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IS FLUORINE GAS REALLY YELLOW?

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SUMMARY

Moissan's observation, that fluorine gas is yellow, has been confirmed.

INTRODUCTION

At an early stage in their studies, all chemistry students are taught that fluorine is yellow or greenish-yellow in colour [1,2]. Some of the more advanced texts [2] go on to say that the colour is paler and more yellow than that of chlorine. However, two of us, fluorine chemists of many years standing, have never seen any colour in fluorine gas either in small clouds (due to escapes!) or in glass tubes (that is, no colour visible when looking across a tube). Other fluorine chemists, in informal and casual conversation, have informed us that for them too fluorine gas has never seemed to be coloured.

DISCUSSION AND RESULTS

It occurred to us that pure fluorine gas might, in fact, be colourless and that the colour reported might be due to some impurity - chlorine or oxygen difluoride, for example - not present in modern samples of the gas.

There is a report [3] on the UV/visible spectrum of fluorine which gives data on the absorption in the visible (>400 nm) region (the maximum is at about 290 nm); this is very weak indeed - weak enough to leave some doubt, after allowing for possible errors in measurement at very low optical densities, whether fluorine gas should be perceptibly coloured to the human eye (in addition, the sample of fluorine used was admittedly impure). If

the figures given are nevertheless accepted and combined with absorption data on chlorine gas [4], then an impurity level of approximately 5% of chlorine in fluorine would give the required depth of colour.

All text-book claims for the greenish-yellow colour of fluorine appear to be based on a paper by Moissan [5] in 1892. He mentions in passing that he too originally thought fluorine to be colourless because the gas escaping from a nozzle appeared to be so when viewed against a white background. Since the other halogens were coloured he decided to carry out a proper experiment. He viewed the gas against a white background in a tube of the design shown (Fig. 1; two tubes were employed, lengths 50 cm and 1 m; both had platinum bodies and side-arms and the end-plates were made of fluorspar) and the relevant part of his paper reads, in translation, "when the 50 cm tube was used, fluorine had a very clear greenish-yellow colour, paler than that of chlorine viewed under the same conditions. The colour also differed from that of chlorine in that it was more of a yellow". The paper then shows three paper discs, glued to the pages of the Journal, which are said to show the colours of a blank, fluorine in the 1 m tube, and chlorine in a 1 m tube. These are reproduced in Photograph 1. It is, of course, possible that the dyes used in the discs have faded or changed colour slightly over the last 93 years.

We have repeated Moissan's experiment in a very similar apparatus (Fig. 1). The tube (5 m long), side-arms, and end-plates were made of Pyrex glass and the tube was wrapped in black paper.

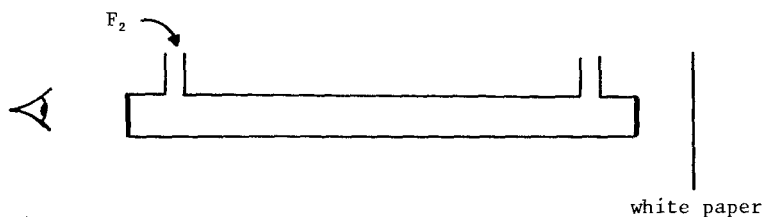
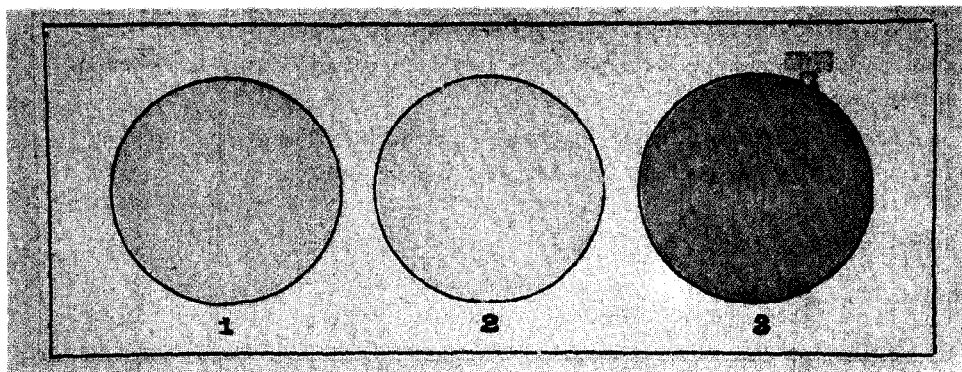


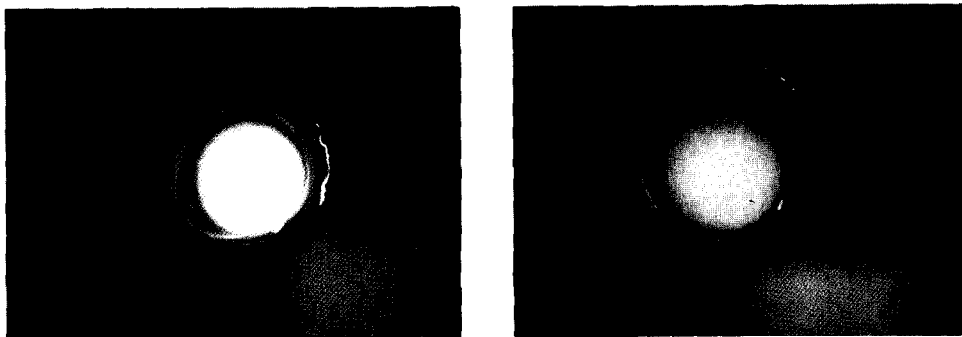
Fig. 1

The fluorine cell (a standard medium temperature cell - KF.2HF electrolyte - with a porous carbon anode) was allowed to run for three days before the experiment commenced in order to remove impurities such as water and to sweep oxygen from the system. In the experiment itself, the fluorine stream (at very slightly over atmospheric pressure) was passed through a tube containing NaF pellets (to remove HF), through a trap



Photograph 1. A reproduction from Moissan's paper [5].

(1) air-filled 1 m tube; (2) tube filled with fluorine; (3) tube filled with chlorine.



Photograph 2. Left, air-filled 5 m tube; right, same tube filled with fluorine at atmospheric pressure.

cooled in liquid oxygen (this should remove all possible volatile impurities - e.g. chlorine, b.p. -34°C , oxygen difluoride, b.p. -145°C), then into the observation tube, and then allowed to escape into a disposal system at atmospheric pressure. After an hour or so visual observation showed that fluorine is indeed yellow (and not particularly 'greenish'), whether viewed in daylight or artificial light; comparison was also made with an identical tube full of air. Photograph 2 shows the colour; several photographs were taken with different exposures and the one shown matches, visually, the colour and the depth of colour in our tube.

A similar experiment with chlorine showed it to be a little greener (but not much) than fluorine but much deeper in colour, again as reported by Moissan [5].

Liquid fluorine is quite strongly coloured [2] ("canary yellow" [2b]), a fact which is not contentious amongst fluorine chemists.

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