an introduction to Industrial Chemistry

Edited by
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Preface

The chemical industry is a major, growing influence on all our lives, encompassing household commodities and utensils, industrial materials and components, medicines and drugs, and the production of chemicals has become an essential factor in the economy of any industrialized nation. The scientists and engineers responsible for the efficient operation of the industry must have a sound knowledge not only of the physical and chemical principles, but also of the economic and environmental aspects and the cost-effective use of energy.

This book provides an introduction to these topics and includes detailed discussion of catalysis and petrochemicals. It is written as a basis from which students of chemistry and chemical engineering will be able to build an understanding and appreciation of the industry.

Acknowledgements

An undertaking of this nature requires teamwork and it is a pleasure to acknowledge the efforts and cooperation of the contributors. Thanks are also due to the publishers for their help and advice at all times. Finally, I wish to thank my wife Joy for typing part of the MS and for the support which she and our children, Susan and Simon, have given.

C.A.H.

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Conversion Factors

Mass

1 tonne (metric ton) = 1000 kilograms = 2205 pounds
= 0·984 tons
1 ton = 1016 kilograms = 2240 pounds
= 1·016 tonnes

Volume

1 litre = 0·220 gallons (U.K. or Imperial) = 1 cubic metre
1 gallon = 4·546 litres
1 gallon = 1·200 U.S. gallons = 0·00455 cubic metres
1 barrel = 42 U.S. gallons = 35 gallons = 0·159 cubic metres

(Densities of crude oil vary, but 7·5 barrels per tonne is an accepted average figure.)

1 cubic metre = 35·31 cubic feet
1 cubic foot = 0·02832 cubic metres

Pressure

1 atmosphere = 1·013 bar = 14·696 pounds per square inch
= $1{\cdot}013 \times 10^5$ newtons per square metre
= $1{\cdot}013 \times 10^5$ pascal

Temperature

Degrees Centigrade = 0·556 (degrees Fahrenheit − 32)
Degrees Fahrenheit = 1·80 (degrees Centigrade) + 32
Degrees kelvin = degrees Centigrade + 273

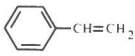
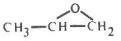
Energy

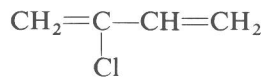
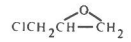
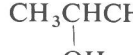
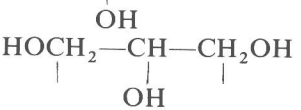
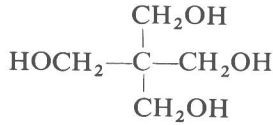
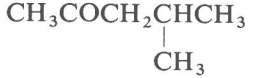
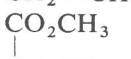
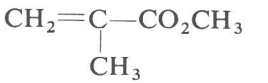
1 therm = 100 000 British thermal units
1 British thermal unit = 0·252 kilocalories = 1·055 kilojoules
1 kilocalorie = 4·184 kilojoules
1 kilowatt hour = 3600 kilojoules = 859·8 kilocalories
= 3412 British thermal units.

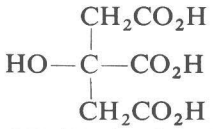
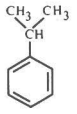
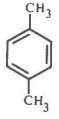
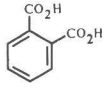
Power

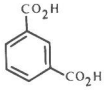
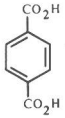
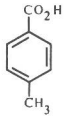
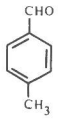
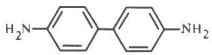
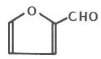
1 horsepower = 0·746 kilowatts
1 kilowatt = 1·34 horsepower

Nomenclature of organic compounds

Common or trivial name	Systematic (or IUPAC) name	Structure
(a) *Classes of compounds*		
Paraffin	Alkane	—
Cycloparaffins or Naphthenes	Cycloalkanes	—
Olefins	Alkenes	—
Acetylenes	Alkynes	—
Methacrylates	2-Methylpropenoates	$CH_2{=}C(CH_3){-}CO_2R$
(b) *Individual compounds*		
Ethylene	Ethene	$CH_2{=}CH_2$
Propylene	Propene	$CH_3CH{=}CH_2$
Styrene	Phenylethene	
Acetylene	Ethyne	$H{-}C{\equiv}C{-}H$
Isoprene	2-Methylbuta-1, 3-diene	$CH_2{=}C(CH_3){-}CH{=}CH_2$
Ethylene oxide	Oxirane	
Propylene oxide	1-Methyloxirane	
Methyl iodide	Iodomethane	CH_3I
Methyl chloride	Chloromethane	CH_3Cl
Methylene dichloride	Dichloromethane	CH_2Cl_2
Chloroform	Trichloromethane	$CHCl_3$
Carbon tetrachloride	Tetrachloromethane	CCl_4
Vinyl chloride	Chloroethene	$CH_2{=}CH{-}Cl$
Ethylene dichloride	1, 2-Dichloroethane	$ClCH_2CH_2Cl$
Allyl chloride	3-Chloropropene	$CH_2{=}CH{-}CH_2{-}Cl$

Chloroprene	2-Chlorobuta-1, 3-diene	
Epichlorohydrin	1-Chloromethyloxirane	
Ethylene glycol	Ethane-1, 2-diol	$HOCH_2CH_2OH$
Propargyl alcohol	Prop-2-yn-1-ol	$H-C\equiv C-CH_2OH$
Allyl alcohol	Prop-2-en-1-ol	$CH_2=CH-CH_2OH$
iso-Propanol	2-Propanol	
Glycerol	Propane-1, 2, 3-triol	
sec-Butanol	2-Butanol	
Pentaerythritol	2, 2-Di (hydroxymethyl) propane-1, 3-diol	
Lauryl alcohol	Dodecanol	$CH_3(CH_2)_{10}CH_2OH$
Acetone	Propanone	CH_3COCH_3
Methylisobutyl ketone	4-Methylpentan-2-one	
Formaldehyde	Methanal	$HCHO$
Acetaldehyde	Ethanal	CH_3CHO
Chloral	2, 2, 2-Trichloroethanal	Cl_3CCHO
Propionaldehyde	Propanal	CH_3CH_2CHO
Acrolein	Propenal	$CH_2=CHCHO$
Butyraldehyde	Butanal	$CH_3CH_2CH_2CHO$
Formic acid	Methanoic acid	HCO_2H
Methyl formate	Methyl methanoate	HCO_2CH_3
Acetic acid	Ethanoic acid	CH_3CO_2H
Acetic anhydride	Ethanoic anhydride	$(CH_3CO)_2O$
Paracetic acid	Perethanoic acid	CH_3CO_3H
Vinyl acetate	Ethenyl ethanoate	$CH_2=CHO_2CCH_3$
Acrylic acid	Propenoic acid	$CH_2=CH-CO_2H$
Dimethyl oxalate	Dimethyl ethanedioate	
Propionic acid	Propanoic acid	$CH_3CH_2CO_2H$
Methyl methacrylate	Methyl 2-methylpropenoate	

Maleic acid	cis-Butenedioic acid	
Maleic anhydride	cis-Butenedioic anhydride	
Citric acid	2-Hydroxypropane-1, 2, 3-tricarboxylic acid	
Methyl laurate	Methyl dodecanoate	$CH_3(CH_2)_{10}CO_2CH_3$
Stearic acid	Octadecanoic acid	$CH_3(CH_2)_{16}CO_2H$
Acrylonitrile	Propenonitrile	$CH_2{=}CH{-}CN$
Adipenitrile	Hexane-1, 6-dinitrile	$NC{-}(CH_2)_6{-}CN$
Urea	Carbamide	H_2NCONH_2
Ketene	Ethenone	$CH_2{=}C{=}O$
Toluene	Methylbenzene	
Aniline	Phenylamine	
Cumene	iso-Propylbenzene	
Benzyl alcohol	Phenylmethanol	
o-Xylene	1, 2-Dimethylbenzene	
m-Xylene	1, 3-Dimethylbenzene	
p-Xylene	1, 4-Dimethylbenzene	
Phthalic acid	Benzene-1, 2-dicarboxylic acid	

Isophthalic acid	Benzene-1, 3-dicarboxylic acid	
Terephthalic acid	Benzene-1, 4-dicarboxylic acid	
o-Toluic acid	2-Methylbenzoic acid	
p-Toluic acid	4-Methylbenzoic acid	
p-Tolualdehyde	4-Methylbenzaldehyde	
Benzidine	4, 4′-Biphenyldiamine	
Furfural	2-Formylfuran	

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