and can be easily refined further if experiments warrant it.

The equilibrium flow however does not represent a static situation as in thermodynamics; even when \( \tau = \bar{\tau} \), \( d\bar{\tau}/dt \neq 0 \). In fact, examination of some simple flows suggests that the equilibrium flow is essentially a diffusive process. Thus, in the equilibrium wake, the stress \( \bar{\tau} \) is given approximately by

\[
\bar{\tau} \sim y^{-2.3} \exp \left( -\frac{y^3}{4k'x} \right)
\]

(\text{where} \( x \text{ and } y \text{ are co-ordinates along and normal to the main flow})\text{, which is just the dipole solution to the diffusion equation}

\[
\frac{\partial \bar{\tau}}{\partial x} = k' \frac{\partial^2 \bar{\tau}}{\partial y^2},
\]

(2)

\text{with a constant diffusion coefficient } k'.

The simplest model which describes both relaxation and diffusion is

\[
\frac{d\bar{\tau}}{dt} = A (\bar{\tau} - \bar{\tau}) + \frac{\partial}{\partial y} \left( k \frac{\partial \bar{\tau}}{\partial y} \right),
\]

(3)

\text{where we now allow for a diffusivity which in general may not be a constant.}

Together with equations of conservation of mass and momentum, (3) provides a closed system. To a first approximation, the parameters \( k \) and \( A \) in (3) can be determined from data on the equilibrium flow and a relaxation experiment.

A rigorously exact equation for \( \tau \) can of course be derived from the equations of motion, but it contains higher order correlations. Term-by-term modelling of this equation (along the lines adopted by Bradshaw et al.\(^3\) for the energy equation) is of course possible, but this involves detailed assumptions which may be questionable in themselves, and are only valid to the extent that the general solutions are properly behaved. The present proposal has the advantage that it models the overall behaviour of the terms taken together rather than individually; the essential behaviour of shear flows is directly incorporated into the equations, without making specific assumptions about relations between the stresses and other mean quantities. Furthermore, at least for the simpler shear flows, the present system seems amenable to general analysis; a detailed application to non-equilibrium wake flows is now being made.

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Bangalore-12, November 26, 1968.


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**REACTION BETWEEN SULPHUR TETRAFLUORIDE AND HYDROGEN IODIDE**

The chemistry of sulphur tetrafluoride has been the subject of intensive study ever since it was isolated and identified\(^1\,^2\) in 1954. It was of interest to study its reaction towards hydrogen iodide as the latter has been employed in this laboratory to characterise a variety of sulphur compounds.\(^3\,^4\) Preliminary studies indicated that the gas would readily get reduced to hydrogen sulphide and a corresponding amount of iodine liberated.

Pure sulphur tetrafluoride was prepared by the fluorination of sulphur dichloride with sodium fluoride in acetonitrile medium.\(^5\) Traces of impurities such as chlorine, sulphur chlorofluoride and sulphur chloride were removed by shaking with mercury. The purified gas was collected over mercury and metered from a gas measuring burette.

A known volume of sulphur tetrafluoride (8-10 ml) was allowed to react with a large excess (10-15 times) of anhydrous hydrogen iodide in a reaction vessel. A series of colour changes (orange-yellowish brown-violet) appeared immediately after the gases were allowed to come in contact with each other. The intensity of the colour deepened and finally the violet colour of iodine was prominent. When the reaction was complete (20-30 minutes), the products were analyzed in the following way. A stream of nitrogen was passed (30 mts.) through the vessel to sweep off the products through traps containing chilled carbon-tetrachloride (\(-16^\circ C\)) followed by sodium hydroxide (4 N) holding a cadmium hydroxide suspension. The carbon tetrachloride dissolved and retained iodine vapours present in the gaseous stream while hydrogen sulphide and hydrogen fluoride were absorbed by the alkali. Cadmium sulphide
was separated by filtration and estimated iodometrically.

Fluorine was estimated in the filtrate by a modified method of Willard and Winter. Iodine retained in carbon tetrachloride and in the reaction vessel was extracted with an aqueous solution of potassium iodide (10%) and titrated against a standard solution of thiosulphate to determine the iodine content. Two representative experimental results (Table I) indicate that sulphur tetrafluoride

| Table I |
|---|---|
| **Reaction between sulphur tetrafluoride and anhydrous hydrogen iodide** |

<table>
<thead>
<tr>
<th>Exp.</th>
<th>SF₄</th>
<th>H₂S</th>
<th>F/H₂S</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>g atom</td>
<td>g atom</td>
<td>I/I₂S</td>
</tr>
<tr>
<td>1</td>
<td>37.16</td>
<td>36.08</td>
<td>223.3</td>
</tr>
<tr>
<td>2</td>
<td>48.06</td>
<td>48.70</td>
<td>292.6</td>
</tr>
</tbody>
</table>

* Concentration of sulphur tetrafluoride and hydrogen sulphide expressed in g. atoms of sulphur × 10⁻⁵.

The reaction may be visualised to take place in terms of the equation:

\[
\text{SF}_4 + 6\text{HI} \rightarrow \text{H}_2\text{S} + 4\text{HF} + 3\text{I}_2.
\]

It is probable that the reaction proceeds with the possible formation of intermediate compounds of sulphur and iodine (responsible for colour changes) which finally get reduced to hydrogen sulphide and a corresponding amount of iodine gets liberated.

Similar results were obtained when a solution of sulphur tetrafluoride in carbon tetrachloride was treated with excess of anhydrous hydrogen iodide.

This reaction, therefore, can be adopted to estimate sulphur tetrafluoride.


**THE TRITERPENES OF **RHADIA LycioideS MART**

**Identification of baueranenol and α and β-amyrrins in Rhabdia lycioide Mart (Syn.) Rotula aquatica Lour is described.**

_Rhabdia lycioide Mart* (family Boraginaceae) is well known for its therapeutic action. The plant was collected from the source of Kaliyarpuzha in North Travancore. After drying in the shade and removing the tiny leaves attached to the corky stem, the plant (4 kg.) was powdered and extracted with pet. ether (60-80°) in a Soxhlet apparatus. The crystalline residue obtained after removal of the solvent was crystallised from acetone to furnish a mixture of triterpene alcohols m.p. 210-13°. The mixture of alcohols (8-5 g.) was acetylated and the acetates refluxed with alcohol (300 ml.) to furnish two fractions, (i) Fraction A (4-5 g.) m.p. 275-80°, insoluble in ethanol and (ii) Fraction B (4-0 g.) m.p. 191-94° soluble in ethanol.

Fraction A after crystallisation from chloroform acetone was obtained as white flakes m.p. 282-84° [α]₁₀° -7° Found: C, 82-28; H, 11-31; C₅₂H₇₂O₂ requires C, 81-99; H, 11-18%. and was identified as baueranenol acetate by direct comparison (mixed m.p.; IR Spectrum) with an authentic sample kindly provided by Dr. P. Sengupta. Further support was provided by converting it to baueranol and to baueranenol benzoate and identified by direct comparison. Baueranol is oxidised by chromic acid to baueronene m.p. 32-33°. [α]₁₀° -48° (Found: C, 84-94; H, 11-62; C₃₉H₄₅O requires C, 84-89; H, 11-32%) Baueranenol acetate was just warmed to dissolve in acetic acid containing a few drops of sulphuric acid and kept at room temperature for 15 minutes. Iso-baueranol acetate separated as colourless needles m.p. 222-23° [α]₁₀° +38°. It was also obtained by passing dry HCl gas for two hours through a cold solution of baueranenol acetate in chloroform. Alkaline hydrolysis furnished iso-baueranol m.p. 175-76° [α]₁₀° +45°.

Fraction B after repeated crystallisations furnished α-amyrrin acetate and β-amyrrin acetate identified through direct comparison (mixed m.p.; IR Spectrum and TLC behaviour) with authentic samples. The mixture of α- and β-amyrrin was effectively separated through their benzoates by fractional crystallisation following the method of Musgrave and Wagner. Both the components and their derivatives analysed satisfactorily.