Nov 2020

1. State the action to be taken by the watch keeping engineer in the event of EACH of the following:

   (a) flooding; (6)

   (b) failure of main propulsion machinery. (4)

Nov 2020

2. State the purpose of infra red photography, explaining where it could be used as part of a condition monitoring programme. (10)

Nov 2020

3. With reference to MARPOL Annex V:

   (a) list the THREE recognised complimentary garbage handling techniques; (3)

   (b) describe the basic requirements of a Garbage Management Plan; (5)

   (c) define what is meant by *E-Waste*. (2)

Nov 2020

4. With reference to marine diesel oil:

   (a) define EACH of the following terms, stating the unit used in EACH:

      (i) density; (2)

      (ii) viscosity; (2)

      (iii) flash point. (2)

   (b) excluding the THREE terms listed in part (a), state FOUR items of information contained on a Bunker delivery note. (4)

Nov 2020

5. With reference to sewage treatment plants:

(a) explain the difference between *black water* and *grey water*; (2)

(b) explain the difference between aerobic and anaerobic micro organisms; (3)

(c) list THREE dangerous gases produced under anaerobic conditions; (3)

(d) explain the dangers of producing the gases listed in part(c) in a confined space. (2)

Nov 2020

6. (a) With reference to food storage rooms:

(i) state, with reasons, the possible danger present in a room used for storing vegetables and fruit; (2)

(ii) state the devices necessary to prevent a person from becoming trapped in a storage room. (3)

(b) State FOUR methods of detecting a refrigeration gas leak. (4)

(c) State the name of the international agreement which stipulates that the production and consumption of compounds that deplete ozone in the stratosphere is phased out. (1)

Nov 2020

7. With reference to reverse osmosis plants:

(a) explain the treatment that the feedwater undergoes to prevent blockage of the membranes; (3)

(b) describe how the purity of the water is measured and protected, stating the limits on purity set by the World Health Organisation; (5)

(c) outline the further treatment the permeated water undergoes before it can be used for domestic purpose. (2)

Nov 2020

8. Explain, with the aid of a sketch, the <u>hydrodynamic</u> operation of an *Active Fin Stabilizer*. (10)

Nov 2020

9. Define EACH of the following, stating an example in EACH case where a fire could be caused:

(a) spontaneous combustion; (4)

(b) flash point; (3)

(c) auto ignition temperature. (3)

Nov 2020

10. (a) With reference to ship construction, define a bulkhead. (2)

(b) State the functions of bulkheads. (8)

Nov 2020

1. State the action to be taken by the watch keeping engineer in the event of EACH of the following:

(a) flooding; (6)

(b) failure of main propulsion machinery. (4)

Watchkeeping Engineer's Actions in Emergencies:

(a) Flooding:

The watchkeeping engineer's actions in case of flooding are crucial for crew safety and vessel stability. Here's what they should do:

1. **Raise the Alarm:** Immediately sound the emergency alarm and notify the bridge of the flooding location and severity.
2. **Assess the Situation:** Locate the source of the flooding and try to isolate it by closing watertight doors and valves.
3. **Activate Pumps:** Start the bilge pumps and any other pumps appropriate for the flooded area.
4. **Control the Spread:** Take steps to prevent the flood from spreading to other compartments. This might involve shoring up doorways or using temporary patching.
5. **Standby for Instructions:** The Chief Engineer or Captain will take over the overall damage control effort. The watchkeeping engineer should be prepared to follow their instructions.

Remember: Crew safety is paramount. If the flooding is severe or the source cannot be contained, prioritize evacuating the engine room and following ship evacuation procedures.

(b) Failure of Main Propulsion Machinery:

A main propulsion failure can severely impact the vessel's maneuverability. Here's how the watchkeeping engineer should respond:

1. **Safely Shut Down Engine:** Following established procedures, safely shut down the main engine to prevent further damage.
2. **Assess the Situation:** Try to diagnose the cause of the failure using instrumentation and alarms.
3. **Inform the Bridge:** Immediately notify the bridge of the engine failure and its potential impact on maneuverability.
4. **Attempt Standby Power (if available):** If the vessel has auxiliary engines or emergency propulsion systems, attempt to bring them online according to procedures.

5. **Standby for Instructions:** The Chief Engineer will assess the situation and determine the next course of action. The watchkeeping engineer should be prepared to assist with troubleshooting or repairs.

Important: During a main propulsion failure, prioritize the safety of the crew and vessel. Communicate effectively with the bridge and follow established emergency procedures.

Nov 2020

2. State the purpose of infra red photography, explaining where it could be used as part of a condition monitoring programme. (10)

Infra-red (IR) photography has several advantages that make it valuable for condition monitoring programs, particularly for ships. Here's a breakdown of its purpose and applications:

Purpose:

- IR photography captures radiation beyond the visible spectrum, primarily heat radiation emitted by objects.
- Unlike standard photography, IR images show variations in temperature rather than reflected light.

Applications in Ship Condition Monitoring:

- **Early Detection of Issues:** IR cameras can detect temperature anomalies that might be invisible to the naked eye. This allows for early identification of potential problems before they escalate into major failures.

- **Examples of Detectable Issues:**

  - **Overheated bearings or machinery components:** Friction from wear and tear can cause components to heat up. IR images can reveal these hot spots, indicating potential bearing failure or lubrication issues.
  - **Electrical faults:** Loose or corroded electrical connections can generate heat. IR can identify these areas before they cause sparking or electrical fires.
  - **Structural defects:** In some cases, cracks or delamination in bulkheads or decks can cause uneven heat distribution. IR might reveal these defects as temperature variations on the surface.
  - **Moisture ingress:** Water infiltration behind walls or ceilings can affect thermal properties of the area. IR imaging might help identify areas of moisture accumulation before it leads to more serious problems like mold growth or corrosion.

Benefits of IR for Ship Condition Monitoring:

- **Non-destructive Testing:** IR inspections are non-destructive, meaning they don't require dismantling equipment or damaging surfaces. This makes them ideal for routine checks and preventive maintenance.
- **Remote Monitoring:** IR cameras can be mounted in strategic locations and connected to a monitoring system. This allows for remote inspections and data collection, improving efficiency and reducing risk of direct exposure to potential hazards.
- **Improved Safety:** Early detection of potential issues using IR can help prevent accidents, injuries, and equipment failures onboard ships.

Limitations of IR:

- **Interpretation Required:** IR images require trained personnel to interpret the temperature variations and identify potential problems.
- **Environmental Factors:** External factors like sunlight, wind, and air temperature can influence IR readings. Careful consideration of these factors is necessary for accurate interpretation.

Overall, IR photography is a valuable tool for condition monitoring programs on ships. Its ability to detect temperature anomalies allows for early identification of potential problems, enhancing preventive maintenance practices and improving overall ship safety and operational efficiency.

Nov 2020

3. With reference to MARPOL Annex V:

(a) list the THREE recognised complimentary garbage handling techniques; (3)

(b) describe the basic requirements of a Garbage Management Plan; (5)

(c) define what is meant by *E-Waste*. (2)

Garbage Management at Sea: Techniques, Plans, and E-waste

(a) Three Recognized Complimentary Garbage Handling Techniques:

There are three main complimentary garbage handling techniques onboard ships, as stipulated by MARPOL Annex V:

1. **Reduce at Source:** This approach prioritizes minimizing garbage generation in the first place. Strategies include:
   - Using reusable items instead of disposables.
   - Implementing food waste reduction programs.
   - Choosing products with minimal packaging.
2. **Minimize Discharge at Sea:** After reducing waste generation, this technique focuses on minimizing the amount of garbage discharged overboard. This can involve:
   - Segregating and storing different garbage categories for proper disposal ashore.
   - Utilizing onboard equipment like compactors or incinerators (meeting strict emission standards) to reduce waste volume.
   - Following designated discharge restrictions in specific sea areas.
3. **Onshore Reception Facilities:** This final technique emphasizes utilizing designated onshore reception facilities for proper waste disposal. This includes:
   - Delivering segregated garbage to authorized ports for recycling, treatment, or safe disposal.
   - Following national and international regulations regarding waste reception ashore.

By implementing all three techniques in a complementary manner, ships can significantly reduce their environmental impact and comply with MARPOL regulations for garbage management.

(b) Basic Requirements of a Garbage Management Plan (GMP):

A Garbage Management Plan (GMP) is a mandatory document for all ships subject to MARPOL Annex V. It outlines the procedures and practices for handling, storing, and disposing of garbage generated onboard. Here are some basic requirements:

- **Designated Garbage Officer:** The GMP assigns responsibility for garbage management to a designated Garbage Officer onboard.
- **Inventory of Garbage Discharges:** The plan includes an inventory of the different types of garbage typically generated onboard and their estimated quantities.
- **Procedures for Segregation and Storage:** It details procedures for segregating waste into different categories (food waste, plastics, paper, etc.) and proper storage practices for each type.
- **Instructions for Record Keeping:** The GMP outlines what garbage-related information needs to be recorded in the Garbage Record Book.
- **Procedures for Port Reception Facilities:** The plan details procedures for utilizing onshore reception facilities for garbage disposal when in port.

A well-developed and implemented GMP ensures crew members are aware of their responsibilities and facilitates proper garbage handling practices onboard.

(c) E-Waste Definition:

E-waste stands for **Electronic Waste**. It refers to any electrical or electronic equipment that is no longer functioning or is outdated and no longer intended for its original use. Examples of E-waste include:

- Discarded computers, laptops, and tablets
- Used mobile phones and chargers
- Old printers, scanners, and fax machines
- Television sets, monitors, and other display devices
- Spent batteries

E-waste poses a significant environmental concern due to the presence of hazardous materials like lead, mercury, and flame retardants. MARPOL Annex V regulations require proper management and disposal of E-waste generated onboard ships, often through specialized onshore reception facilities equipped to handle such materials responsibly.

Nov 2020

4. With reference to marine diesel oil:

(a) define EACH of the following terms, stating the unit used in EACH:

(i) density; (2)

(ii) viscosity; (2)

(iii) flash point. (2)

(b) excluding the THREE terms listed in part (a), state FOUR items of information contained on a Bunker delivery note. (4)

Marine Diesel Oil (MDO) Properties and Bunker Delivery Note (BDN) Information:

(a) MDO Property Definitions and Units:

(i) **Density:** This refers to the mass of MDO per unit volume at a specific temperature. It is typically expressed in kilograms per cubic meter (kg/m^3) or pounds per gallon (lbs/gal).

(ii) **Viscosity:** This property describes the MDO's resistance to flow at a specific temperature. It is measured in kinematic viscosity units, typically centiStokes (cSt). Lower cSt values indicate lower viscosity and easier flow.

(iii) **Flash Point:** The flash point is the minimum temperature at which the fuel vapors will ignite in the presence of a spark or flame. It is measured in degrees Celsius (°C) or degrees Fahrenheit (°F).

(b) Additional Information on a Bunker Delivery Note (BDN):

While density, viscosity, and flash point are crucial, a Bunker Delivery Note (BDN) contains various other items of information:

1. **Fuel Grade:** This specifies the type of MDO being delivered, such as DMA (Marine Gas Oil) or MDO 0.5% (referring to maximum sulfur content).
2. **Quantity:** The total amount of MDO delivered in metric tons (MT) or long tons (LT).
3. **Supplier Information:** Details of the company supplying the fuel, including their name, address, and contact information.
4. **Vessel Information:** Name and registration details of the vessel receiving the fuel.
5. **Date and Time of Delivery:** Records the specific date and time when the bunkering operation took place.

These are just some of the key details found on a BDN. Depending on specific regulations and requirements, additional information like sulfur content analysis results, API gravity (a measure of fuel density), and reference to relevant standards (e.g., ISO 8217) might also be included.

Nov 2020

5. With reference to sewage treatment plants:

(a) explain the difference between *black water* and *grey water*; (2)

(b) explain the difference between aerobic and anaerobic micro organisms; (3)

(c) list THREE dangerous gases produced under anaerobic conditions; (3)

(d) explain the dangers of producing the gases listed in part(c) in a confined space. (2)

Sewage Treatment and Microorganisms: Black Water, Aerobic vs. Anaerobic, and Gas Dangers

(a) Black Water vs. Grey Water:

- **Black Water:**
  - Wastewater containing human waste (feces and urine) from toilets and urinals.
  - It has the highest concentration of organic matter and pathogens, requiring the most stringent treatment in sewage plants.
- **Grey Water:**
  - Wastewater generated from household activities excluding toilets.
  - Examples include water from showers, sinks, dishwashers, and washing machines.
  - It contains lower levels of organic matter and pathogens compared to black water.

In some advanced shipboard systems, black water and grey water may be treated separately due to their differing compositions.

(b) Aerobic vs. Anaerobic Microorganisms:

- **Aerobic Microorganisms:**
  - Thrive in environments with **dissolved oxygen**.
  - Play a crucial role in sewage treatment by breaking down organic matter in the presence of oxygen.
  - Examples include bacteria like nitrifying bacteria and some protozoa.
- **Anaerobic Microorganisms:**
  - Function in environments with **little to no dissolved oxygen**.
  - Break down organic matter through a different process that doesn't require oxygen.
  - Examples include some bacteria and archaea.

Sewage treatment plants on ships typically utilize a combination of aerobic and anaerobic processes for efficient waste breakdown.

(c) Dangerous Gases Produced Under Anaerobic Conditions:

Here are three dangerous gases produced under anaerobic conditions in sewage treatment or confined spaces:

1. **Hydrogen Sulfide (H_2S):**
   - Highly toxic gas with a characteristic rotten egg odor.
   - Exposure can cause respiratory problems, irritation, and even death at high concentrations.
2. **Methane (CH_4):**
   - Flammable gas with no odor or color.
   - Can accumulate in confined spaces and pose an explosion risk if ignited.
3. **Carbon Dioxide (CO_2):**
   - Colorless and odorless gas.
   - Displaces oxygen, leading to suffocation in confined spaces with high CO_2 concentrations.

(d) Dangers of Gases in Confined Spaces:

The confined space environment aboard a ship can exacerbate the dangers of the gases listed above:

- **Limited Ventilation:** Confined spaces often have limited air circulation, allowing these gases to accumulate to dangerous levels more quickly.

- **Reduced Awareness:** Workers in confined spaces may not be aware of the presence of these gases due to their lack of odor (methane) or due to the overwhelming effect of H2S on the sense of smell.

- **Rapid Intoxication:** Inhaling these gases in confined spaces can lead to rapid incapacitation and death if not addressed promptly.

Therefore, proper safety precautions, ventilation, and gas monitoring are crucial when working in confined spaces on ships, especially those containing sewage treatment systems.

Nov 2020

6. (a) With reference to food storage rooms:

   (i) state, with reasons, the possible danger present in a room used for storing vegetables and fruit; (2)

   (ii) state the devices necessary to prevent a person from becoming trapped in a storage room. (3)

   (b) State FOUR methods of detecting a refrigeration gas leak. (4)

   (c) State the name of the international agreement which stipulates that the production and consumption of compounds that deplete ozone in the stratosphere is phased out. (1)

a) Food Storage Rooms:

(i) Danger in Vegetable and Fruit Storage:

There's a potential danger of **oxygen depletion** in a room used for storing vegetables and fruit. Here's why:

- **Respiration:** Fruits and vegetables continue to respire (use oxygen) even after harvesting. This process consumes oxygen (O2) and releases carbon dioxide (CO2).
- **Confined Space:** In a closed storage room, the oxygen level can gradually decrease as fruits and vegetables consume it without proper ventilation.
- **Dangers of Low Oxygen:**
  - **Suffocation:** If the oxygen level in the room falls below a safe level (around 19.5% or lower), a person entering the room could experience suffocation.
  - **Fire Risk:** Low oxygen levels also increase the risk of fire, as combustion requires oxygen.

(ii) Devices to Prevent Trapping:

To prevent a person from becoming trapped in a food storage room, the following devices are essential:

- **Self-Closing Door:** The door should be self-closing to ensure it automatically closes behind someone entering or leaving the room. This prevents accidental latching from the outside.
- **Panic Hardware:** The door should be equipped with panic hardware (e.g., push bar) on the inside to allow for easy exit in case of an emergency.

- **Signage:** Clear signage should be displayed on the door indicating it's a food storage room and may have low oxygen levels.

(b) Refrigeration Gas Leak Detection:

Here are four methods for detecting a refrigeration gas leak:

1. **Gas Detectors:** Specialized gas detectors can be installed in food storage rooms to automatically detect leaks of specific refrigerants. These detectors trigger alarms when they sense a gas concentration exceeding safe limits.
2. **Visual Inspection:** Regular visual inspections of the refrigeration system are crucial. Signs of a leak might include visible damage to pipes, hissing sounds, or frost formation around connection points. 3. **Sniffing (with caution):** While not the most recommended method, some refrigerants have a distinct odor that can be detected during inspections. However, caution is advised, as inhaling some refrigerants can be harmful. Always prioritize using gas detectors and proper ventilation.
3. **Temperature Monitoring:** A sudden increase in storage room temperature or malfunctioning of the refrigeration system could indicate a refrigerant leak.

(c) Ozone Depletion Agreement:

The international agreement that aims to phase out the production and consumption of ozone-depleting substances is the **Montreal Protocol on Substances that Deplete the Ozone Layer**.

Nov 2020

7. With reference to reverse osmosis plants:

(a) explain the treatment that the feedwater undergoes to prevent blockage of the membranes; (3)

(b) describe how the purity of the water is measured and protected, stating the limits on purity set by the World Health Organisation; (5)

(c) outline the further treatment the permeated water undergoes before it can be used for domestic purpose. (2)

Reverse Osmosis Plant: Feedwater Treatment, Purity Monitoring, and Domestic Use

(a) Preventing Membrane Blockage:

To prevent blockage of the delicate membranes in a reverse osmosis (RO) plant, the feedwater undergoes several pre-treatment steps:

- **Coarse Filtration:** Removes large suspended solids like sand, silt, and debris using screens, strainers, or media filters.
- **Coagulation/Flocculation (Optional):** This step (used if necessary) removes smaller particles and organic matter by adding coagulants that cause them to clump together (flocculate) for easier removal by subsequent filtration.
- **Media Filtration:** Water passes through layers of sand, gravel, or other media to trap smaller particles that could damage or clog the membrane.
- **Cartridge Filtration:** Often used as a final polishing step to remove any remaining particulates.

- **Chlorination (Optional):** Chlorine or chlorine dioxide might be added in low doses to control biological growth that could foul the membrane. However, careful management is needed to avoid damaging the membrane itself.
- **Antiscalant Dosing:** Chemicals are added to prevent scaling on the membrane from minerals like calcium and magnesium. These antiscalants bind to the minerals, keeping them in solution and preventing them from precipitating on the membrane surface.

(b) Monitoring and Protecting Water Purity:

Measurement:

- **Electrical Conductivity (EC):** Measures the ability of the solution to conduct electricity, indicating the concentration of dissolved ions (lower EC = higher purity).
- **Total Dissolved Solids (TDS):** Measures the total amount of dissolved solids (organic and inorganic) present in the water (lower TDS = lower impurity).

Protection:

- **Membrane Integrity:** Regular monitoring and replacement of membranes are crucial to maintain their effectiveness in rejecting impurities.
- **Pre-treatment Efficiency:** Ensuring proper pre-treatment reduces the load on the membrane and protects it from damage or fouling.
- **Antiscalant Dosing:** Maintaining the appropriate dosage of antiscalants prevents mineral scaling on the membrane surface.

WHO Limits:

The World Health Organization (WHO) publishes guidelines for drinking water quality in its "Guidelines for drinking-water quality". While not a strict regulation, these guidelines provide a framework for ensuring safe drinking water.

There's no single limit for all impurities in permeate. However, WHO recommends the following general guidelines for some key parameters:

- **Electrical Conductivity (EC):** Less than 250 µS/cm (microsiemens per centimeter) at 25°C.
- **Total Dissolved Solids (TDS):** Ideally less than 500 mg/L (milligrams per liter). However, this value can be adjusted based on local circumstances and palatability considerations.

(c) Further Treatment for Domestic Use:

While RO permeate is relatively pure, it may require additional treatment before it's suitable for domestic use:

- **Remineralization (Optional):** The RO process removes most minerals from the water. In some cases, minerals may be added back to improve taste and address potential health concerns related to long-term consumption of demineralized water.
- **pH Adjustment:** RO permeate can be slightly acidic due to the presence of carbon dioxide. Adjustment to a slightly alkaline pH range (around 7.0-8.5) might be necessary to improve taste and prevent corrosion in pipes.
- **Disinfection:** Depending on the feed water source and local regulations, additional disinfection with chlorine or another method may be required to ensure microbiological safety.

Note: The specific treatment steps for permeate before domestic use will depend on local regulations, feed water quality, and desired water characteristics.

Nov 2020

8. Explain, with the aid of a sketch, the hydrodynamic operation of an *Active Fin Stabilizer*. (10)

Active Fin Stabilizer: Hydrodynamic Operation

Active fin stabilizers are a type of roll stabilization system that utilizes retractable fins and a control system to counteract a ship's rolling motion. Unlike bilge keels (passive stabilizers), active fins are electronically controlled to generate a dynamic opposing force, providing a more responsive and effective roll reduction. Here's a breakdown of their hydrodynamic operation:

Components:

- **Retractable Fins:** These are typically hydrofoil-shaped fins mounted on either side of the vessel, usually near the midship section (middle of the ship). They can retract into recesses in the hull when not in use to minimize drag.
- **Hydraulic Actuators:** Powerful hydraulic rams or cylinders are connected to each fin, allowing for precise control of the fin angle (angle of attack) relative to the water flow.
- **Control System:** This system plays a crucial role in the stabilization process, including:
    - **Roll Sensors:** Gyroscopes or accelerometers continuously monitor the ship's rolling motion and its direction.
    - **Control Unit:** This unit processes the sensor data and calculates the required fin angle adjustment to counteract the roll.

Operation:

1. **Roll Detection:** The roll sensors constantly monitor the ship's rolling motion, measuring the angle and direction of the roll.
2. **Control System Response:** The control unit receives the sensor data and determines the necessary fin movement to counter the roll. It calculates the ideal fin angle and transmits this information to the hydraulic actuators.
3. **Fin Adjustment:** Based on the control unit's output, the hydraulic actuators on each side extend the fins and adjust their angle of attack relative to the oncoming water flow.

- **Starboard Roll:** If the ship rolls to starboard (right), the control unit commands the starboard fin to increase its angle of attack (tilt outwards) and the portside fin to decrease its angle of attack (tilt inwards). As the ship moves forward, the angled fins generate lift (similar to an airplane wing) that acts against the roll motion.

    - **Starboard Fin:** The increased angle of attack on the starboard fin creates a strong lift force directed upwards, counteracting the roll and pushing the starboard side down.
    - **Portside Fin:** The decreased angle of attack on the portside fin reduces or creates a downward lift force, further assisting in bringing the ship back to level.
- **Portside Roll:** Conversely, if the ship rolls to port, the fin angles are adjusted oppositely to generate a counteracting lift force that rights the ship.

Hydrodynamic Principles:

The effectiveness of active fin stabilizers relies on several key hydrodynamic principles:

- **Lift Force:** As water flows past the angled fins, it creates lift, similar to the way an airplane wing generates lift. The angle of attack determines the magnitude of the lift force.
- **Opposing Force:** By adjusting the fin angles, the system creates a lift force that opposes the rolling motion of the ship. This counteracting force helps to dampen the roll and bring the vessel back to a level position.
- **Faster Response:** Compared to passive systems, active fin stabilizers can react much faster to changes in roll angle due to the electronic control system and rapid fin adjustments.

Benefits:

- **Highly Effective:** Active fin stabilizers can achieve significant roll reductions, often exceeding 80% depending on sea conditions.
- **Fast Response Time:** The system can react quickly to changing roll motions due to the real-time sensor data and rapid fin adjustments.
- **Retractable Fins:** When not in use, the fins can be retracted to minimize drag and improve fuel efficiency.
- **Scalability:** The system can be adapted to different vessel sizes and roll reduction requirements by adjusting fin size, actuator power, and control algorithms.

Drawbacks:

- **Complexity:** Active fin stabilizers are more complex than passive systems due to the additional fins, actuators, sensors, and control units. This complexity increases installation and maintenance costs.
- **Power Consumption:** The hydraulic pumps and control systems require power to operate, adding to the overall energy consumption of the vessel.
- **Maintenance Needs:** The hydraulic actuators and moving parts require regular maintenance to ensure proper operation.

Overall, active fin stabilizers are a powerful tool for significantly reducing a ship's rolling motion, enhancing passenger comfort, and improving operational efficiency. However, their complexity, energy consumption, and maintenance needs need to be considered when compared to simpler passive stabilization methods.

Nov 2020

9. Define EACH of the following, stating an example in EACH case where a fire could be caused:

(a) spontaneous combustion; (4)

(b) flash point; (3)

(c) auto ignition temperature. (3)

Fire Starters: Definitions and Examples

Here's a breakdown of each term with a fire cause example:

(a) **Spontaneous Combustion:**

- **Definition:** Spontaneous combustion is a process by which a substance heats up internally and ignites without the presence of an external ignition source like a flame or spark. This typically occurs due to a combination of factors that generate heat within the material.
- **Example:** Oily rags left bunched up in a closed container can undergo spontaneous combustion. The oil oxidizes (reacts with oxygen) slowly, generating heat. If the rags are bunched up and don't allow proper ventilation, this heat can't escape and can build up to the point of ignition.

(b) **Flash Point:**

- **Definition:** The flash point of a liquid is the lowest temperature at which the liquid vaporizes enough to form an ignitable mixture with air in the presence of an ignition source. Below the flash point, there are not enough flammable vapors present to ignite.
- **Example:** Gasoline has a low flash point (around -40°C or -40°F). If gasoline spills and the surrounding temperature rises above its flash point, the gasoline vapors can mix with air and ignite easily from a spark caused by static electricity or even a lit cigarette.

(c) **Autoignition Temperature:**

- **Definition:** The autoignition temperature of a substance is the minimum temperature at which the substance will spontaneously ignite in a normal atmosphere without the need for an external ignition source. At or above this temperature, the material generates enough heat through self-heating processes to reach its ignition point.
- **Example:** Oily rags, again! If left lying around for a long time exposed to high temperatures (e.g., near a heater or in direct sunlight), oily rags can reach their autoignition temperature and ignite spontaneously. This is why oily rags should be stored in properly ventilated containers to prevent heat buildup.

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Nov 2020

10. (a) With reference to ship construction, define a bulkhead. (2)

(b) State the functions of bulkheads. (8)

Bulkheads in Ship Construction:

(a) Definition:

A bulkhead in ship construction is a vertical wall-like structure that extends from the bottom of the vessel (usually the keel) up to the deck(s) above. These walls subdivide the ship's interior into separate compartments. Bulkheads can be made of various materials, typically steel plates welded together to form a strong and watertight barrier.

(b) Functions of Bulkheads:

Bulkheads serve several critical purposes in a ship:

1. **Compartimentolization and Damage Control:** The primary function of bulkheads is to subdivide the ship's interior into watertight compartments. This compartmentalization plays a vital role in damage control. If the ship's hull is punctured in one compartment due to a collision or grounding, the water ingress will be contained within that specific compartment. By limiting flooding to a confined space, the

bulkheads help prevent the entire ship from sinking and improve the vessel's survivability.

2. **Maintaining Buoyancy and Stability:** By restricting floodwater to a specific compartment, bulkheads help the ship maintain overall buoyancy and stability. Uncontrolled flooding throughout the vessel could compromise its ability to stay afloat and upright. The contained water in a damaged compartment can be pumped out to restore buoyancy and improve vessel stability.

3. **Structural Support:** Bulkheads also contribute to the overall structural strength of the ship. They help the hull resist bending forces experienced during rough seas and can add longitudinal stiffness to the vessel.

4. **Functional Separation:** In some cases, bulkheads can be used to separate different functional areas of the ship. For example, a fire-resistant bulkhead might separate the engine room from accommodation areas to contain a potential fire.