

Die Kurve ist vollständig glatt und den Lichtkurven von *W Herculis* und *R Trianguli* sehr ähnlich. Von den leichten Verzögerungen vor den Maxima 2418598, 9689 und 2426002 ist in der mittleren Kurve keine Spur mehr zu bemerken. Merkwürdig ist das stark abweichende, durch viele Schätzungen aber gut verbürgte Minimum 2420370 ( $S = 11^m.7$ ).

Die Streuung in der Nähe von  $70^d$  erreicht die Werte :

	<i>m</i>	<i>M</i>	Mittel
im aufsteigenden Aste :	0.376	0.368	0.372
im absteigenden Aste :	0.295	0.330	0.312
Mittel :	0.335	0.349	

Die Streuung ist wieder grösser beim Maximum, und grösser im aufsteigenden Aste. Das Verhältnis der Streuungen  $0^m.372$  und  $0^m.312$  ist 1.19, das Verhältnis der Geschwindigkeiten des Lichtwechsels bei Auf- und Abstieg 1.12.

### *Zusammenfassung.*

Aus 736 in den Jahren 1905 bis 1931 (2416845 bis 2426765) angestellten Beobachtungen von *S Bootis* sind die folgenden Elemente des Lichtwechsels abgeleitet worden :

$$\begin{array}{lcl} \text{Minimum : } 2421759^d & \left. \begin{array}{l} \\ \\ \end{array} \right\} + 273^d E + 25^d \sin 10^\circ (E - 2); & v = 13^m.26 \\ \text{Maximum : } 2421888 & & v = 8 .68 \\ & & \text{Amplitude} = 4 .58, \end{array}$$

woraus  $\frac{M - m}{P} = 0.473$ .

Die mittlere Lichtkurve hat einen vollkommen glatten Verlauf.

*Utrecht*, April 1932.

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**Chemistry.** — *Osmosis in systems, consisting of water and tartaric acid.*

III. By F. A. H. SCHREINEMAKERS and J. P. WERRE.

(Communicated at the meeting of April 30, 1932).

### *Introduction.*

If in the osmotic system

$$L(W + X) | L'(W + X) \dots \dots \dots (1)$$

in which *X* represents the tartaric acid, we bring a membrane of cellophane, it will belong to type I (fig. 1) as we have seen in the first communic-

ation<sup>1)</sup> ; the water namely diffuses during the entire osmosis  $\rightarrow$  no matter what composition the liquids may have. (We assumed here that the right-side liquid always has a greater  $X$ -amount than the left-side liquid.)

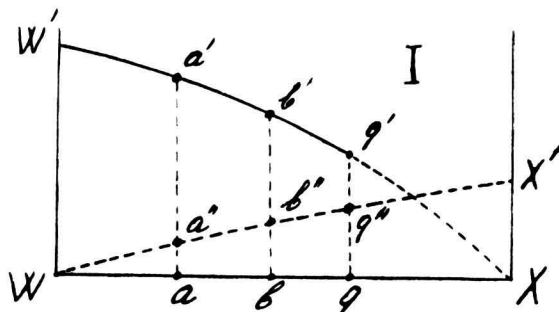


Fig. 1.

If in system (1) we bring a membrane of pig's bladder, it will belong to type IIc (fig. 2) as we have seen in the second communication<sup>2)</sup>. Until now we have considered as a special case only the systems:

$$\text{inv (Water)} | L' (W + X) \dots \dots \dots (2)$$

We found that the direction in which the water diffuses, depends upon the concentration the variable liquid  $L'$  has at the beginning of the osmosis ; namely

when, at the beginning of the osmosis the variable liquid has a smaller  $X$ -amount than liquid  $s$  (fig. 2), then during the entire osmosis the water will diffuse  $\leftarrow o^*$  namely from the solution towards the pure water ;

when at the beginning of the osmosis the variable liquid has a greater  $X$ -amount than liquid  $s$  (fig. 2), the water will first diffuse  $\rightarrow$  and later on  $\leftarrow o^*$ .

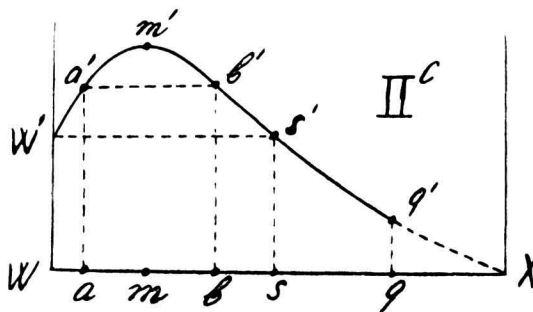


Fig. 2.

We now shall consider a few more cases of system (1).

*Systems in which the right-side liquid is invariant. Type IIc fig. 2.*

<sup>1)</sup> These Proceedings 35, 42 (1932).

<sup>2)</sup> These Proceedings 35, 162 (1932).

As a special case of system (1), in which we place a membrane of pig's bladder, we take the system

$$L (\text{beg. Water}) | \text{inv } L' (W + X) . . . . . (3)$$

in which the right-side liquid is in some way kept invariant during the entire osmosis. On the left side of the membrane is a variable liquid  $L$ , consisting at the beginning of the osmosis of pure water. As the direction in which the water diffuses in this system (3), depends upon the concentration of the invariant liquid  $L'$ , we shall distinguish three cases.

1<sup>0</sup>. When the invariant liquid of system (3) is situated between the points  $W$  and  $m$  (fig. 2), we represent this by:

$$L (\text{beg. Water}) | \text{inv } L' (Wm) . . . . . (4)$$

If, in order to concentrate our thoughts, we assume that the invariant liquid is represented in fig. 2 e.g. by point  $a$ , then its  $W$ -point will be represented by  $a'$ .

The variable liquid, consisting of pure water at the beginning of the osmosis, moves towards point  $a$  during the osmosis; so its  $W$ -point is situated on curve  $W'a'$  between  $W'$  and  $a'$ . From this it appears that during the entire osmosis the right-side liquid has a higher  $W$ -point than the left side liquid, so that the water diffuses  $\leftarrow o \star$  during the entire osmosis. So for system (4) during the entire osmosis the D.T.

$$\leftarrow X \leftarrow o \star W . . . . . (4a)$$

obtains, in which the water runs through the membrane incongruently and negatively.

In order to elucidate this by an example, we take a system, in which the invariant liquid contains

$$94.259 \% \text{ of } W + 5.741 \% \text{ of tartaric acid.}$$

We represent this system by

$$L (\text{beg. Water}) | \text{inv } L' (5.741 \% X) . . . . . (5)$$

The data on this system are found in table  $E$ , which has been arranged in the same way as the tables of the preceding communication.

From this it appears among other things that the  $X$ -amount of the variable liquid, which consisted of pure water at the beginning of the osmosis, had increased after 16 hours to 0.634 %; after 407 hours this  $X$ -amount had increased to 5.692 % and had, therefore, almost approached that of the invariant liquid.

It appears from the arrows in table  $E$  that during the entire osmosis the tartaric acid and the water have diffused according to the D.T. (4a). As the two substances run in the same direction, the diffusing mixture here is a really existing liquid, so that it is represented by a point between  $W$  and  $X$  (fig. 2).

TABLE E. System 5.

Nº.	<i>t</i>	% <i>X</i> of the var. liq. <i>L</i>	Diffused		% <i>X</i> of the invar. liq. <i>L'</i>
			gr. <i>X</i>	gr. <i>W</i>	
1	0	0			5.741
			←	← o *	
2	16	0.634	2.570	1.369	
3	32	1.261	2.420	1.035	
4	53	1.957	2.653	0.882	
5	79	2.760	3.037	0.803	
6	105	3.418	2.461	0.593	
7	146	4.257	1.751	0.304	
8	266	5.013	1.123	0.181	
9	407	5.692	0.394	0.135	

It appears from the diffused quantities of *X* and *W* that this diffusing mixture has a greater *X*-amount than the invariant liquid, so that it is situated in fig. 2 between this invariant liquid and point *X*. As the variable liquid takes in this mixture, the quantity of this liquid increases continuously during the osmosis. [Comp. for this diffusing mixture the two preceding communications also.]

20. When the invariant liquid of system (3) is situated between the points *m* and *s*, we represent this by

$$L \text{ (beg. Water) } | \text{ inv } L' (m s) . . . . . (6)$$

To concentrate our thoughts, we imagine the invariant liquid represented by point *b*; we draw the horizontal line *a'b'* through the *W*-point *b'* of this liquid.

During the osmosis the variable liquid moves from *W* towards *b*; as long as this variable liquid is still situated on the left side of point *a* and its *W*-point consequently on *W'a'*, the variable liquid has a lower *W*-point than the invariant liquid; so the water diffuses ← o \*. Consequently in system (6) the osmosis begins with the D.T.

$$\leftarrow X \leftarrow o * W . . . . . (6a)$$

At the moment the variable liquid arrives in point *a*, the *W*-point of the one liquid is situated as high as that of the other; at this moment the osmosis will then proceed according to the D.T.

$$\leftarrow X - o * W . . . . . (6b)$$

in which no water flows through the membrane.

As soon as the variable liquid has arrived to the right of point *a*, and its *W*-point, therefore, on curve *a'm'b'* above line *a'b'*, the variable liquid will have a higher *W*-point than the invariant liquid; now the water will diffuse  $\rightarrow$ . So the osmosis will proceed until the end according to the D.T.

$$\leftarrow X \rightarrow W \dots \dots \dots (6c)$$

It appears from the D.T.'s (6a), (6b) and (6c):

in system (6) the water will first diffuse  $\leftarrow o^*$  during some time and afterwards until the end of the osmosis  $\rightarrow$ ; in the moment the direction of the water-movement converts, no water flows through the membrane.

In order to elucidate this by an example, we take a system in which the invariant liquid contains

87.855 % of *W* + 12.145 % of tartaric acid

we represent this system by

$$L \text{ (beg. Water)} | \text{inv } L' (12.145 \% X) \dots \dots \dots (7)$$

The data on this system are found in table *F*. From this it appears among other things that the *X*-amount of the variable liquid had increased after

TABLE F. System (7).

Nº.	<i>t</i>	% <i>X</i> of the var. liq. <i>L</i>	Diffused		% <i>X</i> of the invar. liq. <i>L'</i>
			gr. <i>X</i>	gr. <i>W</i>	
1	0	0			12.145
			$\leftarrow$	$\leftarrow o^*$	
2	12	0.847	3.380	0.365	
3	24	1.634	2.985	0.032	
			$\leftarrow$	$\rightarrow$	
4	45	2.877	4.664	0.539	
5	73	4.269	5.232	0.850	
6	116	5.986	6.484	1.820	
7	186	7.946	7.460	3.097	
8	335	10.190	8.570	4.590	
9	790	11.811	6.202	3.736	

12 hours from 0 % to 0.847 % and after 790 hours to 11.811 %. It appears from the arrows that the water first flows  $\leftarrow o^*$  through the membrane for some time and afterwards  $\rightarrow$  and that no water will diffuse when the variable liquid contains  $\pm 2$  % of tartaric acid.

During the first part of the osmosis (namely when the water diffuses  $\leftarrow o^*$ ) the diffusing mixture is situated between *W* and *X*; it appears from

the diffused quantities of  $X$  and  $W$  that this mixture is situated between the invariant liquid and point  $X$ .

In the second part of the osmosis (namely when the water diffuses  $\rightarrow$ ) more  $X$  continuously flows towards the left than water towards the right; then the diffusing mixture will be situated to the right of point  $X$ . At the moment that no water diffuses and consequently only the substance  $X$  flows through the membrane, this diffusing mixture is situated in point  $X$ .

3<sup>0</sup>. When the invariant liquid of system (3) is situated between the points  $s$  and  $q$  (fig. 2), we represent it by:

$$L(\text{beg. Water}) | \text{inv } L'(s q) \dots \dots \dots (8)$$

It appears from fig. 2 that during the entire osmosis the variable liquid now has a higher  $W$ -point than the invariant liquid; consequently during the entire osmosis the substances diffuse according to the D.T.

$$\leftarrow X \rightarrow W \dots \dots \dots (8a)$$

We now first consider a system in which the invariant liquid is saturated with solid tartaric acid; this liquid, which has been represented in fig. 2 by point  $q$ , contains

$$\pm 42.5 \% \text{ of } W \text{ and } 57.5 \% \text{ of tartaric acid.}$$

The data <sup>1)</sup> on this system, which we represent by

$$L(\text{beg. Water}) | \text{inv } L'(57.5 \% X) \dots \dots \dots (9)$$

are found in table G. From this it appears that the  $X$ -amount of the variable liquid had increased after 9 hours to 2.067 % and after 719 hours to 53.59 %.

It appears from the determinations Nos 1 to 12 that more water diffuses towards the right than  $X$  towards the left; consequently in fig. 2 the diffusing mixture is situated on the left side of point  $W$ . The following determinations, however, no longer give regular results, but yet they seem to indicate that more  $X$  now diffuses than water; the diffusing mixture would be situated now to the right of point  $X$ .

Also in two other systems (9) Mr. H. H. SCHREINEMACHERS found irregularities of an other nature in the movement of the substance  $X$ , when the  $X$ -amount of the variable liquid had increased past 50 %. The determination of the osmosis in these concentrated solutions is very difficult, however, and the prolonged action of these concentrated solutions of tartaric acid will at the same time probably influence the nature of the bladder. Only an accurate and repeated examination will perhaps enable us to determine what factors play a part here; we shall then refer to this later on.

We now take one more system in which the invariant liquid contains

$$70.64 \% \text{ of } W + 29.36 \% \text{ of tartaric acid.}$$

<sup>1)</sup> The osmosis in this system has been determined by Dr. H. H. SCHREINEMACHERS.

TABLE G. System (9).

Nº.	<i>t</i>	% <i>X</i> of the var. liq. <i>L</i>	Diffused		% <i>X</i> of the invar. liq. <i>L'</i>
			gr. <i>X</i>	gr. <i>W</i>	
1	0	0			± 57.5
			←	→	
2	9	2.067	6.666	13.508	
3	13	2.908	2.562	5.250	
4	18	3.941	2.966	6.206	
5	23	5.094	3.119	6.665	
6	31	7.084	5.015	10.769	
7	55	13.472	13.898	32.811	
8	78	19.214	10.430	25.981	
9	108	25.880	10.670	28.152	
10	152	34.780	9.990	30.661	
11	220	39.610	10.140	34.534	
12	319	43.330	6.970	23.884	
13	462	49.010	21.720	19.746	
14	504	50.040	3.000	4.515	
15	600	52.080	7.610	7.118	
16	719	53.590	7.020	4.064	

From the determinations <sup>1)</sup> of this system, which we now represent by

$$L (\text{beg. Water}) | \text{inv } L' (29.36 \% X) \dots\dots\dots (10)$$

it appears that here also the D.T. (8a) obtains during the entire osmosis. As in this system more water continuously diffused towards the right than *X* towards the left, the diffusing mixture is situated during the entire osmosis to the left of point *W*.

It appears from these considerations and examples that the direction in which the water will move during the osmosis in the osmotic system

$$L (\text{beg. Water}) | \text{inv. } L' (W + X) \dots\dots\dots (11)$$

depends upon the amount of tartaric acid of the invariant liquid; we distinguish three cases:

1<sup>o</sup>. when the invariant liquid is situated between *W* and *m* (fig. 2) the water will during the entire osmosis diffuse ← o \*.

<sup>1)</sup> J. P. WERRE l. c. pg. 36 table IX.

2<sup>0</sup>. when the invariant liquid is situated between  $m$  and  $s$  (fig. 2) the water will first diffuse  $\leftarrow o \star$  and afterwards to the end of the osmosis  $\rightarrow$ .

3<sup>0</sup>. when the invariant liquid is situated between  $s$  and  $q$  (fig. 2), the water will diffuse during the entire osmosis  $\rightarrow$ .

*Systems in which two variable liquids.*

When we take an osmotic system

$$L(W + X) | L'(W + X). \quad . \quad . \quad . \quad . \quad . \quad (12)$$

in which the two liquids are variable, liquid  $L$  in fig. 2 will move towards the right during the osmosis and liquid  $L'$  towards the left. This osmosis goes on until both liquids get the same composition  $e$ .

In this system the substance  $X$  always diffuses  $\leftarrow$  no matter what concentrations the two liquids may have. With respect to the water, however, we can distinguish four cases; as they may be easily deduced, however, with the aid of the previous considerations, we shall only indicate them briefly.

A. When the two liquids are situated between the points  $W$  and  $m$  (fig. 2), the water diffuses during the entire osmosis  $\leftarrow o \star$ .

B. When the two liquids are situated between the points  $m$  and  $q$ , the water diffuses during the entire osmosis  $\rightarrow$ .

C. When liquid  $L$  is situated, between  $W$  and  $m$  and liquid  $L'$  between  $m$  and  $q$ , the direction of the  $W$ -diffusion depends on

1<sup>0</sup>. the  $W$ -amount of the liquids at the beginning of the osmosis; when namely at the beginning of the osmosis liquid  $L$  as a higher (lower)  $W$ -point than liquid  $L'$ , the water diffuses at the beginning of the osmosis  $\rightarrow$  ( $\leftarrow o \star$ ).

2<sup>0</sup>. the ratio of the quantities of the liquids at the beginning of the osmosis. This ratio namely defines the place of point  $e$  (not drawn in fig. 2) where the two liquids get the same composition. When this point  $e$  is situated to the left (right) of  $m$ , the water moves towards the end of the osmosis  $\leftarrow o \star$  ( $\rightarrow$ ).

So we may distinguish four cases; namely, the water diffuses

1<sup>0</sup>. during the entire osmosis  $\leftarrow o \star$ .

2<sup>0</sup>. during the entire osmosis  $\rightarrow$ .

3<sup>0</sup>. first  $\leftarrow o \star$  and later on  $\rightarrow$ .

4<sup>0</sup>. first  $\rightarrow$  and later on  $\leftarrow o \star$ .

In three systems <sup>1)</sup> the case mentioned sub 3 was found experimentally; the water namely first diffused  $\leftarrow o \star$  and afterwards  $\rightarrow$ ; in two other systems <sup>2)</sup> the water diffused, however, first  $\rightarrow$  and afterwards  $\leftarrow o \star$  and consequently the case mentioned sub 4 occurred.

<sup>1)</sup> J. P. WERRE l. c. Tables I, II and III; pgs. 30 and 31.

<sup>2)</sup> J. P. WERRE l. c. Tables IV and V; pgs. 31 and 32.

By the support of the "Bataafsch Genootschap der Proefondervindelijke Wijsbegeerte te Rotterdam" we are enabled to examine the systems 5, 7 and 9 (tables *E*, *F* and *G*), for which we express our thanks to this "Genootschap".

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**Botany.** — *Die Grundzahl der Tulpenblüte in ihrer Abhängigkeit von der Temperatur.* I. Von A. H. BLAAUW, IDA LUYTEN und ANNIE M. HARTSEMA. (Meded. N<sup>o</sup>. 33 van het Laboratorium voor Planten-fysiologisch Onderzoek, Wageningen, Holland.)

(Communicated at the meeting of April 30, 1932)

Als wir in 1922 und 1924 den Einfluss verschiedener Temperaturen während der Blütenbildung an der Tulpensorte *Pride of Haarlem* studierten, stellte sich heraus, dass die Anzahl der Blütenteile um so grösser ist, je niedriger die Temperatur, worin die Anlage stattgefunden hat. Die Blütenanlage kann innerhalb sehr weiten Grenzen vor sich gehen, so dass in 9° sowohl wie in 28° C. ganz ordentliche Blumen gebildet werden. Bei näherer Betrachtung stellt sich dann aber heraus, dass bei dieser Varietät in 28° C. ganz allgemein die Grundzahl 6—6—3 gebildet wird, mit nur wenigen Ausnahmen, dass aber unterhalb 20° diese monocotyle Grundzahl fast ganz ausgeschaltet wird. Die Blütenkreise zeigen dann — und das fängt auch schon in 25½°—23°—20° C. an — zahlreiche Kombinationen, unter denen aber ganz bestimmte bevorzugt sind. Zahlreich sind besonders die rein vierzähligen Blumen (8—8—4) in 17° C., und weiter die Kombinationen 7—7—3 und 7—7—4 in 17° bis 25½° C., und 9—9—4 in 9° C. Die Erhöhung der normalen Zahl findet nicht in dem einen Kreis auf Kosten eines anderen statt, aber tritt durch die ganze Blume hin in derselben Weise auf. Es trat in den zahlreichen Versuchspflanzen nach ganz verschiedenen Temperaturbehandlungen nie die echte Füllungserscheinung auf <sup>1)</sup>, obwohl die Anzahl der Blütenteile von der Temperatur durchaus abhängig ist und im Mittel von 15.9 ( $\pm 0.37$ ) in 28° C. bis 21.59 ( $\pm 0.58$ ) in 9° C. heranstieg. S. Literatur Meded. Lab. v. Pflanzenphysiol. Onderz. N<sup>o</sup>. 16—19 <sup>2)</sup>.

Es drang sich nun weiter besonders die Frage auf, ob diese Abhängigkeit von der Temperatur in gleicher Weise bei andren Tulpensorten ange-

<sup>1)</sup> K. ORTLEPP. Monographie der Füllungserscheinungen bei Tulpenblüten. Leipzig 1915.

<sup>2)</sup> R. MULDER en I. LUYTEN. De periodieke ontwikkeling van de Darwintulp. Verhand. Kon. Akad. v. Wet. XXVI N<sup>o</sup>. 3 1928. Med. 16.

A. H. BLAAUW en M. C. VERSLUYS. De gevolgen van de Temperatuurbehandeling in den zomer voor de Darwintulp. Versl. Kon. Ak. v. Wet. XXXIV 1925. Med. 17.  
I. LUYTEN, G. JOUSTRA en A. H. BLAAUW. Idem 2e stuk. Kon. Ak. v. Wet. XXXIV 1925. Med. 18.

R. MULDER en A. H. BLAAUW. Idem 3e stuk. Kon. Ak. v. Wet. XXXIV 1925. Med. 19.