STAINLESS STEEL HANDBOOK

ALLEGHENY LUDLUM STEEL CORPORATION

PITTSBURGH, PA.

Stainless Steel Handbook

ALLEGHENY LUDLUM STEEL CORPORATION
Pittsburgh 22, Pennsylvania

IMPORTANT NOTICE

The analyses and properties of the steels discussed in this literature are those normally furnished.

There may, however, be minor variations from time to time because of necessary restrictions on materials.

Users will be kept advised, but due to the possibly temporary nature of these changes, it is not practicable to reflect all of them in our printed material.

PREFACE

THE CURRENT EDITION of the Handbook of Stainless Steel has been completely rewritten and greatly expanded to meet the needs of America's rapidly growing industry and in order to cover adequately the development of the family of corrosion and heat resisting steels. Approximately forty types of stainless are treated in this volume, and many more have necessarily been omitted. Many analyses are in process of development and will be added to the Handbook as soon as practicable, whereas others are types for special applications and their properties are discussed in other company publications. This additional data is available upon application and will be supplemented by special laboratory work, when necessary.

This Handbook discusses first the selection of the proper type of stainless, charting the properties of the more important analyses and listing the resistance of the major types to many corrosive media. In the following chapter each grade is presented by itself, and its analysis, applications and treatments are detailed. The next chapters discuss the stabilized types and those designed for special application to high and low temperatures.

The Allegheny Ludlum stainless steels are produced in all necessary forms, shapes, sizes, and tolerances (bars, wire, sheets, strip, plates, tubes, shapes, clad and castings). Specific information concerning them is given in the printed price and extra lists and in special booklets covering the more important products. An exception is made, however, in the case of stainless castings, as a chapter on this less well known product has been included in this volume.

The section devoted to fabrication in this book is designed, due to lack of space, merely as a check list for those already generally familiar with the handling of stainless. Complete fabrication and treating instructions, covering each operation in detail, are presented in a separate volume.

Limitations of space also preclude the detailing in this book of complete physical data for every grade. This information is made available in the Allegheny Ludlum Blue Sheets covering all major types.

In another series of booklets, the application of stainless to the individual problems of various industries is discussed. The data presented has been developed through careful research in the fields treated and has been thoroughly reviewed by capable industry sources.

To facilitate reference to specific data, the Table of Contents has been expanded and a very complete Index is available. Much useful material, also, has been added to the Tables and Reference Material chapter.

ALLEGHENY LUDLUM STEEL CORPORATION

ALLEGHENY LUDLUM PRODUCTS

Stainless and Heat Resisting

Allegheny Stainless Steels
Sheets • Strip • Plates • Bars • Rods
Wire • Angles • Tubes • Forgings • Castings

Stainless Steel Clad Plates
Stainless Double Armor Sheets & Strip
Stainless and Heat Resisting Castings
Stainless Fine Wire

• • •

Super-Alloy High Temperature Steels

• • •

Silcrome Valve Steels

• • •

4–6% Chromium Alloy Steels

Tool and Die

Tool and High Speed Steels
Hot Work Tool Steels
Die Steels
Shock Resisting Steels
Carbon Tool Steels
Cast-to-Shape Tool Steels

Composite Die Sections
Special Forgings
Drill Rod
Tool Holder Bits
Cast Cutting Alloys
Nitri-Cast-Iron

• • •

Carmet Carbide Metals
Blanks • Die Sections • Special Shapes
Tools • Drawing Dies • Special Parts

Electrical

Electrical Steels
Magnetic Alloys
Silicon Steels
High Permeability Steels

Low Permeability Steels
Alloys for Glass to Metal Seals
High Resistivity Steels
High Saturation Alloys

• • •

Magnet Steels
Permanent Magnets

• • •

Laminations

Carbon

Carbon Strip Steels
Hot and Cold Rolled
Copper Coated

Extrusions

Stainless • Tool • Alloy Steels

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FORGING AND CASTING DIVISION

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ALLEGHENY LUDLUM STEEL CORPORATION

Oliver Building, Pittsburgh 22, Pennsylvania

SS 31 — Ed 6 — 11½M — 657-J

Printed in U.S.A.
William G. Johnston Compar
Pittsburgh, Pa.

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SELECTION OF THE PROPER TYPE OF STAINLESS STEEL

THE STAINLESS STEEL FINDER tabulates for easy reference the important properties of about twenty types of stainless steel. The analyses are listed in detail, followed by the most used physical properties and the electrical properties to which reference is most often made. The mechanical properties for each steel in the annealed state and for various conditions of heat treatment or cold work are then given, properly identified as to the temperatures used to produce them. These heat treatments are detailed thoroughly in Chapter II where each type of stainless is individually discussed. From this chart the types affording the best combinations of the desired properties can be selected almost at a glance. The grades meeting the physical requirements of the application can, in the pages immediately following, be checked for their resistance to the corrosive media to be met in service.

The selections tentatively made from the properties chart and corrosion tables can be confirmed further by reference to the data on each grade presented separately in Chapter II.

Later chapters will supply more specific information regarding heat treatment, fabrication and certain special conditions of service.

It should be noted, however, that tests, simulating actual service conditions, so far as possible, are the most reliable confirmation of the selections made and should always be made prior to the specification of grades for new or important installations.

The assistance of the Allegheny Ludlum technical staff is always available in such cases.

STAINLESS STEEL FINDER

Group	CHROMIUM-NICKEL AUSTENITIC GROUP					
Type Number	*201*	*202*	*301*	*302*	*304*	*304L*
Analyses — percent:						
Chromium	16.0–18.0	17.0–19.0	16.00–18.00	17.00–19.00	18.00–20.00	18.00–20.00
Nickel	3.5–5.5	4.0–6.0	6.00–8.00	8.00–10.00	8.00–12.00	8.00–12.00
Other elements (Note 6)	N_2 .25 max	N_2 .25 max	.....	.....	.....	.....
Carbon	.15 max	.15 max	.15 max	.15 max	.08 max	.03 max
Manganese	5.5/7.5	7.5/10.0	2.00 max	2.00 max	2.00 max	2.00 max
Silicon	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max
Physical data:						
Melting range — °F	.....	.....	2550–2590	2550–2590	2550–2650	2550–2650
Density — lb/in.^{3}	.28	.28	0.29	0.29	0.29	0.29
Specific heat — Btu/°F/lb (32–212 F)	0.12	0.12	0.12	0.12	0.12	0.12
Thermal conductivity — Btu/ft^2/hr/°F/ft:						
212 F	.....	.....	9.4	9.4	9.4	9.4
932 F	.....	.....	12.4	12.4	12.4	12.4
Mean coefficient of thermal expansion — in/in/°F x 10^{-6}:						
68–212 F	9.2	9.4	9.2	9.2	9.2	9.2
68 to indicated temperature — °F	11.3 (1600)	10.9 (1600)	11.0 (1600)	11.0 (1600)	11.0 (1600)	11.0 (1600)
Electrical properties:						
Magnetic permeability at 200 H annealed	1.02 max	1.02 max	1.02	1.02	1.02	1.02
Electrical resistivity — microhm–cm:						
68 F	69.0	69.0	72.0	72.0	72.0	72.0
1200 F	.....	.....	116.0	116.0	116.0	116.0
Heat resistance:						
Maximum operating temperature — °F:						
Intermittent service (Note 1)	1500	1500	1600	1600	1600	1600
Continuous service	1550	1550	1700	1700	1700	1700
Temperatures—working and treating—°F:						
Forging — start	2300	2300	2200	2200	2200	2200
Forging — finish	1700	1700	1700	1700	1700	1700
Annealing — ranges (Note 2)	1850–2000	1850–2000	1950–2050	1850–2050	1800–1950	1800–1950
Annealing — cooling (Note 3)	WQ (AC)	WQ (AC)	WQ(AC)	WQ(AC)	WQ(AC)	A.C.
Hardening — ranges	(Note 7)	(Note 7)	(Note 7)	(Note 7)	(Note 7)	(Note 7)
Quenching	.....	.....	.....	.....	.....	.....
Tempering — for intermediate hardness	.....	.....	.....	.....	.....	.....
Drawing — for relieving stresses	.....	.....	.....	.....	.....	.....
Mechanical properties — annealed:						
Structure annealed	A	A	A	A	A	A
Yield strength — lb/in.^{2} — min	40 000	40 000	35 000	30 000	30 000	25 000
Ultimate strength — lb/in.^{2} — min	115 000	100 000	100 000	80 000	80 000	70 000
Elongation — % in 2 inches — min	40.0	40.0	50.0	50.0	50.0	40.0
Reduction in area — % — min	.....	.....	60.0	60.0	60.0	60.0
Modulus of elasticity in tension — lb/in.^{2} x 10^6	29.0	29.0	29.0	29.0	29.0	29.0
Hardness — Brinell	210 max	210 max	180 max	180 max	180 max	180 max
Hardness — Rockwell	B95 max	B95 max	B90 max	B90 max	B90 max	B90 max
Impact values — Izod — ft-lb	85 min	85 min	85 min	85 min	85 min	80 min
Mechanical properties — heat treated:						
Yield strength — lb/in.^{2}						
Ultimate strength — lb/in.^{2}	(Note 8)	(Note 8)	(Note 8)	(Note 8)	(Note 8)	(Note 8)
Elongation — % in 2 inches						
Hardness — Brinell						
Hardness — Rockwell						
Creep strength — lb/in.^{2} at 1000°F:						
1% Flow in 10,000 hr	.....	.....	19 000	19 000	19 000	19 000
1% Flow in 100,000 hr	.....	.....	13 000	13 000	13 000	13 000

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See page 5 for alternate grades.
See page 6 for notes.

STAINLESS STEEL FINDER

Group	CHROMIUM-NICKEL AUSTENITIC GROUP					
Type Number	*316*	*316L*	*317*	*347*	*309*	*310*
Analyses — percent:						
Chromium	16.00–18.00	16.00–18.00	18.00–20.00	17.00–19.00	22.00–24.00	24.00–26.00
Nickel	10.00–14.00	10.00–14.00	11.00–15.00	9.00–12.00	12.00–15.00	19.00–22.00
Other elements (Note 6)	Mo 2.00–3.00	Mo 2.00-3.00	Mo 3.00–4.00	Cb10xC min	.....	.....
Carbon	.08 max	.03 max	.08 max	.08 max	.20 max	.25 max
Manganese	2.00 max	2.00 max	2.00 max	2.00 max	2.00 max	2.00 max
Silicon	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max	1.50 max
Physical data:						
Melting range — °F	2500–2550	2550–2650	2500–2550	2550–2600	2550–2650	2550–2650
Density — lb/in.^{3}	0.29	0.29	0.29	0.29	0.29	0.29
Specific heat — Btu/°F/lb (32–212 F)	0.12	0.12	0.12	0.12	0.12	0.12
Thermal conductivity — Btu/ft^2/hr/°F/ft:						
212 F	9.4	9.4	9.4	9.3	9.0	8.0
932 F	12.4	12.4	.....	12.8	10.8	10.8
Mean coefficient of thermal expansion — in/in/°F x 10^{-6}:						
68–212 F	9.2	9.2	9.2	9.2	8.7	8.0
68 to indicated temperature — °F	10.7 (1600)	10.7 (1600)	10.7 (1600)	10.7 (1600)	10.9 (2100)	10.9 (2100)
Electrical properties:						
Magnetic permeability at 200 H annealed	1.02	1.02	1.02	1.02	1.02	1.01
Electrical resistivity — microhm-cm:						
68 F	74.0	72.0	74.0	73.0	78.0	78.0
1200 F	116.0	116.0	.....	.....	114.8	.....
Heat resistance:						
Maximum operating temperature — °F:						
Intermittent service (Note 1)	1600	1600	1600	1600	1800	1900
Continuous service	1700	1700	1700	1700	2000	2100
Temperatures — working and treating — °F:						
Forging — start	2200	2200	2200	2200	2150	2150
Forging — finish	1700	1700	1700	1700	1800	1800
Annealing — ranges (Note 2)	1975–2150	1800-2000	1975–2150	1800–2000	2050–2150	2050–2150
Annealing — cooling (Note 3)	WQ(AC)	A.C.	WQ(AC)	WQ(AC)	WQ(AC)	WQ(AC)
Hardening — ranges	(Note 7)	(Note 7)	(Note 7)	(Note 7)	(Note 7)	(Note 7)
Quenching	.....	.....	.....	.....	.....	.....
Tempering — for intermediate hardness	.....	.....	.....	.....	.....	.....
Drawing — for relieving stresses	.....	.....	.....	.....	.....	.....
Mechanical properties — annealed:						
Structure annealed	A	A	A	A	A	A
Yield strength — lb/in.^{2} — min	30 000	30 000	30 000	30 000	30 000	30 000
Ultimate strength — lb/in.^{2} — min	75 000	70 000	75 000	80 000	75 000	75 000
Elongation — % in 2 inches — min	40.0	40.0	40.0	40.0	40.0	40.0
Reduction in area — % — min	50.0	60.0	50.0	50.0	50.0	50.0
Modulus of elasticity in tension — lb/in.^{2} x 10^6	29.0	29.0	29.0	29.0	29.0	30.0
Hardness — Brinell	200 max	180 max	200 max	200 max	200 max	180 max
Hardness — Rockwell	B95 max	B90 max	B95 max	B95 max	B95 max	B90 max
Impact values — Izod — ft-lb	70 min	80 min	70 min	80 min	80 min	80 min
Mechanical properties — heat treated:						
Yield strength — lb/in.^{2}						
Ultimate strength — lb/in.^{2}	(Note 8)	(Note 8)	(Note 8)	(Note 8)	(Note 8)	(Note 8)
Elongation — % in 2 inches						
Hardness — Brinell						
Hardness — Rockwell						
Creep strength — lb/in.^{2} at 1000°F:						
1% Flow in 10,000 hr	24 000	24 000	24 000	32 000	22 000	32 000
1% Flow in 100,000 hr	15 000	15 000	15 000	27 000	12 000	17 000

See page 5 for alternate grades.
See page 6 for notes.

STAINLESS STEEL FINDER

Group	CHROMIUM MARTENSITIC			CHROMIUM FERRITIC			
Type Number	410	431	440 A	405	430	442	446
Analyses — percent:							
Chromium	11.50–13.50	15.00–17.00	16.00–18.00	11.50–14.50	14.00–18.00	18.00–23.00	23.00–27.00
Nickel	.50 max	1.25–2.50	.50 max	.50 max	.50 max	.50 max	.50 max
Other elements (Note 6)	.....	.....	Mo .75 max	Al .10–.30	.....	.....	N_2 .25 max
Carbon	.15 max	.20 max	.60–.75	.08 max	.12 max	.25 max	.20 max
Manganese	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max	1.50 max
Silicon	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max	1.00 max
Physical data:							
Melting range — °F	2700–2790	2550–2650	2500–2750	2700–2790	2600–2750	2600–2750	2550–2750
Density — lb/in.^{3}	0.28	0.28	0.28	0.28	0.28	0.28	0.27
Specific heat — Btu/°F/lb (32-212 F)	0.11	0.11	0.11	0.11	0.11	0.11	0.12
Thermal conductivity — Btu/ft^2/hr/°F/ft:							
212 F	14.4	11.7	14.0	.....	.....	12.5	12.1
932 F	16.6	.....	.....	.....	.....	14.2	14.1
Mean coefficient of thermal expansion — in/in/°F x 10^{-6}:							
68–212 F	5.5	5.5	5.8	6.0	5.6	5.6	5.6
68 to indicated temperature — °F	6.4 (1300)	6.5 (1050)	6.2 (1600)	6.2 (1600)	6.6 (1500)		
Electrical properties:							
Magnetic permeability at 200 H annealed	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic	Magnetic
Electrical resistivity — microhm — cm:							
68 F	57.0	72.0	60.0	61.0	60.0	64.0	67.0
1200 F	108.7	.....	.....	.....	.....	.....	113.0
Heat resistance:							
Maximum operating temperature — °F:							
Intermittent service (Note 1)	1500	.....	1500	1500	1600	1900	2150
Continuous service	1300	1600	1400	1300	1500	1800	2000
Temperatures — working and treating — °F:							
Forging — start	2100	2100	2100	2100	2100	2100	2150
Forging — finish	1600	1500	1600	1600	1300	1600	1600
Annealing — ranges (Note 2)	1500–1650	1150–1225	1550–1650	1350–1500	1400–1500	1300	1450–1600
Annealing — cooling (Note 3)	SFC	FC	FC	AC	FC	WQ or AC	WQ
Hardening — ranges	1700–1850	1750–1850	1850–1900	(Note 11)	(Note 11)	(Note 11)	(Note 11)
Quenching	O or A	O or A	O or A	.....	.....	.....	.....
Tempering — intermediate hardness	(Note 9)	(Note 9)	(Note 9)	.....	.....	.....	.....
Drawing — for relieving stresses	(Note 10)	(Note 10)	(Note 10)	.....	.....	.....	.....
Mechanical properties — annealed:							
Structure annealed	F-C	F-C	F-C	F-C	F-C	F-C	F-C
Yield strength — lb/in.^{2} — min	32 000	90 000	55 000	32 000	35 000	45 000	45 000
Ultimate strength — lb/in.^{2} — min	60 000	105 000	95 000	60 000	60 000	80 000	75 000
Elongation — % in 2 inches — min	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Reduction in area — % — min	50.0	60.0	40.0	50.0	40.0	40.0	40.0
Modulus of elasticity in tension — lb/in.^{2} x 10^6	29.0	28.0	30.0	29.0	29.0	29.0	29.0
Hardness — Brinell	200 max	270 max	240 max	180 max	200 max	200 max	200 max
Hardness — Rockwell	B95 max	C28 max	B100 max	B90 max	B95 max	B95 max	B95 max
Impact values — Izod — ft-lb	85 min	70 min	Low	25 min	3-85	Low	Low
Mechanical properties—heat treated:			Note 4				
Yield strength — lb/in.^{2}	35 000–180 000	90 000–185 000	55 000–240 000	.....	.....	.....	.....
Ultimate strength — lb/in.^{2}	60 000–200 000	105 000–220 000	95 000–275 000	.....	.....	.....	.....
Elongation — % in 2 inches	25–2	25–10	20–2	.....	.....	.....	.....
Hardness — Brinell	120–400	210–440	200–555	.....	.....	.....	.....
Hardness — Rockwell	B70–C45	B95–C45	B95–C55	.....	.....	.....	.....
Creep strength — lb/in.^{2} at 1000°F:							
1% Flow in 10,000 hr	12 000	.....	.....	.....	8500	8500	6500
1% Flow in 100,000 hr	11 000	.....	.....	.....	6500	.....	4600

See page 5 for alternate grades.
See page 6 for notes.

STAINLESS STEEL FINDER

ALTERNATE GRADES

Due to space limitations, no attempt has been made to list in the Finder Charts all of the types of stainless available from Allegheny Ludlum. The more important and widely used grades have been carried there in detail, and others whose properties are generally similar have been listed below. Additional information in regard to these is available in Chapter II.

Basic Types	Alternate Types
302	303 — Free machining (Note 5) 302B — High silicon for oxidation resistance
304	305 — Free spinning 308 — Higher chromium and nickel
316	318 — Columbium stabilized
317	318 — Columbium stabilized
347	347F — Free machining 321 — Titanium stabilized 348 — Tantalum free
309	309S — Carbon .08 max 309Cb — Columbium added
310	314 — High silicon for carburization resistance
410	403 — Turbine 416 — Free machining 418 Special — Tungsten 414 — Nickel 2% 420 — Carbon .30 420F — Free machining (Note 5)
440A	440B & C — Various carbon contents 440F or Se — Free machining
430	430F — Free machining (Note 5)

See page 6 for notes.

STAINLESS STEEL FINDER

NOTES

1. For the austenitic steels, the optimum temperature for intermittent operation will depend largely upon the time cycle and will be lower than that listed for continuous service.
2. Flat rolled products in the chromium martensitic and chromium ferritic groups may be annealed at temperatures 50-100 F lower than those given, where scaling and pickling problems are of more consequence than fully annealed mechanical properties.
3. Thin sections of the 300 Series, marked WQ(AC) are usually air cooled; heavy sections, water quenched.
4. Tensile properties of Types 440 A and C when fully hardened are not dependable and are not, therefore, included in the ranges given.
5. Easy machining grades will have P, S, or Se .07 min; Zr or Mo .60 max.

   Grades containing selenium are available for applications where the sulfur or phosphorus types are not suitable. They are designated by the letters F-SE after the type number. The properties listed apply for all the compositions of a given easy machining grade.
6. Where columbium is specified, tantalum may be substituted for part of the columbium as in Type 347.
7. Hardenable only by cold working.
8. In the case of the chromium-nickel types, mechanical properties higher than in the annealed condition are produced by cold rolling or cold drawing, and ultimate strengths up to 350,000 psi for wire and 250,000 psi for strip can be obtained. Within those limits standard requirements of ¼ hard, ½ hard, ¾ hard and full hard are furnished.
9. Temper over 1100 F.
10. Draw under 700 F.
11. Non-hardening.

Chemical Elements and Abbreviations

Aluminum....Al	Molybdenum....Mo	Silicon....Si
Carbon....C	Nickel....Ni	Sulfur....S
Columbium....Cb	Nitrogen....N_2	Titanium....Ti
Chromium....Cr	Phosphorus....P	Tungsten....W
Manganese....Mn	Selenium....Se	Zirconium....Zr

General Abbreviations

AC = Air cool	WQ = Water Quench	F = Ferrite
FC = Furnace Cool	O = Oil Quench	C = Carbide
SFC = Slow Furnace Cool	AC = Air Cool (mainly used for light sections)	A = Austenite

CORROSION RESISTANCE OF STAINLESS STEELS TO VARIOUS MEDIA

From the preceding discussion of the various analyses of the stainless steels it is readily apparent that this family of steels will vary considerably in corrosion resistance, the low alloy steels such as Type 410, 12% chromium, being less corrosion resistant than those steels having higher alloy content such as Types 316, 317 or 446. This variation in corrosion resistance appears to be related to the amount of chromium contained in the steel, and the resistance can be improved by the addition of nickel or molybdenum. Selection of an alloy is based upon two considerations, (a) an alloy which will withstand the corrosive media involved and (b) economics.

Consider the use of a steel for resistance to the corrosive elements in an industrial atmosphere. Type 410 or any of the 12% chromium steels would develop a superficial rust after several weeks' exposure. The film formed acts as a barrier to further corrosive action, but the resultant part is objectionable from an appearance standpoint. Type 430, 17% chromium, will take several months to form the superficial rust film. The addition, however, of 8% nickel to Type 430 produces a steel, Types 301, 302, or 304, which will not form the rust film and will remain free of corrosive deposits. In some atmospheres even Types 302 or 304 are not satisfactory, particularly coastal installations, and a steel having higher corrosion resistance such as Type 316 must be used.

Thus it can be seen that the application will vary and a number of steels can be used satisfactorily. For instance consider again the case just cited. The 12% chromium grades, Type 410, etc., are used for roofing materials, the rust formed is not objectionable, and these steels have been used 25 years and are still giving satisfactory service. Type 430, 17% chromium, is widely used in the automotive trade for trim and remains bright, since it is cleaned and waxed occasionally. Types 302 and 304, 18 chromium-8 nickel are used as architectural trim because they will not rust, even though they are not cleaned. Where corrosive compounds are deposited on the steel such as salt from the ocean air, a very corrosion resistant material such as Type 316 or 317 must be used to prevent pitting.

All industrial applications of the stainless steels must be thoroughly investigated before applying a particular grade. Laboratory test data, such as presented in the following pages, is based upon commercially pure chemicals under ideal conditions. In industry there are often present other chemicals in the system which may inhibit or accelerate the rate of attack and the following data should only be used as a guide and should be substantiated by service tests.

CORROSION RESISTANCE OF ALLEGHENY LUDLUM STAINLESS STEELS TO VARIOUS MEDIA

CODE: a — Unaffected. b — Slightly attacked. c — Attacked. m — Complete details concerning the conditions of service should be submitted before selecting the grades for resistance to these media.

Except where otherwise stated, all tests are conducted on cp. materials, saturated solutions of salts, at room temperature.

Medium	Allegheny Metal 18-8	18-8M	17	12
ORGANIC SUBSTANCES				
Acetone	a	a	a	b
Alkaform anesthesia	a	a	c	c
Benzol	a	a	a	a
Camphor	a	a	a	a
Carbon disulfide	a	a	..	..
Carbon tetrachloride	m	m	m	m
Carbon tetrachloride (vapors refluxed)	m	m	m	m
Coffee	a	a	a	a
Copal varnish	a	a	a	a
Ethyl alcohol	a	a	a	a
Ethyl chloride	a	a	a	a
Ethyl ether	a	a	a	a
Food pastes	a	a	a	a
Formaldehyde	m	m	m	m
Fruit juices	a	a	a	a
Furfural	a	a	..	..
Gasoline	a	a	a	a
Glue	m	m	m	m
Ink	m	m	m	m
Iodoform dressing	c	a	..	..
Methyl alcohol	a	a	a	a
Methyl chloride	a	a	..	..
Milk — fresh or sour	a	a	a	a
Mustard	m	m	m	m
Naphtha	a	a	a	a
Oils — mineral and vegetable	a	a	a	a
Paraffin (molten)	a	a	a	a
Paregoric cmpd	a	a	..	b
Pine tar oil	a	a	..	..
Quinine bisulfate	b	a	..	c
Quinine sulfate	a	a	..	b
Rosin (molten)	a	a	a	a
Soaps	a	a	a	a
Sodium salicylate	a	a	a	a
Soy bean oil	a	a	..	..

Medium	Allegheny Metal 18-8	18-8M	17	12
ORGANIC SUBSTANCES—Cont.				
Tomato juice	m	m	m	m
Trichlorethylene	m	m	m	m
Tung oil	a	a	..	..
Vinegar at 70 F	m	m	m	m
Vinegar (plus 0.5% salt, 200 F)	m	m	m	m
ACIDS				
Acetic	m	m	m	m
Acetic vapor	m	m	c	c
Arsenic (150 F)	a	a	..	..
Arsenic (225 F)	b	..	..	..
Arsenious	a	a	a	..
Benzoic	a	a	a	a
Boric	m	a	m	..
Butyric	a	a	a	..
Carbolic	m	m	c	c
Chloracetic	c	c	..	..
Chlorosulfonic (conc.)	m	m	..	c
Chlorosulfonic (10%)	b	..	..	c
Chromic (50%)	c	c	..	..
Chromic	c	c	c	c
Citric	a	a	..	b
Cresylic	a	a	..	..
Chromic (plus 10% potassium ferricyanide)	..	..	..	b
Formic	c	m	..	c
Gallic	a	a	a	..
Hydrobromic	c	c	..	..
Hydrocyanic	a	a	c	c
Hydrochloric	c	c	c	c
Hydrofluoric	c	c	c	c
Lactic	a	a	a	b
Lactic plus salt	m	m	..	..
Malic	a	a	..	b
Molybdic	a	a	..	..
Nitric (conc.)	a	a	a	a
Nitric (conc. plus 2% HCl)	a	..	c	c
Nitrous (conc.)	a	a	a	b

Medium	Allegheny Metal 18-8	18-8M	17	12
ACIDS—Cont.				
Oleic	a	a	a	a
Oxalic	m	m	c	c
Phosphoric	a	a	c	..
Phosphoric (10%)	a	a	b	b
Picric (conc.)	a	a	a	a
Pyrogallic (conc.)	a	a	a	a
Pyroligneus (conc.)	a	a	..	..
Stearic (conc.)	a	a	a	a
Succinic (molten)	c	..	..	..
Sulfuric (conc.)	a	a	c	c
Sulfuric (dil.)	m	m	c	c
Sulfuric 15% (plus 2% potassium dichromate)	a	a	..	..
Sulfurous (conc.)	m	a	b	b
Tannic (conc.)	a	a	a	a
Tartaric (conc.)	m	m	m	m
Trichloracetic acid (10%)	a	a	..	..
Uric (conc.)	a	a	a	a
SALTS				
Alum	m	m	..	..
Aluminum chloride	c	..	..	c
Aluminum fluoride	b	..	..	c
Aluminum sulfate	a	a	..	b
Aluminum sulfate (sat. plus 1% sulfuric acid)	a	a	..	c
Aluminum sulfate (sat. plus 1% sodium carbonate)	a	a	..	a
Ammonium alum	a	a	a	..
Ammonium alum (sat. — slightly ammonical) 200 F	a	a	..	c
Ammonium bromide	m	a	b	b
Ammonium carbonate	a	a	a	a
Ammonium chloride	m	m	b	b
Ammonium hydroxide	a	a	a	a
Ammonium monophosphate	a	a	..	..
Ammonium nitrate	a	a	a	a
Ammonium oxalate	a	a	..	a
Ammonium sulfate	a	a	a	b
Ammonium sulfate (plus 0.5% sulfuric acid)	a	a	..	c
Barium carbonate	a	a	..	..
Barium chloride	a	a	..	b
Barium hydrate	a	a	..	..
Bleaching powder	m	m	c	c
Bordeaux mixture	a	a	..	..
Calcium carbonate	a	a	a	a
Calcium chlorate	a	a	..	..

Medium	Allegheny Metal 18-8	18-8M	17	12
SALTS—Cont.				
Calcium chloride	m	m	c	c
Calcium hypochlorite	c	m	c	c
Calcium hypochlorite made alkaline with NaOH	m	m	..	..
Calcium hydroxide or oxide.	a	a	a	a
Copper carbonate	a	a	a	a
Copper chloride	c	..	..	a
Copper cyanide	a	a	a	a
Copper nitrate	a	a	a	c
Copper sulfate (plus 2% sulfuric acid)	a	a	..	b
Copper sulfate	a	a	a	..
Creosote	c	m	..	..
Creosote (plus 3% salt)	c	..	..	..
Ferric chloride (10%)	c	m	c	c
Ferric nitrate	a	a	a	a
Ferrous sulfate	a	a	a	a
Ferric sulfate	a	a	a	..
Glauber's salt	a	a	..	..
Hydrogen peroxide	m	m	m	..
Lactic acid salts	a	a	..	..
Lead acetate	a	a	a	..
Magnesium carbonate	a	a	a	a
Magnesium chloride	m	m	c	c
Magnesium sulfate	a	a	a	b
Magnesium hydroxide	a	a	..	a
Magnesium nitrate	a	a	a	..
Mercurous nitrate	a	a	a	a
Mercuric chloride	m	m	c	c
Mercuric cyanide	a	a	..	b
Nickel nitrate	a	a	a	a
Phosphorous trichloride	a	a	..	..
Potassium bromide	a	a	..	b
Potassium carbonate	a	a	a	a
Potassium chloride	m	m	b	b
Potassium chlorate	a	a	a	..
Potassium cyanide	a	a	a	a
Potassium dichromate	a	a	a	a
Potassium ferricyanide	a	a	a	a
Potassium ferricyanide (boiling)	a	a	..	..
Potassium hypochlorite	c	m	c	c
Potassium iodide	a	a	..	..
Potassium iodide (sat. plus 0.1% sodium carbonate evaporated to dryness)	a	a	..	b

Medium	Allegheny Metal 18-8	18-8M	17	12
SALTS—Cont.				
Potassium hydrate	a	a	a	a
Potassium nitrate	a	a	a	a
Potassium oxalate	a	a	a	a
Potassium permanganate	a	a	a	..
Potassium sulfate	a	a	a	a
Silver bromide	a	a	a	a
Silver nitrate	a	a	a	a
Silver cyanide	a	a	a	..
Sodium acetate	a	a	..	..
Sodium bicarbonate	a	a	a	..
Sodium bichromate	a	a	a	..
Sodium bisulfate	a	a	..	..
Sodium borate	a	a	a	..
Sodium bromide	a	a	..	b
Sodium carbonate (10%)	a	a	a	a
Sodium carbonate (50%)	a	a	a	..
Sodium chlorate (10%)	a	a	a	..
Sodium chlorate (25%)	a	a	a	..
Sodium chloride	m	m	..	..
Sodium chloride (2% aerated)	a	a	b	..
Sodium citrate	a	a	a	a
Sodium fluoride	b	..	..	..
Sodium hydroxide	a	a	a	a
Sodium hypochlorite (Dakin's solution)	m	m	c	c
Sodium hypochlorite (sat. — slightly alkaline) (200 F)	a	a	..	b
Sodium lactate	a	a	..	..
Sodium nitrate	a	a	a	a
Sodium nitrite	a	a	..	..
Sodium peroxide (212 F)	a	a	..	..
Sodium phosphate	a	a	..	..
Sodium sulfate	a	a	a	a
Sodium sulfide	a	a	a	a
Sodium sulfite	a	a	a	a
Sodium thiosulfate (plus 4% potassium meta bisulfate)	a	a	a	a
Sodium thiosulfate 20% plus acetic acid 20%	m	m	m	c
Soda ash (10%) (200 F)	a	a	a	a
Soda ash (50%) (200 F)	a	a	a	a
Stannic chloride	c	c	..	c
Stannous chloride	b	..	c	c

Medium	Allegheny Metal 18-8	18-8M	17	12
SALTS—Cont.				
Sulfur (molten) 500 F	a	a	a	..
Sulfur chloride	b	..	..	..
Sulfur oxychloride	a	a	..	..
Titanium tetrachloride	a	..	..	..
Zinc chloride	c	b	..	c
Zinc sulfate	a	a	a	a
MISCELLANEOUS				
Aluminum (molten)	c	c	c	..
Ammonia	a	a	a	..
Baking oven gases	a	a	a	a
Beer	a	a	a	a
Bromine	c	c	c	c
Bromine water	c	c	c	c
Cadmium (molten)	c	c	..	..
Carbonated beverages	a	a	a	a
Chlorine (wet and dry)	c	c	c	c
Cider	a	a	a	a
Copper sulfate electroplating solution	a	a	..	..
Copper cyanide electroplating solution	a	a	..	..
Glycerin	a	a	a	a
Gold cyanide electroplating solution	a	a	..	..
Hydrogen sulfide (400 F)	m	m	..	..
Iodine	c	m	c	c
Lead (molten)	c	c	..	..
Linseed oil	a	a	..	b
Lysol	m	m	c	c
Meats	a	a	..	..
Mercury	a	a	..	..
Mine water	m	m	m	m
Nickel sulfate electroplating solution	a	a	..	..
Sauerkraut brine	c	a	..	..
Sea water	m	m	..	c
Silver cyanide electroplating solution	a	a	..	..
Steam and air (refluxed)	a	a	..	b
Steam, CO_2 and air	a	a	..	b
Steam, SO_2 CO_2 and air	m	m	b	b
Sulfur dioxide	m	m	..	..
Syrup	a	a	..	..
Vegetable juices	a	a	a	a
Water	a	a	a	a
X-ray developing solution	m	m	..	..
Zinc (molten)	c	c	c	c