UDC 669.35'24'74'1

Cu Ni20 Mn1 Fe

Common names: 80/20 Copper-Nickel-Iron
80/20 Cupro-nickel
Cupro-nickel, 80/20

A copper-nickel alloy with an alpha phase structure. Small amounts of iron and manganese are added to improve corrosion resistance in high-velocity (from 1 to about 4 m/s) waters, including seawater. The alloy is relatively insensitive to stress corrosion. It has good cold-and hot-working properties and is readily weldable. The most commonly used wrought forms are plate, sheet and tube.

COMPOSITION (weight %)

Ni	19.0–22.0
Mn	0.5– 1.5
Fe	0.4– 1.0
Cu	rem.

1 SOME TYPICAL USES

Chemical & Marine

Tubes and tubeplates for medium-duty condensers, feedwater heaters and evaporators.

2 PHYSICAL PROPERTIES

		Metric Units	English Units
2.1	Density at 20 °C *68 °F*	8.95 g/cm³	0.325 lb/in³
2.2	Melting range [a]	1 130–1 190 °C	2 065–2 175 °F
2.3	Coefficient of thermal expansion (linear) at:		
	−183 to 10 °C *−297 to 50 °F*	0.000 013 per °C	0.000 007 per °F
	20 to 300 °C *68 to 572 °F*	0.000 016 „ „	0.000 009 „ „
2.4	Specific heat (thermal capacity) at:		
	20 °C *68 °F*	0.09 cal/g °C	0.09 Btu/lb °F
2.5	Thermal conductivity at:		
	20 °C *68 °F*	0.09 cal cm/cm² s °C	22 Btu ft/ft² h °F
2.6	Electrical conductivity (volume) at:		
	20 °C *68 °F* (annealed or cold worked)	3.5 m/ohm mm²	6% IACS
	200 °C *392 °F* („ „ „ „)	3.5 „	6 „ „
2.7	Electrical resistivity (volume) at:		
	20 °C *68 °F* (annealed or cold worked)	0.29 ohm mm²/m 29 microhm cm	173 ohms (circ mil/ft) 11 microhm in
	200 °C *392 °F* („ „ „ „)	0.29 ohm mm²/m 29 microhm cm	173 ohms (circ mil/ft) 11 microhm in
2.8	Temperature coefficient of electrical resistance at:		
	20 °C *68 °F* (annealed or cold worked) applicable over range from 0 to 100 °C *32 to 212 °F*	0.000 4 per °C (6% IACS)	0.000 2 per °F (6% IACS)
2.9	Modulus of elasticity (tension) at 20 °C *68 °F*		
	annealed	14 800 kg/mm²	21 100 000 lb/in²
	cold worked [b]	13 600 kg/mm²	19 300 000 lb/in²
2.10	Modulus of rigidity (torsion) at 20 °C *68 °F*		
	annealed	5 500 kg/mm²	7 800 000 lb/in²
	cold worked [b]	5 050 kg/mm²	7 200 000 lb/in²

(a) The melting range covers the highest liquidus and lowest solidus temperatures over the composition range quoted. The values are based on: Hansen, M. and Anderko, K. Constitution of Binary Alloys. 2nd ed. (1958) McGraw-Hill, London, New York; more recent work (Feest, E.A. and Doherty, R.D. The Cu-Ni Equilibrium Phase Diagram. J. Inst.Metals, Vol. 99 (1971), pp. 102–103) indicates that the solidus temperature may be slightly higher.

(b) Approximately 50% cold work.

N.B.: The values shown in Section 2, which have been appropriately rounded in view of the composition range involved, are based on selected literature references.

INDEX NUMBERS RELATE TO LITERATURE REFERENCES (see page 6); INDEX LETTERS RELATE TO FOOTNOTES AT END OF TABLE

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DATA SHEET No. K 4

1972 Edition

3 FABRICATION PROPERTIES

The information given in this table is for general guidance only, since many factors influence fabrication techniques. The values shown are approximate only, since those used in practice are dependent upon form and size of metal, equipment available, techniques adopted and properties required in the material.

		Metric Units	English Units
3.1	Casting temperature range	1 250–1 325 °C	2 280–2 415 °F
3.2	Annealing temperature range	650– 825 °C	1 200–1 515 °F
	Stress relieving temperature range	300– 400 °C	570– 750 °F
3.3	Hot working temperature range	875– 975 °C	1 605–1 785 °F
3.4	Hot formability	Good	
3.5	Cold formability	Good	
3.6	Cold reduction between anneals	60% max.	
3.7	Machinability:	See General Data Sheet No. 2	
	Machinability rating (free cutting brass = 100)	20	
3.8	Joining methods:	See General Data Sheet No. 3.9	
	Soldering	Excellent	
	Brazing	Excellent	
	Oxy-acetylene welding	Fair	
	Carbon-arc welding	Not recommended	
	Gas-shielded arc welding	Excellent	
	Coated metal-arc welding	Good	
	Resistance welding: spot and seam	Good	
	butt	Good	

4 NATIONAL SPECIFICATIONS FOR MANUFACTURED FORMS

and ISO Recommendation

Country	Designation of Standards	Designation of Material in Standards	Specification for Chemical Composition[a]	Plate Sheet Strip	Rod	Wire	Tube	Sections / Shapes	Forgings
Australia	SAA	—	—	—	—	—	—	—	—
Belgium	NBN	—	—	—	—	—	—	—	—
Canada	CSA	HC.NF 201	—	—	—	—	HC.7.3 HC.7.4	—	—
Chile	NCh (INDITECNOR)	Cu Ni20 Mn1 Fe	NCh 250. of 68	—	—	—	—	—	—
France	NF	Cu Ni20 Mn1 Fe	—	—	—	—	A 51-102	—	—
Germany	DIN	Cu Ni20 Fe	17 664	17 670	—	—	—	—	—
India	IS	—	—	—	—	—	—	—	—
Italy	UNI	Pt-Cu Ni20 Mn1 Fe	—	—	—	—	6785	—	—
Japan	JIS	CNTF 2 CNTF 2 S	—	—	—	—	H 3635	—	—
Netherlands	N or NEN[b]	Cu Ni20 Mn1 Fe	NEN 6030	NEN 6033	—	—	—	—	—
South Africa	SABS	—	—	—	—	—	—	—	—
Spain	UNE	—	—	—	—	—	—	—	—
Sweden	SIS	—	—	—	—	—	—	—	—
Switzerland	VSM	—	—	—	—	—	—	—	—
United Kingdom	BS	—	—	—	—	—	—	—	—
United States[c]	ASTM	No.710	—	B122	—	—	B111 B359 B395 B466 B467		
International Organization for Standardization	ISO	Cu Ni20 Mn1 Fe	R 429	—	—	—	—	—	—

(a) Applicable when the chemical composition is not given in the specifications for wrought forms.

(b) Older specifications bear prefix N; for new specifications the NEN prefix is used.

(c) In the United States, bar is covered under the Plate-Sheet-Strip column.

5 MECHANICAL PROPERTIES

5.1 Mechanical properties at room temperature

Tensile properties	see tables 5.1.1/3
Hardness	„ „ 5.1.1/3
Shear Strength	„ „ 5.1.1/3
Modulus of elasticity (tension)	see 2.9
Modulus of rigidity (torsion)	„ 2.10

5.2 Mechanical properties at low temperature

Tensile properties	see table 5.2.1
Impact properties	„ „ 5.2.1

5.3 Mechanical properties at elevated temperature

Short-time tensile properties	see table 5.3.1
Creep properties	no data

5.4 Fatigue properties

Fatigue strength at room temperature	see table 5.4.1

5.1 MECHANICAL PROPERTIES AT ROOM TEMPERATURE[a]

5.1.1 Typical Tensile Properties and Hardness Values—Metric Units

This table is representative of practice in many European countries. For American practice, see table 5.1.3.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength kg/mm²	Proof Stress 0.2% offset kg/mm²	Elongation		Hardness		Shear Strength kg/mm²	Typical Size Related to Properties Shown [b]
				%	gauge length	Brinell	Vickers		
Plate Sheet Strip	Annealed	34	15	38	$5.65\sqrt{S_o}$	80	84	25	1–20 mm thick
Tube [c]	Annealed (grain size 0.025 mm)	37	16	40	$5.65\sqrt{S_o}$	85	89	28	10–30 mm O.D. 1–3 mm wall
	Typical Cold Drawn Temper	47	42	14	$5.65\sqrt{S_o}$	130	135	33	10–30 mm O.D. 1–2 mm wall

(a) It will be noted that tables 5.1.1 and 5.1.3, giving typical tensile properties and hardness values in Metric and American units respectively are not directly comparable. This is because the properties quoted reflect to some extent the metalworking techniques, specification practices, and testing procedures in the countries concerned, and in view of the different sizes of products referred to in these tables. Individual manufacturers of semi-fabricated products, can, however, normally meet the requirements of any national standard.

(b) It is possible to obtain sizes outside the ranges given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

(c) Tubes for condensers and heat exchangers are generally supplied in the annealed temper whose representative mechanical properties are shown.

5.1.2 Typical Tensile Properties and Hardness Values—SI and English Units

Tensile properties and hardness values in SI and English units are omitted from this data sheet, since alloys within the composition range concerned are not normally produced by British manufacturers.

5.1.3 Typical Tensile Properties and Hardness Values—American Units

This table is based on American practice and the temper designations shown are those referred to in ASTM and other American Standards. For practice in European countries, see table 5.1.1.

The values shown represent reasonable approximations for general engineering use, taking account of variations in composition and manufacturing procedures. For design purposes, national specifications should be consulted.

For a given temper, individual elongation values may show some variation above or below the typical values indicated.

Form	Temper	Tensile Strength psi	Yield Strength 0.5% extension under load psi	Elongation		Rockwell Hardness			Shear Strength psi	Typical Size Related to Properties Shown [a]
				%	gauge length	F	B	30 T		
Flat Products (Plate, Sheet, Strip)	Annealed	47 000	19 000	27	2 in.	—	32	—	35 000	0.040 in. thick
	Cold Worked 37%	76 000	73 000	6	2 in.	—	83	—	43 000	0.040 in. thick
Tube [b]	Annealed (grain size 0.025 mm)	49 000	18 000	40	2 in.	72	—	—	37 000	1.0 in. O.D. × 0.065 in. wall
	Cold Worked									
	Light Drawn	68 000	62 000	14	2 in.	—	76	—	44 000	1.0 in. O.D. × 0.065 in. wall
	Hard Drawn	80 000	75 000	—	—	—	81	—	48 000	0.75 in. O.D. × 0.049 in. wall

(a) It is possible to obtain sizes different from those given in this column, but information on their mechanical properties should be obtained from the metal manufacturers.

(b) Tubes for condensers and heat exchangers are generally supplied in the annealed temper whose representative mechanical properties are shown.

5.2 MECHANICAL PROPERTIES AT LOW TEMPERATURE

5.2.1 Tensile Properties—Impact Properties

Form	Temper	Testing Temperature		Tensile Strength			Elongation		Reduction of Area %	Impact [a] Strength	
		°C	°F	kg/mm²	ton/in²	psi	%	gauge length		kg m/cm²	ft lb
Plate [1] [b] **13–19 mm 0.5–0.75 in.**	(c)	18	64	42.5	**27.0**	60 500	**33**	1.5 in.	**70.8**	19.6	**71**
		— 20	— 4	45	**28.5**	64 000	**33**	1.5 in.	**70.0**	—	—
		— 50	— 58	47	**29.7**	66 500	**34**	1.5 in.	**68.5**	20.5	**74**
		—100	—148	49	**31.2**	70 000	**38**	1.5 in.	**61.5**	21.6	**78**
		—150	—238	51.5	**32.8**	73 500	**36**	1.5 in.	**65.0**	20.7	**75**
		—196	—321	58.5	**37.3**	83 500	**46**	1.5 in.	**61.5**	20.5	**74**

(a) Charpy test, V notch, cross-sectional area at the notch 0.5 cm².

(b) Results of Navy tear tests on this alloy are also included in ref. (1).

(c) Temper not stated in original document, but probably annealed.

N.B.: — Original values are printed in **bold type**; other values are converted.

— All converted values for impact strength are to be taken as indicative only; the impact energy has been converted from ft lb into kg m/cm² taking into account the actual cross-sectional area of the specimen at the notch.

— Data not available: Proof stress 0.2%, and 0.1% offset,
Yield strength, 0.5% extension under load.

5.3 MECHANICAL PROPERTIES AT ELEVATED TEMPERATURE

5.3.1 Short-Time Tensile Properties

Form	Temper	Testing Temperature		Tensile Strength			Proof Stress		Elongation	
		°C	°F	kg/mm²	ton/in²	psi	0.2% offset kg/mm²	0.1% offset ton/in²	%	gauge length
Strip [2] 2 mm 0.08 in.	Annealed	20	68	35.5	**22.4**	50 000	—	**6.1**	**44**	2 in.
		100	212	32.5	**20.7**	46 500	—	**5.7**	**39**	2 in.
		200	392	30	**19.0**	42 500	—	**5.3**	**35**	2 in.
		300	572	27.5	**17.5**	39 000	—	**4.8**	**30**	2 in.
		400	752	26.5	**16.7**	37 500	—	**4.6**	**27**	2 in.
		500	932	22	**14.0**	31 500	—	**4.3**	**23**	2 in.
Condenser [3] Tube	Annealed	20	68	**36**	23	51 000	**13.5**	—	**38**	$11.3\sqrt{S_o}$
		100	212	**33**	21	47 000	**12.5**	—	**35**	$11.3\sqrt{S_o}$
		200	392	**31**	19.5	44 000	**11.0**	—	**33**	$11.3\sqrt{S_o}$
		300	572	**30**	19	42 500	**10**	—	**30**	$11.3\sqrt{S_o}$
		400	752	**28**	18	40 000	**9.5**	—	**25**	$11.3\sqrt{S_o}$
		500	932	**20**	12.5	28 500	**9**	—	**27**	$11.3\sqrt{S_o}$
		600	1 112	**13**	8.5	18 500	**7**	—	**35**	$11.3\sqrt{S_o}$

N.B.: — Original values are printed in **bold type**; other values are converted.
— Data not available: Yield strength, 0.5% extension under load.

5.3.2 Creep Properties

At the date of publication of this sheet, no data relating to this material have been traced.

Data on an alloy with similar composition to Cu Ni20 Mu1 Fe, but with 1.0 zinc content, are available in the following paper:

■ Weaver, V.P. and Imperati, J. Copper and Copper Alloys for Pressure Vessels. Welding Research Council, New York. Bull. No. 73 (1961), Nov.

5.4 FATIGUE PROPERTIES

5.4.1 Fatigue Strength at Room Temperature

Form	Temper	Number of Cycles $\times 10^6$	Metric Units kg/mm²		English Units ton/in²		American Units psi	
			Tensile Strength	Fatigue Strength	Tensile Strength	Fatigue Strength	Tensile Strength	Fatigue Strength
[4] [5] [a] **Rod 25 mm diam. 1 in. diam.**	Annealed	100	33.5	12.5 [c]	21	8 [c]	**47 300**	**17 800** [c]
	Cold Worked and Stress Relieved [b]	100	44	18 [c]	28	11.5 [c]	**62 400**	**25 500** [c]
Rod [6] 25 mm diam. 1 in. diam.	Annealed	100	36.5	15.5 [d]	**23.2**	**9.7** [d]	52 000	21 500 [d]
	Cold Worked 25%	100	51	19 [d]	**32.3**	**12.2** [d]	72 500	27 500 [d]
	Cold Worked 50%	100	57	23.5 [d]	**36.2**	**14.9** [d]	81 000	33 500 [d]
Tube [7]	Soft	100	**34**	**12**	21.5	7.5	48 500	17 000
	Cold Worked and Stress Relieved	100	**43**	**15** [e]	27.5	9.5 [e]	61 000	21 500 [e]

[a] Alloy containing 0.51% Fe; 0.29% Mn.
[b] Stress relieved for 3h at 204°C *(400°F)*.
[c] Rotating-cantilever test.
[d] Rotating-beam test.
[e] Bending-fatigue test.
N.B.: Original values are printed in **bold type**; other values are converted.

REFERENCES

MECHANICAL PROPERTIES (Section 5)

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(7) Private communication from Kabelmetall, Osnäbruck, Germany.