Aluminum and it's alloys

Properties and Applications

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The appearance of Aluminum ranges from ranging from silvery to dull gray (depending on the surface roughness)

1) Properties of Aluminum

- **3rd most abundant** element on earth (after oxygen and silicon) with 8% by weight.
- Aluminum and its alloys are characterized by a relatively **low density** (2.7 g/cm^3 as compared to 7.9 g/cm^3 for steel)
- It has **FCC** structure.
- **High electrical & thermal** conductivity.
- Aluminum is **nonmagnetic** and **non sparking**.
- It is also **insoluble** in alcohol & water.

- **Resistance to corrosion** : Corrosion resistance can be excellent due to a thin surface layer of aluminum oxide that forms when the metal is exposed to air, effectively preventing further oxidation. (phenomenon of passivation)
- It is easy to **cast** (low m.p.).

Surface of an aluminum bar

2) Applications of Aluminum

- Since it is **ductile**, it can be used to protect pure metals by Al foil.
- As it is **good conductor of electricity & cheap** so it is used for making electrical wires.
- Aluminum has **no aroma,** hence it is widely used in food packing and cooking pots.
- It is used in **mirrors** and other **decorative architectural components.**

However the application of pure aluminum is very rare as compared to that of it’s alloys.

Why is that so ?????

3) Limitations

- The chief limitation of aluminum is its low melting temperature (660 C), which restricts the maximum temperature at which it can be used.
- Moreover it is very soft, which restricts their application in automobile and aircrafts (where lightweight and stronger materials are required).

4) Alloys of Aluminum

- The typical alloying elements of aluminum are copper, magnesium, manganese and zinc.

Alloys of Al and it's composition

Alloy Name	Al (in %)	Cu (in %)	Mn (in %)	Mg (in %)	Zn (in %)
Duralumin	95	4	0.5	0.5	-
Magnalumin	70-90	-	-	30.10	-
Electron	9-10	-	0.5	87-86	3.5

5) Properties of Al alloys

- Aluminum and its alloys are characterized by a relatively **low density** (2.7 g/cm^3 as compared to 7.9 g/cm^3 for steel)
- Having almost equal **strength** as that of steel.
- **Resistance to corrosion** in some common environments, including the ambient atmosphere.
- Many of these alloys are easily formed by virtue of **high ductility.**
- It's tensile strength can be raised **by heat treatment** without affecting it's ductility.

- High **electrical and thermal conductivities**
- They have **excellent fatigue** and low-temperature toughness properties.

6) Application of Al alloys

- Aluminum alloys are widely used for **aeronautical** applications because of high strength weight ratio.
- For **automobiles** for reducing weight of the vehicle thus reducing fuel consumption.
- For applications as **electrical conductors** including overhead transmission lines.
- **House hold and consumer** items such as utensils.
- Used as **sacrificial anode**.
- **Marine** applications. For **surface transport** such as fittings in railway coaches and buses.
- Aluminum is also used in making **windows**, doors and roofs of factories.
- Also in **Sporting Equipments**.

7) Application in Oil & Gas sector

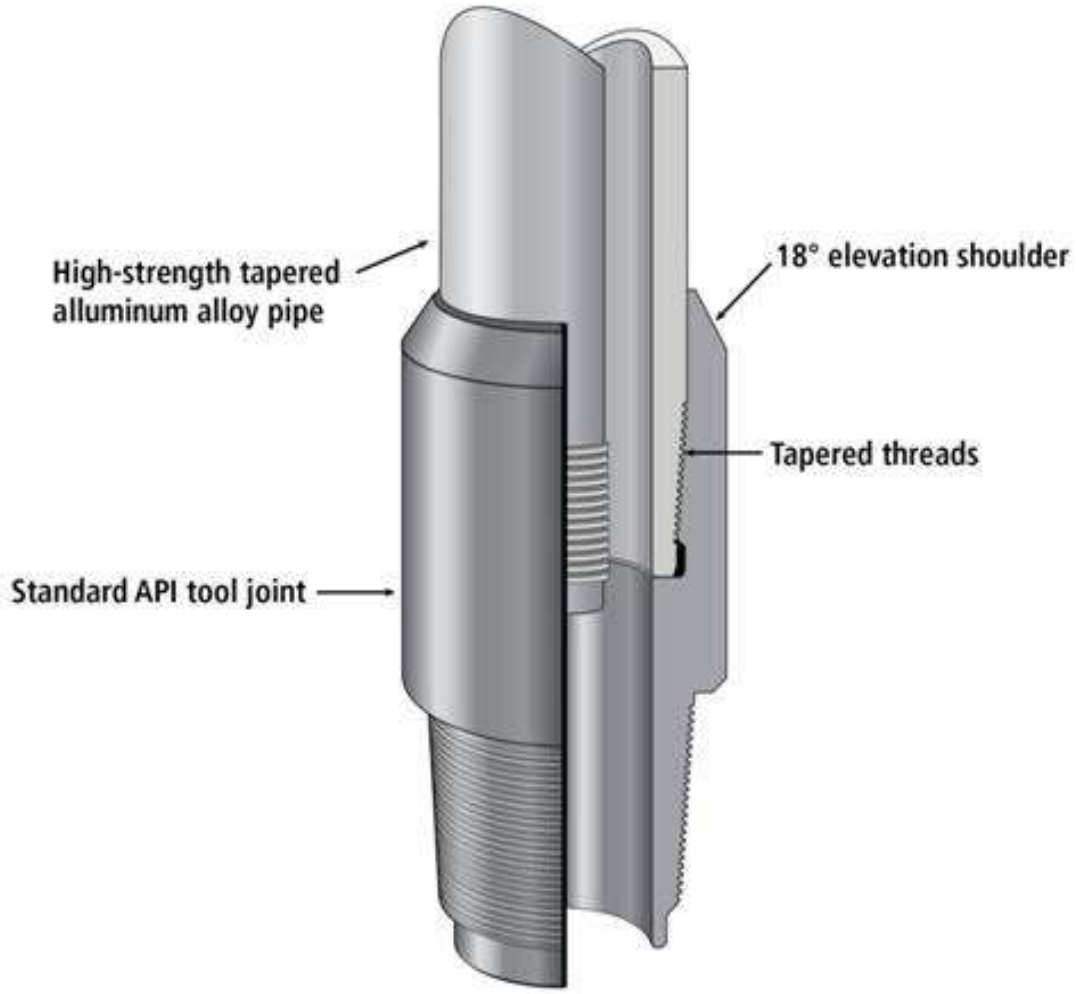
- **Upstream**:

(a) Material for drill pipe.

(b) Full aluminum or mixed aluminum/steel are also used in drill strings.

- **Midstream & Downstream**:

(a) For storage and transportation of CO2, air and oxygen.



Aluminum Alloy Drill Pipe is available in 3-1/2” and 5-1/2” sizes

8) Classification of Al

Aluminum alloys can be can be classified

- Wrought alloys
- Cast alloys

Each of these alloys can be further classified

(a) Non heat treatable alloys

(b) Heat treatable alloys

Table 11.7 Compositions, Mechanical Properties, and Typical Applications for Several Common Aluminum Alloys

Aluminum Association Number	UNS Number	Composition (wt%)[a]	Condition (Temper Designation)	Mechanical Properties: Tensile Strength [MPa (ksi)]	Mechanical Properties: Yield Strength [MPa (ksi)]	Mechanical Properties: Ductility [%EL in 50 mm (2 in.)]	Typical Applications/ Characteristics
			Wrought, Nonheat-Treatable Alloys				
1100	A91100	0.12 Cu	Annealed (O)	90 (13)	35 (5)	35–45	Food/chemical handling and storage equipment, heat exchangers, light reflectors
3003	A93003	0.12 Cu, 1.2 Mn, 0.1 Zn	Annealed (O)	110 (16)	40 (6)	30–40	Cooking utensils, pressure vessels and piping
5052	A95052	2.5 Mg, 0.25 Cr	Strain hardened (H32)	230 (33)	195 (28)	12–18	Aircraft fuel and oil lines, fuel tanks, appliances, rivets, and wire
			Wrought, Heat-Treatable Alloys				
2024	A92024	4.4 Cu, 1.5 Mg, 0.6 Mn	Heat treated (T4)	470 (68)	325 (47)	20	Aircraft structures, rivets, truck wheels, screw machine products
6061	A96061	1.0 Mg, 0.6 Si, 0.30 Cu, 0.20 Cr	Heat treated (T4)	240 (35)	145 (21)	22–25	Trucks, canoes, railroad cars, furniture, pipelines
7075	A97075	5.6 Zn, 2.5 Mg, 1.6 Cu, 0.23 Cr	Heat treated (T6)	570 (83)	505 (73)	11	Aircraft structural parts and other highly stressed applications
			Cast, Heat-Treatable Alloys				
295.0	A02950	4.5 Cu, 1.1 Si	Heat treated (T4)	221 (32)	110 (16)	8.5	Flywheel and rear-axle housings, bus and aircraft wheels, crankcases
356.0	A03560	7.0 Si, 0.3 Mg	Heat treated (T6)	228 (33)	164 (24)	3.5	Aircraft pump parts, automotive transmission cases, water-cooled cylinder blocks
			Aluminum–Lithium Alloys				
2090	—	2.7 Cu, 0.25 Mg, 2.25 Li, 0.12 Zr	Heat treated, cold worked (T83)	455 (66)	455 (66)	5	Aircraft structures and cryogenic tankage structures
8090	—	1.3 Cu, 0.95 Mg, 2.0 Li, 0.1 Zr	Heat treated, cold worked (T651)	465 (67)	360 (52)	—	Aircraft structures that must be highly damage tolerant

[a] The balance of the composition is aluminum.

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