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3. Study on the Characteristics of Metals

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Abstract:

Materials made of metal are among the most used in the engineering industry. Metallic bonds between atoms may be responsible for any of their properties, such as elastic constants. Metals' yield, flow, and fracture stress are controlled by their macro and microstructural features like point faults, dislocations, grain boundaries, and second phase particles. Modern imaging methods allow for the capture of images of microstructural elements. Metals are essential to the engineering process, thus it is important to understand their mechanical and fatigue properties. Metals utilized in engineering, such as wrought iron and mild steel, have been presented in this paper, along with their mechanical properties, as well as their proliferation and plasticity activities. Aluminized steel, iron, and silver are just some of the metals whose properties we investigate here.

Keywords:

Characteristics of Metals, Properties, Metals, Heavy Metal, Material Science.

3.1 Introduction:

Metals are fundamental to the fields of materials science and engineering, and have been used for centuries. Due to environmental and health concerns regarding heavy metals, metals are sometimes viewed as 'unfavourable materials' for medicinal reasons. There has been a lot of work done to increase corrosion resistance and mechanical endurance of metals for medical application, as safety is of paramount importance. While metals were formerly the standard for medical devices, advances in ceramics and polymers over the past three decades have made it possible to replace many metal devices with ceramic and polymer alternatives. Despite this progress, metal remains the material of choice for the vast majority of implant devices due to its strength, hardness, and endurance.

The advantages of metals are the following:

(a)	high strength
(b)	high elasticity
(c)	high fracture toughness
(d)	a combination of high elasticity and stiffness

3.1.1 General Physical Properties of the Metals:

- Shininess and metallic sheen characterize metals' appearances. Due to their glimmer, they can be utilized as ornaments and jewellery. Gold and silver, in particular, are frequently used for jewellery. Historically, mirrors were crafted from precious metals like silver. Because of this, silver is often used as a mirror. Nearly majority of the illumination that strikes it is reflected. These days, metal is only used as a thin coating on all mirrors.

- Electric lines in our homes are constructed of aluminium and copper. They are good conductor of electricity. Gold, silver, copper, and aluminium all conduct electricity well. Gold and silver are utilized for electrical contacts in computers. Electric cables are typically made of aluminium because of its low cost, however copper is utilized in most electrical products.

3.1.2 General Chemical Properties:

- By reacting with oxygen during combustion, metals produce basic oxides.

Metal + Oxygen (from air) → Metal Oxide

For example:

- Mg + O2 → 2 MgO (Magnesium Oxide)

MgO + H2 O → Mg (OH) 2 (Magnesium Hydroxide)

- Water's effects on various metals are not uniform. The combination of sodium with water produces sodium hydroxide and hydrogen gas. Magnesium has a weak reaction to water but a strong reaction to steam. Steam has a modest reaction with both zinc and iron. Gold, silver, and copper do not react with water. In the presence of water, the majority of metals create hydroxide.

$$2Na + H2\ O \rightarrow 2NaOH + H2$$

- The reactions of various metals with acids are quite varied. In the presence of an acid, most metals break down into salts and hydrogen.

$$\text{Metal} + \text{acid} \rightarrow \text{Salt} + \text{Hydrogen}$$

Generally speaking, metals can be divided into two categories: those that are ferrous and those that are not. Nonferrous materials consist of something besides iron, while iron materials are cantered on iron. Alloys of copper, aluminum, magnesium, silver, gold, plum, and zinc make up the bulk of non-ferrous items.

Other, less common nonferrous metals and alloys include cadmium, molybdenum, cobalt, zirconium, berkelium, titanium, tantalum, and the precious metals of gold, silver, and platinum. There are countless applications for nonferrous metals, and researchers are just beginning to scratch the surface of what may be done with this class of materials.

As a lightweight and malleable metal, aluminum has been crucial to this manufacturing process. Aluminum's unique properties allowed it to displace conventional materials including wood, copper, iron, and steel. The volumetric consumption of aluminum far exceeds that of any other non-ferrous element, including copper and its alloys, plumbing, tin, and zinc. Despite the fact that aluminum's production in factories didn't begin until the late 19th century, it has now achieved this position.

3.1.3 Objectives:

1) To study of characteristics of Metals.
2) To Analysis of physical and chemical properties of metals.
3) To concentration of the heavy metals.
4) To concentrations of the dissolved heavy metals.
5) Coefficient of the heavy metals with solid-water partition.

3.1.4 Review of Literature:

The environment lacks natural mechanisms for the removal of heavy metals. Thus, heavy metals can be found in variable concentrations throughout the Earth's ecosystems since they are present in the crust of the planet. However, human activities have severely disrupted the biogeochemical cycle and equilibrium of heavy metals in the world's ecosystems (Joseph et al., 2012). Extensive environmental degradation resulted from the expansion of 19th-century mining, industrial, and mechanized agricultural activities (Torres et al., 2012).

Heavy metal pollution from human activity is a major contributor to ecological crises in many regions of the world, particularly in water systems such as rivers, oceans, lakes, and wetlands. The absence of environmental systems capable of naturally eliminating heavy metals makes this problem much worse. [2]

Located between 40°43′ and 40°53′ North and 120°56′ and 121°05′ East, Jinzhou Bay is found to the east of the Bohai Sea and to the northwest of Liaodong Gulf. The bay is partially enclosed.

Bay waves are often storm waves, with a peak energy of 1508 J. Article by Wang et al. in Procedia Environmental Sciences Volume 13 (2012), Pages 1507-1516J. The seasonal feature was identified by Wang et al. / Procedia Environmental Sciences 8 (2011) 1534-1543 1535. Along the coast of Jinzhou Bay, one of China's older industrial bases, you'll find a wide variety of large and medium-sized businesses engaged in a wide range of manufacturing activities, including but not limited to metallurgy, petroleum, chemistry, mechanics, shipbuilding, and construction materials.

The bay is now one of the most polluted coastal areas in China due to the pollution released by such companies. The majority of the studies concerning the bay's ecology concerned the distribution pattern of heavy metals in the sediments floating on the water's surface. There is a lack of sufficient data on heavy metals in their dissolved and particle states. [3-6]

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Extreme environmental worry is raised when metals are leached into groundwater from toxic waste dumps. Chlorides, nitrates, heavy metals, and hydrocarbons are the four most common pollutants in groundwater, according to Pye & Patrick (1983). The concentration of many pollutants is much higher in groundwater than in surface water (Page, 1981). The concentration of metalion in natural waterways is substantially impacted by interactions with other components, such as clay particles and dissolved organic materials.

To wit: (Slavek & Pickering, 1998). Heavy metal pollution of sediments (Eduljee et al., 1985) and waters has been documented through scientific inquiry (Paulson & Feely, 1985; Laumond et al., 1984). [8-9]

Metals are classified according to their absorption properties, with Ahrland et al. (1958) introducing a system based on the covalent index (i.e. Electronegativity 2 radius) to discriminate between metals with differing affinities to donor ligands. On the basis of their covalent indices, metal ions are categorized as either Type A (hard metals), Type B (soft metals), or intermediate. A number of metals of types B and c, referred to as heavy metals in this thesis, constitute the primary emphasis because that is the most used shorthand for it. The element selenium (Se) is classified as a metalloid rather than a true metal. However, it was categorized as "heavy metal" and included in the study. [10]

3.2 Research Methodology:

We learned about metals, heavy metals, using secondary sources, such as books, educational and development periodicals, government papers, and print and online reference resources. The mechanical and tissue compatibility of metals is governed by their mechanical and surface properties, both of which are the subject of ongoing research and development. In this article, we examine recent findings about the study of metallic materials in dentistry and other medical applications.

3.2.1 Result and Discussion:

A. Concentrations of heavy metals in airborne particles:

Table 3.1 displays the findings of the determination of the concentrations of the particulate heavy metals. With the exception of as, the range of heavy metals was rather constant between different stations.

Table 3.1: The concentration of the heavy metals

Item	Cu	pb	Zn	Cd	Hg	As
The lower value(ug/L)	0.066	1.249	1.040	0.017	0.015	0.026
The highest value (ug/L)	0.953	7.036	7.898	0.105	0.042	1.873
The average value (ug/L)	0.446	3.664	4.045	0.047	0.027	0.403
The means RSD %	49.28	47.02	45.49	53.75	26.40	124.64

Data from Table 3.1 shows that when the dissolved and particulate forms of the heavy metals Cu, Zn, Cd, Hg, and as were compared, the dissolved forms had higher amounts. When comparing Hg levels between the two stages, there was little to no discernible change. [11]

B. Dissolved heavy metal concentrations:

Table 3.2 displays the final decision made. Dissolved heavy metals had mean values of 3.06, 0.61, 11.87, 0.92, 0.030, and 2.190 g/L for Cu, Pb, Zn, Cd, Hg, and as, respectively.

Pb and Zn had the highest relative standard deviations. There was an inefficient distribution of the two types of components. Better dispersion of Cu and as content. Table 2 shows a comparison of the dissolved heavy metal concentrations in the first few meters of seawater in Jinzhou Bay to the Chinese Seawater Quality Standard (GB3097-1997).

Table 3.2: The concentrations of the dissolved heavy metals

Items	Cu ug/L	Pb ug/L	Zn ug/L	Cd ug/L	Hg ug/L	As ug/L	References
Jinzhou	3.06 1.26-6.49	0.61 0.21-1.39	11.87 1.58-25.73	0.92 0.56-2.04	0.030 0.006-0.058	2.190 1.142-3.655	This paper
RSD%	38.91	53.23	59.81	43.11	49.33	35.34	
The primary standards of Seawater Quality Standard of China	< 5	< 1	< 20	< 1	< 0.05	< 20	GB3097-1997
Excessive rate %	5	10	15	25	15	0	

Except for as, all of the heavy metal concentrations were over the primary standard. Cd contamination is the most problematic heavy metal pollution since its concentrations were found to be over the primary criterion at around 25% of the sites. Heavy metal pollution was highest for cadmium, followed by zinc, mercury, lead, copper, and arsenic in that order of increasing toxicity.

C. The pH: salinity, concentration of suspended materials, and specific size all play a role in how heavy metals in seawater are classified, which has important implications for their mobility, behaviour, and bioavailability in the marine environment.

Table 3.3: The solid-water partition coefficient of the heavy metals

Items	Cu	pb	Zn	Cd	Hg	As
The dissolved ratio %	86.44	17.00	70.73	94.80	50.59	85.21
The particulate ratio %	13.56	83.00	29.27	5.20	49.41	14.79
Kd	0.162	8.531	0.566	0.056	1.355	0.232

Dissolved heavy metal to particulate metal ratios are displayed in Table 3.3. Pb was predominantly present in its particle state, which accounted for 83,000.00% of the total concentration. Previous to their current dissolved state, the other heavy metals did exist. [12-13]

All around us are objects that are either metal or non-metal, and it is important to know the difference. It's crucial that we have a firm grasp on what sets metals apart from non-metals and how their reactivity works. A table detailing the relative reactivity of several metals is presented in the reactivity series.

It can be used to foretell the reactivity of metals to water and acids, as well as whether or not one metal can displace another in a metal reaction. You may also use the examples from the reactivity series to figure out if a displacement reaction is single or double.

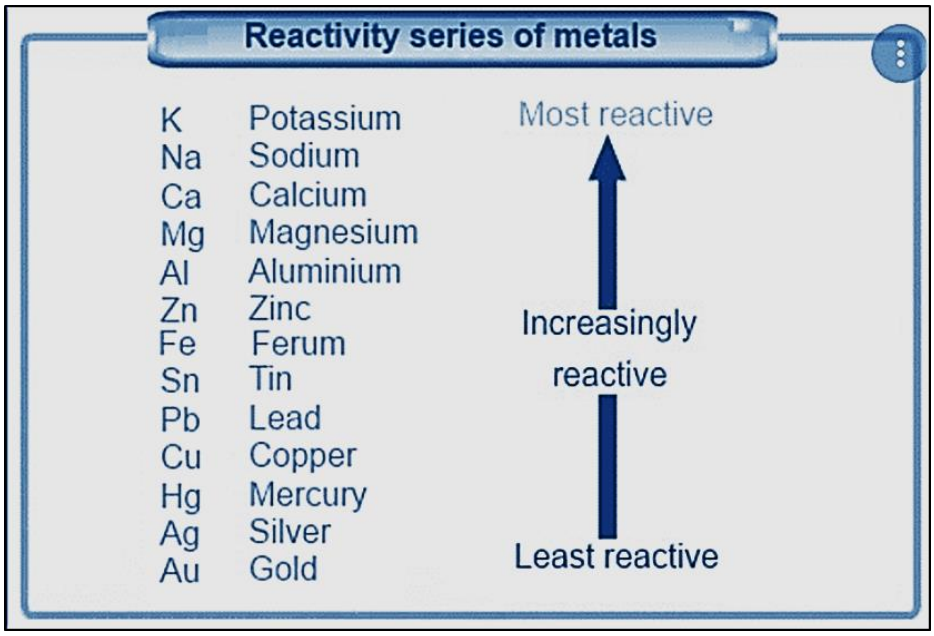

Figure 3.1: Reactivity Series of Metals

As can be seen from Figure 3.1, all metals and non-metals have distinctive properties that can be utilized to determine whether or not they react strongly with air, water, or acid.

3.3 Conclusion:

For the past couple of centuries, metals have been civilization's most important material. Having read thus far, you should have a good idea of what counts as metal and what doesn't, and you'll have a better idea of how to tell them apart.

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