

TEMPERATURE MEASUREMENT AT SEA

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Introduction :

Temperature/Depth profile at sea is the most fundamental and frequently measured parameters to determine :

- i) Salinity
- ii) Density profiles
- iii) Sound velocity
- iv) Study of internal oscillations
- v) Study of air-sea interaction and atmospheric dependance over the sea, etc.

Through a network of sampling stations, the direction magnitude of the rate of thermal flow within the ocean and across its boundaries will be estimated by the Physical oceanographers. Temperature data collected from a network of sampling stations will be used to study the thermal patterns at sea, which will enable the study of upwelling processes related to the coastal regions such as coastal current and thermal structure.

Methods :

The era of temperature measurement began a long time back in the 16th century, with the use of Bucket thermometers, Maximum- Minimum thermometers and specially designed thermometers. This technique remained as the classical type until the 19th century when Reversing thermometers were introduced. The reversing thermometer is designed in such a way that, by means of a fine restriction in the capillary, the column of mercury can be broken by reversing the thermometer. The amount of mercury retained in the stem gives an exact measure of the temperature of water at the point of reverse. These thermometers, when properly calibrated, are accurate to 0.01 degree centigrade. To measure the depth of reversal, another thermometer is used. One thermometer is enclosed in a glass envelope thus protecting the mercury bulb from hydrostatic pressure, whilst the other thermometer bulb is unprotected. The difference between the protected and the un-protected thermometer reading gives a measure of the extent of hydrostatic pressure (depth). For over a century, the use of reversing thermometers was the mainstay of oceanographic thermometry because of its high precision. However, the disadvantages of the Reversing thermometers were that they provide only point measurements and the ship has to be stationary.

In the 1930's, the era of bathythermograph began with a new temperature/depth measuring device, basically a bi-metallic thermometer and a bellow type pressure sensor. The data was recorded on a glass slide continuously and the measurements could be done with the ship moving at normal speed. The main disadvantage of this instrument was that the data recorded on

glass slide was laborious to digitize. For continuous profile, Expendable Bathythermographs are used extensively as they are easy to operate and the data is recorded on normal Y-T recorders. The disadvantage is that they are expendable in nature. The accuracy of temperature measurement is ± 0.1 degree centigrade. A digitally recording bathythermograph filled a natural niche, and in 1982, the Newzealand Oceanographic Institute developed a prototype model of digital bathythermograph. Another instrument, which can record temperature/depth data digitally and provide a digital printout was developed in Japan. In 1985, the institute has successfully carried out field trials and collected extensive data using a digital bathythermograph developed in-house. The main advantages of this instrument is that the data is available in RS232 format and hence data analysis on computer is made easy. The user can communicate with the instrument via the RS232 link and conduct self-test routines to determine the status of sensors, battery, and associated circuitry. Information regarding the cast can be entered from the computer via the RS232 link for future reference. The only demerit of these digital bathythermograph instruments is that the ship has to be stationary while the cast is in progress.

The answer to this problem is the Free-fall recording bathythermograph. The Woods Hole Oceanographic Institute and M/s Endeco company have developed free-fall instruments for recording multiparameters. These instruments can be operated from a ship moving at normal speed. The free-fall drop rate is about 6-7 meters/second. When the instrument reaches its maximum operating depth, the extra weights are released and the instrument comes up due to its buoyancy. The instrument pop-up position is guided towards the ship by sending acoustic signals from the surface.

At present, the Institute is working on development of a free-fall bathythermograph. The instrument is aimed for operation from a slowly moving vessel at free fall rate. Light-weight, high strength non-metallic Kevlar rope with a break strength of 3500lbs will be used to drop the instrument at its free-fall rate and recover it after the data acquisition is complete.

Conclusion :

Temperature measurement at sea is a routine part of every oceanographic cruise because of the major influence it has on oceanographic and atmospheric conditions. Large data collection over a vast area is required to study the thermal structure, internal wave motion studies air-sea interaction studies etc. and data should be collected over a long period. Time is a very crucial factor when operating from the ship. Also, data thus collected should be made available for analysis on computers. The Recording Free-Fall Bathythermograph will meet all these demands of the oceanographers.