

# **Navigational Aids and Bearing instruments- Magnetic Compass**

# Gyrocompass

- Gyrocompass is an electro-mechanical device
  - ❑ to find the direction without adjusting the compass error such as variation or deviation.
  - ❑ readings are always related to true north.
  - ❑ electrically operated very accurate and independent of earth magnetism.

# Working principle of gyrocompass

- Working with the high speed gyro rotor (gyroscope) to accurately seek the direction of true north.
- A Gyroscope (from the Greek '*gyro*' means *turn* or *revolution* and '*skopein*', means to *view*) is an apparatus in which a heavy flywheel or top rotates at high speed, the turning movement resisting change of direction of axis. There are 4 laws or facts act upon which gyrocompass operation depends, the first two are internal properties of the gyroscope namely.
  - i. Gyroscopic inertia (rigidly in space)
  - ii. Precession
- The third and fourth are relate to the earth and are the earth's rotation and gravitation.

# Gyroscopic inertia (Rigidity)

- A freely spinning gyroscope will maintain its axis spin in the same direction in space regardless of how its supporting base is turned.
- It resists any force attempting to turn its axis of spin in a new direction.
- This property is termed as “the rigidity in space”.
- **Rigidity** is the property of the gyro by which it tends to hold its direction of the plane of rotation in space.

# Precession

- Precession is the movement of the spin axis when a force is applied to the gyroscope. When a force is applied about its horizontal axis the spin axis will turn at right angles to the applied force in the direction of the spin of the wheel similarly a couple applied about the vertical axis will make the spin axle turn about the horizontal axis in the direction of the spin of the wheel. This property is called **'precession'**.

# Parts of Gyrocompass

- Master compass
- Transmission unit
- Power adapter
- Repeater

# Advantages

- It seeks the true north instead of the magnetic north.
- It can be used near the earth's magnetic poles, where the magnetic compass is useless.
- It is not being influenced by surrounding magnetic or electric materials which might influence the readings of the magnetic compass.
- Its information can be fed electronically into automatic steering unit or autopilot.
- It also indicates the ship's rolling and pitching data needed for instruments used for celestial navigation.
- Corrections like variation and deviation need not be applied in the readings of gyrocompass and the readings are very accurate.

# Limitations

- It requires a constant source of electrical power. In case of any interruption in its operation for any length of time, nearly four hours may be required for it to settle back into reliable operation.
- It requires intelligent care, attention and maintenance
- The accuracy decrease when latitudes above  $75^{\circ}$  .



# Magnetic compass

- The oldest instrument for navigation
  - an essential tool for navigators at sea to find the directions.
  - 32 points matching the directions of winds which sailors would be familiar with at sea. **North, South, East and West – cardinal points.**
  - **Inter-cardinal directions: NE, SE, SW, and NW.**

# Working Principle of Magnetic compass

- Working with the principle of **Earth's Magnetic Field**
  - Shows the magnetic north and south.
- Sea going vessels of any size carry at least two magnetic compasses; these are the **standard compass** and the **steering compass**.

# Compass error – I Variation

- Magnetic poles of the earth do not coincide with the geographic poles, a compass needle (in line with the earth's magnetic field) will not indicate true north.
- The angular difference between the true meridian and the magnetic meridian is called Variation or Magnetic Variation or **Declination**.
- Compass needle point to MAGNETIC NORTH, which varies from True North by an error is termed VARIATION.
- Variation should always be suffixed with East or West.
- Different values at different locations on the earth place and time specific from the appropriate Magnetic Variation chart.
- line joining places of equal variation is known as an ISOGONIC LINE.

# Deviation

- Local magnetic fields in a ship may cause the resultant field at the compass position to lie in a different direction from the Earth's field alone.
- A ship is built by the steel and steel alloys, and these materials may influence the magnetic needle of the compass placed nearby.
- Boats themselves can also affect compasses due to their construction, steel engines, keel, Ferro-magnetism, electromagnetism,
- This effect is called Deviation, and will vary with the heading of the boat.
- Because of the ship's magnetic effect the compass needle deflected from magnetic north to compass north .the difference between magnetic north and compass north is termed as '**Deviation**'

# Compass error

- Sum of variation and deviation is called as **compass error**.
- True direction, when referred to the true (geographic) meridian as the reference of measurement.
- Magnetic direction, when referred to the axis of the magnetic meridian as the reference of measurement.
- Compass direction, when referred to the axis of the compass card as the reference of measurement.
- Any given direction may be expressed in all three of these ways, if it is understood that:
  - True differs from magnetic by variation.
  - Magnetic differs from compass by deviation.
  - Compass differs from true by compass error.

# Construction of Magnetic Compass

- Based on the construction the magnetic compass can be divided in to two types. They are
  - 1) Dry card
  - 2) Wet card
- **Dry card compass**
- **The card base**
- A light weight aluminum ring with 254 mm dia.
- **The card support**
- Cap fitted with a sapphire frictionless support for the compass card and requires no lubrication.
- **The directive element (magnets)**
- **The compass bowl**
- **The lubber line**
- There is a small line marked on the inner rim of the compass bowl. This line is called **Lubber line** and it represents the direction of the ships head.

- **Suspension of bowl**
- **The Binnacle**
- The binnacle is a cylindrical container(a protection cover) made of teakwood and brass.
- **The helmet**
- Large brass helmet placed on the top of the binnacle is called helmet.
- **Wet card compass**
- **Card**
- made of mica and has about 15 cm in diameter. A nickel-silver float chamber.
- **Directive element**
- **Liquid**
- The movement of the card is dampened by filling the bowl with mixture liquid consisting of distilled water and part pure ethyl alcohol(this is to stop the liquid freezing in extremely cold weather). The mixture of distilled water and pure alcohol has the following properties,
  - a. Low freezing about  $-30^{\circ}\text{C}$ .
  - b. small coefficient of expansion
  - c. does not discolor the card
  - d. Low relative density about 0.93.

# Limitations of the Magnetic Compass

- Sensitive to any magnetic disturbance.
- Useless at the magnetic poles and is sluggish and unreliable in areas near the poles.
- Deviation changes as a ship's magnetic properties change.
  - The magnetic properties also change with changes in the ship's structure or magnetic cargo.
- Deviation changes with heading. The ship as well as the earth may be considered as a magnet. The effect of the ship's magnetism upon the compass changes with the heading.
- Does not point to true north.