Cu & its Alloys

Grades of Pure Cu

- Tough Pitch Cu (0.04 – 0.05)% O₂
- Deoxidized Cu (0)% O₂
- O. F. H. C - Oxygen free high conductivity

Cu Alloys

- Brass - Cu - Zn
- Bronze - Cu - Sn
- Cupronickel - Cu - Ni
- Cupronickel - Cu - Ni - Zn (Nickel – Silver alloy)
- Precipitation Hardening Alloy - Cu – Be
- Precipitation Hardening Alloy - Cu - Cr
Cu & its Alloys

Heat Treatment of Cu & its Alloy:

- Homogenizing
- Annealing
- Stress Relieving
- Solution Treating
- Precipitation Hardening (Aging)

**Homogenizing:**

- Process that employs high temp. for a prolonged period to eliminate or decrease **Segregation in Casting** that are to be hot (H) or Cold worked (C. W).

  - Cu – Sn

  - Cu – Si

  { Subjected to homogenizing treated.

  - Cu – Ni

  - If Sn > 8% (are noted for **Segregation & Coring**) Homogenizing at 200 °F above max. annealing temperature.
Cu & its Alloys

**Annealing:**

- Heating the (Wrought metal) to $^\circ$T
  - 500 – 1200 $^\circ$f (Wrought Cu)
  - 800 – 1450 $^\circ$f (Wrought Cu Alloy)
  - that causes Recrystallization.

- Temperature & time are very important factors during annealing wrought Cu alloys except ($\alpha – \beta$, certain Precipitation hardening alloys) see fig. (31 a, b, c, d)

![Annealing curve for yellow Brass (65% Cu – 35 Zn) hard drawn 63% for 1 hour.](image)
Annealing:

- An increased amount of C. W. prior to annealing lowers the Recrystallization temperature.
- Annealing may be achieved by subsequent anneals (one or two anneals before final anneal) to produce the final grain size.

**Fig. (31 c & d)** Annealing curve for yellow Brass (65% Cu – 35 Zn) hard drawn 63% for 1 hour.

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To obtain best results when annealing Cu & its alloys the following precautions should be observed:

- **Sampling & Testing.**
- Effect of pretreatment (C. W. & anneal prior C. W. effect result obtained during annealing).
- Effect of time (the time in Furnace has an important effect on temp. of the metal).
- Oxidation (should be kept a minimum).
- Effect of lubricant.
- H₂ embrittlement (H₂ + O₂ (in Cu) → H₂O (Vapor) under pressure).
- Impurities.
Copper & its Alloys

**Stress Relieving:**

- Residual stress contributes to stress corrosion cracking in Brass alloy (Zn > 20%).
- Stressed Phosphor Bronze & Cu – Ni alloy are more susceptible to fire cracking (failure similar to stress corrosion cracking but caused when the stressed metal is rapidly heated to above a Recrystallization temp.).
- Low temp. for prolonged time is the deal cycle for relieving stressed and retaining mechanical properties.
- Typical stress relieving temp. for Cu alloys are (375 – 500) °F at 1 hr.

**Precipitation hardening:**

Cu – Al (Al > 10%)
Cu – Be
Cu – Cr
Cu – Zr

Alloys which are Precipitation hardening

- These alloys are hardened by cooling rapidly from high temp. to produce Martensitic type of structure and then tempering at a lower °T.
Solution treating of (Cu – Be) alloys:

- Solution treating temp. (1400 – 1900) °f depending on %Be.
  - # it decrease as %Be increase.
  - 1800 – 1900 °f for %Be of 0.1%.
  - 1425 – 1460 °f for %Be of 2.6 – 2.85%.

- Time at °T is (1 – 3) hr.
- Aging °T is (650 – 950) °f.
- All alloys are water Quenched immediately from the solution treating temperature.
- Shorter time may be desirable to prevent grain growth.
Cu & its Alloys

Cu – Cr alloys:

- Cu – Cr (0.8%) is solution treated at (1750 – 1850) °f.
- Rapidly quenched, C. W. in a manner similar to unalloyed Cu.
- Aged at (750 – 930) °f for 4 hr or more.

Mechanical properties of (Cu – Cr) alloys increased as follows:

<table>
<thead>
<tr>
<th></th>
<th>Solution treated</th>
<th>Solution treated + aged</th>
<th>Drawn + aged</th>
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</thead>
<tbody>
<tr>
<td>$\sigma$ (psi)</td>
<td>$35 \times 10^3$</td>
<td>$60 \times 10^3$</td>
<td>$70 \times 10^3$</td>
</tr>
<tr>
<td>$R_B$</td>
<td>50</td>
<td>60</td>
<td>80 - 85</td>
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