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HIGH-TEMPERATURE CONTACT NUCLEATION OF SUPERCOOLED WATER BY ORGANIC CHEMICALS AND APPENDIX OF COMPOUNDS TESTED

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China Lake, California

November 1972

High-Temperature Contact Nucleation of Supercooled Water by Organic Chemicals and Appendix of Compounds Tested

by

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Research Department

MICHELSON LABORATORIES
Naval Weapons Center
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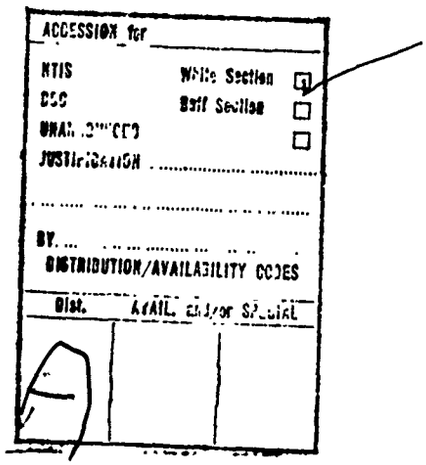

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13. ABSTRACT

A simple, rapid test is described that measures contact nucleation of supercooled water. Application of this contact-nucleation test at -3C to over 1000 organic compounds resulted in only 47 that could be considered as "active." There was a close correlation between the present test and Fukuta's *Method b* when the samples were in the same physical condition (freshly ground). Materials such as metaldehyde, fluorenone, phenazine and phloroglucinol dihydrate were not found to be sufficiently "active" to pass the contact-nucleation test in an unground state.

It is proposed that the initial water-air interface may pass through a configuration that promotes the growth of ice embryos even though the final compound-water interface has a low "activity," i.e., a low prewet-nucleation temperature. Conversely, some compounds such as phloroglucinol dihydrate show little "activity" for contact nucleation yet have a high prewet-nucleation temperature.

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Naval Weapons Center

AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

H. Suerstedt, Jr., RADM, USN ..... Commander

H. G. Wilson ..... Technical Director

FOREWORD

This report represents the first of a series of studies concerning the heterogeneous nucleation of supercooled water. The ultimate goal is to obtain fog and cloud seeding agents with a variety of operational characteristics. An equal effort is concerned with obtaining a better understanding of the principles of heterogeneous nucleation and the individual steps involved in freezing processes.

Knowledge of the compounds that yield a negative test for a particular freezing process is important to scientists searching for active ice nucleating agents as it allows attention to be focused upon the more active compounds. Thus the total list of compounds tested is a valuable addition to the material previously published in the Journal of Applied Meteorology.

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Released by
WILLIAM S. McEWAN, *Head*
Chemistry Division
17 November 1972

Under authority of
HUGH W. HUNTER, *Head*
Research Department

Appendix

ORGANIC COMPOUNDS TESTED AT -3C FOR CONTACT NUCLEATION OF SUPERCOOLED WATER

Acenaphthene, acenaphthene quinone, 1-acenaphthenol, acetamide, acetanilide, acetoacetanilide, 5-p-acetylaminophenyl-azo-8-hydroxyquinoline hydrochloride, 9-acetylanthracene, acetylenedicarboxylic acid monopotassium salt, acetyl ferrocene, 2-acetylphenanthrene, acetylsalicylic acid, 3-acetylthianaphthene, acetyl p-toludine, aconitic acid, acridine, acridine red, acrylamide, adenine, adenine sulfate, adenosine-5-phosphoric acid, adenosine-triphosphoric acid, adipic acid, β-alanine, DL-alanine, alginic acid, alizarine, alizarin carmine, alizarin red S, alizarine yellow R, alizarol cyanone RC, alkaline blue 6B, allantoin, alloxan, allylthiourea, amaranth, 1-aminoanthracene, 2-aminoanthracene, 1-aminoanthraquinone, 2-aminoanthraquinone, m-aminobenzaldehyde, p-aminobenzenesulfonylamide, m-aminobenzoic acid, p-aminobenzoic acid, m-aminobenzonitrile, p-aminobenzonitrile, 2-aminobenzothiazole, 3-aminocarbazole, 2-amino-4(chloromethyl)thiazole hydrochloride, 6-aminochrysene, 2-amino-p-cresol, 5-amino-2,3-dihydro-1,4-phthalazinedione, 2-amino-3,5-diiodobenzoic acid, 2-aminodiphenyl, 4-aminodiphenyl, 1-aminoethanol, 3-aminofluoanthene, aminoguandidine bicarbonate, 2-amino-2-(hydroxymethyl)-1, 3-propanediol, 2-amino-5-iodobenzoic acid, 8-amino-7-methyl-2-phenazinol, 2-amino-5-methylpyridine, 1-amino-2-naphthol-4-sulfonic acid, 5-amino-2-nitrobenzoic acid, m-aminophenol, o-aminophenol, p-aminophenol, 3-aminophthalhydrazide, 2-aminopurine, 2-aminopyridine, 3-aminopyridine, 2-aminopyrimidine, aminopyrine, 5-aminosalicylic acid, 11-aminoundecanoic acid, p-amoxybenzoic acid, aniline green OS, aniline sulfate, p-anisalazine, p-anisidine, anthracene, 9-anthraldehyde, anthranilic acid, anthranilic acid-di-n-propylaniline, anthraquinone, anthrarobin, anthrone, L-arabinose, L-arginine · HCl, L-ascorbic acid, DL-aspartic acid, aurin tricarboxylic acid ammonium salt, azelaic acid, azidotriphenylmethane, azoviolet(4-(p-nitrophenylazo)resorcinol), 4,4'-azoxanisole, azulene;

Barbituric acid, barium diphenylaminesulfonate, basic fuchsin, bathocuprone, benzal acetone, benzal acetophenone, benzamide, benzanilide, 1,2-benzanthracene, 2,3-benzanthracene, benzanthrone, benzeneazodiphenylamine, p-benzene dibromide, benzenephosphinic acid, benzensulfinic acid sodium salt, benzenesulfonic acid, 1,2,4,5-benzenetetracarboxylic acid, benzhydrol, benzidine, benzidine dihydrochloride, benzidine sulfate, benzil, α-benzil dioxime, benzimidazole, benzoic acid, benzoic anhydride, benzoin, α-benzoin oxime, benzophenone, α-benzoxyquinoline,

p-benzoquinone monoxime benzenesulfonate, benzotriazole, benzoylcarbinol, benzoyltrifluoroacetone, benzylaniline, p,p'-benzylidene bis(N,N-dimethylaniline), 1-benzyl-3-phenyl-2-thiourea, benzyphenyl urea, benzyl thiocyanate, betaine, betaine hydrochloride, bibenzyl, bicyclo [2,2,1] 5-heptene-2,3-dicarboxylic anhydride, p,p'-biphenol, biphenyl, α-(p-biphenyl azo)-β-napthol, 2-(4-biphenylyl)-5-phenyloxazole, 2,2'-biquinoline, bis-cyclohexanone oxaldihydrazone, bis(dimethylthiocarbamyl) disulfide, bismarck brown, bis-N-methylacridinium nitrate (lucigenin), bis-o-nitrophenyl urea, bis-m-nitrophenyl urea, bis-p-nitrophenyl urea, biuret, bordeaux red, brilliant yellow, p-bromoacetanilide, bromoacetic acid, p-bromoacetophenone, o-bromobenzoic acid, p-bromobenzoic acid, 4-bromobiphenyl, p-bromoiodobenzene, 4-bromo-2-methylaniline, β-bromonaphthalene, p-bromophenol, α-bromo-p-phenylacetophenone, p-bromophenyl isothiocyanate, β-bromopropronic acid, 4-bromopyridine hydrobromide, N-bromosuccinimide, p-bromotoluene, α-bromo-p-xylene, brucine, brucine sulfate, 1,2,3,4-butanetetracarboxylic acid, 4-n-butoxybenzoic acid, butyl ammonium nitrate, 1-4-butylnediol, n-butyl-sulfone, n-butyl-sulfoxide, butyranilide, 2-butyne 1,4-diol;

Cacotheline, calcein W, calcofluor white ST, calco oil blue ZN, cal red, camphene, camphor, D-camphoric anhydride, D-camphor sulfonic acid, carbazole, 3-carbethoxy-1-phenyl-2-pyrazolin-5-one, carbon tetrabromide, 1,1-carbonyl diimidazole, carmine, caroxite, cedrol, cellobiose octa-acetate, cellulose tri-decanoate, cetyl alcohol, chalcone (benzylidene acetophenone), chloramine T, chloranil, p-chloroacetoacetanilide, chloroanilic acid, chloracetamide, chloroacetic acid, p-chloroaniline, p-chlorobenzesulfonic acid, m-chlorobenzoic acid, o-chlorobenzoic acid, p-chlorobenzoic acid, 2-chloro-N-N-dimethylamine hydrochloride, 1-chloro-2,4-dinitrobenzene, o-chloroformamide, chlorohydroquinone, 1-chloro-4-iodobenzene, chloromalic anhydride, chlorophenol red, m-chlorophenol, p-chlorophenol, o-chlorophenylcarbamoyl morpholide, N-chlorosuccinimide, cholesterol, cholesteryl acetate, cholesteryl benzoate, cholesteryl chloroformate, cholesteryl nitrate, choline chloride, chromatropic acid, chrysine, cinchonidine, cinchonine, cinnamic acid, citric acid, cochineal, congo red, corallin yellow, coumarin, cresol, o-cresoltinic acid, o-cresol sulfon phthalin, crotonic acid, cyanoacetic acid, 4-cyanopyridine, a-cyano-o-tolunitrile, cyanuric acid, cyanuric chloride, 1,2-cyclohexanedicarboxlic anhydride, cis-4-cyclohexene-1,2-dicarboxylic acid, crystal violet, 1,3-cyclohexylphenylurea, cyclopentadecanone, L-cystine;

1,10-decanediol, decacyclene, deoxybenzoin, dexoxyribose nucleic acid, dextrin, dextrose, p-diacetylbenzene, diacetyldithiol, 3,3'-diaminobenzidine, 3,3'-diaminobenzidine hydrochloride, 2,5-diaminochlorobenzene, p,p-diaminodiphenyl methane, 1,4-diaminopiperazine dihydrate, 1,3-diamino-2-propanol, 2,4-diaminotoluene, 2,6-diaminotoluene, 3,4-diaminotoluene, 2,5-diaminotoluene sulfate, dianisidine diisocyanate, diatase of malt, 4-diazo-N,N-diethylaniline fluoroborate, dibenzalacetone, 5H-dibenzo[a,d] cyclohepten-5-ol, dibenzofuran, dibenzol hydrazine, dibenzolmethane, dibenzyl, 1,3-dibenzyl urea, 2,6-dibromoaniline, 4,4'-dibromobiphenyl, dibromo-O-cresol sulfonphthalein, 1,10-dibromodecane, α,β-dibromosuccinic

acid, dibromthymol sulfonphthalein, α,α'-dibromo-m-xylene, α,α'-o-xylene, α,α'-dibromo-p-xylene, dibutylamine hydrochloride, di-n-butyltin dichloride, N,N-di-(2-carboxylethyl)benzene sulfonamide, N,N'-dicarbethoxyhydrazine, dichloroacetaldehyde, s-dichloroacetone, 2,4-dichlorobenzaldehyde, 3,4-dichlorobenzaldehyde, p-dichlorobenzene, dichlorodiphenoxydiphenylcyclotriphosphazene(isomer I), dichlorodiphenoxydiphenylcyclotriphosphazene(isomer II), dichlorofluorescein, dichloromaleic anhydride, 4,6-di-(chloromethyl)-m-xylene, 2,6-dichloro-4-nitroaniline, 2,4-dichlorophenoxythanol, 1,3-dichloro-2-propanone, α,α'-dichloro-p-xylene, dicyandiamide, di-β-cyanoethyl-carbanyl chloride, dicyclohexyl adipate, dicyclohexylcarbodiimide, dicyclohexyl formamide, dicyclohexyl maleate, dicyclohexylurea, o-diethoxybenzene, p-diethoxybenzene, diethyl acetamidomalonate, N,N-diethylacrylamide polymer, p-diethylaminobenzaldehyde, β-diethylaminoethyl chloride hydrochloride, 2-diethylamino-9-fluorenol, diethylamine hydrochloride, diethyl-4,4'-azoxydibenzoate, 1,3-diethyl-2-thiourea, 2,6-diformyl-2,6-diaza-4-oxaheptane, N,N'-diformyl piperazine, digitonin, diglycolic acid, dihydroxyacetone, 2,4-dihydroxyacetophenone, 1,8-dihydroxyanthranol, 1,8-dihydroxyanthraquinone, 2,4-dihydroxybenzaldehyde, 2,6-dihydroxybenzoic acid, 2,4-dihydroxybenzophenone, 2,5-dihydroxy-p-benzoquinone, 2,3-dihydroxynaphthalene, 2,7-dihydroxynaphthalene, 1,5-dihydroxynaphthalene, 4,5-dihydroxy-2,7-naphthalenedisulfonic acid disodium salt, 5,8-dihydroxy-1,4-naphthoquinone, 4,5-dihydroxy-3-(p-nitrophenylazo)2,7-naphthalene-disulfonic acid disodium salt, p-diiodobenzene, 3,5-diiodo-L-tryosine, 2,5-dimercapto-1,3,4-thiadiazole, p-dimethylaminobenzaldehyde, 2,5-dimethoxyaniline, 2,3-dimethoxybenzaldehyde, 2,4-dimethoxybenzaldehyde, 2,5-dimethoxybenzaldehyde, 3,4-dimethoxybenzaldehyde, 2,6-dimethoxynaphthalene, (3,4-dimethoxyphenyl)-acetic acid, p-dimethylaminoazobenzene (methyl yellow), diamethylaminoazobenzene-o-carboxylic acid (methyl red), p-dimethylaminoazophenylarsonic acid, p-dimethylaminobenzaldehyde, p-dimethylaminobenzenalrhodanine, 4-(4-dimethylamino-1-naphthylazo)-3-methoxy-benzenesulfonic acid, p-dimethylaminonitrosobenzene, p-dimethyaminophenylarsonic acid, 9,10-dimethylanthracene, dimethylamine hydrochloride, 2,4-dimethylbenzoic acid, 2,2'-dimethyl carbanilide, 3,3'-dimethylcarbanilide, N,N'-dimethylcarbanilide, dimethyldiaminophenazinechloride (neutral red), dimethyldihydroresorcinol, 3,3'-dimethyl-1,1'diphenyl-[4,4'-bi-2-pyrazoline-5,5'-dione, 6,7-dimethyl-2,3-di-(2-pyridyl)quinoxaline, dimethylfumarate, dimethylglyoxime, 2,5-dimethyl-3-hexyne-2,5-diol, 1,2-dimethylhydrazine dihydrochloride, 3,3-dimethylnaphthidine, 3,6-dimethyl-4-octyne-3, 6-diol, dimethylol urea, dimethyloxalate, 2,9-dimethyl-1,10-phenanthroline hemihydrate (neo-cuproine), 4,5-dimethyl-o-phenylenediamine, 2,5-dimethylphenol, 3,4-dimethylphenol, 3,5-dimethylphenol, 2,3-dimethyl-1-phenyl-3-pyrazoin-5-one, trans 2,5-dimethylpiperazine, 2,2-dimethyl-1, 3-propanediol, dimethyl sulfone, 1,3-dimethylurea, 2,4-dinitroaniline, 3,5-dinitroaniline, 2,4-dinitroanisole, m-dinitrobenzene, p-dinitrobenzene, 2,4-dinitrobenzenesulfenyl chloride, 2,4-dinitrobenzenesulfonic acid, 2,4-dinitrobenzoic acid, 3,5-dinitrobenzoic acid, 4,4'-dinitrobiphenyl, 2,4-dinitrochlorobenzene, 4,6-dinitro-o-cresol, 2,3-dinitro-2, 3-dimethylbutane, 4,4'-dinitrodiphenyl, 2,4-dinitrodiphenylamine,

p,p'-dinitrodiphenylether, 2,4-dinitrophenylhydrazine, dinitromesitylene, 1,5-dinitronaphthalene, 2,4-dinitrophenol, 2,6-dinitrophenol, 2,4-dinitrophenyl disulfide, 2,2-dinitropropane, 2,2-dinitro-1,3-propanediol, 3,5-dinitrosalicylic acid, 1,2-dinitrotetrachloroethane, 2,4-dinitrothiophene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, dipentaerythritol, diphenyl, N,N-diphenylacetamide, diphenylacetonitrile, diphenylamine, diphenylamine sulfate, diphenylanthracene, p-diphenylbenzene, diphenylbenzidine, diphenylcarbamylchloride, diphenylcarbazide, diphenylcarbazone, diphenylcarbonate, 1,2-diphenylethanol, N,N'-diphenylethylenediamine, N,N'-diphenylformamide, diphenylfulvene, diphenylguanidine, 5,5'-diphenylhydantoin, as-diphenylhydrazine hydrochloride, 2,3-diphenylindole, diphenylmercury, diphenylmethane, diphenylnitrosoamine, 4,7-diphenyl-1, 10-phenanthroline, diphenylphthalate, 2,2-diphenyl-1-picrylhydrazyl, 1,3-diphenyl-1,3-propanedione, 2,3-diphenylquinoxaline, diphenylthiocarbazone, 1,3-diphenyltriazene, 1,1-diphenylurea, 1,3-diphenylurea, 2,2'-dipyridyl, disodium 2,6-dibromobenzenoneindo-3-carboxyphenol, disodium-1,2-dihydroxybenzene-3,5-disulfonate monohydrate, disodium ethylenediamine tetraacetate, 2,2'-dithiobisbenzothiazole, 2,4-dithiobiuret, 4,4-dithiodimoropholine, dithizone, di-o-toluidinoethane, dulcitol, duroquinone;

Eosin, eosine J, ergosterol, eriochrome cyanin R, eriochrome black T, eriochrome blue black R, erythrosine, ethanol ammonium nitrate, 6-ethoxy-2-mercaptobenzothiazol, 6-ethoxyquinaldine, ethylamine hydrochloride, ethylcarbamate, ethyl carbanilate, ethyl-p-dimethylaminobenzoate, ethylene carbonate, ethyl cellulose, ethylenediamine benzenesulfonamide, ethylenediamine tetraacetonitrile, (ethylenedinitrilo) tetraacetic acid, (ethylenedinitrilo)tetraacetic acid disodium salt, ethylene dimaleate, ethylene thiocyanate, ethylene trithiocarbonate, ethyl ethoxymethylene cyanoacetate, ethyl glycinate hydrochloride, 2-ethyl-2-(hydroxymethyl)-1,3-propanediol, ethyl 3-quinuclidinone-2-carboxylate hydrochloride, N-ethyl urea;

Ferrocene, ferrocene carboxaldehyde, fluoranthene, fluorene, fluorescein, 1-fluorenemethanol, 9-fluorenone, Cll-fluoroalcohol, formanilide, fructose, fumaric acid, furil, α-furil dioxime, 2-furoic acid, furoin;

Gallein, gallocyanin, gelatin, Girards reagent "P", glutamic acid, glutaric acid, glycerol a,y-diphenyl ether, glycerol tribenzoate, p-glycerophosphoric acid disodium salt, glycine, glycine ethyl ester hydrochloride, glycolic acid, glycylglycine, glyoxalic acid gramine, guanidine carbonate, guanidine chromate, guanidine hydrochloride, guanidine nitrate, quanine, quanine hydrochloride, L-(+)-gutamic acid;

Hematoxylin, hemoglobin, heperin, hexachlorobenzene, hexachloroethane, 1-hexadecanol, 2,4-hexadienoic acid, 2,4-hexadiyne-1,6-diol, hexaethylbenzene, cis-hexahydrophthalic acid, hexaiodobenzene,hexamethylene diamine dihydrochloride, p-hexamethyltriborphane, m-hexanediol-1,6, hippuric acid, histidine, homophthalic acid, hydrazine dihydrochloride, hydrazine sulfate, p-hydrazinobenzenesulfonic acid, hydroquinone, p-hydroxyacetanilide, p-hydroxybenzaldehyde, m-hydroxybenzaldehyde,

m-hydroxybenzoic acid, p-hydroxybenzoic acid, o-hydroxycinnamic acid, 4-hydroxy-1,2-dimethylbenzene, N-(hydroxyethyl)-β-alanine, 2-hydroxyfluorene, 9-hydroxyfluorene, 5-hydroxyisoquinoline, hydroxylamine, hydroxylamine sulfate, hydroxylamine-O-sulfonic acid, 2-hydroxyl-3-methylbenzoic acid, 2-hydroxymethyl-2-methyl-1,3-propanediol, 1-hydroxynaphthlane-2-azo-4-biphenyl, 1,-(2-hydroxy-1-naphthylazo-2-naphthol-4-sulfonic acid zinc salt, 1-hydroxy-2-naphthoic acid, 3-hydroxy-2-naphthoic acid, N-(p-hydroxyphenyl)glycine, 3-hydroxypyridine, 8-hydroxyquinaldine, 8-hydroxyquinoline, 5-hydroxytetrazole;

Iminotriacetic acid, 1,3-indandione, 1-indanone, indigo, indigo carmine, indole, inositol, i-inositol(meso-inositol), iodoform, β-iodopropinonic acid, p-iodotoluene, iron dicyclopentanediene, isatin, isatonic anhydride, L-isoleucine, isonicotinic acid, isonicotinic acid hydrazide, isophthalamide, isopropylamine oxalate, isoquinolone, itaconic acid;

Janus green B;

Kojic acid;

Lactose, DL-leucine, L-leucine, levulose, litmus powder, ltaconic anhydride, lycopodium, L-lysine monohydrochloride;

Malchite green, maleic acid, maleic anhydride, maleimide, malonamide, malonic acid, maltose, DL-mandelic acid, mannitol, melamine, mellitic trianydride, 2-mercaptobenzothiazole, menthol, 5-mercapto-3-phenyl-1,3,4-thiodiazole-2-thione potassium salt, mercuric chloranilate, m-cresol sulfonphthalein, metaldehyde, metanilic acid sodium salt, metanil yellow, DL-methionine, methoxyamine hydrochloride, p-methoxycinnamic acid, methoxymethyl cellulose, 6-methoxyquinaldine, N-methylacetanilide, methylamine hydrochloride, 1-methylaminoanthraquinone, N-methylanthranilic acid, methylbenzilate, 4-methylbenzophenone, methylcellulose, α-methylcinnamic acid, methyleneaminoacetonitrile, methylene-bis-acrylamide monomer-polymer, methylene bis-(diphenylphosphine), methylene blue thiocyanate, methylene diphenyl diisocyanate, N-methyleneglycinonitrile, methyl p-hydroxybenzoate, 2-methylimidazole, 3-methylisoquinoline, 4-methyl-2-nitroaniline, N-methyl-p-nitroanaline, N-methyl-p-nitrobenzamide, 2-methyl-2-nitro-1-propanol, 2-methyl-2-nitro-1,3-propanediol, methyl orange, methyl oxalate, 3-methyl-1-phenyl-2-pyrazolin-5-one, 2-methylene-3-quinuclidinone hydrochloride dihydrate, 3-methyl-1-p-sulfophenyl-5-pyrazolone, methyl-sulfone, methyltestosterone, N-methyl-p-toluenesulfonamide, 9-methyl-2, 3,7-trihydroxy-6-fluorone, 4-methylumbelliferone, methylurea nitrate, methyl violet, monochloroacetic acid, morin(2',3',4',5,7 pentahydroxyflavone), mucic acid, mucochloric acid, muconic acid, murexide, myristyl alcohol;

Naphthalene, naphthaleneacetic acid, naphthalene-β-sulfonic acid monohydrate, naphthionic acid sodium salt, α-naphthoflavone, 1-naphthol, 2-naphthol, naphthol blue-black, 2-naphtholic acid, 1,2-β-naphthoquinoline, 1,2-naphthoquinone, 1,4-naphthoquinone, α-naphthyl acetate, 1-naphthylamine, 2-naphthylamine, 1-naphthylamine hydrochloride, β-naphthylamine

hydrochloride, α-naphthylhydrazine hydrochloride, N-1-naphthylethylenediamine dihydrochloride, neopeptone, neutral cyanine green GN EX, nicotinic acid, nigrosine, nile blue, ninhydrin, nioxime, N-nitranilic acid, o-nitroacetanilide, m-nitroacetanilide, p-nitroacetanilide, p-nitroacetophenone, α-nitroalizarin, 4-nitro-2-aminotoluene, 5-nitro-2-aminotoluene, m-nitroaniline, o-nitroaniline, p-nitroanaline, p-nitroanisole, 5-nitrobarbituric acid, m-nitrobenzaldehyde, o-nitrobenzaldehyde, p-nitrobenzaldehyde, nitrobenzene azoresorcinol, p-nitrobenzenediazonium fluoborate, p-nitrobenzenesulfonic acid, p-nitrobenzenesulfonyl chloride, m-nitrobenzhydrazide, p-nitrobenzhydrazide, 6-nitrobenzimidazole, m-nitrobenzoic acid, o-nitrobenzoic acid, p-nitrobenzoic acid, p-nitrobenzonitrile, m-nitrobenzoyl chloride, nitrobenzoyl-2-formyl hydrazine, p-nitrobenzyl, p-nitrobenzyl alcohol, p-nitrobenzyl bromide, p-nitrobenzyl chloride, m-nitrobromobenzene, p-nitrobromobenzene, 2-nitro-4-chloroaniline, 4-nitro-2-chloroaniline, o-nitrochlorobenzene, p-nitrochlorobenzene, 4-nitrochlorobenzene-2-sulfonic acid, 2-nitrochlorophenol, 2-nitro-4-chlorotoluene, o-nitrocinnamic acid, p-nitrocinnamic acid, 2-nitro-1,4-diaminobenzene, 4-nitro-1,2-diaminobenzene, 5-nitro-1,3-diaminobenzene, m-nitrodimethylaniline, 2-nitrodiphenylamine, o-nitroiodobenzene, 3-nitro-2-iodotoluene, 5-nitroisoquinoline, nitromesitylene, p-nitromethylaniline, 2-nitro-2-methyl-1-propanol, nitron, α-nitronaphthalene, m-nitrophenol, o-nitrophenol, o-nitrophenol sodium salt, p-nitrophenol, p-nitrophenol sodium salt, o-nitrophenylacetic acid, p-nitrophenylacetic acid, 4-(p-nitrophenylazo) resorcinol, p-nitrophenyl benzoate, 2-nitrophenyl disulfide, o-nitrophenyl hydrazine, p-nitrophenylhydrazine, 4-(p-nitrophenyl)-morpholine, p-nitrophenyl phenyl ether 4-nitrophthalic acid, 3-nitrophthalic anhydride, 2-nitroresorcinol, 5,nitrosalicylic acid, p-nitrosodiphenylamine, N-nitrosodiphenylamine, p-nitroso methyl aniline, 1-nitroso-2-naphthol, 2-nitroso-1-naphthol, p-nitrosophenol, nitrosorisorcinol sodium salt, 3-nitrothianaphthene, 2-nitrothiophene, p-nitrotoluene, 4-nitrotoluene-2-sulfonic acid, 3-nitro-p-toluidine, nonanamide, norbornylene, nucleic acid Na salt(thymus), nucleic acid(yeast);

n-octadecane, n-octadecyl alcohol, octafluoronaphthalene, octamethylenediamine, 2-octyl hydrogen phthalate, octylphenol, orange 11, orange shellac, oxalic acid, oxamide, oxanilide, 2-oxazolidone, oxindole, oxohydroxy bis(8-hydroxyquinolino)-vanadium(V);

Pan(1-(2-pyridylazo)-2-naphthol), palmitic acid, pentabromophenol, pentachlorobenzenethiol, pentachlorobenzylchloride, pentachloronitrobenzene, pentachlorophenol, pentaerythritol, pentaerythrityl tetrasterate, 1,5-pentamethylenetetrazole, perfluoroglutaramide, phenacyl bromide, phenanthrene, phenanthrenequinone, phenanthridine, 1,10-phenanthroline, 1,10-phenantroline monohydrate, phenazine, 1,2,3-phenenyl triacetate, 1,2,4-phenenyl triacetate, phenol, phenolphthalein, phenol sulfon phthalein, phenylacetamide, phenylacetic acid, phenylacetylurea, DL-phenylalanine, 9-phenylanthracene, p-phenylazobenzoyl chloride, 4-phenyl-3-buten-2-one, trans-4-phenyl-3-buten-2-one, phenyl carbonate, p-phenylene diacetate, o-phenylenediamine, p-phenylenediamine,

phenyl diethanolamine, phenyl-1,2-ethanediol, phenylglycene, phenylhydrazine hydrochloride, 2-2-(phenylimino)diethanol, 3-phenyl phthalide, 1-phenyl-semicarbazide, phenylsemicarbazide hydrochloride, phenyl salicylate, 4-phenylthiosemicarbazide, phenylthiourea, phenylurea, phloroglucinol dihydrate, phloxine, o-phthalic acid, phthalic acid anhydride, phthalimide, o-phthalonitrile, 4-picoline-N-oxide, picolinic acid, picramic acid, pimelic acid, piperazine hydrate, piperazine phosphate, piperidine ethanol, polyethylene glycol, polyoxymethylene, polystyrene (beads), pontacyl brilliant pink B, potassium biphthalate, potassium methyl-xhathate, L-proline, 2-propanesulfonic acid sodium salt, purpurin, pyrazine dicarboxylic acid pyrazole, pyrazoline-5-one, 2,5-pyridine carboxylic acid, 4-pyridylcarbinol, pyrocatechin, pyrocatechol, pyrocatichol violet;

Quinaldine red, pyrogallic acid, quinhydron, quinhydrone, quinine, quinine acid sulfate, quinine sulfate, 2-quinolinol, 8-quinolinol sulfate, quinone, p-quinonedioxime, 3-quinuclidinone hydrochloride, quinoxaline;

Raffinose, resorcinol, resorufin, ricinoleic acid sodium salt, rhodamine B base, D-(-)-ribose, rosin, rosolic acid;

Saccarin, safranin O, salicylic acid, saponin, sebacic acid, semicarbazide hydrochloride, DL-serine, shellac (white), sodium benzenoneindo-3' chlorophenol, sodium benzenoneindo-2'-methyl-5-isopropylphenol, sodium benzenoneindo-3'-methyl-6'-isopropylphenol, sodium benzenoneindo-2'-methyl phenol, sodium benzenoneindophenol, sodium chloranilate, sodium 2, 6-dibromobenzenoneindo-3'bromo-phenol, sodium 2,6-dichlorobenzenoneindo-3-chloro-phenol, sodium 2,6-dibromobenzenoneindo-3'-methoxyphenol, sodium 2, 6-dibromobenzenone-2'-methyl-5-isoprophlindophenol, sodium 2-6-dibromo-benzenoneindo-3'-methyl phenol, sodium 2,6-dibromobenzenoneindo-phenol, sodium 2,6-dichloro-benzenoneindophenol, sodium diethyl dithiocarbamate, sodium diphenylbenzidine sulfonate, sorbic acid, D-sorbitol, starch, stearamide, stearic acid, stigmasterol, strychnine, styrene dibromide, suberic acid, succinic acid, succinic anhydride, succinimide, sulfosalicylic acid, sulfamic acid, sulfanilimide, 3-sulfolene;

Tannic acid, tartrazine, 1,4,5,8-tetrahydroxyanthraquinone, terephthalamide, terephthalic acid, terephthaldehyde, terephtalonitrile, terpin hydrate, p-tertbutyl catechol, 4-tert-butylcyclohexanol, p-tert-butylphenol, N-tert-butylurea, 4-tert-butylurea, testosterone, 2,2,4,4-tetraamino-5,5-dimethyldiphenyl-menthane sulfate, tetraazinotetrazine, tetrabromocatechol, tetrabromo-m-cresolsulfonphthalein, tetrabromophenolsulfon phthalein, terra-n-butylammonium iodide, tetrachlorohydroquinone, 2,3,4,6-tetrachlorophenol, tetrachlorophthalic anhydride, n-tetradecanol, tetraethyl[illegible]ium bromide, 1,4,9,10-tetrahydroxyanthracene, 2,2',4,4'-tetr[illegible]oxybenzophenone, 2,2',4,4'-tetrahydroxybiphenyl, tetrahydr[illegible]y-1,4-quinone dihydrate, tetramethylammonium chloride, tetramethylammonium fluoride, tetramethyl-1,3-cyclobutanedione, p,p'-tetramethyldiaminobenzophenone, p,p-tetramethyldiaminodiphenylmethane, 3,5,6,8-tetramethyl-1,10-phenanthroline monohydrate,

1,1'3,3'-tetramethyl-2-thiourea, 2,2'4,4'-tetranitrodiphenyl, tetraphenylarsonium chloride, tetraphenylboron, 1,2,3,4-tetraphenyl-1, 3-cyclopentadiene, tetraphenylcyclopentadienone, tetraphenylethylene, tetraphenylphosphonium chloride, 1,3,6,8-tetraphenylpyrene, thioacetamide, thio-β-naphthol, thiosemicarbazide, thiourea, DL-threonine, thymol, thymol blue, tiron, o-tolidine, o-tolidine dihydrochloride, toluene α,α,2-triacetate, p-toluenesulfinic acid, p-toluenesulfonamide, p-toluenesulfonic acid, p-toluenesulfonyl chloride, m-toluic acid, o-toluic acid, p-toluidine, 1,2,4-triaminobenzene-dihydrochloride, 1,3,5-triaminobenzene trihydrochloride, 2,4,6-tribromoaniline, 1,3,5-tribromobenzene, 2,2,2-tribromoethanol, trichloroacetic acid, 2,4,6-trichloroaniline, 1,3,5-trichloro-2,4-dinitrobenzene, 2-(trichloromethyl)-benzimidazole, 1,1,1-trichloro-3-nitro-2-propanol, triethylenediamine, triethylenetetramine disulfate, triketohydrindene hydrate (nihydrine), 2,4,4'-trihydroxybenzophenone, 4',5,7-trihydroxy-flavanone, triiodobenzoic acid, 2,4,5-trimethoxybenzaldehyde, 3,4,5-trimethyoxybenzaldehyde, trimethyl acethydrazine ammoniumchloride, trimethylamine hydrochloride, 2,4,6-trimethylhexahydro-1,3,5-triazine, trimethylol aminomethane, trimethylol nitromethane, trimethyl phenyl-ammonium iodide, 1,3,5-trimethyl-2,4,6-tris-[3,5-di-tert-butyl-4-hydroxybenzyl]benzene, 1,3,5-trinitrobenzene, triphenylamine, s-trioxane, triphenylchloromethane, triphenylene, triphenylmethane, triphenylmethanol, triphenyl phosphate, triphenylphosphine oxide, 2,3,5-triphenyl-2H-tetrazolium chloride, tripotassium nitrophenol disulfonate, 2,2', 2'-tripyridine, tri(hydroxymethyl)aminomethane, 1,1,1-tris-(hydroxy-methyl)-ethane, tropaolin O, tropaolin OO, DL-tryptophan, L-tryosine, turmeric, L-(-)-tyrosine;

Uracil, uranine, urea nitrate, uric acid;

DL-valine, vanillin, variamine blue B hydrochloride, veratraldehyde, victoria blue, violanthrone[6,15-dihydro-5,9,14,18-anthrazinetetrone];

Xanthine, 9-xanthone, xylene cyanol FF, xylene fast, p-xylenesulfonic acid, zinc dithiol.

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