Table 1 .... Relative Capacity of 50-min Activated Coconut Shell Charcoal for Contaminant Vapors

The capacity index has the following meaning:—

4—High capacity for all materials in this category. One pound takes up about 20% to 50% of its own weight—average about ⅓ (33⅓%). This category includes most of the odor causing substances.

3—Satisfactory capacity for all items in this category. These constitute good applications but the capacity is not as high as for category 4. Adsorbs about 10 to 25% of its weight—average about ⅙ (16.7%).

2—Includes substances which are not highly adsorbed but which might be taken up sufficiently to give good service under the particular conditions of operation. These require individual checking.

1—Adsorption capacity is low for these materials. Activated charcoal cannot be satisfactorily used to remove them under ordinary circumstances.

3—Acetaldehyde
4—Acetic acid
4—Acetic anhydride
3—Acetone
1—Acetylene
3—Acrolein

4—Acrylic acid
3—Acrylonitrile
4—Adhesives
4—Airwick
4—Alcoholic beverages
2—Amines

2—Ammonia
4—Amyl acetate
4—Amyl alcohol
4—Amyl ether
3—*Animal odors*
3—Anesthetics

4—Aniline
4—Antiseptics
4—Asphalt fumes
4—Automobile exhaust
3—Bathroom odors
4—Benzene

3—Bleaching solutions
4—Body odors
3—Borane
3—Bromine
4—Burned flesh
4—Burned food

4—Burning fat
3—Butadiene
2—Butane
3—Butanone
4—Butyl acetate
4—Butyl alcohol

4—Butyl cellosolve
4—Butyl chloride
4—*Butyl ether*
2—Butylene
2—Butyne
3—Butyraldehyde

4—Butyric acid
4—Camphor
4—Cancer odor
4—Caprylic acid
4—Carbolic acid
3—Carbon bisulfide

1—Carbon dioxide
1—Carbon monoxide
4—Carbon tetrachloride
4—Cellosolve
4—Charred materials
4—Cheese

3—Chlorine
4—Chlorobenzene
4—Chlorobutadiene
4—Chloroform
4—Chloro nitropropane
4—Chloropicrin

3—Cigarette smoke odor
4—Citrus and other fruits
4—Cleaning compounds
3—Coal smoke odor
3—Combustion odors
4—Cooking odors

3—Corrosive gases
4—Creosote
4—Cresol
4—Crotonaldehyde
3—Cyclohexane
4—Cyclohexanol

3—Cyclohexanone
3—Cyclohexene
4—Dead animals
4—Decane
4—Decaying substances
3—Deodorants

4—Detergents
4—Dibromoethane
4—Dichlorobenzene
4—Dichlorodifluoromethane
4—Dichloroethane
3—Dichloroethylene

4—Dichloroethyl ether
3—Dichloromonofluoromethane
4—Dichloro-nitroethane
4—Dichloropropane
4—Dichlorotetrafluoroethane

4—Diesel fumes
3—Diethyl amine
4—Diethyl ketone
4—Dimethylaniline
4—Dimethylsulfate
3—Dioxane

4—Dipropyl ketone
4—Disinfectants
4—Embalming odors
1—Ethane
2—Ether
3—Ethyl acetate

4—*Ethyl acrylate*
4—Ethyl alcohol
3—Ethyl amine
4—Ethyl benzene
4—Ethyl bromide
4—Ethyl chloride

2—Ethyl ether
3—Ethyl formate
3—Ethyl mercaptan
4—Ethyl silicate
1—Ethylene
4—Ethylene chlorhydrin

4—Ethylene dichloride
3—Ethylene oxide
4—Essential oils
4—Eucalyptole
3—Exhaust fumes
4—Female odors

3—Fertilizer
3—Film processing odors
3—*Fish odors*
4—Floral scents
3—Fluorotrichloromethane
4—Food aromas

2—Formaldehyde
3—Formic acid
2—Fuel gases, cooking
4—Gangrene
4—Garlic
4—Gasoline

4—Heptane
4—Heptylene
3—Hexane
3—Hexylene
3—Hexyne
4—Hospital odors

4—Household odors
1—Hydrogen
3—*Hydrogen bromide*
3—Hydrogen chloride
3—Hydrogen cyanide
2—Hydrogen fluoride

4—*Hydrogen iodide*
3—Hydrogen selenide
2—Hydrogen sulfide
4—Incense
3—Indole
2—Inorganic chemicals

3—Incomplete combustion
3—Industrial wastes
4—Iodine
4—Iodoform
4—Irritants
4—Isophorone

3—Isoprene
4—Isopropyl acetate
4—Isopropyl alcohol
3—Isopropyl ether
4—Kerosene
4—Kitchen odors

4—Lactic acid
4—Lingering odors
4—Liquid fuels
4—Liquor odors
4—Lubricating oils and greases

4—Lysol
4—Masking agents
4—Medicinal odors
4—Melons
4—Menthol
4—Mercaptans

3—Mesityl oxide
1—Methane
3—Methyl acetate
4—Methyl acrylate
3—Methyl alcohol
4—Methyl bromide

4—Methyl butyl ketone
4—Methyl cellosolve
4—Methyl cellosolve acetate
4—Methyl chloride
4—Methyl chloroform
3—Methyl ether

3—*Methyl ethyl ketone*
3—Methyl formate
4—Methyl isobutyl ketone
4—Methyl mercaptan
4—Methylcyclohexane
4—Methylcyclohexanol

4—Methylcyclohexanone
4—Methylene chloride
3—Mildew
3—Mold
4—Monochlorobenzene
4—Monofluorotrichloromethane

4—Moth balls
4—Naphtha (Coal tar)
4—Naphtha (Petroleum)
4—Naphthalene
4—Nicotine

2—*Nitric acid*
4—Nitro benzenes
3—Nitroethane
2—Nitrogen dioxide
4—Nitroglycerine
2—*Nitromethane*

4—Nitropropane
4—Nitrotoluene
4—Nonane
4—Octalene
4—Octane
4—Odorants

4—Onions
4—Organic chemicals
4—Ozone
4—Packinghouse odors
4—Paint and redecorating odors

4—Palmitic acid
4—Paper deteriorations
4—Paradichlorbenzine
4—Paste and glue
3—Pentane
4—Pentanone

3—Pentylene
3—Pentyne
4—Perchloroethylene
4—*Perfumes, cosmetics*
4—Perspirations
4—Persistent odors

4—Pet odors
4—Phenol
3—Phosgene
4—Pitch
4—Plastics
3—Poison gases

Table 1 .... Relative Capacity of 50-min Activated Coconut Shell Charcoal for Contaminant Vapors (*Concluded*)

4—Popcorn and candy
4—Poultry odors
2—Propane
3—Propionaldehyde
4—Propionic acid

4—Propyl acetate
4—Propyl alcohol
4—Propyl chloride
4—Propyl ether
4—Propyl mercaptan

2—Propylene
2—Propyne
3—Putrefying substances
3—Putrescine
3—Pyridine

4—Radiation products
4—Rancid oils
4—Resins
4—Reodorants
4—Ripening fruits

4—Rubber
4—Sauerkraut
3—Sewer odors
4—Skatole
3—*Slaughtering odors*

4—Smog
4—Soaps
4—Smoke
3—Solvents
4—Sour milks
4—Spilled beverages

4—Spoiled food stuffs
4—Stale odors
4—Stoddard solvent
4—Stuffiness
4—Styrene monomer

2—Sulfur dioxide
3—Sulfur trioxide
4—Sulfuric acid
4—Tar
3—*Tarnishing gases*

4—Tetrachloroethane
4—Tetrachloroethylene
4—Theatrical makeup odors
4—Tobacco smoke odor
4—Toilet odors
4—Toluene

4—Toluidine
4—Trichlorethylene
4—Trichloroethane
4—Turpentine
4—Urea

4—Uric acid
4—Valeric acid
4—Valericaldehyde
4—Varnish fumes
4—Vinegar

4—Vinyl chloride
3—Volatile materials
4—Waste products
3—Wood alcohol
4—Xylene

[a] Some of the contaminants listed in the table are specific chemical compounds, some represent classes of compounds, and others are mixtures and of variable composition. Activated charcoal's capacity for odors varies somewhat with the concentration in air, with humidity and temperature, and with the actual velocity used through the filters. The numbers given represent typical or average conditions and might vary in specific instances. The values in the table have been assembled from many sources including laboratory tests and field experience. In cases where numerical values were not available, the author has listed his opinion of the probable capacity based on general experience. The table should be used as a general guide only.

replaced by clean outdoor air. It has been shown by ASHRAE and other research that ventilation requirements for human occupancy are a function of the space per person and the degree of activity (see Table 1, Chapter 7). Data from this table and other sources have been presented in a readily usable form in Fig. 2.[18] The values from Curve D of Fig. 2, have also been found to apply reasonably well to densely populated heavy-smoke-laden atmospheres such as sports arenas where vision and irritation are more of a problem than odor. It has been found that 30 cfm per person are necessary for effective commercial ventilation for such arenas, to avoid objectionable eye irritation, odors, and impaired visibility.[17]

The actual oxygen requirement per person varies with activity. It is normally about 0.89 cu ft per man hour when walking at a rate of 1 mile per hour. About 0.74 cu ft of carbon dioxide is liberated per man hour for normal activity.[18] Normal air contains about 0.03 percent carbon dioxide. Fig. 3 shows the effect of carbon dioxide on lung action. A concentration of 0.6 percent has little effect on lung action, increasing it only about 10 percent above normal.[19]

As shown in Fig. 2, the oxygen and carbon dioxide requirements can be met with an outdoor-air ventilation rate of less than 4 cfm per person.[20] This may include infiltration. An outdoor-air ventilation rate above 4 cfm is required to dilute odors, irritants, smoke density, or other nontoxic conditions. The amount of ventilation required per person to remove human odors, or dilute them to an acceptable value, can be found from Curve D of Fig. 2 for the space occupancy.

Adsorption

Adsorption is the physical condensation of a gas or vapor on activated solid substrate. These substrates are typically high porosity, yielding internal surface areas of 100–300 square meters per gram. The adsorbents are generally of two types: (1) those which store the adsorbed odor (e.g. charcoal) and when saturated are regenerated by high temperatures; and (2) those which contain reactant chemicals in the substrate (e.g., permanganate alumina) to destroy or inactivate the adsorbed odor.

Charcoal adsorption is the physical condensation of a gas or vapor sorbate on the charcoal sorbent. The capacity of charcoal to adsorb gases or vapors varies with the gas or vapor.[21] Some are readily adsorbed, while others are not. The relative adsorption qualities of high quality 50-minute unimpregnated coconut shell charcoal for some vapors are given in Table 1. The values used are based on the removal of the substance from dilute concentrations in air, as encountered in air recovery and air-conditioning systems. If the weight of the vapor to be adsorbed is known, then the quantity of charcoal required for the period under consideration can be obtained by use of Table 2.

Table 3 serves as a guide to the relative odor levels of various types of occupancies. These are the levels existing prior to installation of special odor removal equipment. The occupancies are classified into four odor levels. Odor level *A* contains the lowest amount of odor, and level *D*, the highest.

Table 2 .... Yearly Requirement in Pounds of 50-min Activated Coconut-Shell Charcoal for Various Occupancies[a]

Residences	
Total per person	
Non-smoking	1
Smoking	2
Individual rooms per person	
Living room	0.5
Dining room	0.25
Kitchen	0.25
Toilet and bath	0.25
Bedroom	0.15
Laundry	0.15
Office	
Total per person	
Non-smoking	1
Smoking	2
Hotel, per person, average occupancy	2
School, per pupil	1.5
Hospital (room or ward), per bed	3
Laboratory (average), per person	3
Bar or tavern, per occupant	5

[a] Add up the amount of activated charcoal needed by units as indicated in the table. For example, if there are 6 people in an office, 3 of whom are smokers, and 3 non-smokers, a total of 9 lb for one year's service under average conditions is indicated.