UNIT – III

WEAR AND CORROSION AND THEIR PREVENTION

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

WEAR AND CORROSION AND THEIR PREVENTION

Wear and corrosion are two common types of material degradation that can affect a wide range of industrial and everyday objects. Both can lead to significant damage and economic losses if not properly addressed. Let's explore wear and corrosion, their causes, and methods of prevention.

Wear:

1. Types of Wear:

Abrasive Wear: Occurs when hard particles or abrasive materials come into contact with a surface, causing it to wear down gradually.

Adhesive Wear: Happens when two surfaces in relative motion adhere to each other and then separate, causing material to transfer between them.

Fatigue Wear: Occurs due to repeated cyclic loading and unloading of a material, leading to crack formation and eventual failure.

Erosive Wear: Results from the impact of solid particles or liquid droplets on a surface, leading to material removal.

Causes of Wear:

Friction between moving parts.

High-speed motion.

Particle contamination.

Poor lubrication.

Mechanical stress.

Prevention of Wear:

Lubrication: Proper lubrication can reduce friction between moving parts.

Surface Hardening: Heat treatment methods can increase surface hardness and resistance to wear.

Material Selection: Choosing wear-resistant materials such as ceramics, hard coatings, or composite materials**.**

Maintenance: Regular maintenance and inspection of equipment can help identify wear issues early.

Design Modifications: Redesigning components to minimize wear-prone areas.

Corrosion:

1. Types of Corrosion:

Uniform Corrosion: Occurs evenly across the entire surface of a material.

Localized Corrosion: Happens in specific areas and includes forms like pitting corrosion andcrevice corrosion.

Galvanic Corrosion: Occurs when two dissimilar metals are in contact in the presence of an electrolyte.

Intergranular Corrosion: Takes place along grain boundaries of a material.

Stress Corrosion Cracking: Caused by the combined effect of tensile stress and a corrosive environment.

Causes of Corrosion:

Exposure to moisture and

oxygen.Chemical exposure.

High temperatures.

Electrical potential differences (galvanic corrosion).

Stress and strain in the material (stress corrosion cracking).

Prevention of Corrosion:

Protective Coatings: Applying coatings such as paint, plating, or corrosion-resistant polymers.

Corrosion-Resistant Materials: Using materials that are naturally resistant to corrosion, like stainless steel or corrosion-resistant alloys.

Cathodic Protection: Placing sacrificial anodes or using impressed current systems to protect metals from corrosion.

Proper Design: Design structures and components to minimize moisture and oxygen exposure.

Environmental Control: Keeping corrosive substances away from materials or providingproper ventilation.

In summary, wear and corrosion can have detrimental effects on materials and equipment. Preventing wear involves reducing friction and choosing appropriate materials, while preventing corrosion requires protecting materials from exposure to corrosive environments. A combination of good design, proper maintenance, and suitable materials cango a long way in mitigating both wear and corrosion-related issues

Define Wear

Wear is the gradual deterioration of a material's surface due to mechanical action,often resulting from friction or contact with other surfaces, leading to the loss of material and potential damage or degradation of the affected object or component.

Wear, in the context of materials and engineering, refers to the gradual loss or deterioration of the surface of a material due to the mechanical action of one or more externalforces. It occurs when two surfaces are in relative motion or when there is contact between them, resulting in the removal of material from one or both of the surfaces. Wear can manifestin various forms, including abrasion, adhesion, fatigue, or erosion, depending on the specific mechanisms and conditions involved. It is a common phenomenon that can lead to the deterioration and failure of components, machinery, and structures over time. Preventing wearis crucial in various industries to ensure the longevity and reliability of equipment and materials.

Types of Wear

There are several types of wear, each characterized by different mechanisms and causes. The main types of wear include:

1. **Abrasive Wear:** This type of wear occurs when hard particles or abrasive materials come into contact with a surface, causing gradual material removal. It is common in applications where abrasive substances like sand, grit, or minerals are present.
2. **Adhesive Wear:** Adhesive wear happens when two surfaces in relative motion adhere to each other and then separate, causing material to transfer between them. It often occurs in metal-on-metal contacts and can lead to surface damage and component failure.
3. **Fatigue Wear:** Fatigue wear results from repeated cyclic loading and unloading of a material, leading to the formation of cracks and eventual failure. This type of wear is prevalent in components subjected to cyclic stress, such as springs or rotating machinery.
4. **Erosive Wear:** Erosive wear occurs due to the impact of solid particles or liquid droplets on a surface, leading to material removal. Examples include erosion of aircraft surfaces due to rain and the wear of industrial components exposed to abrasive materials.
5. **Corrosive Wear:** Corrosive wear is a combination of wear and corrosion. It happens when a corrosive environment weakens the protective layer on a material's surface, making it more susceptible to wear. This type of wear is common in applications involving chemicals or exposure to harsh environments.
6. **Fretting Wear:** Fretting wear occurs in small, repetitive movements or vibrations between two surfaces in contact. It can lead to material removal, especially at the contact points, and is often seen in bolted or press-fitted assemblies.
7. **Rolling Wear:** Rolling wear is primarily observed in rolling contacts, such as in bearings or wheels. It involves the gradual wear of the contact surfaces due to rolling motion.
8. **Sliding Wear:** Sliding wear occurs when two surfaces slide past each other, generating friction and leading to material loss. It is common in applications like sliding bearings, gears, and brake systems.
9. **Cavitation Wear:** Cavitation wear happens when the rapid formation and collapse of vapor bubbles in a liquid lead to pitting and material damage on surfaces, often seen inpumps and propellers.

Understanding the specific type of wear involved is crucial for designing preventive measures and selecting appropriate materials and lubrication methods to mitigate wear-relatedissues and prolong the life of components and machinery.

Wear Causes

The causes of wear are varied and can depend on the specific type of wear being considered. However, some common causes and contributing factors to wear include:

1. **Friction:** Friction between two surfaces in relative motion generates heat and mechanical forces, which can lead to material removal and wear.
2. **Abrasive Particles:** The presence of abrasive particles like sand, dust, grit, or debris can accelerate wear by physically abrading the surface of materials.
3. **Lack of Lubrication:** Insufficient or ineffective lubrication can increase friction and promote adhesive wear or abrasive wear between moving parts.
4. **High-Speed Motion:** Components moving at high speeds experience greater forces and can be more susceptible to wear due to increased friction and heat generation.
5. **Mechanical Stress:** Excessive mechanical stress, such as high loads or repeated cyclic loading and unloading, can lead to fatigue wear, causing cracks and material failure.
6. **Corrosive Environments:** Exposure to corrosive substances like chemicals or moisture can weaken a material's surface, making it more susceptible to wear.
7. **Electrochemical Factors:** In cases of galvanic corrosion, the electrochemical interaction between dissimilar metals in the presence of an electrolyte can promote wear.
8. **Temperature Extremes**: Extreme temperatures can affect material properties and lubrication, influencing the wear rate.
9. **Improper Material Selection:** Choosing materials that are not suitable for the specific application or environment can lead to accelerated wear.
10. **Inadequate Surface Finish:** Rough or uneven surface finishes can create localized stress concentrations, increasing wear susceptibility.
11. **Fretting:** Small, repetitive movements or vibrations, known as fretting, can occur at the contact points between two surfaces, leading to wear.
12. **Cavitation:** In cavitation wear, rapid formation and collapse of vapor bubbles in a liquid cause pitting and material damage on surfaces.
13. **Chemical Reactions:** In some cases, chemical reactions between materials and their environment can contribute to wear, especially in corrosive or chemically aggressive settings.

Understanding the specific causes of wear in a given application is essential for implementing effective preventive measures and selecting appropriate materials and lubrication methods to minimize wear-related problems and extend the lifespan of componentsand machinery.

Wear Effects

Wear can have various effects, depending on its type, severity, and the components or materials involved. Some common effects of wear include:

1. **Loss of Material:** One of the most immediate and noticeable effects of wear is the

gradual removal of material from the surfaces in contact. This can result in the thinning of components, leading to reduced functionality and structural integrity.

2. **Surface Damage:** Wear can lead to surface roughening, pitting, scratches, and grooves, which can negatively impact the appearance and performance of components.

3. **Increased Friction:** As surfaces wear down, friction between them often increases, leading to reduced efficiency, higher energy consumption, and increased heat generation.

4. **Reduced Lubrication Effectiveness:** Wear can compromise the effectiveness of lubrication systems, leading to even more significant friction and accelerated wear.

5. **Component Failure:** In severe cases, wear can lead to the failure of critical components, resulting in costly repairs, downtime, and potentially hazardous situations,especially in machinery and equipment.

6. **Tolerance Changes:** Wear can alter the dimensional tolerances of components, which can lead to poor fits, misalignment, and decreased performance.

7. **Increased Noise and Vibration:** As surfaces wear and become less smooth, noise and vibration levels often increase, affecting the comfort and safety of users.

8. **Loss of Functionality:** Wear can impair the functionality of components, leading to reduced performance and potentially rendering the equipment or system unusable.

9. **Safety Risks:** In certain applications, such as in the aerospace or automotive industry, wear-related issues can pose safety risks if critical components fail due to wear-induced damage.

10. **Economic Costs:** The effects of wear can result in significant economic costs, including repair or replacement expenses, increased maintenance, and reduced productivity.

11. **Environmental Impact:** Increased wear can lead to higher energy consumption and emissions, contributing to environmental concerns.

12. **Aesthetic Issues:** In consumer products, wear can negatively affect the appearance of items, leading to reduced aesthetics and perceived value.

13. **Increased Maintenance:** To address wear-related issues and extend the life of components, increased maintenance, and inspections may be necessary, adding to operational costs.

To mitigate the adverse effects of wear, preventive measures such as proper lubrication, material selection, design modifications, and regular maintenance are commonly employed across various industries. Understanding the specific effects of wear and its underlying causes is essential for effective wear prevention and management.

Wear Reduction Methods

Reducing wear is crucial to extend the lifespan of components, machinery, and equipment while minimizing maintenance costs. Here are several methods and strategies to reduce wear:

1. Lubrication: Proper lubrication is one of the most effective ways to reduce wear. Lubricants create a protective film between moving surfaces, reducing friction and minimizing contact, which in turn reduces wear. Ensure that the right type and quantity

of lubricant are used and that lubrication schedules are followed.

2. **Material Selection:** Choosing wear-resistant materials can significantly reduce wear rates. Materials like hardened steel, ceramics, and certain polymers are known for their resistance to wear. Select materials based on the specific application and environmentalconditions.
3. **Surface Treatments:** Applying surface treatments, such as hard coatings or plating, can increase the wear resistance of materials. Processes like nitriding, carburizing, and thermal spraying can harden the surface and make it more wear-resistant.
4. **Polishing and Surface Finish:** Smoother surfaces experience less friction and wear. Proper machining and finishing techniques can help achieve smoother surfaces, reducing wear and improving performance.
5. **Proper Alignment and Tolerance:** Ensure that components are correctly aligned and manufactured within specified tolerances. Misaligned or poorly fitted parts can experience increased wear due to uneven contact.
6. **Design Modifications:** Redesigning components or systems to minimize wear-prone areas and distribute loads more evenly can significantly reduce wear. For example, using rolling instead of sliding contact can reduce wear.
7. **Sacrificial Components:** Implementing sacrificial wear parts, such as replaceable bushings or liners, can protect critical components from wear and be more cost-effective to replace than entire components.
8. **Maintenance Practices:** Regular maintenance, including inspections, cleaning, and adjustments, can help identify wear-related issues early, preventing further damage andminimizing downtime.

9. **Environment Control:** Control the operating environment to reduce wear. This may involve reducing contamination, controlling temperature and humidity, or minimizing exposure to corrosive substances.
10. **Cathodic Protection:** In cases of galvanic corrosion, using cathodic protection systems can reduce wear by preventing the corrosion of metals through the use of sacrificial anodes or impressed current systems.
11. **Cavitation Control:** To reduce cavitation-induced wear, altering fluid flow or using specialized designs in pumps and other equipment can be effective.
12. **Education and Training:** Proper training of personnel involved in equipment operation and maintenance can help prevent wear due to incorrect usage or mishandling.
13. **Monitoring and Condition-Based Maintenance:** Implement monitoring systems that can detect wear-related issues early, allowing for timely maintenance and repairs.
14. **Use of Polymers and Lubricious Materials:** In applications where friction and wear are concerns, using polymers or lubricious materials that inherently reduce friction canbe beneficial.
15. **Load Reduction:** Minimizing excessive loads or overloading of components can reduce wear and prevent premature failure.

Applying a combination of these methods, tailored to the specific application and conditions, can effectively reduce wear and extend the life of components and machinery. It's important to conduct thorough assessments and consult with experts when implementing wearreduction strategies to ensure their effectiveness.

Define Lubricants

Lubricants are substances that reduce friction between moving surfaces by creating a protective layer, allowing for smoother motion and reducing wear and heat generation.

Lubricants are substances, typically in the form of liquids or semi-liquids, that are used to reduce friction and minimize wear between moving surfaces in contact with each other. They are employed in various mechanical systems and industrial applications to create a protective layer or film between the surfaces, allowing them to move more smoothly and with less resistance. Lubricants serve several essential functions, including reducing heat generation, preventing corrosion, and improving the overall efficiency and longevity of machinery and equipment. Common examples of lubricants include oils, greases, and synthetic lubricants, each tailored to specific applications and environmental conditions.

Lubricants Types

Lubricants come in various types, each tailored to specific applications and conditions. The main types of lubricants include:

1. **Liquid Lubricants:**

- **Mineral Oils:** Derived from crude oil and commonly used in automotive engines and machinery.
- **Synthetic Oils:** Chemically engineered lubricants with specific properties, often used in high-performance and extreme-temperature applications.
- **Biodegradable Oils:** Environmentally friendly lubricants used in applications where ecological concerns are paramount, such as forestry equipment.

2. **Greases:** These are semi-solid lubricants consisting of a base oil thickened with a soap, polymer, or other thickening agent. Greases are used in applications where a more viscous and adhesive lubricant is required.
3. **Solid Lubricants:** Solid lubricants are materials that reduce friction and wear without becoming a liquid. Common examples include graphite and molybdenum disulfide (MoS_2).
4. **Dry Lubricants:** Dry lubricants, such as PTFE (Teflon), are typically applied as a dry powder or coating and reduce friction without the need for liquid lubrication.
5. **Gas Lubricants:** Gases like air or nitrogen can be used as lubricants in certain applications, such as in air bearings or some high-speed machinery.
6. **Boundary Lubricants**: These lubricants form a protective boundary film on surfaces, reducing direct metal-to-metal contact. Examples include anti-wear additives in engine oils.
7. **Extreme Pressure (EP) Lubricants:** EP lubricants are designed to withstand high loads and pressures. They often contain additives that form a protective film under extreme conditions.

8. **High-Temperature Lubricants:** Lubricants formulated to perform well in high-temperature environments, such as in industrial ovens or metalworking applications.
9. **Low-Temperature Lubricants:** Lubricants designed to remain effective at very low temperatures, commonly used in refrigeration and cryogenic applications.
10. **Biological Lubricants:** Some applications require lubricants that are compatible with biological systems, such as medical devices or food processing equipment. These lubricants are often food-grade and biocompatible.
11. **Specialty Lubricants:** Lubricants with unique properties for specific industries or applications, such as aerospace, marine, or the textile industry.

The choice of lubricant depends on factors such as the type of machinery or equipment, operating conditions, temperature range, load, and environmental considerations. Selecting the appropriate lubricant is crucial to ensure efficient operation, reduce wear and friction, and extend the life of components.

Applications of Lubricants

Lubricants have a wide range of applications across various industries and settings where reducing friction and wear between moving parts is essential. Here are some common applications of lubricants:

1. **Automotive Industry:**

- Engine Lubrication: Lubricants like motor oil reduce friction and heat in engines, ensuring smooth operation and preventing wear.
- Transmission and Gear Lubrication: Gear oils or transmission fluids keep gears and bearings properly lubricated.
- Chassis Lubrication: Grease is applied to chassis components such as ball joints, tie rod ends, and suspension parts to reduce friction and prevent corrosion.

2. **Industrial Machinery:**

- **Bearings:** Lubricants keep industrial bearings, such as those in conveyor systems, turbines, and pumps, running smoothly.
- **Hydraulics:** Hydraulic fluids are used in hydraulic systems to transfer power efficiently and lubricate moving parts.
- **Gears:** Gear oils are applied to gears in various machinery, including manufacturing equipment and heavy machinery.

3. **Aerospace and Aviation:**

- **Aircraft Engines:** High-performance lubricants are crucial for the reliable operation of aircraft engines.
- **Landing Gear:** Lubricants are used to ensure smooth functioning of landing gear mechanisms.

4. **Marine Industry:**

- **Ship Engines:** Marine lubricants are used in ship engines and equipment to withstandharsh saltwater environments.

- **Winches and Pulleys:** Lubricants keep winches and pulleys operating smoothly on ships.

5. **Mining and Construction:**

- **Heavy Equipment:** Lubricants are used to reduce wear and extend the life of heavy machinery like bulldozers, excavators, and loaders.

- **Conveyor Systems:** Conveyor belts and components are lubricated to ensure efficientmaterial handling.

6. **Food Processing:**

- **Food-Grade Lubricants:** Special food-grade lubricants are used in the food industry to ensure product safety and maintain equipment hygiene.

7. **Medical Devices:**

- **Medical Equipment:** Lubricants are applied to various medical devices, such as surgical instruments and imaging equipment, to ensure precise and smooth operation.

8. **Textile Industry:**

- **Textile Machinery:** Lubricants are used in textile manufacturing machinery to reduce friction and improve the efficiency of production processes.

9. **Energy Production:**

- **Wind Turbines:** Lubricants are used in wind turbine gearboxes and bearings to ensure the efficient generation of electricity.

- **Nuclear Power Plants:** Lubricants are applied to components in nuclear power plants to maintain smooth operation and prevent corrosion.

10. **Consumer Products:**

- **Household Appliances:** Lubricants are used in various consumer products like sewing machines, vacuum cleaners, and kitchen appliances to reduce friction and extend their lifespan.

11. **Railroad Industry:**

- **Railway Bearings and Tracks:** Lubricants are applied to railway components to reduce wear and improve the performance of trains.

12. **Oil and Gas Industry:**

- **Drilling Equipment:** Lubricants are used in drilling operations to reduce friction and heat in drilling machinery.

13. **Automated Manufacturing:**

- **Robots and CNC Machines:** Lubricants are essential for the precise and smooth movement of robotic arms and CNC machining equipment.

14. **Printing Industry:**

- **Printing Presses:** Lubricants are used in printing presses to reduce friction between rollers and ensure high-quality printing.

15. **Automotive Aftermarket:**

- **DIY Maintenance:** Lubricants are used by individuals for maintenance and DIY projects on their vehicles.

These are just a few examples, and lubricants play a crucial role in many other industries and applications where the reduction of friction and wear is necessary for efficient operation and equipment longevity.

Lubrication methods

Lubrication is a critical aspect of machinery and equipment maintenance. Various lubrication methods are employed to ensure that moving parts remain well-lubricated, reducingfriction and wear. Here are some common lubrication methods:

1. **Manual Lubrication:**

- In manual lubrication, an operator applies lubricant directly to the lubrication pointsusing tools such as oil cans, grease guns, or brushes.
- This method is suitable for equipment with relatively few lubrication points or forperiodic maintenance tasks.

2. **Centralized Lubrication Systems:**

- Centralized lubrication systems use automated pumps and distribution systems todeliver lubricant to multiple lubrication points simultaneously.
- These systems can be programmed to provide precise and consistent lubrication,reducing the risk of over-lubrication or under-lubrication.

3. **Automatic Lubrication Systems:**

- Automatic lubrication systems, also known as lubrication or lubricators, deliver acontrolled amount of lubricant at regular intervals to specific lubrication points.
- These systems are ideal for machinery with numerous lubrication points or wherecontinuous lubrication is required.
- Types of automatic lubrication systems include single-point lubricators, multi-pointlubrication systems, and progressive lubrication systems.

4. **Mist and Aerosol Lubrication:**

- Mist and aerosol lubrication systems atomize the lubricant into fine droplets or particles, which are then carried to the lubrication points by a stream of air.
- These systems are often used in environments where traditional liquid lubricants arenot practical, such as high-temperature or dusty conditions.

5. **Oil Bath Lubrication:**

- In oil bath lubrication, a component or bearing is partially submerged in a pool of oil.
- As the component rotates or moves, it picks up oil, providing continuous lubrication.
- This method is commonly used in applications like gearbox lubrication.

6. **Oil Circulation Lubrication:**

- Oil circulation systems pump oil through pipes and channels to lubricate variouscomponents, such as bearings, gears, or turbine blades.
- These systems often include filters and coolers to maintain the quality and temperatureof the lubricating oil.

7. **Grease Lubrication:**

- Grease is applied directly to lubrication points using grease guns or dispensing equipment.
- Grease is a semi-solid lubricant that stays in place and provides long-lasting lubrication.
- It is commonly used in applications where oil lubrication may not be practical.

8. **Drip Lubrication:**

- Drip lubrication involves allowing lubricant to drip or flow onto lubrication points at a controlled rate.
- This method is suitable for applications with slow-moving parts or where continuouslubrication is needed.

9. **Fogging Lubrication:**

- Fogging systems use compressed air to create a mist of lubricant, which is then directedto lubrication points.
- It is used in applications where precise lubrication and minimal oil consumption areessential.

10. **Brush Lubrication:**

- Brushes or wicks soaked in lubricant are placed in contact with moving parts, allowing for continuous lubrication as the parts come into contact with the brush.

11. **Solid Lubrication:**

- Solid lubricants, such as graphite or molybdenum disulfide, are applied as coatings orinserts in areas where traditional liquid or grease lubricants are not suitable.

The choice of lubrication method depends on factors such as the type of equipment, the number of lubrication points, the operating environment, and the desired level of automation. Proper lubrication is essential for maximizing equipment performance, minimizing wear, and extending the lifespan of machinery and components.