ISO Mini Dip & Standard Viscosity Cups

Mini Dip Cup with: 3mm, 4mm & 6mm Orifices
Standard Cup with: 3mm, 4mm, 6mm and 8mm Orifices

The Gardco/ISO Mini Dip and Standard viscosity cups are produced with easily removable orifices of the Gardco "Snap-In, Snap-Out" type. Cup and orifice production tolerance permits replacement or inter-change of orifices without loss of acceptable cup accuracy.

- GARDCO/ISO viscosity cups are designed to comply with requirements of Interntional Standard ISO 2431 and ASTM D5125. It conforms to ISO 9000 when ordered with calibration certification. The ISO viscosity cups qualify under ANSI/NCSL Z540-1 or MIL-STD-45662A as applicable.
- Conversion formulas & table relating efflux time in seconds, to the nearest tenth second, to viscosity in centistokes are furnished with each GARDCO/ISO viscosity cup.
- Calibration of the GARDCO/ISO cup is traceable to the National Institute of Standards and Technology.
- The GARDCO/ISO viscosity cup is machined from solid aluminum bar stock with removable stainless steel orifices.
- The cup has been greatly reduced in weight by removal of excess metal on the lower portion of the cup adjacent to the orifice. This reduces errors due to possible temperature change imposed by the cup.
- A horizontal ledge existing at the top of the orifice in earlier
cups has been eliminated.

- Exterior cup dimensions are chosen to fit existing support
  stands for the Gardco Ford Cup series.
- GARDCO/ISO cups are not matched by any other such cups with respect to the advantages listed above, in highest quality of workmanship and in continuing quality control procedures.
- The GARDCO/ISO viscosity cup was designed, developed, manufactured & calibrated by Paul N. Gardner Company, Inc.

The following is quoted in part from the rationale of the ASTM for the inclusion in ASTM standards, a reference for the design and use of the ISO viscosity cups: "In the 1984 edition of Recommendations of the Committee of Experts on the Transportation of Dangerous Goods, and in similar documents of the International Civil Aviation Organization (ICAO) and of the International Maritime Organization (IMO), an ISO Flow Time Test (ISO 2431) appears. It is used as one of several criteria used to permit shippers of paint and other viscous materials to transport them as a less hazardous material than that indicated by flash point alone. (Request our Flash Point Tester Literature) The three standards involved are: 1. viscosity (ISO 2431), 2. flash point (ISO 1523/ASTM D 3941), and 3. solvent separation test (Now being proposed as an ASTM method.)".

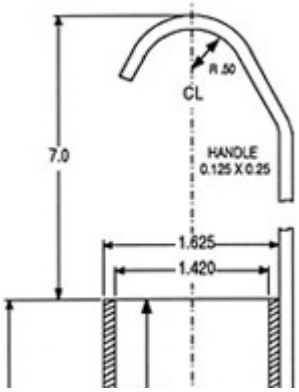
Orifice Interchange (Not applicable to certified cups)

Production tolerance on the Gardco Standard ISO cup, the Gardco/ISO Mini Dip Cup and the orifice, whether it be 3mm, 4mm, or 6mm, is sufficiently close to permit interchange of orifices in any one cup or between cups. For convenience and for best possible results, however, it is recommended that such interchanges be held to a minimum.

The orifices for the cup are machined from stainless steel with the exact conical exterior to match the opening in the base of the cup. Positive orifice identification is assisted by "steps" at the base of the orifice as shown in the cross section drawing. (See "Care of Cup" for orifice removal instructions.)

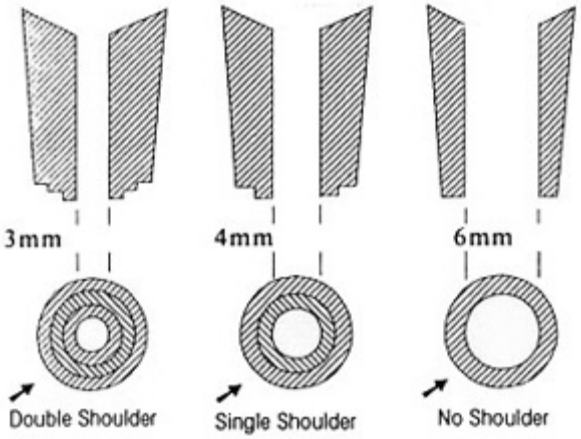
ISO Dip Cup Construction Detail

The physical dimensions of the new Gardco/ISO Dip viscosity cups have been chosen to provide just one half of the efflux time in seconds of the Gardco Standard ISO cups of the same number and orifice. The inverted cone bottom shape of the cup terminating in the removable stainless steel orifice is retained to insure a sharp end point and best possible comparable accuracy.



For the first time a dip cup has been developed primarily for field use which is a direct counterpart of the cup used in the laboratory. Gardco is pleased to have made this contribution and to introduce

the Gardco/ISO Mini Dip Cup series along with the new Gardco Standard ISO series.The Gardco Dip series has all of the advantages listed for the Standard series except it does not have a drip ring at the top of the cup & a handle is attached for support . The Dip cup capacity is one-half that of the Standard cup.



Stainless Steel Orifice Indentification

ISO Dip Series Cups Use

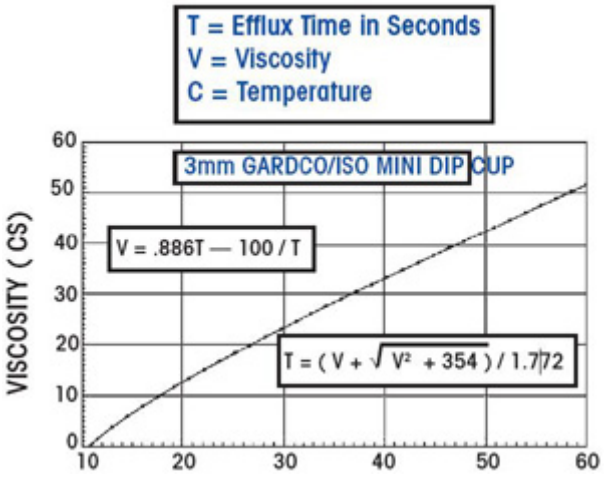
The Gardco/ISO Mini Dip Cups should have the same care as the Gardco Standard ISO Series since they are produced to the same close tolerance. The use of the dip cup, however, is somewhat different.

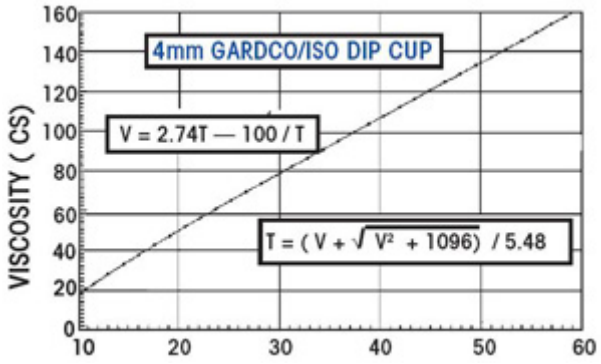
- Adjust the temperature of the material to be measured if necessary. Lower the cup into the material so that the top rim is submerged. Place a thermometer into the cup as it is immersed and determine the temperature of the confined sample.
- Remove thermometer. Hold cup vertically by inserting index finger into handle ring. In a quick, steady motion, lift the cup out of the sample material, starting the timer when the cup breaks the surface. During the flow time, hold the cup no more than 6” above the level of the sample material. Stop the timer when the first definite break in the stream at the base of the cup is observed.
- Record the cup used such as 3mm Gardco/ISO Mini Dip Cup, the measured temperature and the efflux time. If the efflux time is immediately converted to Standard Gardco/ISO Cup time by multiplying by 2, it should be so noted.
- Promptly clean the cup with close attention to the orifice. (Use a length of nylon fishing line to clean the orifice.)

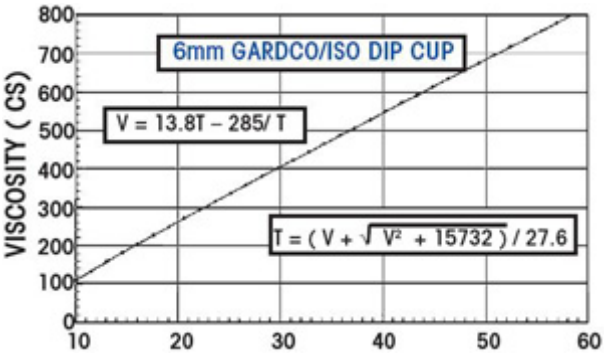
ISO Dip Cup Technical Information

The POISE is the fundamental unit of viscosity. It is a defined mechanical measurement of the resistance of a liquid to flow where gravity is not a factor. 100 CENTIPOISE = 1 POISE. However, gravity is the driving force causing liquid in a viscosity cup to flow through the

orifice. A high density material will flow from a cup in a shorter time than a low density material of the same viscosity. The STOKE is defined as the POISE divided by specific gravity (or weight per gallon in pounds times 0.120). 100 CENTISTOKES = 1 STOKE. The CENTISTOKE is the unit of reference in all viscosity cup measurements.







The graphs relate efflux time in SECONDS to viscosity in CENTISTOKES for each of the three cups of the Gardco/ISO Mini Dip Cup series. The graphs may be used for determining the rough relationship between these factors, but usually reference will be made to the table that is furnished with each cup which provides values to the nearest tenth of a second. If there is a necessity to determine the relationship beyond the range of the table, the mathematical formulas shown on the graphs may be used.

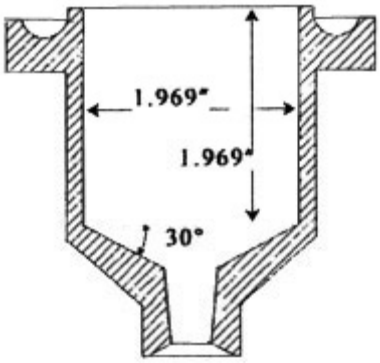
The top formula shown on the 4mm Cup graph is used when efflux time in SECONDS is known. As an example, assume 35.4 SECONDS in the 4mm Dip cup. Multiply 35.4 by 2.74 and the result is 97.0. Divide 100 by 35.4, which is 2.8, and subtract this value from 97.0. The result is 94.2, the CENTISTOKE value of 35.4 SECONDS efflux time from this cup.

The lower formula shown on the 6mm Cup graph is used when the CENTISTOKE value is known. As an example, assume 420 CENTISTOKES in the 6mm Dip cup. Square 420 which is 176,400 and add 15,732 for a total of 192,132. Take the square root of this value, which is 438.3 and add 420 for a total of 858.3. Divide 858.3 by 27.6 and the result is 31.1 SECONDS, the efflux time of a 420 CENTISTOKE material from this cup.

Top of the Page

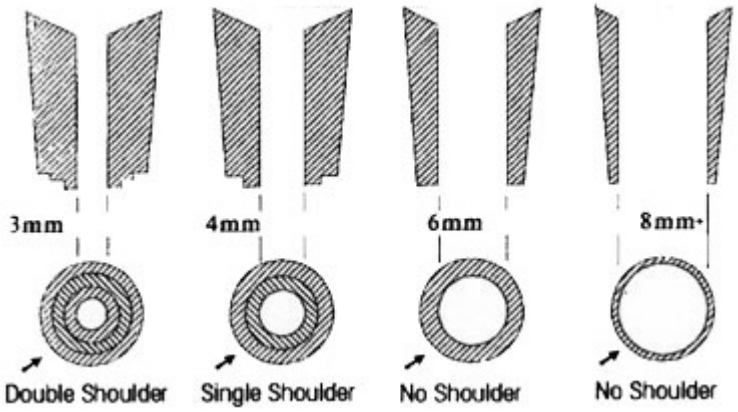
ISO Standard Cup Construction Detail

The body of the cup is machined from solid aluminum bar stock. Note from the cross section drawing of the cup the relatively deep well surrounding the top of the cup which serves to catch any overflow from the filling of the cup. Note also the conical opening for the orifice which permits gentle “tapping in” or “tapping out” of the orifice.



Orifice design provides for extension between the opening in the body and the lowermost extension of the cup. This design insures protection for the orifice and prevents interference with the efflux stream by any contamination surrounding the orifice.

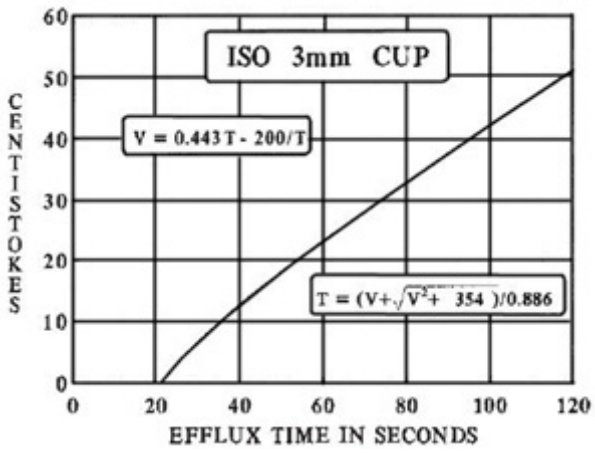
The orifices for the cup are machined from stainless steel with the exact conical exterior to match the opening in the base of the cup. Positive orifice identification is assisted by “steps” at the base of the orifice as shown in the following cross section drawing.



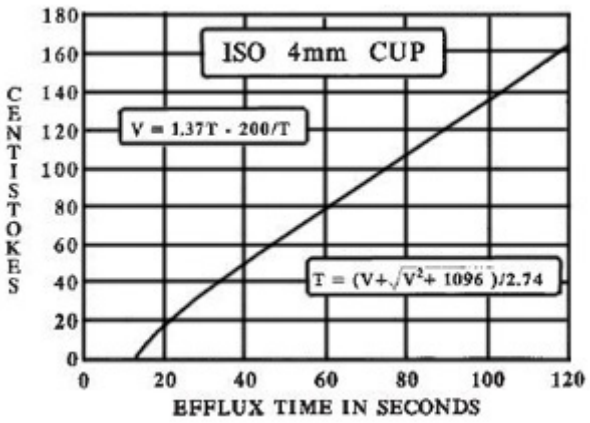
ISO Standard Cup Instructions For Use

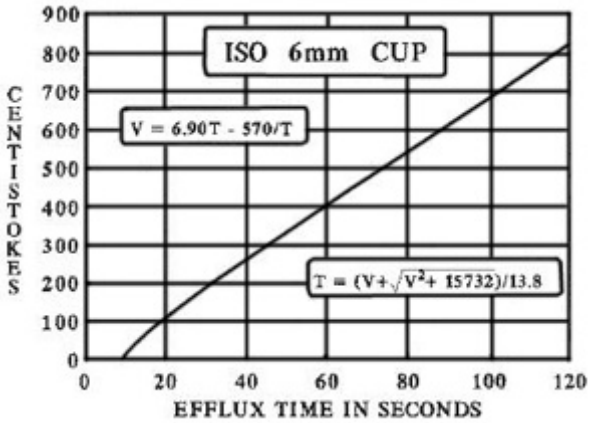
- Select the proper cup/orifice combination to be used from the Specification Table, which is dependent on the expected viscosity range of the material to be measured.
- Insure that the cup is clean and that there is no residual dried material in or around the orifice.
- Insure that the test material is at specified measuring temperature.
- Place the selected cup in a suitable leveled holder and place a receiving container under the cup.
- Place a finger against the orifice and fill the cup until the meniscus where the liquid joins the sidewall of the cup disappears. If there are bubbles in the sample, allow time for them to rise to the surface. If overfilled, remove the excess by sliding the cover plate across the top of the cup. With the plate in this position, the finger may be removed. Remove the finger from the orifice or pull the scraper plate from the top at the cup and simultaneously start a timer.
- Hold a thermometer in the efflux stream in order to accurately determine the temperature of the test material.
- Stop the timer at the first observed break in the efflux stream between one and two inches below the orifice. Caution: There may not be a distinct break with the 8mm orifice. Instead, there may be a distinct change in the efflux stream as the flow shifts from a filled orifice to drainage from the cup sidewall. Stop the timer at the time of this distinct change. This distinct change is sometimes better observed looking down into the cup when testing clear materials.
- Record the cup used, the designation and temperature of the test material and the number of seconds of efflux time. (Example: GARDCO/ISO 4mm Cup, (test material), 25.1°C, 35.0 seconds)
- Promptly clean the cup unless it will be used immediately for a rerun of the same material.

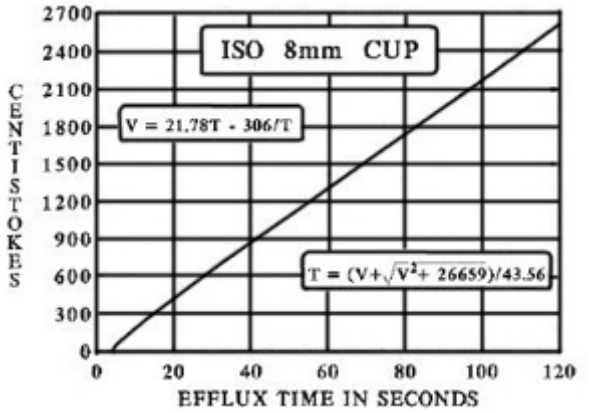
ISO Standard Cup Technical Information



The POISE is the fundamental unit of viscosity. It is a defined mechanical measurement of the resistance of a liquid to flow where gravity is not a factor. 100 CENTIPOISE = 1 POISE. However, gravity is the driving force causing liquid in a viscosity cup to flow through the orifice. A high density material will flow from a cup in a shorter time than a low density material of the same viscosity. The STOKE is defined as the POISE divided by density (or weight per gallon times 0.120). 100 CENTISTOKES = 1 STOKE. The CENTISTOKE is the unit of reference in all viscosity cup measurements.







The graphs relate viscosity in CENTISTOKES to efflux time in SECONDS for each of the four cups of the GARDCO/ISO cup series. The graphs may be used for determining the rough relationship between these factors, but usually reference will be made to the table that is furnished with each cup which provides values to the nearest tenth second. If there is a necessity to determine the relationship beyond the range of the table, the mathematical formulas shown on the graphs may be used.

The top formula shown on the graph is used when efflux SECONDS is known. As an example, assume 45.0 SECONDS in the 4mm Cup. Multiply 45.0 by 1.37 and the result is 61.7. Divide 200 by 45.0, which is 4.4 and subtract this value from 61.7. The result is 57.3, the CENTISTOKE value of 45.0 SECONDS efflux time from this cup.

The lower formula shown on the graph is used when the CENTISTOKE value is known. As an example, assume 188 CENTISTOKES in the 6mm Cup. Square 188 which is 35344 and add 15732 for a total of 51076. Take the square root of this value, which is 226 and add 188 for a total of 414. Divide 414 by 13.8 and the result is 30.0 SECONDS, the efflux time of a 188 CENTISTOKE material from this cup.

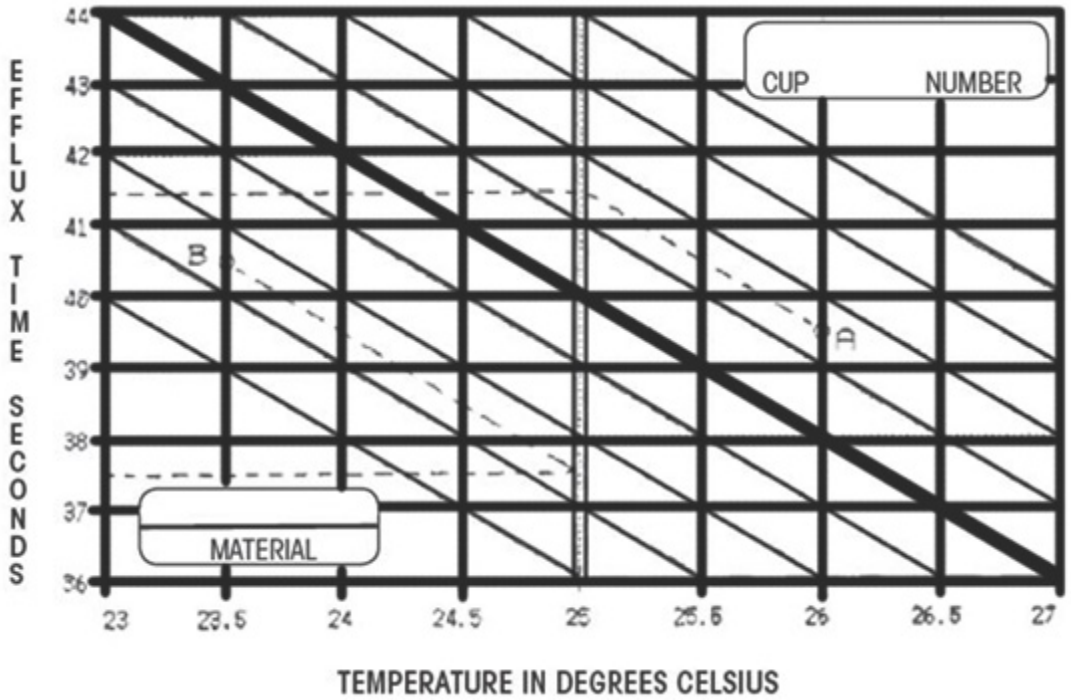
Top of the Page

Temperature For Both Cups

Most materials change in viscosity as a function of temperature. Those normally measured with viscosity cups change in the range of 3% to 8% per degree Celsius change in temperature. Usually, the higher the viscosity the greater the change. For acceptable accuracy, it is necessary to measure temperature at the same time that viscosity cup readings are taken. When many determinations are to be made on similar products in the

same viscosity range, it may be helpful to produce a graph for converting measured temperature and viscosity cup efflux seconds to seconds at a specified temperature, normally 25° Celsius.

There are three variables to consider: viscosity, efflux time and temperature. All three can be shown on a graph with a family of curves as shown in the following example. Viscosity level is indicated by the diagonal lines, increasing from the lower left to the upper right. Such a graph can be prepared for a given material by taking readings with the GARDCO/ISO cup over a limited temperature range as shown in the example. Within this limited range, the plots of the obtained data will normally result in a straight line such as the heavy diagonal line. Draw parallel lines as shown which represent different viscosity levels. Enter on the graph the material represented and the GARDCO/ISO designation with cup number.



Use the prepared graph by plotting on it measured temperature and efflux seconds. At “A” in the example, these values are 26.0°C and 39.5 seconds. Read parallel to the diagonal lines to the intersection with the heavy vertical line which is 25.0°C, the target temperature. Reading horizontally to the left, it is found that the corrected efflux seconds at 25°C is 41.5 seconds. Similarly, at “B” in the example, it is found that a reading taken at 23.5°C, when corrected to 25.0°C, changes from 40.5 to 37.5 seconds.

Compensating for a measured temperature near to but not as specified, must be with caution. Even within the limited range of ± 2.0°C, the variation of viscosity with temperature may not be truly linear and any thinning materials used to adjust viscosity may also change the rate of this variation.

Care of Cups

GARDCO/ISO viscosity cups are precision instruments. They are ruggedly constructed and, with reasonable care, will give many years of satisfactory service, requiring only thorough cleaning following each use. Particular care should be used in cleaning the orifice to avoid leaving deposits or scratches on internal surfaces.

Never strike the orifice directly when removing it from the cup. Place the dowel rod furnished with the cup against the orifice and strike the dowel with a heavy object such as a paper weight, catching the orifice. Prior to inserting an orifice into the cup, insure that the exterior of the orifice and the receiving cone of the cup are clean.

It is good practice to retain one or more standard oils which can be used to periodically insure that the cup retains its initial calibration. Such oils are available from the Paul N. Gardner Company. Refer to the Specification Table for the oil recommended for use with each cup orifice combination.

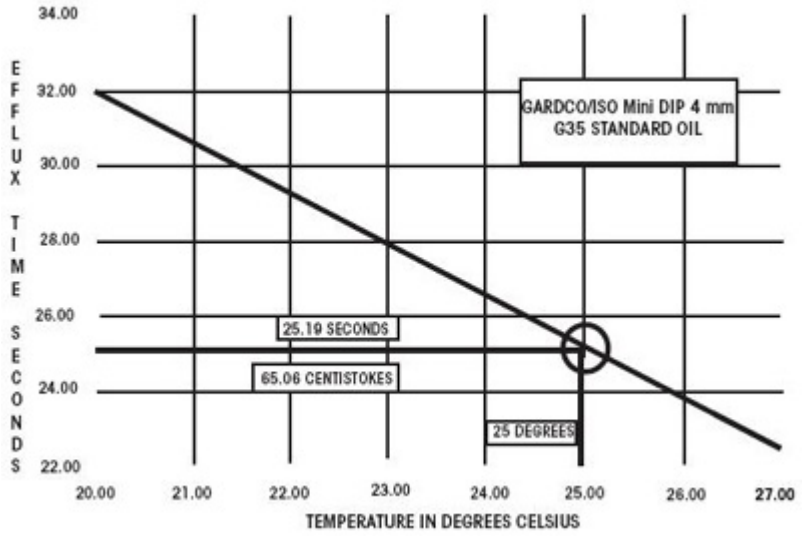
Standard "G" Series Oils - Meets ISO 9002

Gardco produced viscosity cups are calibrated with standard “G” Series oils. Centistoke viscosity of these oils is traceable to the National Institute of Standards and Technology. These standard oils, prepared expressly by the Cannon Instrument Company for the Paul N. Gardner Company, are produced in accordance with ISO 9002; EN ISO 29002:1994; BS EN ISO 9002:1994; ANSI/ASQC Q9002:1994.

Oil Temperature

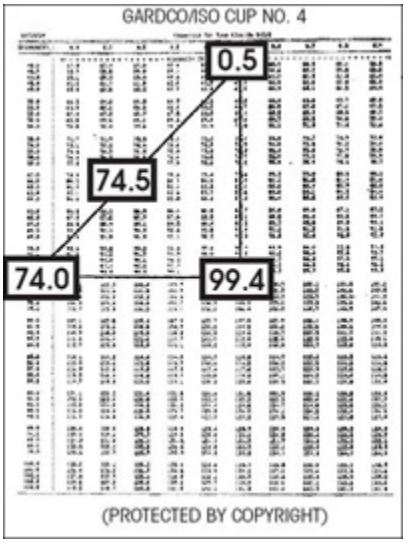
Shown in the graph is the viscosity cup number and the standard “G” Series oil used for its calibration. Normally, cup calibration is at 25.0° Celsius, shown on the graph by bold lines intersecting with the curve in the circle. Temperature/Efflux Time Graphs for all cups in the series are included with each cup sold by the Paul N Gardner Company.

Viscosity of most liquids, including the standard oils, are dependent on temperature. Efflux time in seconds for the indicated cup-oil combination from twenty (20) to twenty-seven (27) degrees Celsius is shown in the graph. The cup may be checked with the indicated “G” oil with reasonable accuracy within these limits. For best accuracy, the standard oil label viscosity with temperature at 25.0° Celsius should be used. Conversion from centistoke viscosity to efflux time in



seconds is by the formula or table furnished with the cup. This information, furnished as an additional customer service, is included with each viscosity cup sold by the Paul N. Gardner Company.

Conversion Table Between Efflux Seconds and Centistokes



Flow characteristics of the GARDCO/ISO viscosity cups are accurately defined by mathematical formula relating them to the viscosity of standard oils which are traceable to the National Institute of Standards and Technology. The formula for each cup in the series is shown on the cup graphs on prior pages. For convenience, the formula for each cup has been solved for each tenth second within the normal cup range. Results are available in table form as shown at the left and are furnished with each cup. They are also available in sets of four for the four cup series.

Use the table as follows: Assume an efflux time of 74.5 seconds. Read down the left column to the 74.0 second line and then to the right on this line to the 0.5 column. The value at the intersection is 99.4 centistokes. The tables may be read in reverse to find efflux seconds from a known centistoke value. Note that conversion values are accurate only for those materials that do not deviate greatly from true liquids.

In order to make the ISO viscosity cup series readily available with the most advanced design, the Paul N. Gardner Company engineered an improved design and is now manufacturing this instrument. The GARDCO/ISO viscosity cups retain the original internal cup dimensions and the same orifice length and diameter but with the following improvements:

The weight of the new cup has been materially reduced adjacent to the orifice for easier temperature control when cup and material are not at the same temperature. The orifices are of the readily replaceable type permitting coverage of the complete viscosity range with one cup and interchangeable orifices. The orifice may be readily replaced, if damaged, rather than requiring replacement of the entire cup. The design of the lower portion of the cup and the readily replaceable orifice eliminates the horizontal ledge inherent in earlier designs at the top of the orifice. For greatest possible user convenience, the outside dimensions of the cup have

been chosen for accommodation by support stands commonly in use with the GARDCO/Ford series of viscosity cups.

In addition to physical improvements, the cups are furnished with conversion formulas and a copyrighted table which relates the nearest tenth second of total efflux time to viscosity in centistokes. This table is particularly useful in determining efflux time in seconds when viscosity in centistokes is known.

As an additional service, the GARDCO/ISO cups may be ordered with a Certificate of Calibration which contains calibration data with the use of oils traceable to the National Institute of Standards and Technology, and a calculated correction factor, if any, that may be used with the cup. Such viscosity cup certification procedures and conditions comply with the specifications of ANSI/NCSL Z540-1or MIL-STD-45662A as applicable.

The GARDCO/ISO viscosity cups are produced to very close mechanical tolerance in elaborate jigs and fixtures. Such equipment not only insures that each cup is correctly produced, but also that all cups are identical. The body of the cup is machined from solid aluminum bar stock and the orifices of stainless steel. The following table provides operating range specifications and the graphs with the included mathematical formulas define the flow characteristics for each numbered cup orifice combination.

Technical Data				
Orifice	**Seconds Range**	**Centistoke Range**	**Midrange Sensitivity [1]**	**Calibration Oil No./ Cenistokes [2]**
3mm	27 → 120	4.6 → 52	.05	#G 10/19Cs
4mm	21 → 120	19 → 163	1.4	#G 35/68Cs
6mm	17 → 120	84 → 823	7.1	#G 100/233Cs
8mm	10 → 120	187 → 2611	22	#G 350/878Cs

[1] Stated as centistokes per second of efflux time.
[2] Centistoke values are nominal - actual values printed on labels

Caution

Silicone fluids should not be used to calibrate viscosity cups. These materials change the interface between the cup surface and the test material and therefore change the cup calibration. The following
is taken from ASTM D 445: Viscometers used for silicone fluids should be reserved for the exclusive use of such fluids. Solvent washings from these viscometers should not be used for cleaning other viscometers.