ADSORPTION CAPACITY
of Various Compounds in Air

INTRODUCTION

Activated carbon has excellent adsorption capacity for a wide range of mainly organic compounds. The adsorption capacity of activated carbon is influenced by the following factors:

- **Type of compound to be removed** - In general compounds with a high molecular weight, lower vapour pressure/higher boiling point and high refractive index are better adsorbed.
- **Concentration** - The higher the concentration, the higher the carbon consumption.
- **Temperature** - The lower the temperature, the better the adsorption capacity
- **Pressure** - The higher the pressure, the better the adsorption capacity
- **Humidity** - The lower the humidity, the better the adsorption capacity

The tables show the estimated adsorption capacity of various compounds in air on **ENVIROCARB™ AP3-60** and **AP4-60**. **ENVIROCARB™ AP3-60** and **AP4-60** are high grade 3 and 4 mm pellet activated carbons which are suitable for most air purification applications

In general, 3 mm pellets are used in thin bed applications such as cartridges with a bed depth of 10 to 50 cm, whereas 4 mm pellets are used for greater bed depths covering the majority of applications. Experience has shown this to be the best balance of kinetics and pressure drop.

In addition, **Chemviron Carbon** supply a range of equipment and services. The **VENTSORB®** series of adsorbers are designed to treat up to 12,000 m³/h of air. The **CYCLEVENT®** service is designed to facilitate the exchange of exhausted carbon by using mobile adsorbers where frequent carbon change is required.

Product bulletins for all of these products are available.

The tables include the following information:
Class - Air pollution class according to the TA Luft German air quality recommendations. C indicates the compound is carcinogenic. B indicates the compound is now banned under the Montreal protocol. The emission limits corresponding to the class are:

	Amount for limit to apply	Concentration Limit
Carcinogenic (C)		
Class I	0.5 g/h	0.1 mg/m³
Class II	5 g/h	1 mg/m³
Class III	25 g/h	5 mg/m³
Non-carcinogenic		
Class I	0.1 kg/h	20 mg/m³
Class II	2 kg/h	0.10 g/m³
Class III	3 kg/h	0.15 g/m³

Conversion factor - This can be used to convert a concentration from ppm (volume/mole) to g/m³. This is only valid at or near 20°C at atmospheric pressure.

Saturation concentration at 20°C - The maximum concentration of the pure compound in air before it begins to condense.

Loading on ENVIROCARB™ AP3-60/AP4-60 - This is the approximate capacity of the compound at 20°C in dry air at 3 different concentrations. An isotherm graph can be supplied on request showing the adsorption capacity over a wide range of concentrations. This loading should be used for estimation purposes only.

In some cases, the compound may not be suitable for adsorption and a chemisorption or catalytic type activated carbon should be selected. These include **SOLCARB™ KS3**, **AMMONOSORB™ 3MM** and **FORMASORB™3MM**. Please contact **Chemviron Carbon** for further information on these products and applications.

Name	Class (TA Luft)	Molecular Weight	Conv. Factor (g/m³)/ppm	Boiling Point °C	Saturation Conc. g/m³	0.1g/m³ %w/w	1g/m³ %w/w	10g/m³ %w/w
Acetic Acid	II	60.1	0.00250	118	38	9	19	38
Acetone	III	58.1	0.00241	56	589	3	6	13
Acetonitrile	IIIC	41.1	0.00171	80	163	2	6	16
Acrolein	I	56.1	0.00233	52	681	5	9	17
Acrylic Acid	I	72.1	0.00300	79	342	8	15	27
Acrylonitrile	IIIC	53.1	0.00221	74	262	5	11	20

Name	Class (TA Luft)	Molecular Weight	Conv. Factor (g/m³)/ppm	Boiling Point °C	Saturation Conc. g/m³	0.1g/m³ %w/w	1g/m³ %w/w	10g/m³ %w/w
Ammonia	-	17.0	0.00071	-33	-	AMMONOSORB™ 3MM		
Aniline	I	93.1	0.00387	184	2	37	48	-
Benzene	IIIC	78.1	0.00325	80	319	10	16	25
1,3-Butadiene	IIIC	54.1	0.00225	-5	5337	4	7	11
iso-butane	III	58.1	0.00242	-12	7187	3	5	9
Butane	III	58.1	0.00242	-1	4951	3	6	10
1-Butanol	III	74.1	0.00308	118	17	18	27	39
2-Butanol	III	74.1	0.00308	100	46	15	23	33
Butyl Acetate	III	116.2	0.00483	126	54	23	30	38
Carbon Disulfide	II	76.1	0.00317	46	1239	11	19	29
Carbon Tetrachloride	b	153.8	0.00640	77	764	24	33	45
Carbonyl Sulphide	-	60.1	0.00250	-50	SOLCARB™C3			
Chlorine	-	70.9	0.00295	-34	ENVIROCARB™ STIX 4MM			
2-Chloro-1,3-Butadiene	II	88.5	0.00368	59	920	13	19	27
Chlorobenzene	II	112.6	0.00468	132	55	28	37	48
Chloroethane	III	64.5	0.00268	12	3554	3	6	12
Chloroform	I	119.4	0.00496	61	1014	14	23	36
2-Chloropropane	II	78.5	0.00327	35	1881	7	11	18
m-Cresol	I	108.1	0.00450	202	1	44	55	-
o-Cresol	I	108.1	0.00450	191	1	46	60	-
p-Cresol	I	108.1	0.00450	202	0.3	53	-	-
Cumene	II	120.2	0.00500	152	22	28	35	42
Cyclohexane		84.2	0.00350	81	357	12	17	25
Cyclohexanone	II	98.1	0.00408	155	18	26	35	46
p-Dichlorobenzene	II	147.0	0.00611	174	10	42	52	64
o-Dichlorobenzene	I	147.0	0.00611	180	8	45	56	-
Dichlorodifluoromethane	III	120.9	0.00503	-60	64136	2	4	8
1,2-Dichloroethane	I	99.0	0.00411	84	335	15	24	36
cis-1,2-Dichloroethylene	III	96.9	0.00403	60	865	11	19	30
1,1-Dichloroethylene	I	96.9	0.00403	32	2625	9	15	23
1,4-Dioxane	I	88.1	0.00366	101	139	15	24	35
Epichlorohydrin	IIIC	92.5	0.00385	118	62	19	30	45
Ethanol	III	46.1	0.00192	78	111	4	10	21
Ethyl Acetate	III	88.1	0.00366	77	356	18	24	31
Ethyl Acrylate	I	110.1	0.00458	99	176	19	26	34
Formaldehyde	I	30.0	0.00125	-20	FORMASORB™ 3MM			
Heptane	III	100.2	0.00417	98	194	16	21	26
1-Heptanol	III	116.2	0.00483	176	1	35	43	-
1-Heptene	III	98.2	0.00408	94	236	16	21	26
Hexane	III	86.2	0.00358	69	564	12	16	21
1-Hexanol	III	102.2	0.00425	157	2	31	39	-
1-Hexene	III	84.2	0.00350	63	691	11	16	21
Hydrogen Chloride	-	36.5	0.00152	-85	IVP			
Hydrogen Sulphide	-	34.1	0.00142	-61	SOLCARB™ KS3			
Isopropyl Alcohol	III	60.1	0.00250	82	102	9	16	26

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Methanol	III	32.0	0.00133	65	171	1	3	11
Methyl Acetate	II	74.1	0.00308	57	698	6	12	20
Methyl Acrylate	II	86.1	0.00358	80	312	12	19	29
Methyl Chloride	I	50.5	0.00210	-24	10265	0.3	1	4
Methyl Ethyl Ketone (MEK)	III	72.1	0.00300	80	280	10	15	24
Methyl Isobutyl Ketone	III	100.2	0.00416	116	79	19	25	33
Methyl Isocyanate		57.0	0.00237	39	1086	2	5	12
Methyl Methacrylate	II	100.2	0.00416	97	152	18	25	35
Methyl tert-Butyl Ether		88.2	0.00366	55	983	11	15	21
Methylene Chloride	III	84.9	0.00353	40	1669	2	6	15
Naphthalene	II	128.2	0.00533	218	1	43	51	-
Nitrobenzene	I	123.1	0.00512	213	1	48	60	-
Nitrotoluene	I	137.1	0.00570	233	0.3	55	-	-
Octane	III	114.2	0.00475	126	65	20	25	31
Ozone	-	48.0	0.00200	-112	ENVIROCARB™ 207C 4x8			
Pentane	III	72.2	0.00300	36	1675	7	11	16
1-Pentanol	III	88.1	0.00366	138	6	25	34	-
2-Pentene	III	70.1	0.00292	37	1566	8	12	17
1-Pentene	III	70.1	0.00292	30	2038	7	11	15
Phenol	I	94.1	0.00391	182	1	43	57	-
Propane	III	44.1	0.00183	-42	15110	1	2	4
n-Propanol	III	60.1	0.00250	97	48	11	19	31
Propionaldehyde	II	58.1	0.00241	48	812	4	8	15
Propylene	III	42.1	0.00175	-48	17422	1	3	5
Pyridine	I	79.1	0.00329	115	68	19	28	39
Styrene	II	104.2	0.00433	145	25	28	35	43
1,1,2,2-Tetrachloroethane	I	167.9	0.00698	147	28	43	57	74
Tetrachloroethylene	II	165.9	0.00690	121	124	33	46	62
Tetrahydrofuran	II	72.1	0.00300	66	511	9	14	23
Toluene	II	92.1	0.00383	110	113	21	28	35
o-Toluidine	I	107.2	0.00445	200	2	39	49	-
1,2,4-Trichlorobenzene		181.5	0.00754	213	3	57	69	-
1,1,2-Trichloroethane	I	133.4	0.00555	114	120	27	39	54
1,1,1-Trichloroethane	b	133.4	0.00555	68	770	19	28	39
Trichloroethylene	II	131.4	0.00546	87	386	21	31	45
Trichlorofluoromethane	III	137.4	0.00571	24	4998	9	15	25
Triethylamine	I	101.2	0.00421	89	291	16	21	27
1,2,3-Trimethylbenzene	II	120.2	0.00500	176	8	32	39	-
1,2,4-Trimethylbenzene	II	120.2	0.00500	169	10	31	38	46
1,3,5-Trimethylbenzene	II	120.2	0.00500	165	11	30	37	44
Vinyl Acetate	II	86.1	0.00358	73	425	11	18	27
Vinyl Chloride	IIIC	62.5	0.00260	-14	8654	2	4	8
m-Xylene	II	106.2	0.00441	137	36	25	32	40
o-Xylene	II	106.2	0.00441	144	28	26	33	41
p-Xylene	II	106.2	0.00441	138	38	25	32	39

DESIGN INFORMATION

Carbon consumption

The rate at which the activated carbon is consumed in removing a compound from air. It is normally expressed as kg(carbon)/h.

$$\text{Carbon cons.(kg/h)} = \frac{\textit{Flowrate of compound (kg/h)}}{\textit{Loading (\%w/w)/100\%}}$$

Contact time

The contact time is the flow rate divided by the carbon volume. For a fixed flow rate, this determines the carbon volume required. The typical contact time in simple gas applications is 1 to 3 seconds. It is often determined from the size of standard adsorption systems.

$$\text{Contact time (s)} = \frac{\textit{Volume of carbon (m}^3\textit{) x 3600 (s/h)}}{\textit{Flowrate (m}^3\textit{/h)}}$$

Linear velocity

This is mainly depends on the ratio of bed depth to height and can be used to determine the pressure drop. The typical linear velocity in simple gas phase applications is 0.1 to 0.5 m/s. Pressure drop curves for **ENVIROCARB™ AP3-60 and AP4-60** are available on the product bulletin.

$$\text{Linear velocity (m/h)} = \frac{\textit{Flowrate (m}^3\textit{/h)}}{\textit{Surface area (m}^2\textit{) x 3600 (s/h)}}$$

WORKED EXAMPLE

Estimate the carbon consumption to remove 250ppm of toluene from a 100 m³/h air stream at 20°C and atmospheric pressure.

Answer:

Calculate concentration in g/m³

Conversion factor	=	0.00383 (g/m³)/ppm (from Table)
Concentration	=	250 ppm x 0.00383 (g/m³)/ppm
	=	0.96 g/m³
	~	1 g/m³
Toluene flowrate	=	0.96 g/m³ x 100m³/h x 0.001 kg/g
	=	0.096 kg/h
Loading at 1g/m³	=	28 % w/w (from Table)
Carbon cons.	=	0.096 kg/h x 100 %/28 %
	=	0.34 kg(carbon)/h

SAFETY MESSAGE

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low-oxygen spaces should be followed.

QUALITY

Each of our worldwide operations has achieved **ISO 9001** certification for their quality management system related to activated carbon. **Chemviron Carbon** guarantees the specifications against representative sampling.

CHEMVIRON CARBON

Chemviron Carbon, the European operation of Calgon Carbon Corporation, is a global manufacturer, supplier, and developer of granular activated carbon, innovative treatment systems, value added technologies, and services for optimising production processes and safely purifying the environment.

With our experience developed since the early years of the twentieth century, facilities around the world and a world-class team of over 1,200 employees, Calgon Carbon Corporation can provide the solutions to your most difficult purification challenges.

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Visit our website at **www.chemvironcarbon.com**

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CALGON CARBON CORPORATION

Corporate Headquarters
400 Calgon Carbon Drive
Pittsburgh, PA 15205, USA
Tel.: +1 (0) 412 787-6700
Fax: +1 (0) 412 787-6713

Chemviron Carbon

European Operations of Calgon Carbon Corporation
Zoning Industriel C de Feluy
B - 7181 Feluy, Belgium
Tél.: +32 (0) 64 51 18 11
Fax: +32 (0) 64 54 15 91

Your local office

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