Heat Transfer Fluids

DOWCAL™ Fluids

Inhibited Glycol-based Heat Transfer Fluids

Guide to Products, System Design, Installation and Operation

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Breweries use DOWCAL™ N Fluid to control fermentation and wort tanks temperature.

DOWCAL™ 100, DOWCAL™ 200 and DOWCAL™ N Fluids

High Performance Inhibited Glycol-based Heat Transfer Fluids

DOWCAL™ heat transfer fluids are clear, ethylene or propylene glycol-based liquids formulated with our signature corrosion inhibitors for optimum system performance. They are optimal solutions if the freezing point of water is not low enough to allow its use in certain applications. Typically diluted with water, DOWCAL™ fluids offer reduced viscosity, increased heat capacity and thermal conductivity, and take advantage of the excellent heat transfer properties of water over a broad range of temperatures.

Advantages of DOWCAL™ Heat Transfer Fluids

Are all heat transfer fluids the same?
Absolutely not. Heat transfer fluids must address a wide range of often vastly different process-specific needs. Selection of the wrong product for a given application may cause damage when the system is filled. Corrosion or gasket decomposition can lead to leaks, lack of performance and damage to property at the worst case. Major equipment overhauls may be required to repair system damage. Considering the potential high price of system repairs – and the potential cost of property and other damage in the event of a system failure and leakage due to ruptured components, it pays to carefully select a heat transfer fluid.

Dow offers a full range of DOWCAL™ heat transfer fluids – including both ethylene glycol- and propylene glycol-based fluids – to meet your specific system requirements. When you choose a DOWCAL™ fluid, you can be confident it will provide long-lasting protection and performance without jeopardizing the integrity of the equipment in which it is used.

- **Corrosion Protection –** DOWCAL™ fluids are formulated with carefully chosen corrosion inhibitors to provide protection to the metallic parts of process equipment, therefore improving process efficiency and reducing maintenance costs. DOWCAL™ 100 and DOWCAL™ 200 in particular are very efficient at protecting aluminum (see additional details on page 11 and 12).

- **Compatibility –** DOWCAL™ fluids set the industry standard for compatibility. The fluid formulations will not affect most plastics and metals, minimizing the potential for gasket decomposition in process equipment.

Ground source heat pumps use DOWCAL™ 100 and DOWCAL™ 200 fluids to help provide efficient heating and cooling in private and industrial buildings while reducing energy use.

- **Long-lasting Performance –** DOWCAL™ fluids are also long-lasting and can be operated for many years in properly maintained systems. Their special corrosion inhibitor package supports higher temperature operation compared to alternative technologies.

- **Sustainable –** DOWCAL™ fluids are nitrite, borax, and CMR (carcinogenic, mutagenic, and reprotoxic) free.

- **Formulated for Maximum Convenience –** DOWCAL 100 and DOWCAL 200 can be diluted with local tap water supplies when demineralized water is not available. (See additional details on page 14).

- **Use in Regulated Industries –** DOWCAL™ N is suitable for use in food plants (see additional details regarding food contact on page 15 of this brochure).

Expert Technical Support
As a Dow heat transfer fluids customer, you have direct access to our industry-leading heat transfer expertise, including our in-depth and highly diversified application experience. Dow heat transfer specialists will help you select the exact fluid you require, then work with you to properly install and optimize fluid operation for best results. Contact us as indicated on the back of this brochure to learn more about our services and to begin working with our experts on your successful heat transfer project.

Additional Resources
FLUIDFILE™ software from Dow is available to assist in the design of heating and cooling processes and in the selection of the best DOWCAL™ fluid for specific applications. FLUIDFILE™ provides physical properties and fluid dynamics for any temperature range and any DOWCAL™/water mixing ratio. Combined with the information in this guide, FLUIDFILE™ can help you achieve optimum heat transfer system performance. Visit www.DOWCAL.com to download the FLUIDFILE™ Software.

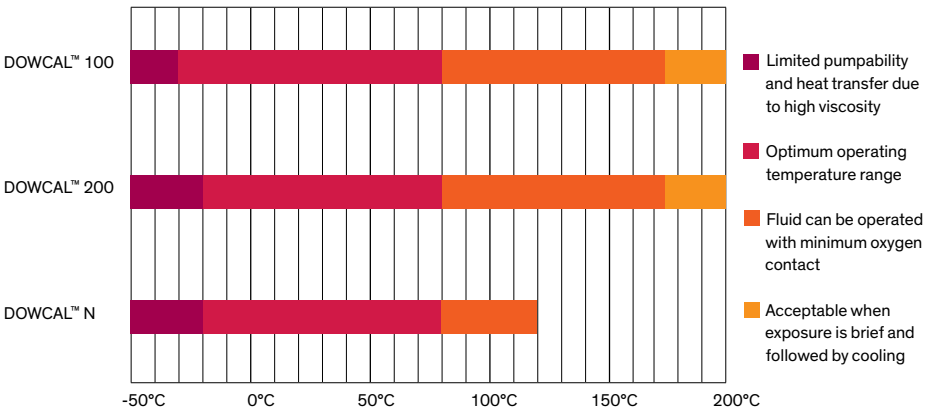
Selecting the Right DOWCAL™ Fluid

DOWCAL™ fluids are used successfully in a wide range of applications, from renewable energy and HVAC systems, to chemical, pharmaceutical and food processing. Your choice of fluid will depend both on where it will be used and your operating temperature requirements.

- DOWCAL™ 100 heat transfer fluid is an ethylene glycol-based fluid especially suitable for use in the pharmaceutical and specialty chemical industry to heat and cool reactors, but also for heating, ventilating, and air conditioning (HVAC) systems, as well as ground source heat pumps.
- DOWCAL™ 200 heat transfer fluid is a propylene glycol-based fluid that is low in acute oral toxicity, which makes it particularly suitable for applications where toxicity is a concern. In particular, it is suitable for heating, ventilating and air conditioning (HVAC) systems, ground source heat pumps, and solar panels. It can also be used for secondary cooling systems in recreational facilities such as ice rinks.
- DOWCAL™ N heat transfer fluid is a propylene glycol-based fluid containing a special corrosion inhibitor package. It is the preferred choice for the food and beverage industry.

DOWCAL™ 100 and DOWCAL™ 200 have recommended operating temperature ranges of -50°C to 175°C while DOWCAL™ N has a recommended range from -50°C to 120°C. Efficiency and operating conditions can differ within those temperature ranges. Refer to the graphic below for guidance.

DOWCAL™ 100 and DOWCAL™ 200 heat transfer fluids are suitable for HVAC systems.



Note: If operated above 100°C, the fluid needs to be pressurized to avoid evaporation in the system

Typical Properties of DOWCAL™ Fluids*

	DOWCAL™ 100	DOWCAL™ 2OO	DOWCAL™ N
Composition, wt % •Ethylene glycol •Propylene glycol •Inhibitors and water	 91 9	 92 8	 95.5 4.5
Color	Colorless	Colorless	Colorless
Density at 20°C, g/cm^3	1.130 - 1.140	1.045 - 1.055	1.045 - 1.055
Reserve alkalinity min. (mL)	10	10	9
pH 50% vol. in water	7.6 - 8.2	7.2 - 7.6	9.5 - 10.5
Maximum Concentration %	20%	20%	25%
Freezing point 50% volume in water 33% volume in water	 -38 -19	 -33 -16	 -31 -14

Physical Properties of DOWCAL™ Fluids*

	DOWCAL™ 100	DOWCAL™ 2OO	DOWCAL™ N
Boiling Range at 1013 mbar, °C	145 - 155	140 - 150	160 - 170
Viscosity at 20°C dynamic, mPa.sec	25 - 30	60 - 65	45 - 60
Viscosity at 20°C kinematic, mm^2/sec	15 - 25	55 - 60	40 - 60
Refractive Index, N_D, 20°C	1.434	1.436	1.432
Specific Heat at 20°C, kJ/kg.K	2.33	2.18	2.45
Thermal Conductivity at 20°C, W/m.K	0.29	0.21	0.24
Specific electrical conductivity 50% vol. in water, MS/cm	5140	2770	2060

*Typical properties, not to be construed as specifications

Note: freezing point varies as a function of the concentration of DOWCAL™ fluid in the solution. Specific heat, density, thermal conductivity and viscosity also vary depending on the concentration of DOWCAL™ fluid as well as the temperature at which the DOWCAL™ solution is used. See the freezing and boiling point tables on pages 16,17 and 18 or refer to FLUIDFILE™ software from Dow to review properties data at specific fluid concentrations and system temperatures. Download the FLUIDFILE™ software at www.DOWCAL.com.

Typical Applications for DOWCAL™ Fluids

Heating and Cooling Applications

Ground Source Heat Pumps

A heat pump system extracts the consistent subsurface temperature of the earth or surface water to provide efficient heating and cooling in private and industrial buildings while reducing energy use. DOWCAL™ fluids are circulated through underground or underwater piping, carrying thermal energy to and from the building. To prevent freezing when the transfer fluid contacts the evaporating refrigerant at sub-zero temperatures, DOWCAL™ 100 or DOWCAL™ 200 can be circulated in the captors/probes. DOWCAL™ fluids can be diluted to 20% concentration in order to provide corrosion protection while maintaining pumping efficiency.

Solar Panels

Active solar thermal systems, such as flat panel collectors, rely on the solar energy to heat-up a fluid, which is circulated in an area that requires heat. This is how, in residential buildings for instance, domestic water can be indirectly (via a heat exchanger) warmed-up, therefore supporting the building's heating system. In such applications, DOWCAL™ 200 is an optimum heat transfer fluid choice: it prevents pipes from bursting during cold weather, and/or eliminates the need for system drainage every year, while maintaining excellent heat transfer efficiencies. In collectors built with aluminum tubes, DOWCAL™ 200 offers best in class corrosion protection, reducing overall collector maintenance costs.

HVAC

Modern HVAC systems frequently use a glycol based heat transfer fluid to transport heat and cold from heating and cooling units to the consumers. When designing, installing or operating these water-based HVAC systems, DOWCAL™ 100 and DOWCAL™ 200 provide the required system protection against freezing and corrosion and provide efficient heat transfer for years with minimal maintenance.

In solar panels, a solution of DOWCAL™ 200 fluid absorbs solar heat, and transports the energy so it can be used to heat water or air.

Food Industry Applications

Cooling Liquid Foods
Because of its outstanding performance features and favorable regulatory profile, DOWCAL™ N fluid is widely used in the beverage industry to cool products such as beer, wine, milk and juices.

Fermentation Cooling
Breweries and wineries use DOWCAL™ N fluid to cool fermentation and wort tanks. The fluid's anti-corrosive properties safeguard the integrity of the piping systems.

Packaging of Carbonated Beverages
DOWCAL™ N fluid is used prior to bottling to cost-effectively chill and prevent loss of carbonation from carbonated beverages such as sparkling wines, champagne and beer.

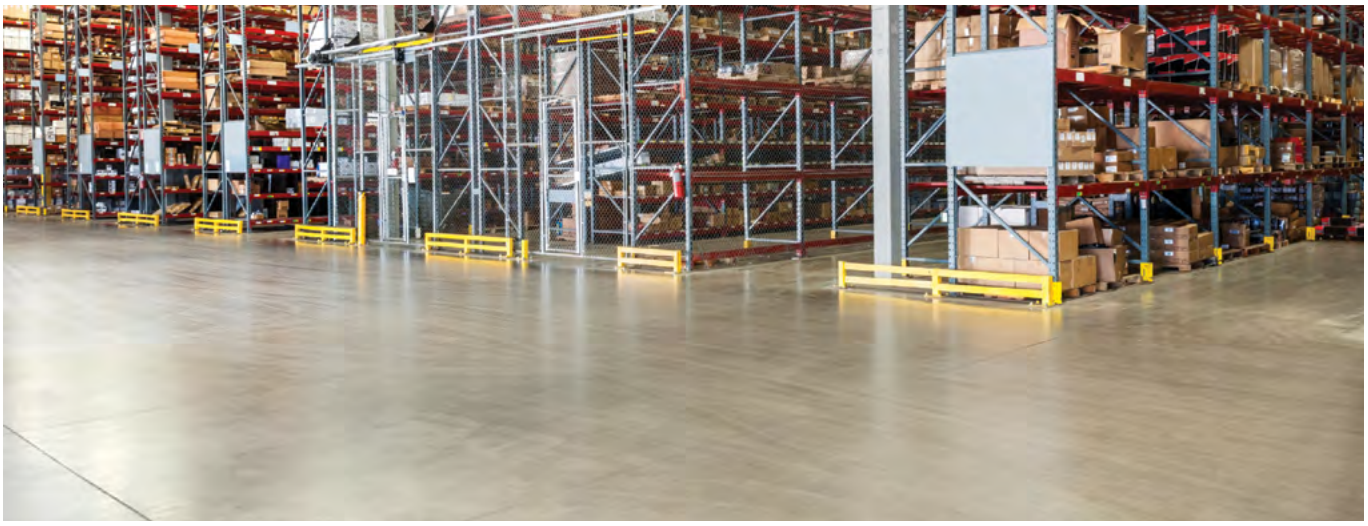
Immersion Freezing of Wrapped Foods
In the food industry, products sealed in airtight and water-tight pouches are immersion-frozen in baths of DOWCAL™ N fluid. This method is popular because it is fast and efficient while ensuring uniform freezing.

Refrigeration Coil Defrosting
When moisture from the air condenses on the refrigeration coils of walk-in freezers and chillers, frost build-up can result in loss of refrigeration efficiency. Sprayed directly onto the coils, DOWCAL™ N fluid will prevent frost formation and, because it is hygroscopic, DOWCAL™ N fluid also absorbs condensation.

Conveyor Roller Deicing
The conveyors in food freezing tunnels are often affected by frost formation on rollers and other moving parts. DOWCAL™ N fluid offers an ideal remedy; sprayed directly onto the rollers, it absorbs free moisture, lowers the freeze point of water, prevents frost build-up and protects the rollers against corrosion.

DOWCAL™ N fluid is widely used to cool, ferment, and bottle beverages.

Typical Applications for DOWCAL™ Fluids continued



A solution of DOWCAL™ 200 fluid can help protect warehouse floors from damage caused by frost heaving.

Industrial Applications

Process Chilling

The chemical and petrochemical industries use secondary cooling for chilling purposes or to remove heat generated during processing. The choice of product depends on the use. DOWCAL™ 100 and DOWCAL™ 200 fluids are often used for process chilling because they are nonflammable in aqueous solutions and are low in corrosivity.

Batch Processing Systems

In batch processing environments, such as in the pharmaceutical and specialty chemical industries, reactors must be cooled and heated. Because of their wide temperature ranges, DOWCAL™ 100 and DOWCAL™ 200 fluids can be used in both hot and cold loops.

Process Pipeline Tracing

DOWCAL™ 100 fluid is used to keep process fluids at a constant temperature and to prevent freezing. Compared to conventional steam tracing, tracing using DOWCAL™ 100 fluid offers better temperature control over a wider range, eliminates waste disposal problems, and requires less maintenance.

Heat Recovery

Many industries operate heat recovery systems to improve the overall thermal efficiency of their processes. In this application, DOWCAL™ 100 fluid collects waste heat that would otherwise be expelled to the environment and pumps it to places where this thermal energy can be put to use.

Construction and Civil Engineering Applications

Ice Skating Rinks

Some of the most elite indoor ice arenas depend on DOWCAL™ to help keep the ice cool and consistent. For ice skating rinks, solutions containing DOWCAL™ 100 or DOWCAL™ 200 fluid are chilled by refrigeration equipment and then circulated through a network of pipes beneath the rink floor. The cold solution causes a layer of water to freeze into a smooth sheet of ice. Used in ice rinks, DOWCAL™ fluids provide fast freezing, lower operating and maintenance costs, as well as excellent corrosion protection for metal pipes.

Snow Melting Systems

A snow melting system consists of a network of pipes or tubing embedded in concrete or asphalt. A solution of heated DOWCAL™ 200 and water is circulated through the pipes in order to melt snow and ice from bridges, service areas, roads and sidewalks. DOWCAL™ 200 fluid can provide years of heat transfer and corrosion protection in properly maintained snow melting systems.

Floor Heating

Massive damage can be inflicted on warehouse floors due to frost heaving. This risk is reduced by embedding a grid of tubing in the soil beneath the floor and heating it with a solution of DOWCAL™ 200 fluid.

Corrosion Protection Capabilities

DOWCAL™ fluids are suitable for a very broad range of applications. The specially formulated inhibitor packages of DOWCAL™ fluids are effective in preventing corrosion of a wide variety of metals that are used in industrial and residential applications, reducing maintenance costs and extending the life of the process equipment.

These inhibitors prevent corrosion of metals in two ways. First, they passivate the surface of metals, reacting with the surface or forming a layer on the surface to prevent acids from attacking it. Second, the inhibitors in DOWCAL™ fluids buffer any acids formed as a result of glycol oxidation. All glycols produce organic acids as degradation products. This degradation is accelerated in the presence of oxygen and/or heat. Left in solution, acids lower pH and contribute to corrosion. Properly formulated inhibitors such as those in DOWCAL™ fluids neutralize these acids and contribute to a long fluid life time. Many commonly available coolants – such as fluids with pure organic acid technology (OAT) – have little ability to buffer these degradation products and therefore need to be changed more frequently.

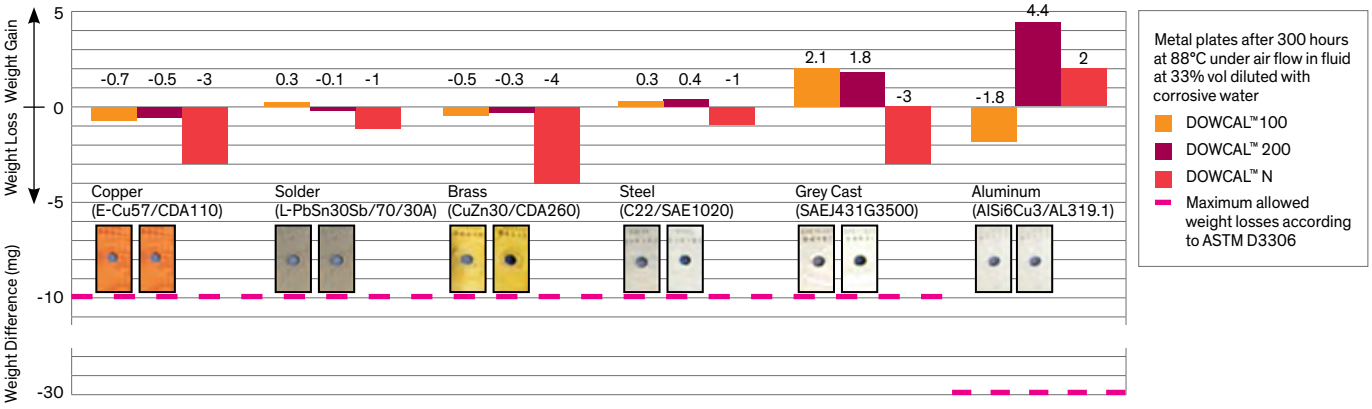
The following data show the comparatively low corrosion of widely used metals caused by DOWCAL™ fluid/water mixtures. The results were derived from tests performed according to the widely known ASTM D 1384 corrosion test method and represent the weight loss of metallic plates in milligrams per specimen due to corrosion (ASTM D 1384, 88°C for 2 weeks, glycol concentration 33% by volume, air bubbling, corrosive water contains 100 ppm Cl^-, 100 ppm $SO_4$2, 100 ppm HCO_3^-).

DOWCAL™ fluids fall well within the generally accepted corrosion limits considered adequate under this test. Rates in excess of 10 mg (30 mg for aluminum) are generally evidence of inadequate corrosion protection.

Many inhibited glycols show acceptable corrosion results at 33% concentration, however, concentrations as low as 20% by volume are required for certain applications. The tables on page 12 show ASTM D1384 corrosion test results under the same conditions for various coolants at a 20% concentration by volume. For comparison purposes, pure water and uninhibited propylene glycol and ethylene glycol are included.

The data shows that the DOWCAL™ fluids demonstrate effective corrosion protection on all metals while the alternative products were more corrosive to aluminum. The tests also demonstrated that water and uninhibited glycols are highly corrosive, reinforcing the need for inhibited fluid protection.

Metal Probes Cleaned After ASTM D1384 Corrosion Testing at a Concentration of 33% by Volume



Corrosion of Cast Aluminum Under Heat-Rejecting Conditions According to ASTM D 4340 at a concentration of 25% by volume
Measured at BfB Oil Research S.A., Gembloux, Belgium, 05/2012 and 03/2013

Corrosion Protection Capabilities continued

Below are corrosion test result data with corresponding test result coupons.

ASTM D1384 Corrosion Test Results at 20% Concentration by Volume Ethylene Glycol (Weight Difference [mg])

		Non-inhibited Ethylene Glycol	Automotive Coolant, MEG-based	OAT fluid, MEG-based	DOWCAL™ 100 Solution
1	Copper	-19	-1.4	-0.8	-0.6
2	Solder	-46	-1.1	-0.8	-0.8
3	Brass	-29	-0.4	-0.4	-0.9
4	Mild Steel	-819	0.5	0.7	-0.2
5	Cast Iron	-642	1.8	1.6	2.7
6	Aluminum	-111	-10.2	-16.0	0.1

ASTM D1384 Corrosion Test Results at 20% Concentration by Volume Propylene Glycol (Weight Difference [mg])

		Non-inhibited Propylene Glycol	Industrial Propylene Glycol Coolant	Alternative OAT Fluid	DOWCAL™ 200 Solution
1	Copper	-12	-0.5	-1.3	-0.3
2	Solder	-55	-1	-1.8	-0.5
3	Brass	-31	-0.7	-1.4	0.3
4	Mild Steel	-969	0.7	0.3	0.6
5	Cast Iron	-700	1.5	0.3	1.3
6	Aluminum	-150	-11.3	-22	0.7

Corrosion of Cast Aluminum under Heat-Rejecting Conditions According to ASTM D 4340

	DOWCAL™ 100	DOWCAL™ 200	Limit according to ASTM D 3306
Weight change in mg/cm²/week:	0.75*	0.16*	max. 1.0

* Measured at BfB Oil Research S.A., Gembloux, Belgium, 05/2012 and 03/2013

Using DOWCAL™ Fluids

Material Compatibility

Solutions of DOWCAL™ fluids are compatible with all metals, with the exception of zinc. The heat transfer fluid can dissolve zinc when hot and should, therefore, not be used in galvanized pipelines.

DOWCAL™ fluids are compatible with most plastics and rubbers, such that they can be considered industry standards. The following table provides a list of compatible plastics and rubbers together with the materials' maximum recommended temperatures (in some cases the maximum use temperature is for the plastics, regardless of the fluid).

Materials	Ethylene glycol based fluid, e.g. DOWCAL™ 100	Propylene glycol based fluid, e.g. DOWCAL™ 200 & DOWCAL™ N
Plastics		
ABS	66°C	32°C
Acrylics	32°C	
Chlorinated Polymer	110°C	
CPVC	93°C [a]	93°C[b]
Epoxy	143°C	99°C(U)[c]
Fluorocarbons FEP	199°C	199°C
Fluorocarbons TFE	249°C	249°C
Noryl®	66°C	
Polyamides - Nylon	99°C	
Bisphenol A-Fumurate	110°C	88°C
Hydrogenated Bisphenol A-Bisphenol A	104°C	93°C
Isophthalic	43°C(U)[c]	88°C
Chlorinated Polyesters	127°C	104°C
Polystyrenes	77°C	
Polyethylene	71°C	66°C
Polypropylene	116°C	66°C
PVC – Type 1	49°C	49°C[d]
PVC – Type 2	49°C	49°C[d]
Polyvinylidene Chloride	88°C	
Vinylidene Fluoride	143°C	138°C
Vinyl Ester	104°C	104°C
Polymethylmethacrylate (PMMA)		70°C[e]
Rubbers		
Butyl GR-1	93°C	
Fluoro Elastomers Viton® A	182°C	38°C
Fluoro Elastomers KEL-F 3700	99°C	
Hard Rubber	93°C	
Chlorosulfonated Polyethylene (CSPE)	99°C	
Koroseal®	71°C	
Natural Rubber (GRS)	71°C	
Neoprene GR-M (CR)	77°C	32°C
Nitrile Buna M (NBR)	88°C	32°C
NORDEL™	154°C	
Polyurethane	38°C	

(a) But only if the solution contains 50% or less of ethylene glycol, according to BF Goodrich

(b) But not in a solution containing more than 25% of propylene glycol, according to BF Goodrich

(c) When U follows a recommended temperature range, the fluid was found to cause a problem with the plastic above the range, and is therefore unsuitable at higher temperatures

(d) The Geon Company, a major manufacturer of PVC resins and compounds, cautions against using PVC above 49°C

(e) Tested by Ecofys Netherlands BV, 2008

Table Sources: "Corrosion Resistance Tables," Second Edition, Philip A. Schweiter, P.E., 1986 BF Goodrich and The Geon Company

Using DOWCAL™ Fluids continued

Storage of DOWCAL™ Fluids

DOWCAL™ fluids require no special climate storage precautions. DOWCAL™ fluids and fluid solutions should be stored in plastic storage containers rather than metallic containers. Zinc, in particular, is not resistant to undiluted DOWCAL™ fluids. Therefore, exposure of zinc or zinc coatings to pure DOWCAL™ fluids should be avoided.

When properly stored, DOWCAL™ fluids will meet sales specification requirements for a period of at least 24 months from date of production in Dow. Continued storage beyond the designated shelf life does not necessarily make the fluid unsuitable for use. Dow offers a fluid analysis service to evaluate fluid condition after prolonged storage.

Fluid Analysis Recommendations

Experience confirms that DOWCAL™ fluids can be used in installations for many years. However, the concentration of DOWCAL™ fluids and the products' functional performance should be checked at intervals of one to two years. Please refer to the back cover of this brochure to find the toll-free number of the Dow Customer Information Group and ask for our fluid analysis procedure.

Fluid Dilution Requirements

Whenever possible, DOWCAL™ fluids should be diluted with demineralized or distilled water. DOWCAL™ 100 and DOWCAL™ 200 fluids can also be mixed with other water within the limits of the following table. Local tap water typically meets these requirements. If water of adequate quality is not available, Dow or Dow's local distributor can supply ready-to-use solutions of DOWCAL™ fluids.

Dilution Water Quality Requirements

	DOWCAL™ 100 / 200
Chloride	<400 ppm*
Sulphate	<400 ppm*
Total Hardness	<450 ppm (25°dH)

*<100 ppm if the system contains aluminum or aluminum alloy components

Although DOWCAL™ fluids are completely miscible with water in all proportions, dilution should preferably be made before the system is filled to help ensure uniform fluid concentration across the system. This will minimize the potential for higher or lower concentrations of fluid to collect at system dead ends. If it is only possible to add the water to the system separately, it is recommended that the system be filled with about two thirds of the calculated amount of water before adding the DOWCAL™ fluid. The system can be topped up with the remaining water after the fluid is introduced. When fluid and water are added separately to the system, it may take several days after startup for the fluid and water to completely mix.

Disposal of Solutions of DOWCAL™ Fluids

The primary component of DOWCAL™ fluids, propylene or ethylene glycol, is readily biodegradable and it is not classified as dangerous to aquatic organisms. However, any disposal practice must be in compliance with all local and national laws and regulations. Do not dump into any sewers, on the ground, or into any body of water.

Fluid Flammability and Fire Hazards

When mixed with water in concentrations of up to 80%, DOWCAL™ fluids are nonflammable since they have no measurable flash points. Therefore, they pose no fire hazard in most applications. The following flashpoint and fire point values apply to pure DOWCAL™ fluids.

Fluid Flammability

	DOWCAL™ 100	DOWCAL™ 200	DOWCAL™ N
Flash point, °C	120	101	101
Ignition temperature, °C	435	420	420

Some of the most elite ice arenas depend on DOWCAL™ 100 and DOWCAL™ 200 fluids to help keep the ice cool and consistent.

Facts on Food Contact

DOWCAL™ N fluid is based on propylene glycol which is generally recognized as safe by the United States Food and Drug Administration (FDA) in section 21CFR184.1666 and meets the specifications of the Food Chemicals Codex, 6th edition (2008). It can therefore be used for direct and indirect food additive applications. In Europe, the ingredients in DOWCAL™ N are listed in the Commission Regulation (EU) No 1130/2011 concerning food additives authorized for use in foodstuffs intended for human consumption. Propylene glycol (PG) is classified as E1520 in an amendment to European Union Directive 95/2/EC, which regulates human food additives and it is listed in Annex I of the Commission Regulation (EU) No 10/2011 as an authorized monomer and additive for plastic materials and articles intended to come into contact with food. Finally, DOWCAL™ N fluid is approved by the National Sanitation Foundation (NSF). It is suitable as a heat transfer medium for food plants.

Fluid Handling

Please refer to the relevant Material Safety Data Sheets (MSDS) available from Dow.

System Design

Like all other fluids, solutions containing DOWCAL™ fluids expand as temperatures increase. Expansion tanks are commonly used in systems containing DOWCAL™ fluids. Expansion tanks must be sized appropriately. To determine the volume required for expansion, the formula given on this page can be used.

$$\Delta V = \frac{\rho(T_{low}) - \rho(T_{high})}{\rho\,(T_{high})} \times V$$

where: $\rho\,(T_{low})$ = the density at the lowest anticipated temperature

$\rho\,(T_{high})$ = the density at the highest anticipated temperature

Preparing New Systems for Use of DOWCAL™ Fluids

When preparing new equipment for systems using DOWCAL™heat transfer fluids, it is good practice to remove oil, grease or protective coatings that may have been applied during fabrication, construction or storage following the equipment manufacturer's recommendations. The system should be free of all foreign matter and debris before any cleaning procedure. Chemical cleaning of new systems can be performed with a 1 to 2 wt % solution of water and trisodium phosphate.

After cleaning the system, it must be thoroughly flushed with clean soft water prior to adding DOWCAL™ fluids. After pressure-testing with water or a solution of DOWCAL™ fluid, systems should be left in the filled state to avoid pitting at the liquid/air phase boundary. If systems that have been filled with water or a solution of DOWCAL™ fluid need to be drained and cannot be refilled within a few days, they should be thoroughly rinsed and dried.

Preparing Existing Systems for Use of DOWCAL™ Fluids

When changing from another heat transfer fluid to a DOWCAL™ fluid, systems should be carefully cleaned to remove all traces of the previous fluid and any deposits which may be present. To help ensure optimum performance of the DOWCAL™ fluid, it is very important to remove any corrosion and replace damaged seals before filling the system. When replacing brine solutions, special care should be taken to remove all scale and corrosion deposits that may have built up.

It is particularly important to remove calcium deposits and chlorides. Residual calcium will react with, and deplete, the inhibitors in DOWCAL™ fluids, reducing the products' corrosion protection capabilities. Chlorides are potentially corrosive to the system if present at high levels. For large or severely corroded systems, it is recommended that a professional cleaning organization be consulted.

When changing from another propylene glycol-based heat transfer fluid, compatibility of the fluid with DOWCAL™ N fluid or DOWCAL™ 200 fluid should be checked. Similarly, if changing from another ethylene glycol based fluid, compatibility with DOWCAL™ 100 fluid should be checked. If the fluids are compatible and if the system is still in proper condition, the system can be filled with a DOWCAL™ fluid.

Physical Properties of DOWCAL™ Fluids

The following data tables provide freezing and boiling point data as well as refractive index, density, dynamic and kinematic viscosity at 20°C for varying concentrations of DOWCAL™ fluids. Specific heat, density, thermal conductivity and viscosity also vary depending on both the concentration and temperature of DOWCAL™ fluid. Specific properties depending on temperature and concentration can be calculated with Dow's FLUIDFILE™ software available at www.DOWCAL.com.

Typical Freezing, Boiling Points and other properties of DOWCAL™ 100 Fluid†*

DOWCAL™ 100 Vol.%	DOWCAL™ 100 Wt. %	Freezing Point °C	Refractive Index @ 20°C	Boiling Point °C @ 1 bara	Density g/cm³ @ 20°C	Dyn. Viscosity mPa.s @ 20°C	Kin. Viscosity mm²/s @ 20°C
5.0	5.6	-2.1	1.3386	100.5	0.983	1.07	1.03
10.0	11.2	-4.3	1.3442	101.1	1.001	1.26	1.22
15.0	16.7	-6.7	1.3498	101.7	1.016	1.49	1.43
20.0	22.1	-9.4	1.3554	102.4	1.029	1.77	1.69
21.0	23.2	-10.0	1.3565	102.5	1.031	1.83	1.75
22.0	24.3	-10.6	1.3576	102.7	1.033	1.89	1.81
23.0	25.3	-11.3	1.3588	102.8	1.036	1.96	1.87
24.0	26.4	-11.9	1.3599	102.9	1.038	2.03	1.93
25.0	27.5	-12.6	1.3610	103.1	1.040	2.09	1.99
26.0	28.5	-13.2	1.3621	103.2	1.042	2.17	2.06
27.0	29.6	-14.0	1.3632	103.3	1.044	2.24	2.13
28.0	30.6	-14.7	1.3643	103.5	1.046	2.32	2.20
29.0	31.7	-15.4	1.3654	103.6	1.048	2.40	2.27
30.0	32.7	-16.2	1.3665	103.8	1.050	2.48	2.35
31.0	33.8	-17.0	1.3676	103.9	1.052	2.57	2.43
32.0	34.8	-17.8	1.3687	104.0	1.053	2.65	2.51
33.0	35.9	-18.7	1.3698	104.2	1.055	2.75	2.59
34.0	36.9	-19.5	1.3709	104.3	1.057	2.84	2.68
35.0	38.0	-20.4	1.3720	104.5	1.059	2.94	2.77
36.0	39.0	-21.4	1.3731	104.6	1.060	3.04	2.86
37.0	40.0	-22.3	1.3742	104.8	1.062	3.14	2.96
38.0	41.0	-23.3	1.3752	104.9	1.064	3.25	3.06
39.0	42.1	-24.3	1.3763	105.1	1.065	3.36	3.16
40.0	43.1	-25.4	1.3774	105.2	1.067	3.48	3.27
41.0	44.1	-26.4	1.3785	105.4	1.068	3.60	3.38
42.0	45.1	-27.5	1.3796	105.5	1.070	3.72	3.49
43.0	46.1	-28.7	1.3806	105.7	1.071	3.85	3.60
44.0	47.2	-29.9	1.3817	105.9	1.073	3.98	3.73
45.0	48.2	-31.1	1.3828	106.0	1.074	4.12	3.85
46.0	49.2	-32.3	1.3838	106.2	1.076	4.26	3.98
47.0	50.2	-33.6	1.3849	106.4	1.077	4.41	4.11
48.0	51.2	-34.9	1.3859	106.5	1.079	4.56	4.25
49.0	52.2	-36.3	1.3870	106.7	1.080	4.71	4.39
50.0	53.2	-37.7	1.3880	106.9	1.081	4.88	4.54
51.0	54.2	-39.1	1.3891	107.1	1.083	5.04	4.69
52.0	55.2	-40.6	1.3901	107.3	1.084	5.22	4.85
53.0	56.2	-42.1	1.3912	107.5	1.085	5.40	5.01
54.0	57.1	-43.7	1.3922	107.7	1.087	5.58	5.18
55.0	58.1	-45.3	1.3932	107.9	1.088	5.77	5.35
56.0	59.1	-46.9	1.3943	108.2	1.089	5.97	5.53
57.0	60.1	-48.6	1.3953	108.4	1.090	6.18	5.71
58.0	61.1	-50.3	1.3963	108.7	1.092	6.39	5.90
59.0	62.0	<-51	1.3973	108.9	1.093	6.61	6.10
60.0	63.0	<-51	1.3983	109.2	1.094	6.84	6.31
65.0	67.8	<-51	1.4033	110.8	1.100	8.10	7.43
70.0	72.6	<-51	1.4082	112.8	1.105	9.59	8.76
75.0	77.3	<-51	1.4130	115.4	1.111	11.4	10.3
80.0	82.0	<-51	1.4176	118.8	1.116	13.4	12.2
85.0	86.6	-50.9	1.4220	123.2	1.120	15.9	14.4
90.0	91.1	-40.8	1.4264	128.9	1.125	18.8	16.9
95.0	95.6	-34.5	1.4305	136.1	1.129	22.3	19.9
100.0	100.0	-28.7	1.4345	145.1	1.134	26.4	23.5

†Typical properties, not to be construed as specifications.

*Temperature-dependent physical properties are provided in the FLUIDFILE™ Software.

Generally, for an extended margin of protection you should select a temperature in this table that is at least 3°C lower than the expected lowest ambient temperature. Contact Dow for information and further assistance with specific cases.

Typical Freezing, Boiling Points and other properties of DOWCAL™ 200 Fluid†*

DOWCAL™ 200 Vol.%	DOWCAL™ 200 Wt. %	Freezing Point °C	Refractive Index @ 20°C	Boiling Point °C @ 1 bara	Density g/cm³ @ 20°C	Dyn. Viscosity mPa.s @ 20°C	Kin. Viscosity mm²/s @ 20°C
5.0	5.3	-1.6	1.3391	100	1.006	1.36	1.95
10.0	10.5	-3.3	1.3452	100	1.011	1.62	1.66
15.0	15.8	-5.3	1.3513	101	1.015	1.93	1.81
20.0	20.9	-7.5	1.3573	101	1.020	2.30	2.11
21.0	22.0	-8.0	1.3585	101	1.021	2.39	2.18
22.0	23.0	-8.5	1.3597	101	1.022	2.48	2.26
23.0	24.0	-9.1	1.3609	102	1.022	2.57	2.34
24.0	25.1	-9.6	1.3621	102	1.023	2.66	2.42
25.0	26.1	-10.2	1.3633	102	1.024	2.76	2.51
26.0	27.1	-10.8	1.3645	102	1.025	2.87	2.61
27.0	28.2	-11.4	1.3657	102	1.026	2.97	2.71
28.0	29.2	-12.1	1.3669	102	1.027	3.09	2.81
29.0	30.2	-12.7	1.3681	102	1.028	3.20	2.92
30.0	31.2	-13.4	1.3693	102	1.029	3.33	3.04
31.0	32.3	-14.1	1.3704	102	1.030	3.45	3.16
32.0	33.3	-14.8	1.3716	102	1.031	3.58	3.29
33.0	34.3	-15.6	1.3728	102	1.032	3.72	3.42
34.0	35.3	-16.4	1.3739	102	1.033	3.87	3.56
35.0	36.3	-17.2	1.3751	102	1.034	4.02	3.70
36.0	37.4	-18.0	1.3762	103	1.035	4.17	3.85
37.0	38.4	-18.9	1.3774	103	1.036	4.34	4.01
38.0	39.4	-19.8	1.3785	103	1.037	4.51	4.17
39.0	40.4	-20.7	1.3797	103	1.038	4.68	4.35
40.0	41.4	-21.7	1.3808	103	1.039	4.87	4.53
41.0	42.4	-22.7	1.3820	103	1.039	5.06	4.71
42.0	43.4	-23.7	1.3831	103	1.040	5.26	4.91
43.0	44.4	-24.8	1.3842	103	1.041	5.47	5.12
44.0	45.4	-25.8	1.3853	103	1.042	5.69	5.33
45.0	46.4	-27.0	1.3864	103	1.043	5.92	5.55
46.0	47.5	-28.1	1.3875	104	1.044	6.16	5.79
47.0	48.5	-29.3	1.3886	104	1.045	6.40	6.03
48.0	49.5	-30.5	1.3897	104	1.046	6.66	6.29
49.0	50.5	-31.8	1.3908	104	1.047	6.93	6.55
50.0	51.5	-33.1	1.3919	104	1.048	7.22	6.83
51.0	52.5	-34.5	1.3930	105	1.048	7.51	7.12
52.0	53.5	-35.9	1.3941	105	1.049	7.82	7.42
53.0	54.4	-37.3	1.3951	105	1.050	8.14	7.74
54.0	55.4	-38.7	1.3962	105	1.051	8.48	8.07
55.0	56.4	-40.3	1.3973	105	1.052	8.83	8.41
56.0	57.4	-41.8	1.3983	106	1.053	9.20	8.77
57.0	58.4	-43.4	1.3993	106	1.053	9.58	9.14
58.0	59.4	-45.0	1.4004	106	1.054	9.98	9.54
59.0	60.4	-46.7	1.4014	106	1.055	10.4	9.94
60.0	61.4	-48.5	1.4024	107	1.056	10.8	10.4
65.0	66.3	-51	1.4074	108	1.059	13.3	12.8
70.0	71.2	-51	1.4122	109	1.062	16.5	15.8
75.0	76.1	-51	1.4168	111	1.064	20.4	19.5
80.0	80.9	-51	1.4212	113	1.066	25.4	24.1
85.0	85.7	-51	1.4253	116	1.066	31.6	29.8
90.0	90.5	-51	1.4291	121	1.065	39.5	36.9
95.0	95.3	-51	1.4327	129	1.062	49.5	45.7
100.0	100.0	-51	1.4360	142	1.057	62.3	56.5

†Typical properties, not to be construed as specifications.

*Temperature-dependent physical properties are provided in the FLUIDFILE™ Software.

Generally, for an extended margin of protection you should select a temperature in this table that is at least 3°C lower than the expected lowest ambient temperature. Contact Dow for information and further assistance with specific cases.

Physical Properties of DOWCAL™ Fluids continued

Typical Freezing, Boiling Points and other properties of DOWCAL™ N Fluid†*

DOWCAL™ N Vol.%	DOWCAL™ N Wt. %	Propylene Glycol Wt. %	Freezing Point °C	Refractive Index @ 22°C	Boiling Point °C @ 1 bara	Density g/cm³ @ 20°C	Dyn. Viscosity mPa.s @ 20°C	Kin. Viscosity mm²/s @ 20°C
5.0	5.2	5.0	-1.6	1.3383	100	1.004	1.2	1.2
10.0	10.5	10.0	-3.3	1.3438	100	1.009	1.4	1.4
15.1	15.7	15.0	-5.1	1.3495	100	1.014	1.6	1.6
20.3	20.9	20.0	-7.1	1.3555	101	1.020	2.0	2.0
21.3	22.0	21.0	-7.6	1.3567	101	1.021	2.0	2.0
22.4	23.0	22.0	-8.0	1.3579	101	1.022	2.1	2.1
23.4	24.1	23.0	-8.6	1.3591	101	1.023	2.2	2.2
24.5	25.1	24.0	-9.1	1.3603	101	1.023	2.3	2.2
25.5	26.2	25.0	-9.6	1.3615	101	1.024	2.4	2.3
26.5	27.2	26.0	-10.2	1.3627	101	1.025	2.5	2.4
27.6	28.3	27.0	-10.8	1.3639	101	1.026	2.6	2.5
28.6	29.3	28.0	-11.4	1.3651	102	1.027	2.7	2.6
29.7	30.4	29.0	-12.0	1.3663	102	1.028	2.9	2.8
30.7	31.4	30.0	-12.7	1.3675	102	1.029	3.0	2.9
31.8	32.5	31.0	-13.4	1.3687	102	1.030	3.1	3.0
32.8	33.5	32.0	-14.1	1.3698	102	1.031	3.3	3.2
33.9	34.6	33.0	-14.8	1.3710	102	1.032	3.4	3.3
35.0	35.6	34.0	-15.6	1.3621	102	1.032	3.5	3.4
36.0	36.6	35.0	-16.4	1.3733	103	1.033	3.7	3.6
37.1	37.7	36.0	-17.3	1.3744	103	1.034	3.9	3.8
38.2	38.7	37.0	-18.2	1.3756	103	1.035	4.0	3.9
39.2	39.8	38.0	-19.1	1.3767	103	1.036	4.2	4.1
40.3	40.8	39.0	-20.1	1.3779	103	1.036	4.4	4.2
41.4	41.9	40.0	-21.1	1.3790	104	1.037	4.5	4.3
42.4	42.9	41.0	-22.1	1.3802	104	1.038	4.7	4.5
43.5	44.0	42.0	-23.2	1.3813	104	1.039	4.8	4.6
44.5	45.0	43.0	-24.3	1.3825	104	1.039	5.0	4.8
45.7	46.1	44.0	-25.5	1.3836	104	1.040	5.2	5.0
46.7	47.1	45.0	-26.7	1.3847	104	1.041	5.4	5.2
47.8	48.2	46.0	-27.9	1.3858	104	1.041	5.6	5.4
48.9	49.2	47.0	-29.3	1.3870	104	1.042	5.8	5.6
50.0	50.3	48.0	-30.6	1.3881	105	1.043	6.1	5.8
51.1	51.3	49.0	-32.1	1.3892	105	1.043	6.3	6.0
52.2	52.4	50.0	-33.5	1.3903	106	1.044	6.6	6.3
53.2	53.4	51.0	-35.0	1.3914	106	1.045	6.9	6.6
54.3	54.5	52.0	-36.6	1.3924	106	1.045	7.2	6.9
55.4	55.5	53.0	-38.2	1.3935	106	1.046	7.6	7.3
56.5	56.5	54.0	-39.8	1.3945	106	1.046	7.9	7.6
57.5	57.6	55.0	-41.6	1.3956	106	1.047	8.2	7.8
58.5	58.6	56.0	-43.3	1.3966	106	1.047	8.6	8.2
59.6	59.7	57.0	-45.2	1.3977	107	1.048	8.9	8.5
60.6	60.7	58.0	-47.1	1.3987	107	1.048	9.3	8.9
61.7	61.8	59.0	-49.0	1.3998	107	1.049	9.7	9.2
62.7	62.8	60.0	-51.1	1.4008	107	1.049	10.0	9.5
68.0	68.1	65.0	-51.1	1.4058	108	1.052	11.7	11.1
73.2	73.3	70.0	-51.1	1.4104	110	1.054	14.2	13.5
78.4	78.5	75.0	-51.1	1.4150	114	1.055	17.1	16.2
83.6	83.8	80.0	-51.1	1.4193	118	1.054	21.2	20.1
88.9	89.0	85.0	-51.1	1.4235	125	1.053	26.0	24.7
94.1	94.2	90.0	-51.1	1.4275	132	1.052	33.4	31.7
100.0	100.0	95.5	-51.1	1.4315	165	1.051	45.7	43.5

†Typical properties, not to be construed as specifications.

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DOWCAL™ Fluids

Inhibited Glycol-based Heat Transfer Fluids

Guide to Products, System Design, Installation and Operation

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