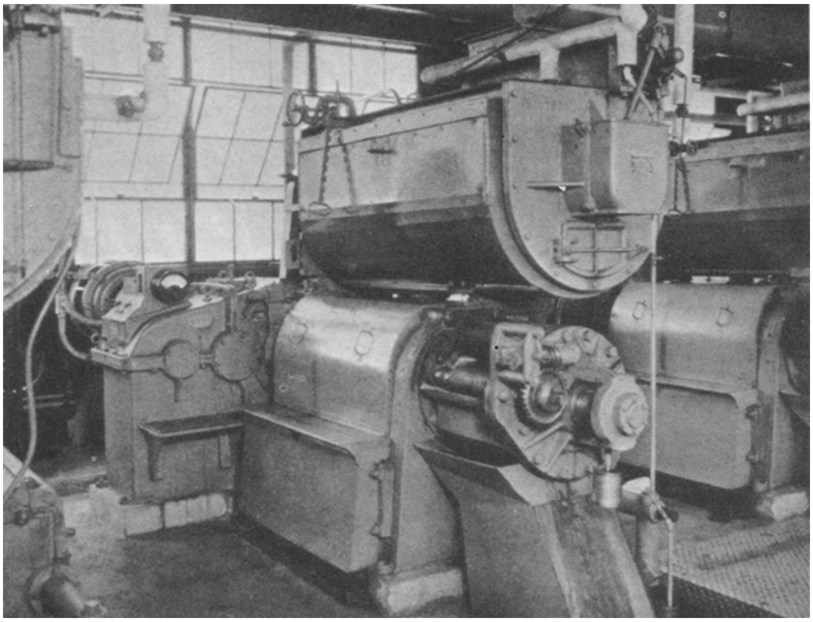
SOYA BEAN OIL REFINING—EXTRACTED CLARIFIED—SERIES NO. 13—SEASON 1937-38
(90 min. fast agitation 20-24° C. 25 min. slow agitation 65° C.)

	14 Beaumé		16 Beaumé		18 Beaumé	
	Max. Amt. Lye Used for C.S. Oil	⅞ Max. Amt. Lye Used for C.S. Oil	Max. Amt. Lye Used for C.S. Oil	⅞ Max. Amt. Lye Used for C.S. Oil	Max. Amt. Lye Used for C.S. Oil	⅞ Max. Amt. Lye Used for C.S. Oil
Per cent lye used	6.5	5.7	5.6	4.9	4.9	4.3
Grams lye used	32.5	28.5	28.0	24.5	24.5	21.5
Grams dry NaOH used for 500 grams of oil	3.088	2.710	3.100	2.710	3.110	2.730
Grams of H_2O used for 500 grams of oil	29.412	25.790	24.900	21.790	21.390	18.770
Grams of oil first pour off	466.5	470.5	462.2	467.0	463.2	452.5
Grams of oil recovered by remelting foots	0.2	0.4	1.3	0.6	2.5	17.1
Total grams of oil	466.7	470.9	463.5	467.6	465.7	469.6
Number times foots were remelted	one	one	one	one	two	three
Loss (per cent)	6.7	5.8	7.3	6.5	6.9	6.1
Color (red)	Excess lye in oil		9.5	9.7	9.6	9.4
Condition of foots	hard	hard	hard	hard	soft	soft
Break at end of fast agitation	slight	slight	slight	slight	slight	slight
Break at end of slow agitation	good	good	good	good	good	good
Color taken on by oil upon addition of lye	creamy	creamy	creamy	creamy	creamy	creamy

Oil set overnight before pouring off.
F.F.A. 0.4.

At the right is shown the screw press used in pressing soya beans at Swift & Company Soya Bean Plant, Champaign, Ill.



THE VAPOR PRESSURE OF COMMERCIAL SOAPS

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Abstract

This paper describes a technique for obtaining the vapor pressures of commercial soaps at low temperatures. The effect of various relative humidities on the equilibrium water content of concentrated soap is discussed, and the vapor pressures of the soap at various moisture contents are given.

THE physical chemist likes to work with dilute solutions, and most of the physical chemical data related to soaps in the literature refer to soap solutions which contain but little soap. On the other hand soaps are manufactured and sold in concentrated form, and it is with the properties of these concentrated bars, flakes and powders that the manufacturer has to deal. As an example, the vapor pressures of dilute solutions of soap are fairly well worked out[1] but the vapor pressures of bar soap or flaked soap in granule form are not so well understood.

Now the vapor pressure of a bar or flake or granule of soap is important in many theoretical connections. This paper will not consider these theoretical matters, however, but will deal with one of the more practical problems in which vapor pressure data may be useful. More particularly the effect of various relative humidities on the equilibrium water content of concentrated soap will be discussed.

Method of Measuring Vapor Pressure of Soap

Several methods of measuring vapor pressures of soaps have been investigated in our laboratories. Some of these methods are suitable under one set of conditions and some under another. For fairly concentrated soaps at room temperature the "dew point" method as developed by McBain[3] gives satisfactory results. This method is relatively simple and requires no very complicated apparatus.

The dew point tube itself is a copper brass tube, either silver or chromium plated, about 1 in. in diameter and 3¾ in. long. It is

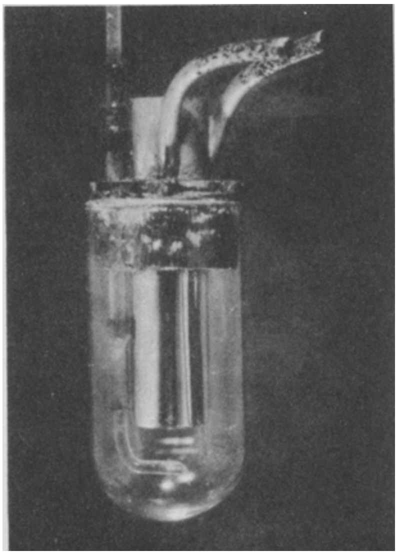

FIGURE 1

held in a 2 in. glass tube as shown in Figure 1.

The procedure for making a determination is as follows: The glass tube is washed and baked dry at 130° C. The metal tube is polished with soap and chalk polish and then with rouge and a chamois. After polishing the tube is held at 130° C. for a few minutes and then a portion of the lower tip is dipped in distilled water. (Alternatively, the cold tube can be dipped in boiling distilled water.) After cooling, it is filled ⅔ full with ether, through which air can be bubbled to induce cooling by evaporation. About 15 cc. of soap are then placed in the bottom of the glass tube, the metal tube is inserted above the soap in the glass tube and the latter is immersed in a constant temperature bath. A slight evacuation is then given the soap, but not enough to change the moisture content. Equilibrium is established more rapidly in an evacuated sample.

After the sample has come to equilibrium the temperature of the metal tube is lowered very slowly by bubbling air through the ether. Finally a temperature is reached in the metal tube at which dew is observed along the line between the dipped and undipped portion of the tube. Further cooling deposits more dew, and upon allowing the tube to heat up slowly the dew disappears. The average temperature of appearance and disappearance of the dew is taken as the dew point.

Cumming[2] and McBain[3] recommended silver tubes, but we have found chromium plated tubes to be superior in an industrial atmosphere, since they retain a polished surface longer, do not tarnish, and are less subject in general to vagaries of surface behavior which obscure the true dew point.

Experimental Work

Soap of a certain water content will come to equilibrium in an atmosphere of relative humidity such that the partial pressure of the water vapor is equal to the vapor pressure of the soap. Hence the relative humidity at which soap of a given water content will neither gain nor lose water at a specified temperature is found by dividing the vapor pressure of the soap by the vapor pressure of water at the same temperature. Now the vapor pressure of the soap at the temperature of the constant temperature bath is the same as that of the deposited water (dew) at the temperature of the metal tube. The vapor pressure of the sample is found by simply looking up the vapor pressure of water at the temperature of the dew point. (Tables used in the work are in Handbook of Chemistry and Physics. Chemical Rubber Company 18th Edition.)

The present paper gives the results of applying this method to two powdered soaps. Soap A was an unbuilt soda soap while soap B was a mixed soda-potash soap containing about 21 per cent potassium soap. The fat formulae were identical and consisted of 75 per cent tallow and 25 per cent coconut oil. These soaps were prepared with moisture contents ranging from 6 per cent to 1 per cent and the dew points were then determined as above.

Results and Discussion

The results are shown in Table 1 and Figures 2 and 3.

Figure 2 shows the vapor pressure of the soda and potash soaps as a function of water content. The smooth rise of the curves suggests that the composition of the soap phase varies continuously with the per cent water in the system, and

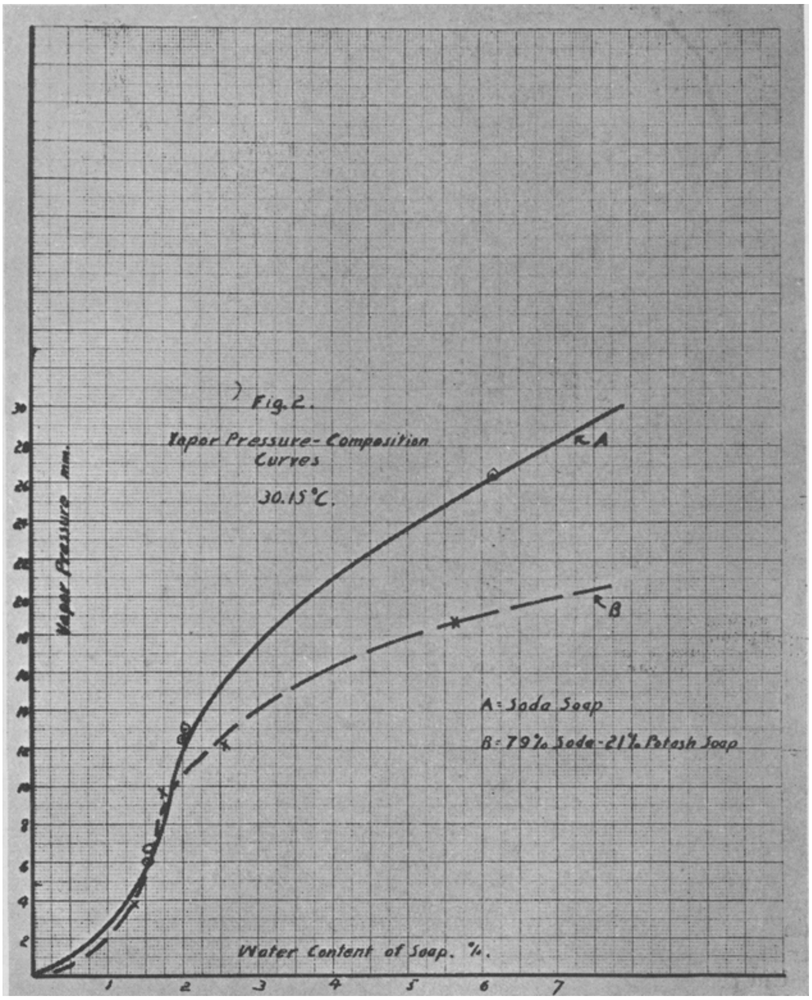

FIGURE 2

there is no evidence of any stepwise absorption of water as the proportion of water increases, although the data are not adequate to settle this point precisely.

Figure 3 shows the relation between relative humidity and water content. Up to relative humidities of 30 per cent the two soaps behave much alike and are about equally hygroscopic but in more humid atmospheres the potash soap becomes much more hygroscopic. Thus a relative humidity of 46 per cent is sufficient to raise the water content of the potash soap to 3.5 per cent, but a 60 per cent humidity is necessary before the sodium soap will absorb that much water.

Since the vapor pressure measurements were made only at 30.15° C. it might be expected that the results are of limited value. However Kamei and Sedohara[4] found that the equilibrium water content-relative humidity curves for soap coincide within 10 per cent over a temperature range between 20° and 30°. Hence small changes in temperature will probably not greatly influence the curves shown above.

A few experiments were performed to ascertain whether soda and potash soaps in air would actually change their water content in accord with predictions based on the equilibrium curves. It was found that after eight days' exposure to an atmosphere of a relative humidity of 50 per cent, the water content of a sample of soda soap increased from 1.55 per cent to 2.05 per cent. while that of a similar sample of potash soap increased from 1.55 per cent to 5.66 per cent. Thus it appears that the behavior of the soaps under non-equilibrium conditions can be qualitatively predicted from the curves.

In applying these results to the probable moisture content of packaged soap products it should be recalled that the figures apply strictly to equilibrium conditions only and that the absorbent paper of the carton and the general tightness of the carton will affect the rapidity of change in water content of the soap.

TABLE I

Sample	Moisture Content	Dew Point ° C.	Vapor Pressure mm.	Equilibrium Relative Humidity %
Na Soap	1.55	5.4	6.7	20.8
Na Soap	1.63	3.9	6.1	19.0
Na Soap	1.99	14.7	12.5	39.0
Na Soap	2.05	15.2	13.0	40.5
Na Soap	6.14	26.8	26.4	82.4
Mixed K-Na Soap	1.37	3.8	6.0	18.7
Mixed K-Na Soap	1.69	11.1	9 9	30.8
Mixed K-Na Soap	2.54	14.1	12.1	37.7
Mixed K-Na Soap	5.66	21.0	18.7	58.3

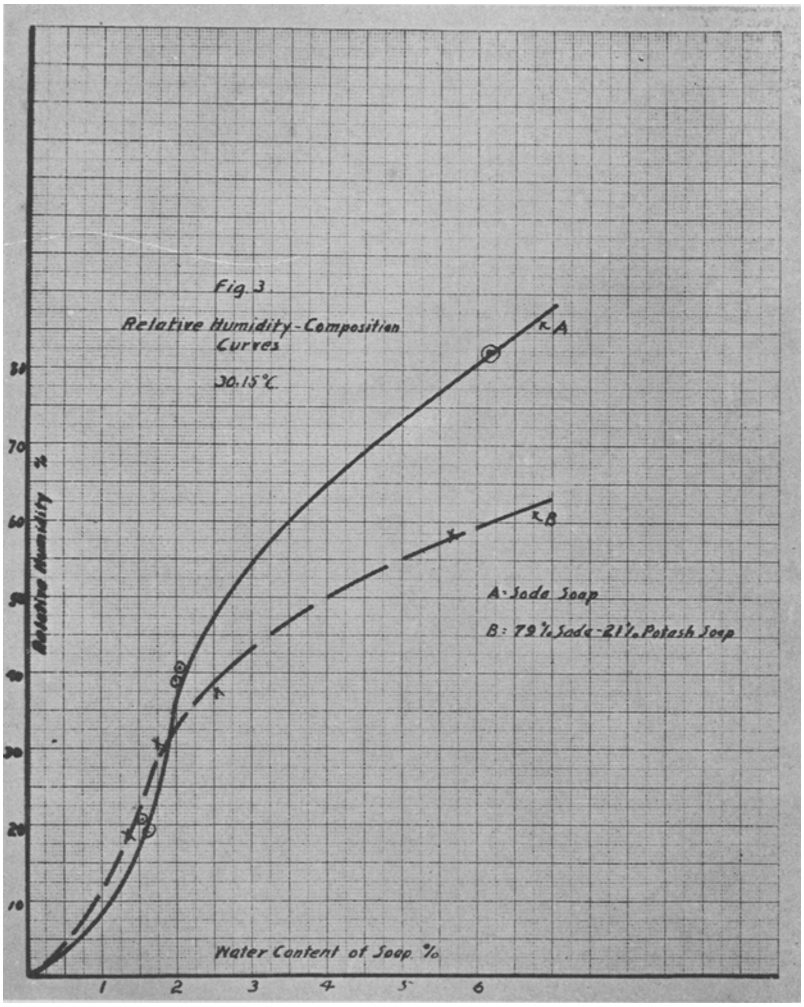

FIGURE 3

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1. Z. physik chem. **76**, 186 (1911), McBain and Taylor; J. Am. Chem. Soc. **42**, 450 (1920), McBain and Salman.

2. J. Chem. Soc. **95**, 1772 (1909), Cumming.

3. J. Phys. Chem. **38**, 1075 (1934), McBain, Bull and Staddon.

4. J. Chem. Ind. Japan **35**, 57B (1932), Kamei and Sedohara.

REPORT OF REFEREE BOARD

The Referee Board of the American Oil Chemists' Society has had a busy year, but has only a perfunctory report to make in the absence of any unusual activities. We have, as usual, carefully examined and acted on all applications for referee certificates. To supplement the check meal samples of the Smalley Foundation Committee, we have distributed ten check seed samples and five check samples of crude cottonseed oils to twenty-eight referee chemists and a still larger number of voluntary collaborators.

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