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THE DESIGN AND OPERATION OF AN EXPERIMENTAL GAS CHAMBER

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There are essentially two methods for preparing known concentrations of gases or vapours in air: the static and the dynamic method. The static method is more reliable. However, there is a serious drawback to the static method: the chambers used for this purpose are expensive. As such equipment is rather rare in European industrial hygiene laboratories it might be of interest to present here some data on the design and operation of an experimental gas chamber built in the Institute of Industrial Hygiene in Zagreb.

The essential features of the chamber are illustrated in figs 1, 2 and 3. Fig. 1 shows diagramatically the design principles of the chamber. The chamber consists of a steel cylinder; its diameter is 190 cm, the height 300 cm. The volume amounts to approximately 10 m^3 (9630 litres). Large volumes of air can be thus withdrawn without appreciably changing the pressure in the chamber. There are 18 sampling openings at various heights (A, fig. 1) and a sampling tube (B, fig. 1) for taking samples at any height. This sampling tube can be removed if not in use. There are four windows (C, fig. 1) for observing the inside of the chamber which is illuminated by an electric bulb (D, fig. 1). The manhole is placed near the bottom of the chamber (E, fig. 1).

The chamber is equipped with mixing and ventilating equipment (F, fig. 1). The same fan is used for both purposes and the change-over from circulation to ventilation is effected by means of two valves (G, fig. 1). The ventilating fan capacity amounts to 3–4 m^3/min., depending on the number of sampling openings left open during the ventilation period. The fan capacity is sufficient to secure one air change in 3 to 4 minutes, and thus the desired concentrations can be set up in a short time. Other equipment of the chamber includes thermometers, manometers, a hygrometer and a »Sihi« watersealed vacuum pump. Figures 2 and 3 give an outside view of the chamber.

A preliminary testing of the chamber was carried out using carbon dioxide – air mixtures. The main purpose of these experiments was to estimate the efficiency of the mixing equipment of the chamber. With

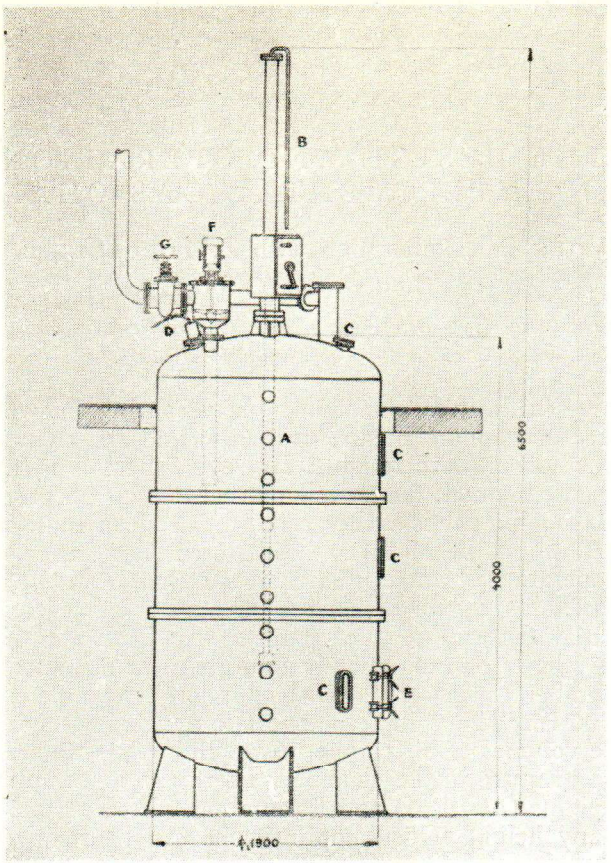

Fig. 1.

perfect mixing the change of concentration of a gas in a ventilated room should obey the well known equation: $c = c_0 e^{-n}$, where c is the concentration after n air changes if the initial concentration is c_0. The number of air changes is calculated from the relation $n = v/V$, v being the volume of air which has entered the chamber since the beginning of the ventilation and V is the volume of the chamber. If carbon dioxide is used this equation is obeyed only approximately owing to the natural presence of carbon dioxide in air. However, if the concentrations are high enough, this equation is sufficiently accurate even for carbon dioxide. By plotting v against the logarithm of c, an estimate of the chamber volume V_c can be obtained. If the »true« volume of the chamber is known (e. g. from constructional data) a measure of the efficiency of the mixing equipment can be obtained by dividing the

estimated volume (V_c) by the »true« volume (V). Our experiments gave:

$$\rho = \frac{V_c}{V} = \frac{9470}{9630} = 0.98$$

showing that the performance of the mixing equipment is very satisfactory.

Two methods can be used for preparing a known concentration. The chamber can be partially evacuated, the reduction in pressure (Δ p) recorded, and the barometric pressure (b) established again by filling the chamber with the gas. The volume concentration is then calculated from the relation $c = \Delta p/b$. The other possibility consists in filling the chamber with the gas without the preliminary evacuation. The increase in pressure is recorded, the mixing equipment put in operation, and after a few minutes the pressure in the chamber is reduced to barometric pressure by opening a valve. The concentration is calculated from the relation $c = \Delta p/(b + \Delta p)$, where Δp is now the increase in pressure. The latter method gave more accurate results in the case of carbon dioxide. The carbon dioxide concentrations obtained by these methods and by the dilution method were checked using a well known analytical method due to Schlöpfer and Hoffmann. Tables 1 and 2 give an illustrative sample of the results obtained in our experiments. They are quite satisfactory if the moderate precision of the analytical method is taken into consideration.

Table 1

Preparation of known concentrations of carbon dioxide

$C_{calc.}$	C_{found}	Method of preparation
vol. %		
0.420	0.357	Preliminary evacuation
0.704	0.654	
2.43	2.60	Overpressure
2.49	2.54	
2.39	2.36	Dilution $C_{calc.} = C_0 \cdot e^{-bv}$ b = 0.10564 (obtained from regression analysis)
2.01	2.06	
1.63	1.86	
1.46	1.53	
0.920	0.944	
0.826	0.915	
0.769	0.885	
0.682	0.656	
0.657	0.593	
0.599	0.541	
0.548	0.503	

The protection of the chamber from corrosion presents a special problem. It would have been more satisfactory if anticorrosive steel had been used as building material, but the prohibitive cost made it impossible. At present the chamber is painted inside with a lacquer used for painting benzine tanks (»Titanwhite«, »International Paint Products«, England). We have not enough experience as yet to judge the quality of this paint.

Owing to the robust design (wall thickness 8 mm) the chamber can be also used as a reduced pressure chamber as well as a pressure chamber for moderate pressures.

Table 2

Stability of air-CO_2 mixtures prepared in the chamber

C_{found} vol %	Analysed after	
	hours	minutes
2.340	0	0
2.304	0	40
2.650	1	20
2.288	2	5
2.312	9	15
2.286	24	14
2.315	25	0

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The design and construction of the experimental gas chamber was a joint enterprise in which many workers collaborated. I would like to mention especially the following: J. Trnka, Z. Tudja, N. Teskeredžić, and the staff of the metal works »Jedinstvo», Zagreb.

Sadržaj

EKSPERIMENTALNA PLINSKA KOMORA

Opisana je konstrukcija eksperimentalne plinske komore Instituta za medicinska istraživanja u Zagrebu. Komora je izrađena iz čeličnog lima, cilindrična je oblika i približno volumena od 10 m^3. Može poslužiti za pripremanje baždarnih smjesa plinova i para i zraka, ili kao ekspoziciona komora za toksikološke eksperimente. Izneseni su rezultati preliminarnog određivanja karakteristika komore.

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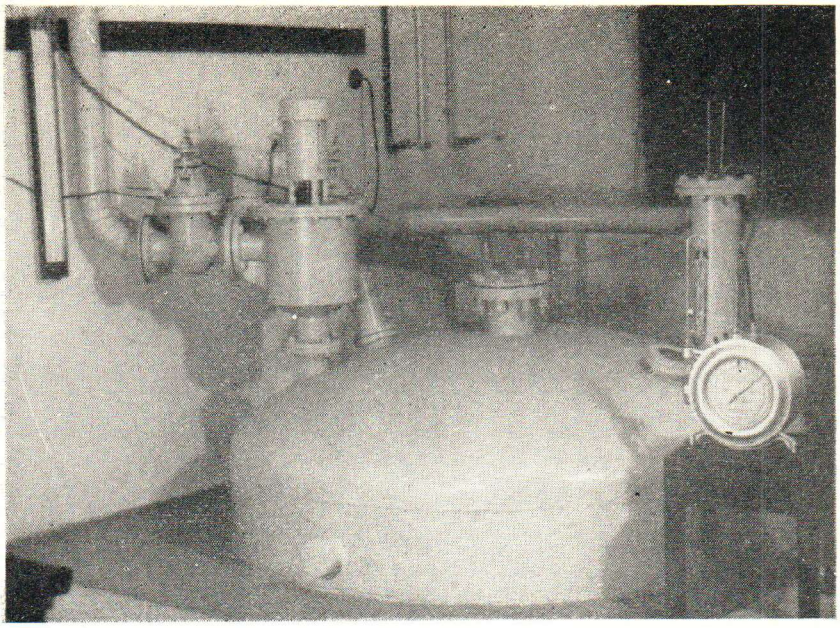

Fig. 2

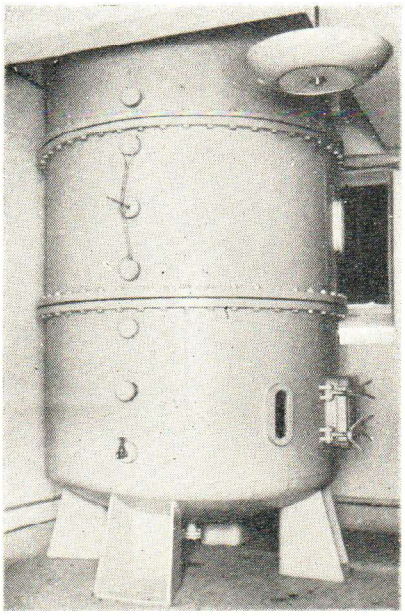

Fig. 3