



University of Queensland

PAPERS

DEPARTMENT OF CHEMISTRY

Volume 1

1940

Number 15

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REPRINTED

from

THE PROCEEDINGS OF THE ROYAL SOCIETY OF QUEENSLAND

VOL. LI., No. 2, pp. 15-18

19th AUGUST, 1940

DEPARTMENT OF CHEMISTRY.

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[Reprinted from the *Proceedings of the Royal Society of Queensland*,

Vol. LI., No. 2. pp. 15-18.]

A. H. TUCKER, Government Printer, Brisbane.

THE ABSORPTION OF ACIDS BY WOOL.

By L. S. BAGSTER, D.Sc., and MADOLINE V. CONNAH, M.Sc.

(*Read before the Royal Society of Queensland, 29th May, 1939.*)

The absorption of acids by wool has been studied by a number of workers—*e.g.*, Speakman *et al.* (1933). Such work has been chiefly concerned with single acids, and, apart from early experiments of Mills and Takamine (1883), little attention has been given to the behaviour of mixed acids. The present work was undertaken to study the absorption from solution of pairs of mixed acids. The acids employed were hydrochloric, sulphuric, acetic, and monochloroacetic.

The wool used was merino from several fleeces of uniform grade from the Roma district. The sample contained body wool of wethers with no belly or skirting. It had a spinning count of 64 to 66 and yield condition about 58 per cent. scoured wool. It was rendered as uniform as possible by spreading and mixing several times before cleaning. During cleaning and sampling further spreading and mixing occurred. The raw wool was washed five times with solvent petrol, air-dried, and then washed with changes of rain water until free from dust. Between washings the material was drained in a centrifuge. It was finally sun-dried. The samples used in experiments were hand-picked to remove foreign matter. The cleaned stock wool was kept in a jar with an atmosphere of 50 per cent. relative humidity attained by placing in the vessel a container with an appropriate sulphuric acid solution. Sufficient material was taken for each experiment to contain 20 grams of dry wool. (The moisture content determined at 100°C. was very close to 12 per cent.)

The work was carried out with room temperatures of 20° to 25°C.

The samples of wool were soaked in the various combinations of acids contained in stoppered bottles, and allowed to stand for five days, by which time tests had shown that all the acid which could be absorbed had been taken up by the wool. The fact that no further acid was removed from solution after five days showed that no appreciable reaction took place between the acids and the containing vessels after preliminary treatment. The wool was stirred occasionally during the five days' soaking. Two hundred c.c.—the quantity of solution used in the majority of the experiments—was absorbed by the wool to a loose sponge, thus giving thorough contact. Samples were withdrawn from the main body of the liquid by means of a pipette and residual acidity determined by titration against carbonate-free alkali in a quarter of the total volume of liquid, using phenol phthalein indicator. The hydrochloric acid content for mixed acids was determined by titration against silver chloride, while the sulphuric acid content was estimated gravimetrically as barium sulphate. The acetic and monochloroacetic acids were determined by difference.

The results are shown in Tables I. and II.

The stock acid solutions were all very close to normal. The quantities of stock acid used in the various experiments are shown in the tables in column 1. Table I. gives the absorption of individual acids at different concentrations, the amount of acid being expressed in equivalents per 20 grams of wool, while the results for mixed acids are shown in Table II., where each pair of acids is represented in a double column. A and B in each column give the equivalents of individual acids absorbed.

TABLE I.

Acid (c.c.).	Water (c.c.).	Hydrochloric.	Sulphuric.	Acetic.	Monochlor-acetic.
400	1,000	·0139	·0184	·0070	·0236
		·0132	·0184	·0070	·0234
200	1,000	·015	·019	·0057	·017
		·016	·019	·0057	·018
100	1,100	·0157	·0146	·0029	·026
		·0156	·0146	·0036	·026
400	0	·022	·028	·015	·040
		·022	·028	·016	·039
200	200	·017	·023	·010	·032
		·017	·023	·010	·032
200	0	·019	·026	·0125	·037
		·020	·026	·014	·037
		·018	·022	·015	·036
		·018	·025	·015	·036
		..	·025
1.0	50	·014	·021	·011	·031
		·015	·021	·011	·030
		·015	·024	·011	·021
		·016	·023	·012	·031
		·016
100	100	·016	·022	·0092	·025
		·016	·022	·0088	·025
		·016	·022	·0094	·025
		·016	·022	·0092	·025
50	150	·016	·017	·0060	·017
		·016	·016	·007	·018
		..	·019	·0060	·018
		..	·019	·0061	·018
20	180	·012	·015	·0034	·012
		·012	·015	·0034	·012
		·012	..	·0034	·011
		·012	..	·0034	·011
10	190	·0079	·0088	·0021	·0076
		·0079	·0086	·0023	·0076
		·0080	·0084	·0025	·0071
		·0080	·0084	·0021	·0071

TABLE II.

Total Acid c.c.	Proportion.	A HCl.	B Acetic.	A HCl.	B H ₂ SO ₄ .	A H ₂ SO ₄ .	B Acetic.	A HCl.	B Mono.	A H ₂ SO ₄ .	B Mono.*
200 + 1,000 water ..	100 A	·015	·0009	·0052	·012	·018	·0004	·013	·0040	·017	·0023
	100 B	·014	·0013	·0052	·012	·018	·0005	·014	·0031	·017	·0025
400 ..	200 A	·015	·0057	·010	·013	·023	·0050	·015	·0175	·0232	·0110
	200 B	·015	·0051	·010	·013	·023	·0045	·013	·0169	·0232	·0105
200 ..	100 A	·015	·0051	·010	·010	·019	·0039	·015	·011	·024	·0079
	100 B	·015	·0047	·011	·0097	·019	·0039	·014	·011	·023	·0089
200 ..	150 A	·015	·0052	·011	·011	·022	·0045			·021	·011
	50 B	·016	·0052	·011	·011	·021	·0045			·021	·011
200 ..	150 A	·014	·0028	·012	·0033	·021	·0009	·014	·011	·023	·0061
	50 B	·014	·0032	·013	·0037	·021	·0019	·015	·011	·023	·0062
200 ..	50 A	·013	·0032	·0057	·013	·015	·0063	·013	·017	·019	·015
	150 B	·013	·0028	·0057	·013	·016	·0063	·013	·017	·019	·015
20 + 180 water ..	10 A	·0073	·0011	·0043	·0091	·0089	·0007	·0075	·0051	·0094	·0037
	10 B	·0073	·0013	·0044	·0092	·0089	·0007	·0074	·0051	·0097	·0039
		·0075	·0012	·0043	·0088			·0073	·0047	·0093	·0035
		·0075	·0012	·0043	·0088			·0075	·0048	·0094	·0035

* Mono = monochloroacetic acid.

A. Individual Acids.—The results of varying the concentration show that about 200 c.c. of normal acid solution are sufficient to saturate the wool though only a small proportion of the acid is actually absorbed. The amount absorbed from solutions not sufficient for saturation decreases more with dilution with the weaker organic acids in corresponding solution. This is in accordance with the results of Meyer and Fikentscher (1926).

The absorption of sulphuric acid at saturation is about 25 per cent. more than that of hydrochloric. Were the sulphuric behaving as a monobasic acid the absorption should have been double. The greater absorption has been found with more dilute solutions (pH greater than 2.4) by Elod (1933). In the present work, where the most dilute solutions were $\frac{N}{100}$, the pH of the strong acids would be less than 2.4.

B. Mixed Acids.—As might be expected, mixtures of hydrochloric and sulphuric acids behave very like equivalent solution of either single acid, each being absorbed nearly in proportion to its relative concentration.

The proportion of acetic acid absorbed from mixtures with strong acids is much less than corresponds with its relative concentration, but more than would be expected from its relative activity.

Monochloroacetic acid shows the most striking variation. Alone it is absorbed to a much greater extent than hydrochloric or sulphuric acids; mixed with these it is absorbed in much smaller proportion.

This work was carried out through a grant from funds provided to the University of Queensland by the Commonwealth Government through the Council for Scientific and Industrial Research.

The authors are indebted to Miss N. McGinn who carried out some of the later experimental work.

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