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CATALYTIC COMBUSTION OF CHLORINATED HYDROCARBONS

Conversion of chlorinated hydrocarbons ($C_2H_2Cl_2$, C_2HCl_3 and C_2Cl_4) to HCl and CO_2 in the presence of co-catalyst with a base metal oxide, $Pt/(CuO/Al_2O_3)$ has been investigated by the author. Catalyst containing 0.6% $Pt/(CuO/Al_2O)$, gives 66–74% conversion with all three reactants at about 430°C. Effects of temperature and amount of catalyst were examined at different vapour pressures of chlorinated hydrocarbons.

1. INTRODUCTION

Chlorinated hydrocarbons, which are widely used in dry cleaning and degreasing, are well known to be toxic to human beings through the damage they cause to liver function; they are also inimical to the bacterial processes on which the treatment of sewage depends. The purpose of this investigation was to study the feasibility of disposing of chlorinated hydrocarbons by passing them over a catalyst in the presence of air and hydrocarbon fuel such as butane. The reasoning was that in the presence of sufficiently reducing conditions, it should be possible to convert the chlorinated hydrocarbon substantially into HCl gas, which then can be scrubed out and used, thereby removing the danger of a biologically harmful substance reaching the public drainage system. (Chlorinated hydrocarbons slow down, in some cases stop the biological digestion processes used at sewage works).

The aim of this work was to use, a cheaper catalyst by which waste chlorinated compounds could be rendered harmless [1].

Catalysed destruction of chlorinated hydrocarbons in the presence of Pt/Al_2O_3 has been reported [2].

2. EXPERIMENTAL METHODS

2.1. APPARATUS AND PROCEDURE

The reactor is of *T* shape with fuel gas entering on one side at the bottom through a flexible tube, and air entering the other side. Combustion products exit at the top, trough a Quickfit socket. A porosity *0* sinter is interposed between inert alumina filling and both

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gas streams; the gases mix in the alumina. The gas mixture thence passes over catalyst and the desired reaction takes place. A coil of fine rhodium-iridium iniwire was heated electrically to initiate combustion. The resultant flame rapidly „lit back" and flameless combustion of the fuel took then place within the catalyst bed. After several seconds the catalyst attains a temperature high enough to support catalytic combustion which then takes over from normal combustion. At this stage the reactor is ready for use with chlorinated hydrocarbons. Full details of the procedure and the reactor system used for this work have been reported by G. C. BOND and N. SADEGHI [2].

2.2. CATALYSTS

10% CuO/Al_2O_3 was prepared by impregnating Alcoa F-1 — alumina, 14–36 mesh, with aqueous copper nitrate solution, and calcinating the product in air for six hours at 420 °C, which was then treated with a volume of aqueous chloroplatinic acid to give 0.2, 0.4 and 0.6% $Pt/(CuO/Al_2O_3)$ catalysts. The amount of each catalyst used ranged within 6 g (0.2% Pt, 6.1g; 0.4% Pt, 6.2g; 0.6% Pt, 6.4g).

3. RESULTS

The effects of vapour pressure of various catalysts and of reactor temperature on the per cent of conversion were studied. The applied vapour pressure ranged from 1 to 13 mm Hg for $C_2H_2Cl_2$, C_2HCl_3 and C_2Cl_4. The efficiency of conversion depending on vapour pressure, and on temperature for all reactants is presented in Tables 1 to 4. The results are shown in Figures 1 and 2. In all the cases one observes a very slight decrease in conversion due the increasing vapour pressure, and a very small change due to temperature. All the foregoing experiments were performed with 0.6% $Pt/CuO/Al_2O_3$. Dependence of conversion on Pt content of catalyst at vapour pressure 10 mm Hg is presented

Table 1

Efficiency of conversion depending on vapour pressure for $C_2H_2Cl_2$

Vapour pressure mm Hg	Temperature °C	Conversion %
1	430	73.9
5	425	73.5
10	425	72.9
13	425	72.3

Table 2

Efficiency of conversion depending on vapour pressure for C_2HCl_3

Vapour pressure mm Hg	Temperature °C	Conversion %
1	420	72.2
5	420	71.7
10	420	71.2
13	425	70.8

in Table 5. The results are shown for all reactants in Figure 3. For all three reactants the variation of conversion with bed depth of catalyst (0.6% $Pt/CuO/Al_2O_3$) was studied at vapour pressure 10 mm Hg. Dependence of conversion on bed depth is presented in Table 6. The results are shown in Figure 4. In all cases a significally increase in conversion with increasing catalyst bed depth has been stated.

Table 3

Efficiency of conversion depending on vapour pressure for C_2Cl_4

Vapour pressure mm Hg	Temperature °C	Conversion %
1	415	68.9
5	415	68.5
10	410	68.5
13	410	67.6

Table 4

Efficiency of conversion depending on temperature at vapour pressure 10 mm Hg

Temperature °C	Conversion %		
	$C_2H_2Cl_2$	C_2HCl_3	C_2Cl_4
370	70.9	69.9	68.1
380	71.6	70.1	68.2
390	72.1	70.6	68.1
400	72.5	71.1	68.4
410	73.2	71.5	68.5
420	72.9	71.2	68.5
430	73.2	71.4	68.8

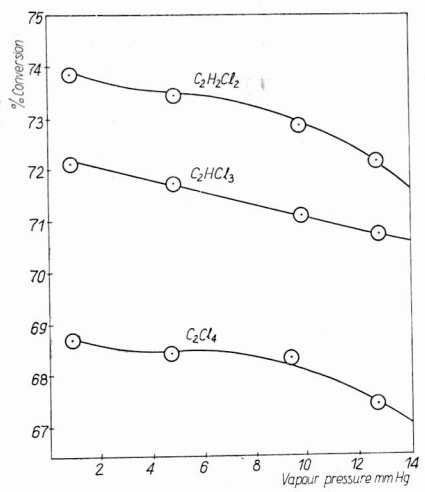

Fig. 1. Conversion vs. vapour pressure for $C_2H_2Cl_2$, C_2HCl_3 and C_2Cl_4

Rys. 1. Konwersja $C_2H_2Cl_2$, C_2HCl_3 i C_2Cl_4 w zależności od ciśnienia pary

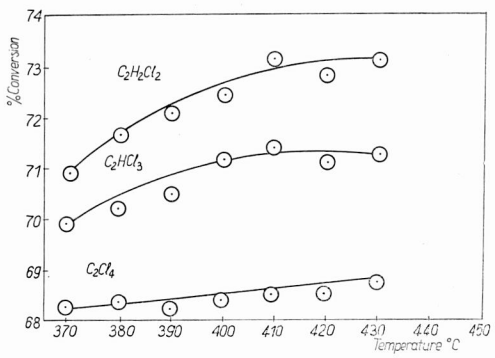

Fig. 2. Conversion vs. temperature for $C_2H_2Cl_2$, C_2HCl_3 and C_2Cl_4 (10 mm Hg)

Rys. 2. Konwersja $C_2H_2Cl_2$, C_2HCl_3 i C_2Cl_3 (10 mm Hg) w zależności od temperatury

Table 5

Efficiency of conversion depending on Pt content at vapour pressure 10 mm Hg in per cent

Reactant	0.2 [2]	0.4	0.6
$C_2H_2Cl_2$	33.6	55.6	72.9
C_2HCl_3	32.4	52.2	71.2
C_2Cl_4	30.8	51.7	68.5

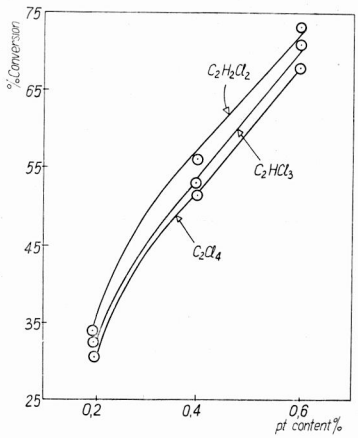

Fig. 3. Conversion vs. Pt content of catalyst for $C_2H_2Cl_2$, C_2HCl_3 and C_2Cl_4 (10 mm Hg)

Rys. 3. Konwersja $C_2H_2Cl_2$, C_2HCl_3 i C_2Cl_4 (10 mm Hg) w zależności od zawartości Pt w katalizatorze

Table 6

Efficiency of conversion depending on bed depth of catalyst, in cm

Reactant	5	6	7	8
$C_2H_2Cl_2$	72.2	72.9	73.4	73.6
C_2HCl_3	70.5	71.2	72.4	72.5
C_2Cl_4	67.8	68.5	69.7	70.3

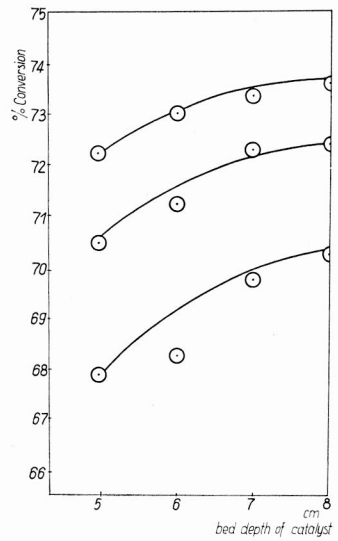

Fig. 4. Conversion vs. bed depth of catalyst for $C_2H_2Cl_2$, C_2HCl_3 and C_2Cl_4 (10 mm Hg)

Rys. 4. Konwersja $C_2H_2Cl_2$, C_2HCl_3 i C_2Cl_4 (10 mm Hg) w zależności od grubości warstwy katalizatora

4. DISCUSSION

The results described above show that conversion of all reactants is similar: under all conditions the conversion falls in the sequences $C_2H_2Cl_2$ C_2HCl_3 C_2Cl_4, but difference between conversion of C_2HCl_3 and C_2Cl_4 is strong. The variation of conversion with bed depth of catalyst was of a great importance

The use of cheaper catalysts can be readily visualised, and more economic use of fuel can be achieved by insulation of the reactor. The results of this feasibility study encourage consideration of the next stages in development of the system to investigate sulphur compounds, such as mercaptans.

SPALANIE KATALITYCZNE WĘGLOWODORÓW CHLOROWANYCH

Badano konwersję chlorowanych węglowodorów ($C_2H_2Cl_2$, C_2HCl_3 i C_2Cl_4) na HCl i CO_2 w obecności kokatalizatora na bazie tlenku metalu Pt/(CuO/Al_2O_3). Katalizator zawierający 0–6% Pt/(CuO/Al_2O_3) daje 66–74% konwersji wszystkich trzech reaktantów, w temp. około 430°C. Badano wpływ temperatury i ilości katalizatora przy różnych ciśnieniach par węglowodorów chlorowanych.

KATALYTISCHE VERBRENNUNG CHLORIERTER KOHLENWASSERSTOFFE

Es wurde die Onversion chlorierter Kohlenwasserstoffe ($C_2H_2Cl_2$, C_2HCl_3 und C_2Cl_4) auf HCl und CO_2 in Anwesenheit des Katalysators auf der Basis des Metalloxides Pt/CuO/Al_2O_3) geprüft.

Der Katalysator mit 0–6% Pt/(CuO/Al_2O_3) gibt für alle drei Reaktanten in der Temperatur ca. 430°C, 66–74% Konversion.

Es wurde der Einfluss der Temperatur und Quantität des Katalysators verschiedener Dampfspannungen chlorierter Kohlenwasserstoffe geprüft.

КАТАЛИТИЧЕСКОЕ СЖИГАНИЕ ХЛОРИРОВАННЫХ УГЛЕВОДОРОДОВ

Была исследована конверсия хлорированных углеводородов ($C_2H_2Cl_2$, C_2HCl_3, C_2Cl_4) на HCl и CO_2 в присутствии сокатализатора на базе окиси металла Pt/(CuO/Al_2O_3). Катализатор, содержащий 0—6% Pt/(CuO/Al_2O_3) дает 66–74% конверсии всех трех реактантов при температуре около 430°C. Исследовалось влияние температуры и количества катализатора при разных давлениях парахлорированных углеводородов.

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