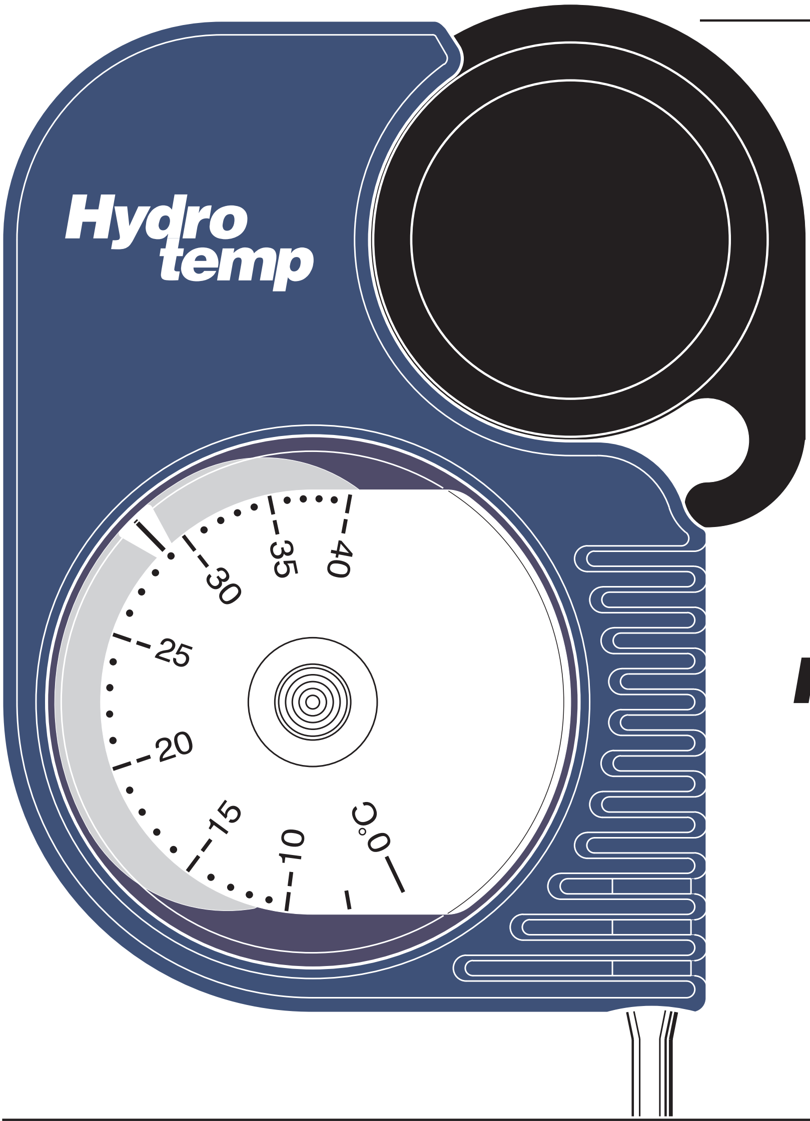

Hydro temp Antifreeze Tester

The HYDROTEMP antifreeze tester is a heavy-duty, chemical-resistant hydrometer which is direct-reading and accurate at all temperatures. Its advanced design incorporates important practical features which simplify antifreeze service as never before:

- sturdy, shock-resistant materials, noncorrosive throughout
- large, easy-to-read scale with temperatures in °C or °F
- fast, bubble-free intake of fluid sample
- automatic air-lock prevents fluid loss and air bleed
- readings independent of vertical positioning of instrument
- unexcelled temperature compensation and measuring accuracy
- tests all ethylene-glycol antifreeze coolants

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The HYDROTEMP antifreeze tester uses a unique twin-rotor system of two density-responsive elements, each consisting of two temperature-responsive materials which have been selected so that their combination provides optimal temperature compensation [1]).

Various concentrations of ethylene glycol in radiator coolant result in various coefficients of thermal expansion; furthermore, these coefficients vary with temperature. Thus, temperature compensation should be effective at all concentrations and temperatures of the solution, a requirement that cannot be fulfilled by any single material. This is generally true, e.g. for float hydrometers made of glass, and is the reason why all density meters with only a single element are of necessity relatively inaccurate.

The reading provided by the HYDROTEMP instrument results from the relative angle of the two elements, the material and construction of which are so selected that the elements are mutually corrective, thus avoiding temperature error over the entire density range. These elements respond to the temperature of the fluid sample within seconds, which means that the antifreeze protection value read off directly from the instrument is always accurate, regardless of the temperature and the concentration of the ethylene glycol in the solution.

Since the relative position of the two HYDROTEMP elements is independent of the position of the housing, the instrument need not be held vertically in order to obtain an accurate reading, nor does it require any kind of “artificial horizon” for providing reference to the vertical. When immersed in antifreeze solution, the elements are practically weightless, i.e. they are not inhibited by friction, and therefore will accurately indicate density differences of less than 0.001g/ml (with full temperature compensation, as described above).

Obviously, no type of hydrometer will provide accurate readings if its buoyancy is affected by adhering air bubbles, and this has been a serious practical disadvantage of such instruments so far. Therefore, in designing the HYDROTEMP tester, a careful study was made of this problem, since a solution to it was mandatory if the unique advantages of the HYDROTEMP system were to be retained under conditions of actual use. These studies resulted in a new laminar-flow inlet duct which allows very rapid filling (as is necessary in practical use), but avoids the formation of air bubbles under all normal conditions. Backflow, which occurs particularly in the testing of hot fluids, is no problem with the HYDROTEMP system, since hydrostatic lock automatically prevents loss of fluid from the measuring chamber.

In practical use no other hydrometer is more accurate than the HYDROTEMP system 2), not even relatively expensive optical antifreeze testers. At the same time, this instrument is extremely simple to use:

1. While holding the instrument more or less upright, press the bulb to fill the measuring chamber completely, and
2. Read off the freezing point shown by the indicator. HYDROTEMP does the rest automatically!

Calibration and Measurement Accuracy

Water has a sharply defined freezing point at which it turns into ice, thereby undergoing an expansion of approximately 9 %, which would result in physical damage to any closed system in which it is contained. Fluids consisting of a mixture of ethylene glycol and water have a freezing point which is much lower, and not so sharply defined. As the temperature of such fluids decreases, a temperature T1 (ice crystallization point) is attained at which ice crystals begin to form. Further cooling causes an increase in the amount of ice, until a temperature T2 (solidification point) is reached at which the ice sludge no longer flows freely.

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[1]) Because of thermal expansion, the density (specific gravity) of every fluid varies with temperature. This temperature error must be corrected if the density measurement is to be an accurate indication of the concentration, and thus of the freezing point of the solution. This is particularly important when measuring automobile antifreeze, since coolant temperatures may range from 0 °C to 80 °C (32 °F to 175 °F). Clear and accurate values are also important in summer, since in sealed cooling systems the antifreeze concentration is adapted to the operating conditions of the motor (which is why errors could lead to disturbances), and in modern aluminum systems, the antifreeze is essential in preventing corrosion.

[2]) This accuracy is the result of an optimal combination of twin measuring elements, design, and choice of materials. The accuracy of the HYDROTEMP system cannot be compared with that of other antifreeze testers, since the latter. (e.g. glass hydrometers) are inherently inaccurate. The true density of a fluid can be determined by hydrostatic weighing, or by differential pyknometry (with the use of quartz pyknometers at extreme temperatures).

With further cooling, this sludge solidifies completely, and also expands somewhat, but to a much lesser extent than pure water does when it freezes.

In commonly used antifreeze solutions the difference between temperatures T_1 and T_2 may vary from 4 °C to 8 °C (7 °F to 15 °F). Thus it is customary to designate a temperature halfway between these two temperatures (it might be called an "average freezing point") as the antifreeze protection temperature. This has proved to be a good compromise between safety and economy, because this "average" temperature is always higher than the solidification temperature T_2.

In spite of the sometimes contrary claims made by manufacturers, different brands of glycol antifreeze provide almost identical protection when diluted to the same concentrations. However, all antifreezes contain additives (mainly corrosion inhibitors), and thus their densities may not be identical. Freezing temperatures are customarily listed as a function of concentration, but since all hydrometers actually measure density, it is instructive to consider the relation between temperature and density as shown in the accompanying diagram. Here it will be seen that because of the abovementioned density differences, temperatures T1 and T2 for commercial antifreezes fall within two density ranges as indicated by the tolerance fields T1 and T2. The diagram thus makes it possible to evaluate the calibration and measurement accuracy of HYDROTEMP testers.

When assessing the accuracy of any measuring instrument, all possible sources of error must be taken into consideration. In this type of hydrometer, errors may result from:

1. Excessive tolerances in dimensions and materials during manufacture,
2. Temperature and friction effects during use,
3. Alterations in materials due to ageing.

By a careful choice of materials and strict quality controls, these errors can be reduced to a minimum in well-designed instruments. However, since no quantity-produced instrument, regardless of its cost, can be said to be absolutely free of error, it is customary to assess accuracy in terms of the standard deviation of the sum of all possible errors. The resulting tolerance field for HYDROTEMP testers is shown in the diagram. In view of the fact that the temperature effects included in this field range from 0 °C to 80 °C (32 °F to 175 °F), the remarkable accuracy of HYDROTEMP instruments under all conditions is immediately apparent [3]).

The diagram also shows the calibration of HYDROTEMP temperature readings relative to the significant temperatures of commercial antifreeze solutions. HYDROTEMP readings coincide approximately with temperature T_1, and the average antifreeze protection provided by these solutions has been taken as the lower limit of the tolerance field; thus, the antifreeze protection indicated by HYDROTEMP testers is always on the "safe side". In addition, it will be seen that the tolerance field is narrowest in the range of freezing points between -20 °C and -30 °C (-5 °F and -25 °F), which coincides with the most commonly used antifreeze concentrations. This is the most frequently used measuring range, and it should be noted that the HYDROTEMP temperature scale is relatively expanded in this range in order to provide even greater measurement accuracy. Actually, HYDROTEMP testers can be safely used at temperatures far below the freezing point of water, i.e. as long as the antifreeze solution is still fluid. The temperature indicated by the instrument at such extremes will always be above the solidification point T_2 of the solution, thus providing a reliable indication of antifreeze protection.

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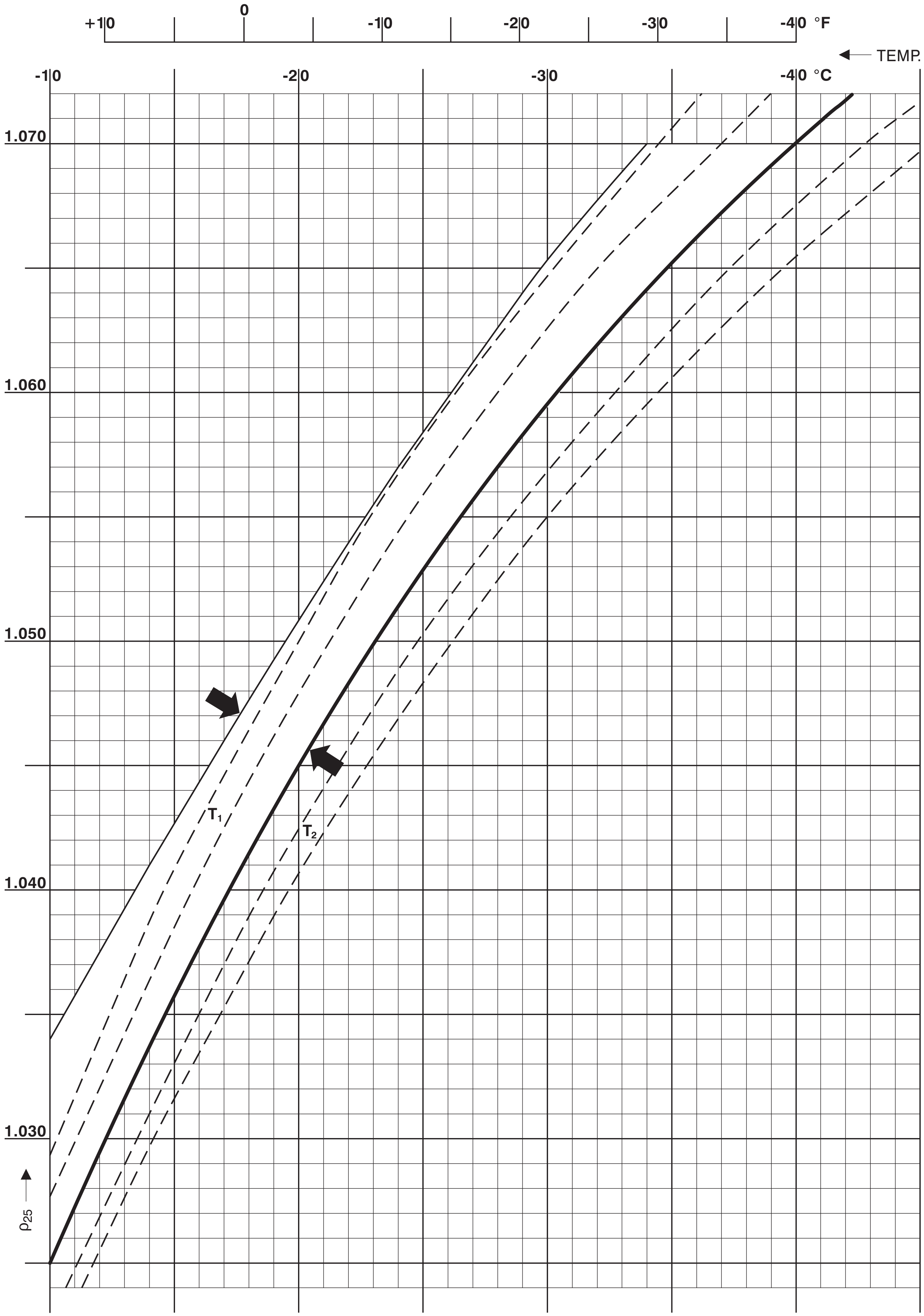
[3]) The diagram is valid for a single (standard) temperature, because the HYDROTEMP system automatically cancels temperature effects to give a reading which is equivalent to that at the standard temperature.

Temperature T_1, is determined according to ASTM D 1177,

Temperature T_2 is determined according to DIN 51 583.



Hydro temp

0 - 80 °C
32-175 °F