



**AGH**



## **CuPHC**

**UNS:C10300**  
**EN:CW020A**

### **Manufactures list:**

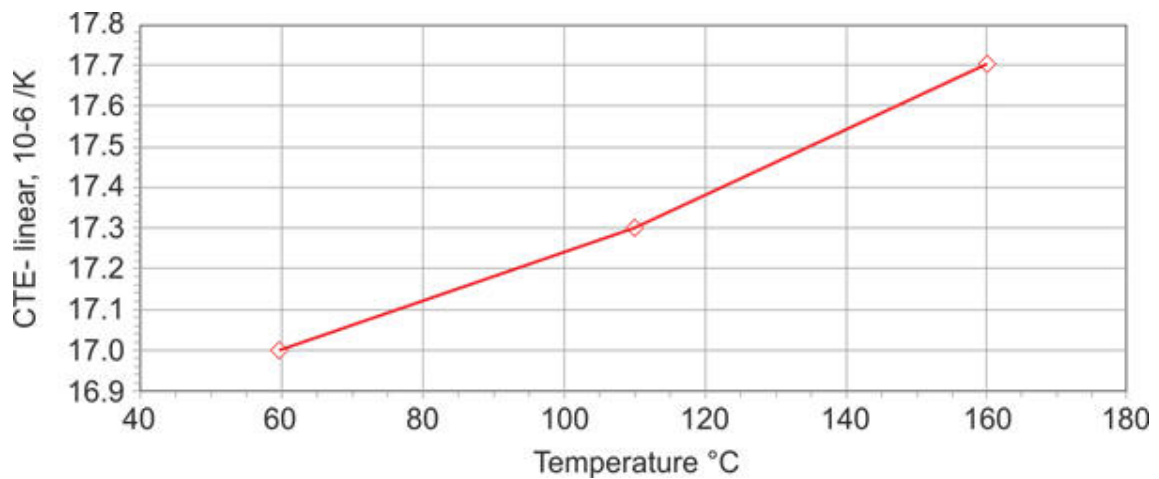
Aurubis (<http://www.aurubis.com/en/>) - PNA 209  
Halcor S.A. (<http://www.halcor.gr/en/>) - CuPHC  
KGHM Polska Miedź S.A. (<http://www.kghm.pl/>) - CuPHC  
KM Europa Metal AG (<http://www.kme.com/>) - KME159  
Luvata (<http://www.luvata.com/>) - CuPHC  
Nexans (<http://www.nexans.us/>) - CuPHC

Cu-PHC combines good electrical conductivity with excellent hot and cold fabricability and joining characteristics (welding and brazing). C10300 has 99% IACS electrical conductivity, excellent hot and cold workability. C10300 is not hardenable by heat treatment. It may be joined by gas shielded arc with excellent results. Soldering and brazing performance is also excellent. Butt resistance welding is good and oxyacetylene weldability, fair. Common fabrication processes include: blanking, coining, coppersmithing, drawing, etching, forming and bending, heading and upsetting, hot forging and pressing, piercing and punching, roll threading and knurling, shearing, spinning, squeezing and swaging, stamping.

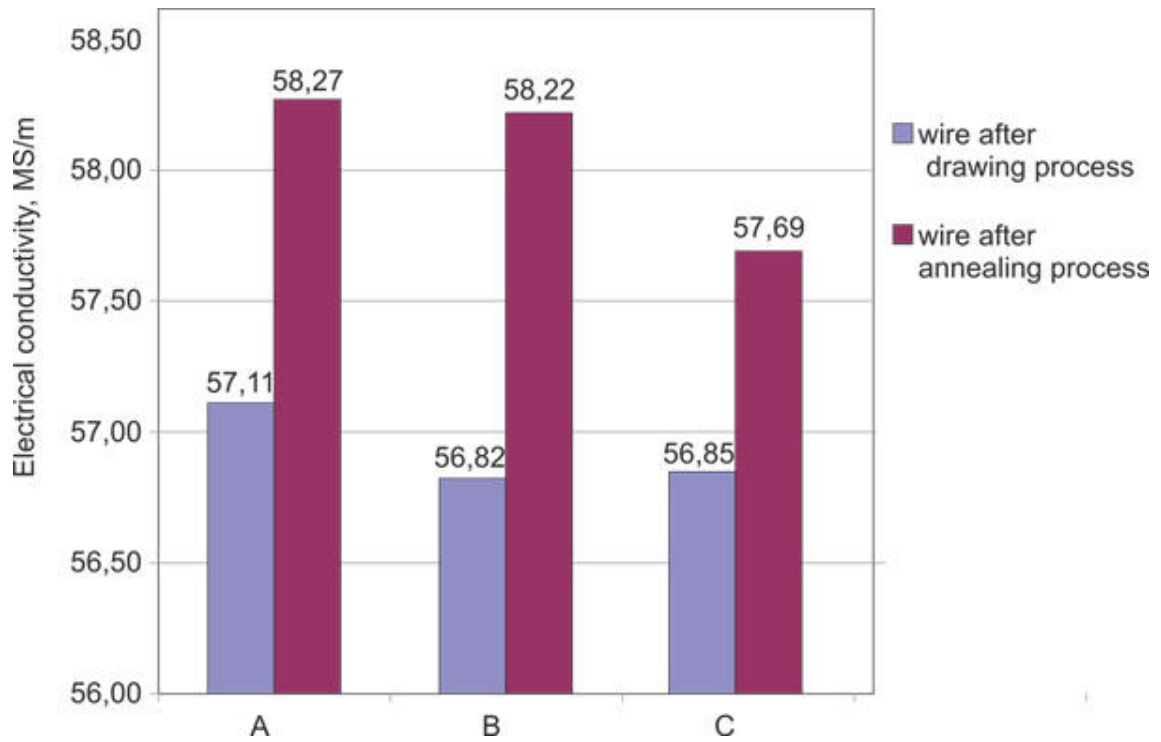
## Basic properties

Basic properties	Value	Comments
Density [g/cm <sup>3</sup> ]	8,76-8,94	
Specific heat capacity [J/(kg*K)]	385	
Temperature coefficient of electrical resistance (0...100°C) [10 <sup>-3</sup> /K]	3,7	20-300°C
Electrical conductivity [T=20°C, (% IACS)]	100 99	CuPHC CuHCP
Thermal conductivity [W/(m*K)]	386	
Thermal expansion coefficient 20...300°C [10 <sup>-6</sup> /K]	17,6	

[Ref: 305, 306, 307, 308, 309, 310, 252, 268, 267, 254, 255, 256]



Thermal expansion coefficient of Cu-PHC vs temperature [Ref: 267]



*Electrical conductivity of Cu-PHC wires (diameter 2.00 mm) after drawing process and after annealing process [Ref: 567]*

Chemical composition of Cu-PHC wires (diameter 2.00 mm) [Ref: 567]

No of alloy	Chemical composition, wt%										
	Bi	Pb	Sb	As	Fe	Ni	Sn	Zn	S	O <sub>2</sub>	P
A	0,5	0,5	1	0,5	8,4	2,2	0,4	1	5	22	34
B	0,5	0,5	1	0,7	8,2	2,6	0,4	1	7	26	24
C	0,3	1,4	0,9	0,9	2,6	2	0,5	1,3	-	3,7	15

# Applications

## Main applications

Standard material for longitudinally welded cables, Wave Guide Tubing, Commutators, Applications Requiring High Conductivity, Tubular Bus, Electrical Conductors, Clad Products, Busbars, Terminals, Thermostatic Control Tubing Applications Requiring Good Brazing, Applications Requiring Good Weldability, Pressure Vessels, Billet Mold Tube, Extrusion Cans for Powder Metallurgy. *Literature:* [Ref: 305, 306, 307, 308, 310, 268, 254]

## Kinds of semi-finished products/final products

Product	Specification	Literature
Bar	ASTM B152	[Ref: 254, 268, 257]
Bar, Bus	ASTM B187	
Brazing Filler Metal	FEDERAL QQ-B-650	
Nipples	ASTM B687	
Pipe	ASTM B698, B42	
Pipe, Bus	ASTM B188	
Pipe, Threadless (Seamless)	ASTM B302	
Plate	ASTM B152	
Plate, Clad	ASTM B432	
Rod, Bus	ASTM B187	
Shapes, Bus	ASTM B187	
Sheet	ASTM B152	
Strip	ASTM B272, B152	
Tube	ASTM B698	
Tube, Bus	ASTM B188	
Tube, Coils	ASTM B743	
Tube, Condenser	ASTM B111	
Tube, Finned	ASTM B359	
Tube, Rectangular Waveguide	ASTM B372	
Tube, Seamless	ASTM B75, B641	
Tube, Seamless Bright Annealed	ASTM B68	
Tube, Seamless for Torpedo Use	MILITARY MIL-T-3235	
Tube, U-Bend	ASTM B395	
Tube, Welded	ASTM B641, B447, B716	
Wire, Flat	ASTM B272	

## Chemical composition

Chemical composition	Value	Comments
Cu [wt.%]	99,94-99,95	Calculated
P [wt.%]	0,001-0,005	
Pb [wt.%]	0-0,005	
Others [wt.%]	0,05	
[Ref: 254, 268]		

Chemical composition of Cu-HCP according to [Ref: 254, 268]

Chemical composition, wt.%												
Ag	Mg	Sn	Ni	Si	Cr	Zr	Fe	P	Pb	Zn	other	Cu
-	-	-	-	-	-	-	-	0.002- 0,007	Max 0.005	-	Max 0.05	min. 99.5

## Mechanical properties

Mechanical properties	Value	Comments	Literature
UTS [MPa]	200-400		
YS [MPa]	100-360		
Elongation [%]	2-45		
Hardness	40-110		
Young's modulus [GPa]	119		
Kirchhoff's modulus [GPa]	45		
Poisson ratio	0,33		

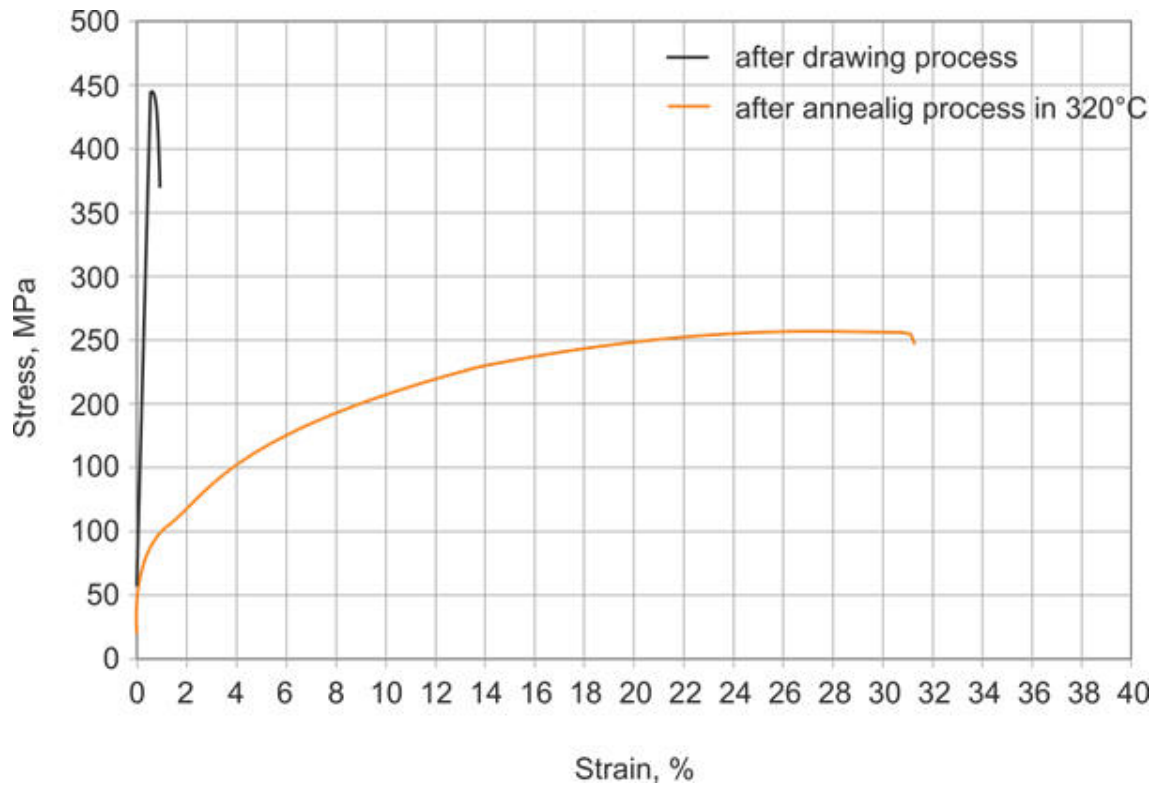
*Mechanical properties of CuPHC according KME [Ref: 309]*

Cu - PHC	Tensile strength, MPa	Yield strength, MPa	Elongation, %	Hardness, HV	Literature
R200	200-250	≤100	-	40-65	[Ref: 309]
R220	220-260	<140	33	40-65	
R240	240-300	≥180	8	65-95	
R290	290-360	≥250	4	90-110	
R360	≥360	≥320	2	≥110	

*Mechanical properties of CuPHC [Ref: 310]*

Form	Section, mm	Tensile strength, MPa	Yield strength, MPa	Elongation	Literature
flat	1	224	70	45	[Ref: 310]
		238	77	45	
		252	196	30	
		266	210	25	
		294	252	14	
	6,25	350	315	6	
		224	70	50	
		252	196	40	
		350	315	12	
	25	224	70	50	
315		280	20		
rod	6,25	385	350	20	
		336	308	16	
		315	280	20	
		224	70	45	
		238	77	45	
		280	224	25	
pipe		385	350	8	
		350	315	10	
shapes	12,5	224	70	50	
		280	224	30	



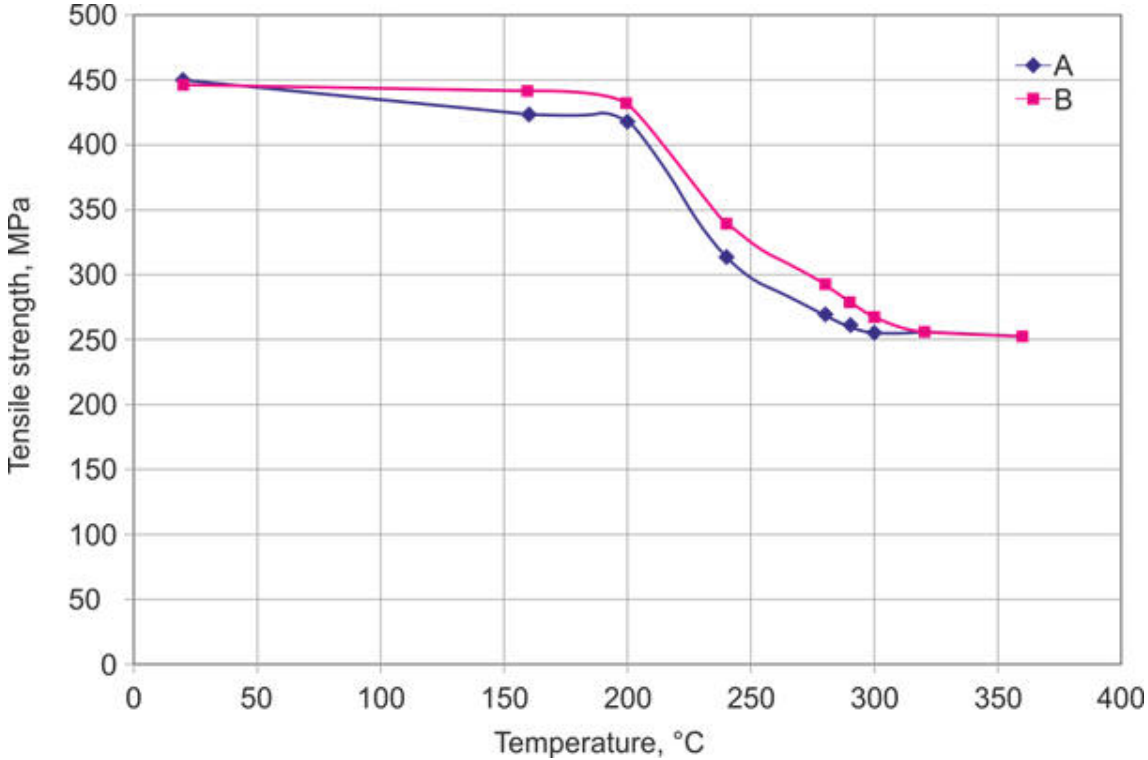


*Stress strain characteristic of Cu-PHC wires (diameter 2 mm) after drawing process and after annealing process in 320°C temperature [Ref: 567]*

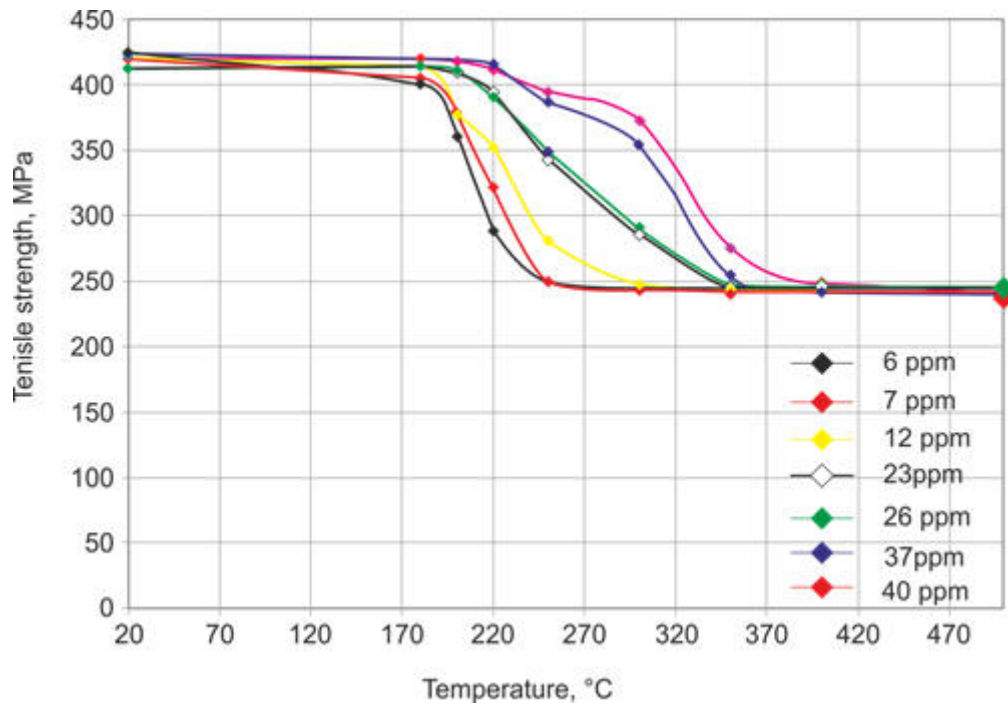
# Exploitation properties

## Heat resistance

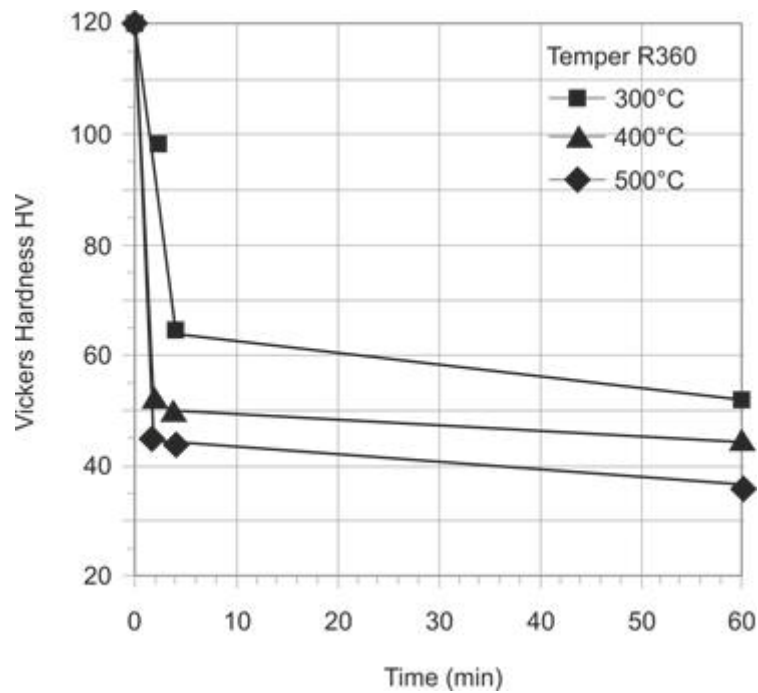
### Mechanical and electrical properties vs temperatures



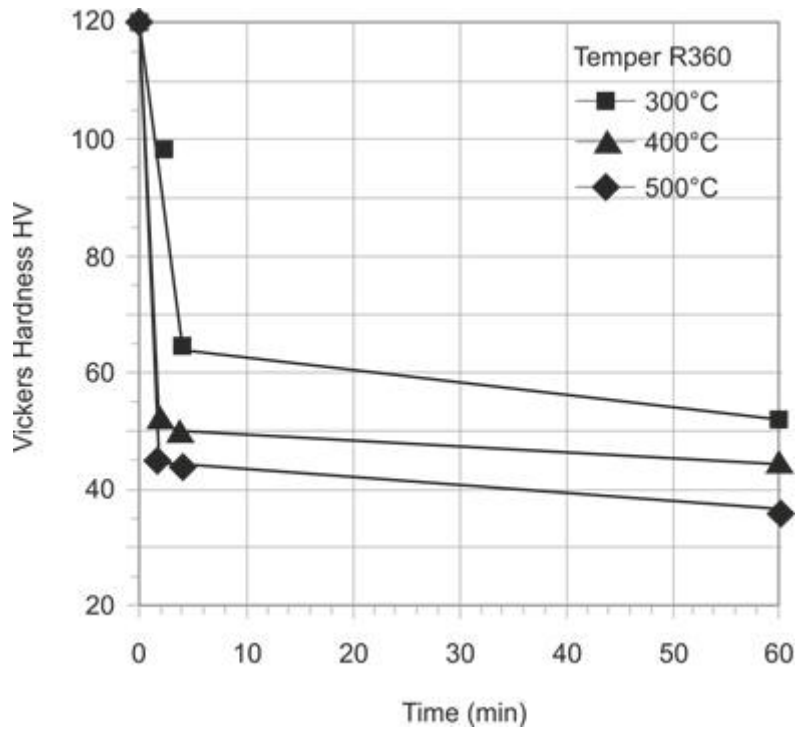
Softening curves of CuPHC Cu-PHC wire (diameter 2.00 mm, P-24 pm, oxygen -20ppm)  
[Ref: 567]



Softening curves of CuPHC Cu-PHC wire (diameter 2.00 mm) vs various P content [Ref: 567]



Softening resistance of Cu-PHC [Ref: 306]

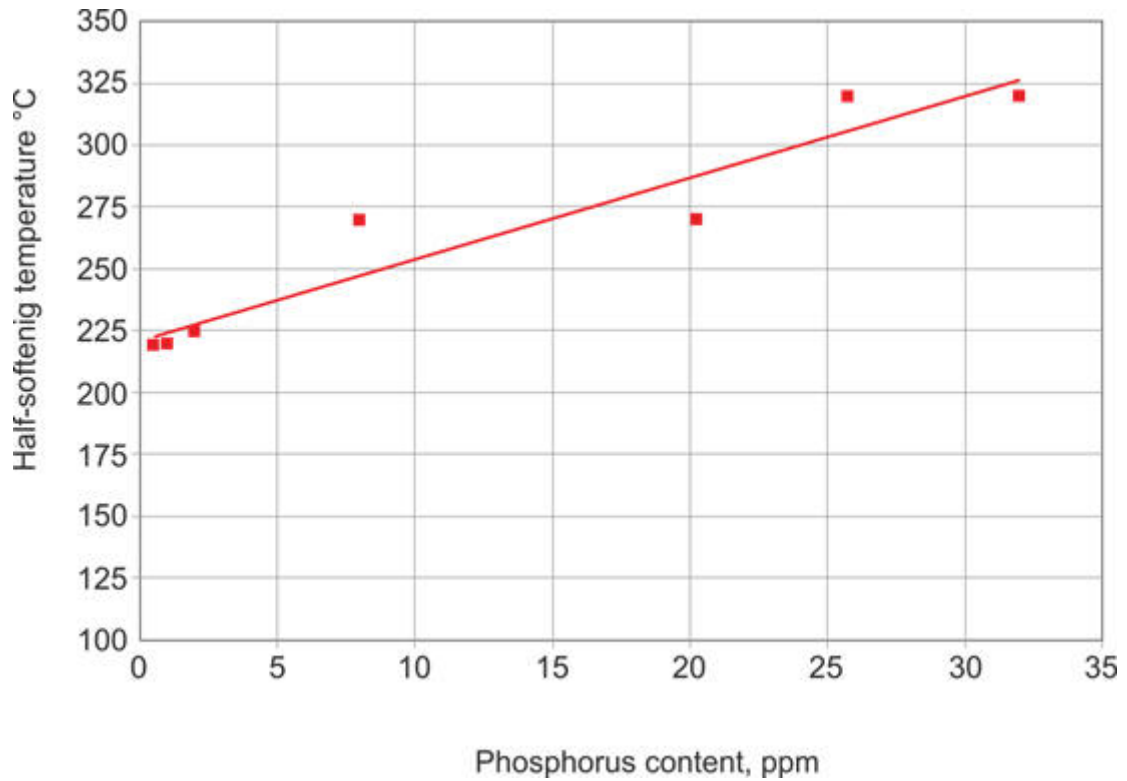


Softening resistance of Cu-HCP [Ref: 305]

**Long-term heat resistance, e.g. Arrhenius curve**

NO DATA AVAILABLE

**Half- softening temperature**



Half-softening temperature of Cu-PHC wire (diameter 2.00 mm) vs various P content, [Ref: 567]

## Corrosion resistance

### Hydrogen embrittlement resistance

Good hydrogen embrittlement resistance [Ref: 254, 310]

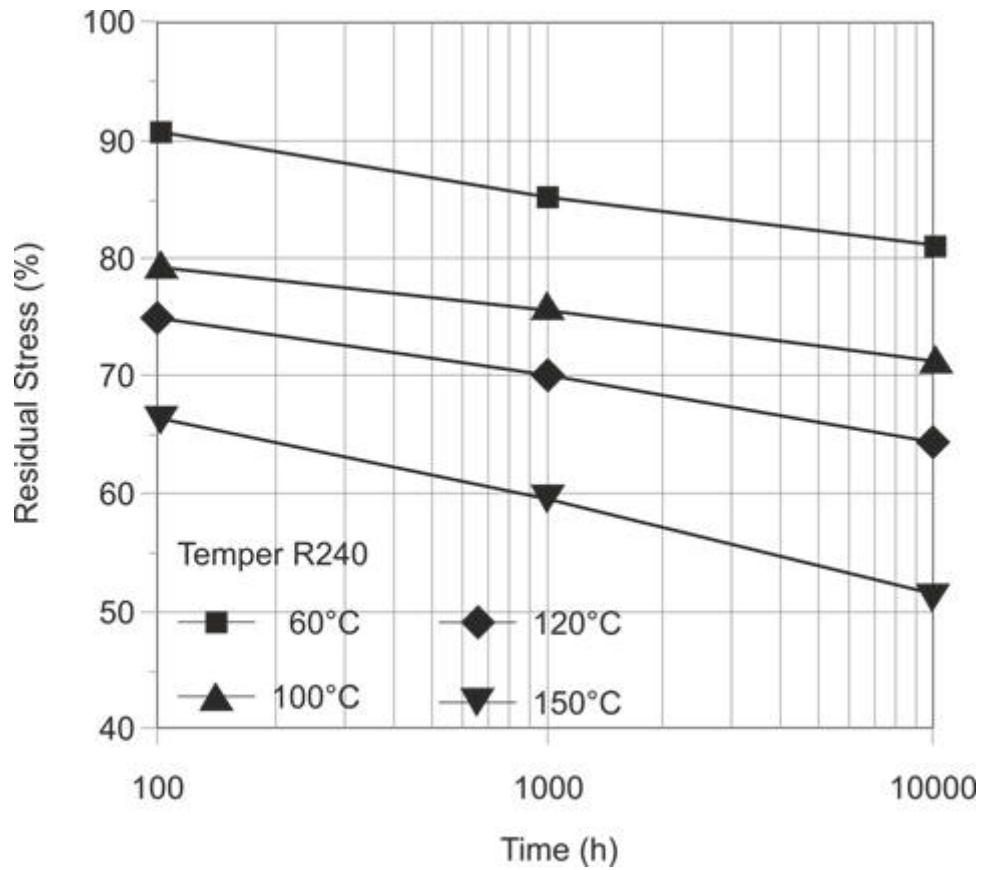
### Other kind of corrosion elements

Cu-PHC and Cu-HCP are resistant to industrial atmosphere, industrial and drinking water (max. flow rate approx. 1,5-2 m/s), pure water vapor, nooxidizing acids, alkalis. Cu-PHC is not resistant to oxidizing acids, hydrous ammonia and halogenated gases, hydrogen sulfide, seawater

Type of corrosion	Suitability	Literature
Atmospheric	Good	[Ref: 254, 310]
Marine environment	No data	-
Stress crack	No data	-
Hydrogen embrittlement	Good	[Ref: 254, 310]
Electrolytic	No data	-

## Rheological resistance

### Stress relaxation



*Stress relaxation resistance of Cu-HCP [Ref: 305]*

### Creep

NO DATA AVAILABLE

### Wear resistance

### Friction resistance

NO DATA AVAILABLE

### Fatigue resistance

### Fatigue cracking

Temper	Fatigue strength ( $100 \times 10^6$ ) cycles, MPa	Literature
1mm thick strip OS025	76	[Ref: 254]
H02 i H04	90	

### Impact strength

NO DATA AVAILABLE

## Fabrication properties

Fabrication properties	Value	Comments
Soldering	Excellent	
Brazing	Excellent	
Hot dip tinning	Excellent	
Laser welding	Fair	
Oxyacetylene Welding	Fair	
Gas Shielded Arc Welding	Excellent	
Coated Metal Arc Welding	Not recommended	
Resistance welding	Fair	
Spot Weld	Not recommended	
Seam Weld	Not recommended	
Butt Weld	Good	
Capacity for Being Cold Worked	Excellent	
Capacity for Being Hot Formed	Excellent	
Forgeability Rating	65	
Machinability Rating	20	
[Ref: 310, 252, 254]		

## Technological properties

Technological properties	Value	Comments
Melting temperature [°C]	1083	
Casting temperature [°C]	1140-1200	
Annealing temperature [°C]	225-650	
Stress relieving temperature [°C]	175-225	
Hot working temperature [°C]	750-950	
[Ref: 310, 252, 254]		



## References:

- 252. **Electronic Materials Handbook, vol.1 Packaging** - ASM International
- 254. **Copper and copper alloys** - J.Davis, ASM International, 2001
- 255. **Electrical and magnetic properties of metals** - Ch.Moosrigger, ASM International, 2000
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- 268. **Copper Development Association Inc.** - [www.copper.org](http://www.copper.org)
- 305. **Data sheet - K12** - Wieland
- 306. **Data sheet - K14** - Wieland
- 307. **Data sheet - Cu-PHC** - Kemper
- 308. **Data sheet - Cu-HCP** - Fornitrade LCC
- 309. **Data sheet - KME 159** - KME
- 310. **Data sheet - 10300** - Alloy Digest, June 2002
- 567. **AGH-UST - own research** - contact person: [tknych@agh.edu.pl](mailto:tknych@agh.edu.pl)