Organic Liquid targets for the production of ^{123}I and ^{77}Br

J.A. Osso, R. Bett, H.E. Sims

AERE, Harwell, Didcot, Oxon, England

Introduction

^{123}I and ^{77}Br are made indirectly by the production of ^{123}Xe and ^{77}Kr respectively, using flowing CH_2I_2/I_2 or $CHBr_3$ targets. A schematic of the targetry is shown in figure 1 and the target can be seen in figure 2.

The stripping gas passes through the following traps:

- cold trap to remove volatile products
- silver zeolite to remove halogens and C_2H_2
- if necessary $CuO/CaCl_2$/soda-lime to remove CH_4, C_2H_4, etc. The product is then trapped at 71 K.

Reaction	$^{127}I(p,5n)^{123}Xe \rightarrow {}^{123}I$	$^{79}Br(p,3n)^{77}Kr \rightarrow {}^{77}Br$
Target	CH_2I_2/I_2	$CHBr_3$
Volume	800/600 ml	280 ml
Energy	60-45 MeV	41-21 MeV
Current	up to 60 μA	up to 20 μA
Temperature	< 50^oC	55^oC
Target Power	900 watts	400 watts
Yields	^{123}Xe: 1.7 mCi/μAh ^{125}Xe: 3.7 mCi/μAh ^{123}I: 11.0 mCi/μAh* < 0.2 % of ^{125}I*	^{77}Kr: 47.544 mCi/μAh ^{76}Kr: 0.088 mCi/μAh ^{77}Br: 1.154 mCi/μAh* 1.67 % of ^{76}Br*
	* after 6 h decay	* after 7 h decay

Advantages

High yields: continuous removal of ^{123}Xe and ^{77}Kr lead to high yields and lower impurity levels (^{125}I and ^{76}Br).
High currents: despite their complexity much higher currents may be used on flowing liquid targets than molten targets (e.g. Davis Labs: 15–20 μA molten NaI).

Disadvantages

The following properties give rise to problems:

- both target materials are corrosive, and these corrosive properties are enhanced during irradiation. This necessitates a titanium target body and window, and titanium/glass/PTFE or Viton components. Even so, under some circumstances (e.g. elevated temperatures) titanium may corrode in figure 3.

- Doses of the order of 10^5MegaRads an hour also lead to radiolysis of the liquids:

Radiolysis products	
CH_2I_2:	$CHBr_3$:
I_2, HI	Br_3, HBr
CH_4, C_2H_4,	CH_4, C_2H_4, C_2H_6,
C_2H_6, C_2H_2	C_2H_2, $CHBr_3$(gas)
saturated and unsaturated	saturated and unsaturated
aliphatic halides	aliphatic halides
figure 4	figure 5

The I_2 and Br_2 stop polymerisation reactions which would also be a problem. Volatile products have to be removed from the gas stream otherwise final traps block and recoil labelling occurs during the decay of ^{123}Xe or ^{77}Kr causing significant product loss. A typical trapping sequence is shown below.

- considerable maintenance and setting up time.

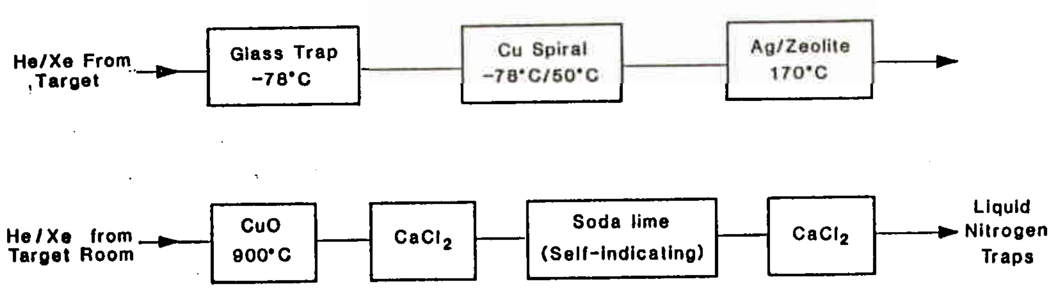

Fig. 6: Diagram of the trapping sequence used to purify ^{123}Xe and ^{77}Kr.

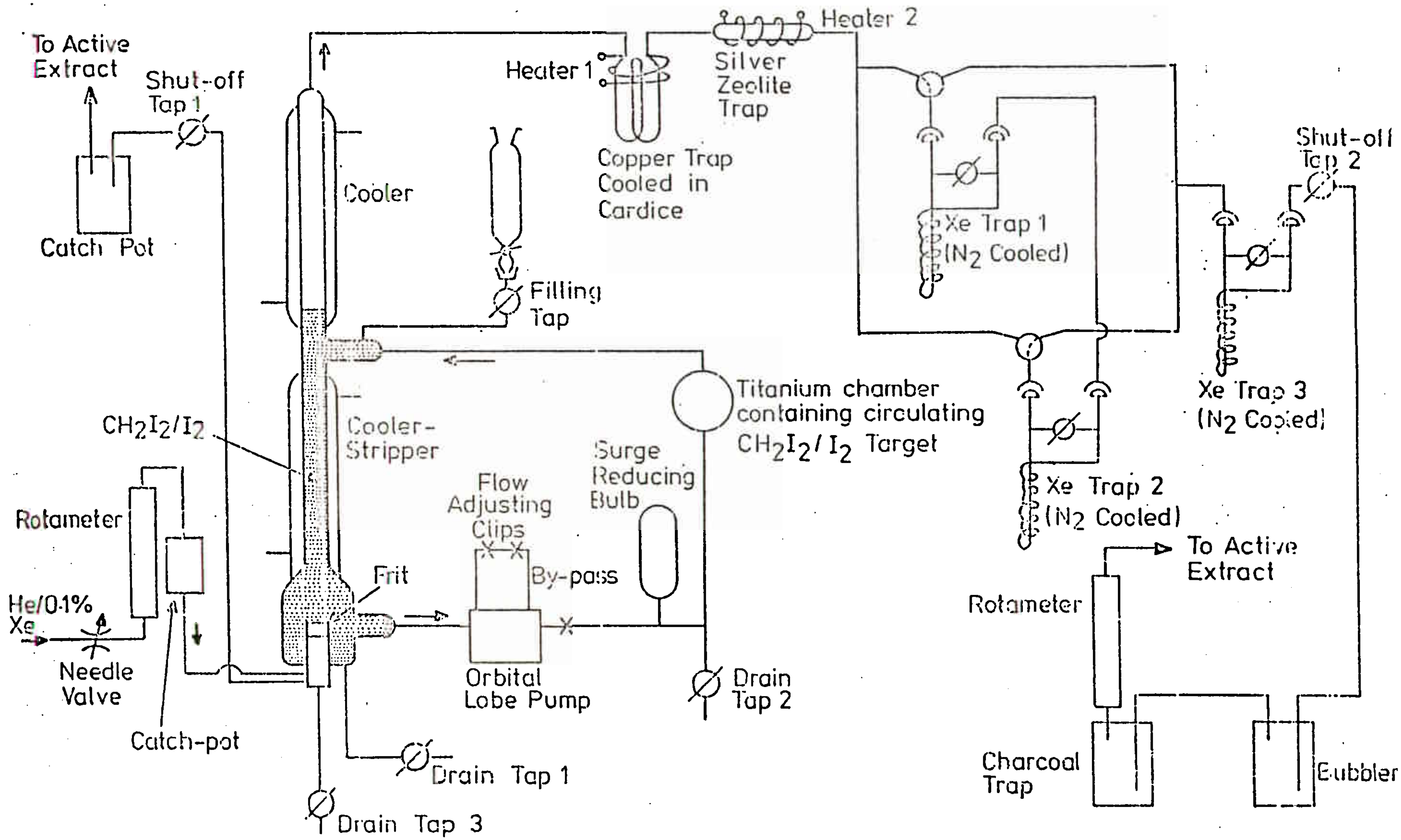

FIG. 1. SCHEMATIC DIAGRAM OF EQUIPMENT USED TO IRRADIATE CH_2I_2/I_2 WITH PROTONS, SEPARATE THE ^{123}Xe FORMED, PURIFY THE GAS STREAM AND TRAP THE XENON AS SOLID.

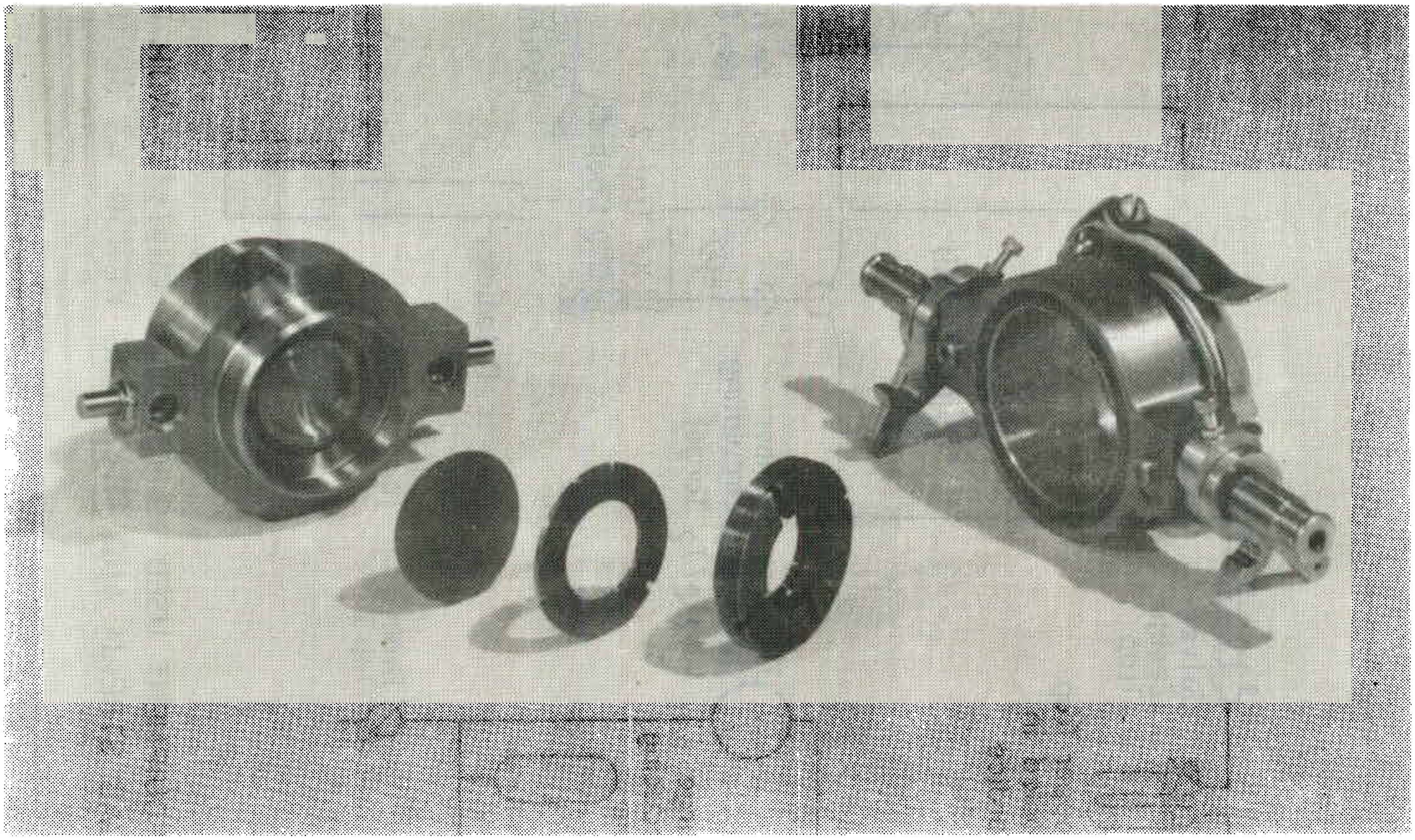

Fig.2 : Exploded view of the target used for the production of ^{123}I and

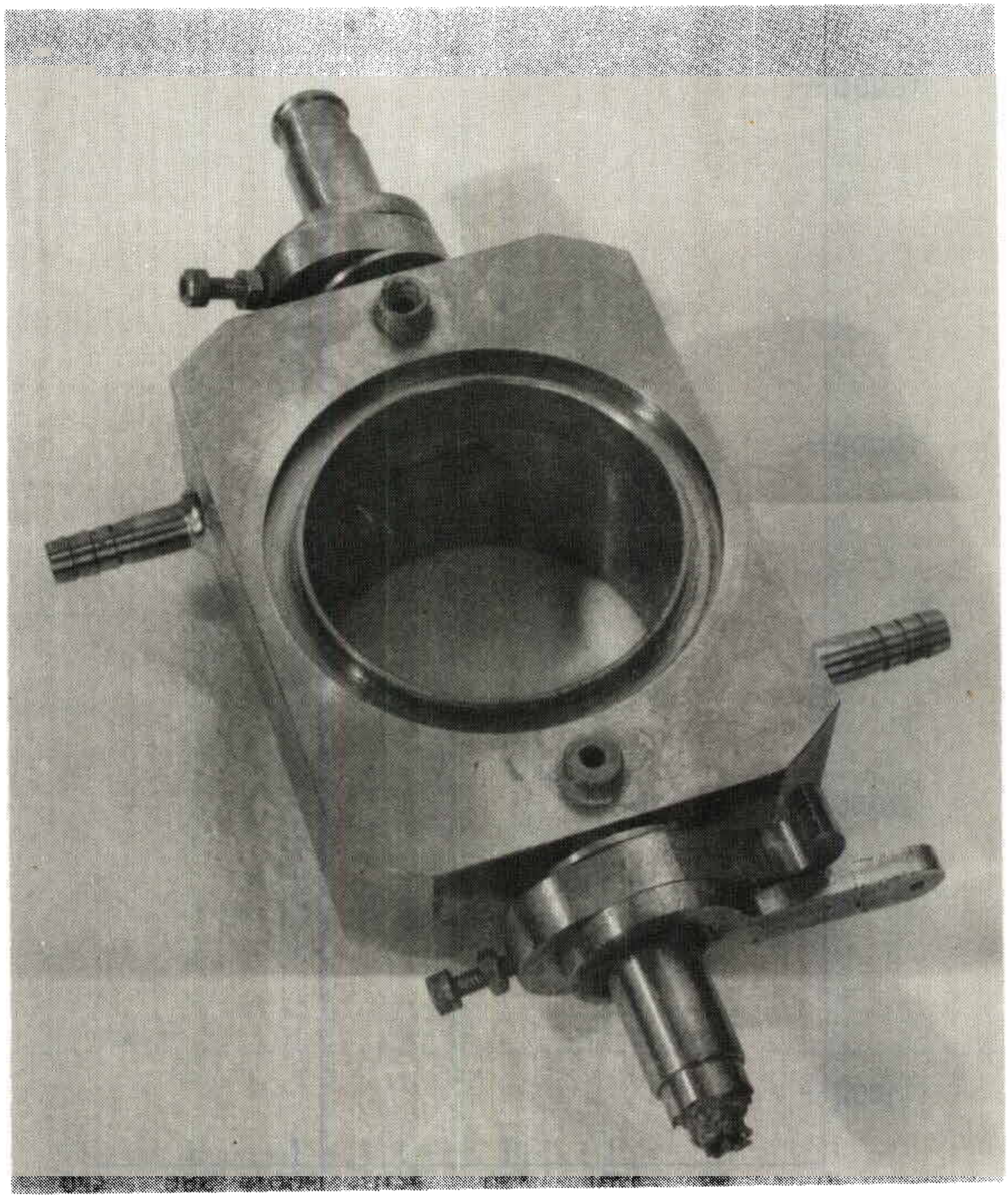

Fig.3 : Corrosion of the titanium target body by the liquid target

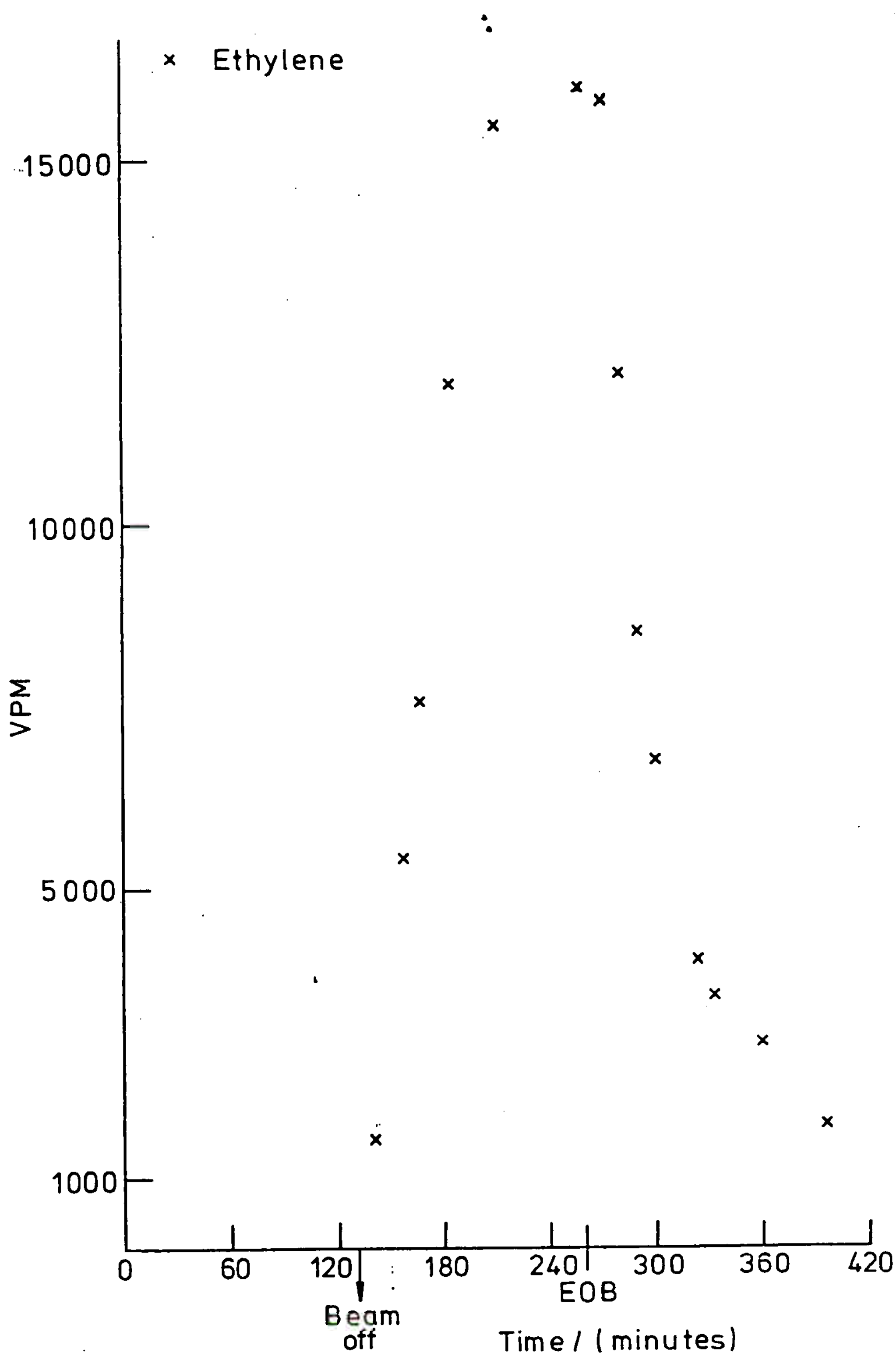

Fig. 4: Production of ethylene during the irradiation of CH_2I_2/I_2

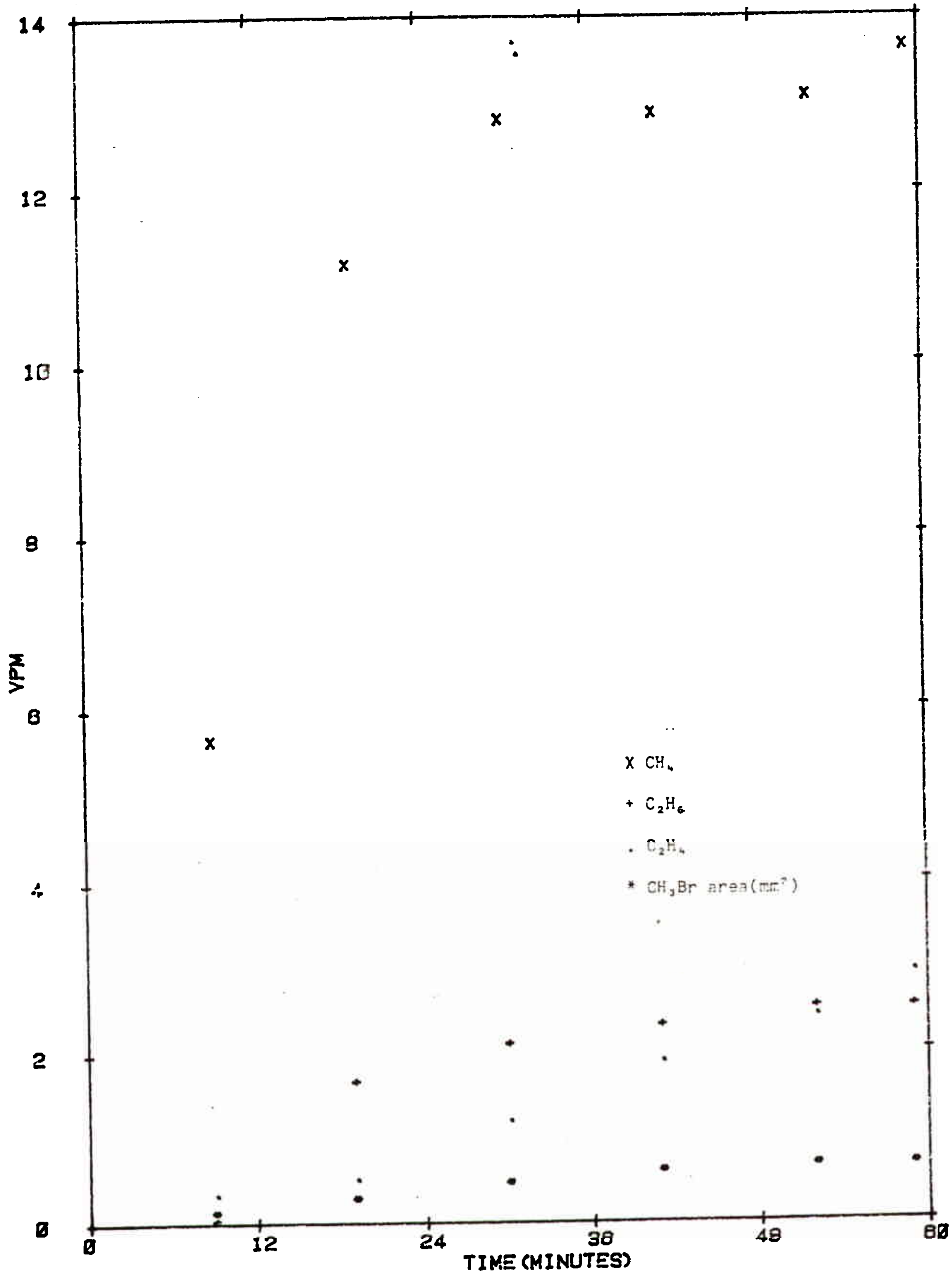

Fig.5 : Production of organic gases during the irradiation of $CHBr_3$