THE INDEX OF ANTIOXIDANTS & ANTIOZONANTS

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An International Guide to More Than 1500 Products by Trade Name, Chemical, Application, and Manufacturer

Compiled by

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Preface

This reference work describes more than 1500 trade name products and chemicals that are used as antioxidants and antiozonants in the chemical industry and in research.

Antioxidants are used in organic materials to inhibit or retard the rate of reaction with atmospheric oxygen and thus prevent the degradation of the material. Antioxidants are used in a variety of applications including: polymers—to retain physical properties and ensure an adequate service life; elastomers—to protect the rubber during drying and storage; food products—to retard rancidity; fuels and lubricants—to prevent darkening and the formation of gums and deposits.

The selection of an antioxidant for a product or system involves consideration of the following factors: the chemical nature of the substrate; conditions of exposure; what antioxidants are commercially available; the advantages of using antioxidants in combination for their synergistic effect; and the cost requirements for the manufacturing process.

Antiozonants are used to protect elastomeric materials against deterioration by the ozone that is either naturally generated by electrical discharge and solar radiation or produced in urban areas as a consequence of pollutant emissions. Ozone attacks the double bonds of the polymeric compound and causes cracking along the stress lines of the material, destroying the usefulness of the product. Ozone degradation of materials has become more of a problem as a result of the increase in atmospheric ozone.

For an antiozonant to be effective, it must either react rapidly with ozone or form a protective barrier on the surface of the product. The choice of antiozonants must factor in: the end product's processing characteristics; the nondiscoloring and staining requirements for the end product; the static and dynamic conditions for the product's use; as well as cost.

The extensive information presented here on both antioxidants and antiozonants is gathered from more than 700 worldwide manufacturers, distributors, trade magazines, reference books and chemical databases. This reference functions as a single source for decision-making in formulating products that require the use of antioxidants and antiozonants, purchasing them, and understanding the safety issues presented by their use. Current information on chemical composition, properties, function and application, toxicology, and environmental impact for both trade name and generic antioxidants and antiozonants that are manufactured worldwide is provided.

This reference contains comprehensive information on a broad range of antioxidants and antiozonants that are available from major chemical manufacturers and it serves to expedite the material selection process for chemists, formulators and purchasing agents while providing important toxicological and environmental information for industrial hygienists, safety officers, and researchers. Trade name products are cross-referenced by chemical composition, application, CAS and EINECS/ELINCS numbers. Generic chemicals that function as antioxidants and antiozonants are also included along with their manufacturers and distributors.

The book is divided into four sections:

Part I—*Trade Name Reference* contains more than 1100 alphabetical entries of trade name antioxidants and antiozonants. Each entry contains information in the following format: manufacturer, chemical description, CAS (Chemical Abstract Service), EINECS/ELINCS (European Inventory of Existing Commercial Chemical Substances/European List of Notified Chemical Substances), and UN identifying numbers, applications and functions, use levels, regulatory details, general properties, toxicology, environmental data, precautions, hazardous rating, and storage requirements, as provided by the manufacturer or derived from other reference sources. Not all entries contain information for every category as product descriptions are dependent, in many cases, on the literature that the individual manufacturers provide.

Part II—*Chemical Dictionary/Cross-Reference* contains more than 400 alphabetical entries of chemicals that function as antioxidants/antiozonants or are components of trade name antioxidants/antiozonants. Each chemical entry contains information in the following format: CAS , EINECS/ELINCS, and UN numbers, synonyms, classification, definition, empirical formula, molecular formula, general properties, toxicological and environmental data, precautions, hazardous decomposition products, hazardous rating, applications and functions, use levels, regulatory details, manufacturers and/or distributors of the chemical compound, a cross-reference of trade name products (from Part I) that are equivalent to the chemical entry and a cross-reference of trade name products that contain that chemical entry as one of its constituents. More than 1100 synonyms are cross-referenced back to their main entries. This ensures finding the chemical by knowing only one of its alternative names.

Part III—*Application Cross-Reference* contains an alphabetical listing of major antioxidant/antiozonant application categories. Nineteen categories are included, e.g., Adhesives, Cosmetic and Personal Care, Fats, Oils, and Greases, Feed, Foods, Food Packaging, Fuels, Lubricants, Paints and Coatings, Plastics, Polymers, and Resins, Rubber and Latex Compounding, and Waxes.

Part IV—*Manufacturers Directory* contains detailed contact information for the more than 700 manufacturers of the trade name products and generic chemicals that are referenced in this handbook. Wherever possible telephone, telefax, toll-free 800 numbers, e-mail and internet addresses, and complete mailing addresses are included for each manufacturer.

The *Appendices* contains the following cross-references:

CAS Number-to-Trade Name Cross-Reference orders many trade names found in Part I by identifying CAS numbers; it should be noted that trade names contain more than one chemical component and the associated CAS numbers in this section refer to each trade name product's primary chemical component.

CAS Number-to-Chemical Cross-Reference orders chemical compounds found in Part II by CAS numbers.

EINECS/ELINCS Number-to-Trade Name Cross-Reference orders many trade names

found in Part I by identifying EINECS or ELINCS numbers that refer to each trade name product's primary chemical component.

EINECS/ELINCS Number-to-Chemical Cross-Reference orders chemical compounds found in Part II by EINECS or ELINCS numbers.

This book is the culmination of many months of research, investigation of product sources, and sorting through a variety of technical data sheets, brochures and MSDS's, acquired through personal contacts and correspondences with major chemical manufacturers worldwide as well as toxicological databases, chemical reference books, trade magazines and journals, etc. We would especially like to express our gratitude to Roberta Dakan for her contribution to standardizing the entry format and managing the trade name and chemical database that represents the basis of the Chemical Reference Series. Her untiring efforts have been instrumental in the production of this reference.

M. & I. Ash

NOTE:

Abbreviations

ABS	acrylonitrile-butadiene-styrene
abs.	absolute
absorp.	absorption
ACGIH	American Conference of Governmental Industrial Hygienists
act.	active
ADI	acceptable daily intake (FAO/WHO)
adsorp.	adsorption
agric.	agricultural
agrichem.	agrichemical(s)
agrochem.	agrochemical
a.i.	active ingredient
alc.	alcohol
Am., Amer.	American
amts.	amounts
anhyd.	anhydrous
APHA	American Public Health Association
applic(s).	application(s)
aq.	aqueous
ASA	acrylic-styrene-acrylonitrile
atm	atmosphere
at.wt.	atomic weight
aux.	auxiliary
avail.	available
avg.	average
a.w.	atomic weight
BATF	Bureau of Alcohol, Tobacco, and Firearms (U.S.)
BGA	Federal Republic of Germany Health Dept. certification
BHA	butylated hydroxyanisole
BHT	butylated hydroxytoluene
biochem.	biochemical
biodeg.	biodegradable
bldg.	building
blk.	black
BOD	biological oxygen demand
BP	British Pharmacopeia
b.p.	boiling point
BR	butadiene rubbers, polybutadienes
B&R	Ball & Ring
br., brn.	brown
brnsh.	brownish
BS	British Standards
B/S	butadiene/styrene
BSS	British Standard Sieve
Btu	British thermal unit
B.U.	Brabender units (viscosity)
byprod.	byproduct(s)
C	degrees Centigrade
CAA	Clean Air Act
calcd.	calculated
cap.	capillary
CAS	Chemical Abstracts Service
CC	closed cup
cc	cubic centimeter(s)

CCl_4	carbon tetrachloride
CD	completely denatured
CDA	completely denatured alcohol
CEL	corporate exposure limit
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act (U.S.)
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations (U.S.)
ch.	chapter
char.	characteristic, characterized
chel.	chelation
chem(s).	chemical(s)
CI	Color Index
CIIR	chlorobutyl rubber
CIR	Cosmetic Ingredient Review
cks	centistoke(s)
CL	ceiling concentration
cl	clear
cm	centimeter(s)
cm^3	cubic centimeter(s)
CMC	carboxymethylcellulose
CMC	critical Micelle concentration
c.m.p.	capillary melting point
CNS	central nervous system
CO	carbon monoxide
COC	Cleveland Open Cup
COD	chemical oxygen demand
coeff.	coefficient
compat.	compatible
compd(s).	compound(s)
compr.	compression
conc(s).	concentrated, concentration
conduct.	Conductive, conductivity
const.	constant
contg.	containing
cosolv.	cosolvent
CP	Canadian Pharmacopeia
cp	centipoise(s)
cps	centipoise(s)
CPVC	chlorinated polyvinyl chloride
CR	chloroprene rubber, polychloroprene
cryst.	crystalline, crystallization
cs	centistoke(s)
cSt	centistoke(s)
ctks	centistoke(s)
cwt	hundred weight
dc	direct current
DEA	diethanolamide, diethanolamine
dec.	decomposes
decomp.	decomposition
DEG	diethylene glycol
deliq.	deliquescent
dens.	density
deriv(s).	derivative(s)
descrip.	description

dg	decigram(s)
DI	deionized
diam.	diameter
dielec.	dielectric
dil.	dilute
disp.	dispersible, dispersion
dissip.	dissipation
dist.	distilled
distort.	distcrtion
distrib.	distributor
dk.	dark
DOP	dioctyl phthalate
DOT	Department of Transportation (U.S.)
DW	distilled water, deionized water
eb, EB	electron beam
EC	European Community
EC50	environmental concentration, 50%
EDTA	ethylenediamine tetraacetic acid
e.g.	for example
EINECS	European Inventory of Existing Commercial Chemical Substances
elec.	electrical
ELINCS	European List of Notified Chemical Substances
elong.	elongation
EMI	electromagnetic interference
EMS	electromagnetic shielding
EO	ethylene oxide
EP	European Pharmacopoeia
EPA	Environmental Protection Agency (U.S.)
EPDM	ethylene-propylene-diene rubber, ethylene-propylene terpolymer
EPR	ethylene-propylene rubber
EPS	expandable polystyrene
equip.	equipment
equiv.	equivalent
ESD	electrostatic discharge
ESP	electrostatic protection
esp.	especially
EU	European Union
Eur.Ph.	European Pharmacopeia
EVA	ethylene vinyl acetate
exc.	excellent
F	degrees Fahrenheit
FA	fatty acid
FAO	Food and Agriculture Organization (United Nations)
FCC	Food Chemicals Codex
FDA	Food and Drug Administration (U.S.)
FD&C	Foods, Drugs, and Cosmetics
FEMA	Flavor and Extract Manufacturers' Association (U.S.)
FEP	fluorinated ethylene propylene
FG	food grade
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act (U.S. EPA)
fl	fluid
flamm.	flammable, flammability
flex.	flexural
f.p.	freezing point
FR-ABS	flame retardant ABS

FRP	fiberglass-reinforced plastics
F-T	Fischer-Tropsch
ft	foot, feet
f.w.	formula weight
G	giga
g	gram(s)
gal	gallon(s)
G-H	Gardner-Holdt
GI	gastro-intestinal
glac.	glacial
gr.	gravity
gran.	granules, granular
GRAS	generally regarded as safe
grn.	green
GRP	glass-reinforced plastics, glass-reinforced polyester
GVS	Gardner varnish scale (color)
h	hour(s)
HALS	hindered amine light stabilizer
HAP	hazardous air pollutant
HC	hydrocarbon
HCl	hydrochloride, hydrochloric acid
HDPE	high-density polyethylene
Hg	mercury
HIPS	high-impact polystyrene
HLB	hydrophilic lipophilic balance
HMIS	Hazardous Material Information System
hr	hour(s)
hyd.	hydroxyl
hydrog.	hydrogenated
Hz	hertz
IARC	International Agency for Research on Cancer (United Nations)
i.b.p.	initial boiling point
I&I	industrial and institutional
IIR	isobutylene-isoprene rubber
IM	intramuscular
immisc.	immiscible
in.	inch(es)
Inc.	Incorporated
inc.	increases, increased
INCI	International Nomenclature Cosmetic Ingredient
incl.	including
incompat.	incompatible
ing.	ingestion
ingred(s).	ingredient(s)
inh.	inhalation
inj.	injection
inorg.	inorganic
insol.	insoluble
Int'l.	International
IP	intraperitoneal
IPA	isopropyl alcohol
IPM	isopropyl myristate
IPP	isopropyl palmitate
IR	isoprene rubber (synthetic), polyisoprene
IU	International Unit

IV	intravenous
J	joule
JCID	Japanese Cosmetic Ingredients Dictionary
JP	Japanese Pharmacopoeia
JSCI	Japanese Standard of Cosmetic Ingredients
JSFA	Japan Standards for Food Additives
k	kilo
KB	Kauri-Butanol
kg	kilogram(s)
KTPP	potassium tripolyphosphate
KU	Krebs units
l	liter(s)
lb	pound(s)
LC50	lethal concentration 50%
LCLo	lethal concentration low
LD0	lethal dose 0%
LD50	lethal dose 50%
LDLo	lowest published lethal dose
LDPE	low-density polyethylene
LED	light-emitting diode
lg.	large
liq.	liquid
LLDPE	linear low-density polyethylene
lt.	light
Ltd.	Limited
LVP	low vapor pressure
M	mega
M	mole
m	milli
m	meter(s)
m-	meta
manuf.	manufacturer
max.	maximum
mbar	millibar
MEA	monoethanolamine, monoethanolamide
mech.	mechanial
med.	medium
MEK	methyl ethyl ketone
mfg.	manufacture
mg	milligram(s)
MIBK	methyl isobutyl ketone
microcryst.	microcrystalline
microgran.	microgranules, microgranular
MID	Meat Inspection Division (USDA)
MIL	Military Specifications
mil	$^{1}/_{1000}$th inch
min	minute(s)
min.	mineral
min.	minimum
MIPA	monoisopropanolamine, monoisopropanolamide
misc.	miscible, miscellaneous
mixt(s).	mixture(s)
ml	milliliter(s)
mm	millimeter(s)
MMW-HDPE	medium molecular weight high density polyethylene

mN	millinewton(s)
mo, mos	month(s)
mod.	moderately
mod.	modulus
monocl.	monoclinic
m.p.	melting point
mPa·s	millipascal-second(s)
mus	mouse
m.w.	molecular weight
N	normal
nat.	natural
NBR	nitrile rubber, nitrile-butadiene rubber
NC	nitrocellulose
need.	needles
neut.	neutral, neutralized
NF	National Formulary
NFPA	National Fire Protection Association
ng	nanogram
nm	nanometer
no.	number
nonalc.	nonalcoholic
nonaq.	nonaqueous
nonbiodeg.	nonbiodegradable
nonflamm.	nonflammable
nonyel.	nonyellowing
NR	natural rubber, isoprene rubber (natural)
NSF	National Sanitation Foundation
NSF	National Standards Foundation
NV	nonvolatiles
o-	ortho
OBPA	oxybisphenoxarsine
OC	open cup
ODC	ozone-depleting compound
ODP	ozone-depletion potential
OEL	occupational exposure limit
OEM	original equipment manufacturer
OMS	odorless mineral spirits
org.	organic
OSHA	Occupational Safety and Health Administration (U.S.)
o/w	oil-in-water
oz	ounce
p-	para
Pa	Pascal
PBT	polybutylene terephthalate
pbw	parts by weight
PC	polycarbonate
PCP	Pest Control Product Act, Canada, 1972
PCTFE	polychlorotrifluoroethylene
PE	polyethylene
PEEK	polyetheretherketone
PEG	polyethylene glycol
PEK	polyetherketone
PEL	permissible exposure level
percut.	percutaneous
PES	polyether sulfone

PET	polyethylene terephthalate
petrol.	petroleum
PG	propylene glycol
pH	hydrogen-ion concentration
Ph.	Pharmacopoeia
pharm.	pharmaceutical
Ph.Eur.	European Pharmacopoeia
phr	parts per hundred of rubber or resin
PIB	polyisobutylene
pkg.	packaging
PM, P-M	Pensky-Martens
PMCC	Pensky-Martens closed cup
PMMA	polymethyl methacrylate
PMOC	Pensky-Martens open cup
PO	propylene oxide
POE	polyoxyethylene, polyoxyethylated
polyunsat.	polyunsaturated
POM	polyoxymethylene
POP	polyoxypropylene, polyoxypropylated
powd.	powder
PP	polypropylene
ppb	parts per billion
PPE	polyphenylene ether
PPG	polypropylene glycol
pph	parts per hundred (percent)
ppm	parts per million
PPO	polyphenylene oxide
PPS	polyphenylene sulfide
ppt	parts per trillion
pract.	practically
prep(s).	preparation(s)
prod.	product(s), production
props.	properties
PS	polystyrene
ps	poise
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
pt.	point
Pt-Co	platinum-cobalt
PTFE	polytetrafluoroethylene
PTMEG	polytetramethylene ether glycol
PU	polyurethane
PUR	polyurethane
PVA	polyvinyl alcohol
PVAc	polyvinyl acetate
PVAL	polyvinyl alcohol
PVB	polyvinyl butyral
PVC	polyvinyl chloride
PVDC	polyvinylidene chloride
PVDF	polyvinylidene fluoride
PVP	polyvinylpyrrolidone
qt	quart
quat.	quaternary
R&B	Ring & Ball

rbt	rabbit
RCRA	Resource Conservation and Recovery Act (40 CFR §261)
rdsh.	reddish
rec.	recommended
ref.	refractive
reg.	register, registry
regs.	regulations
rep.	represents
resist.	resistance, resistant, resistivity
resp.	respectively
RFI	radio frequency interference
r.h.	relative humidity
rhomb.	rhombic
RIM	reaction injection molded/molding
RO	reverse osmosis
RQ	reportable quantity
R.T.	room temperature
RTECS	Registry of Toxic Effects of Chemical Substances
RTV	room temperature vulcanizing
s	second(s)
s-	secondary
SAN	styrene-acrylonitrile
sapon.	saponification
SARA	Superfund Amendments and Reauthorization Act (U.S.)
sat.	saturated
S/B	styrene/butadiene
SBR	styrene/butadiene rubber
SBS	styrene-butadiene-styrene
SD	specially denatured
SDA	specially denatured alcohol
SE	self-emulsifying
SEBS	styrene-ethylene/butylene-styrene
sec.	secondary
semicryst.	semicrystalline
semiliq.	semiliquid
semisyn.	semisynthetic
sl.	slight, slightly
sm.	small
soften.	softening
sol.	soluble, solubility
solid.	solidification
sol'n.	solution
solv(s).	solvent(s)
sp.	specific
spec.	specification, specialty
spp.	non-specified species
SSU	Saybolt Universal Seconds
std.	standard
STEL	short term exposure limit
Stod.	Stoddard solvent
str.	strength
subcut.	subcutaneous
subl.	sublimes
surf.	surface
SUS	Saybolt Universal Seconds

susp.	suspension
syn.	synthetic
t	tertiary
TCC	Tag closed cup
TCLo	toxic concentration low
TDLo	toxic dose low
TDS	total dissolved solids
TEA	triethanolamine, triethanolamide
tech.	technical
temp.	temperature
tens.	tensile , tension
tert	tertiary
THF	tetrahydrofuran
thru	through
TIPA	triisopropanolamine
TKPP	tetrapotassium pyrophosphate
TLV	Threshold Limit Value
TOC	Tag open cup
TPE	thermoplastic elastomer
TSCA	Toxic Substances Control Act
tsp	teaspoon
TSS	total suspended solids
TWA	time weighted average
TWC	time weighted concentration
typ.	typical
uel	upper explosive limits
UF	urea formaldehyde
UHF	ultra high frequency
UL	Underwriter's Laboratory
UN No.	United Nations Substance Identification Number (transport)
unsat.	unsaturated
USDA	U.S. Department of Agriculture
USP	Unites States Pharmacopeia
uv, UV	ultraviolet
V	volt
VA	vinyl acetate
VAE	vinyl acetate ethylene
VC	vinyl chloride
VdC, VDC	vinylidene chloride
veg.	vegetable
visc.	viscous, viscosity
VM&P	Varnish Makers and Painters
VOC	volatile organic compounds
vol.	volume
v/v	volume by volume
wh.	white
WHO	World Health Organization (United Nations)
wks	weeks
w/o	water-in-oil
wt.	weight
w/v	weight by volume
w/w	weight by weight
yel.	yellow
ylsh.	yellowish
yr	year

#	number
%	percent
±	plus or minus
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
@	at
α	alpha
β	beta
δ, Δ	delta
ε	epsilon
γ	gamma
ω	omega
μ	micron, micrometer
μg	microgram
≈	approximately equal to

Contents