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GEOlube® Quenchant A

GEOlube® Quenchant A is a non-flammable polymeric fluid manufactured from an aqueous solution of polyalkylene glycol and corrosion inhibitor.

Typical Physical Properties *

Property	Quenchant A
Density @ 20°C, kg/m^3	**1098**
Refractive index @ 20°C	**1.41**
Viscosity @40°C, mm^2 / sec	**450**
Flash point	**none**
Fire point	**none**
Pour point, °C	**-30**
pH	**Slightly**
Cloud point, °C	**74**

* The typical values presented here are believed to be accurate; they should not, however be considered to constitute a specification.

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Applications

Aluminium Quenching

The solution heat treatment procedures for aluminium alloys, in either the cast, forged or wrought form, has traditionally incorporated a water quench. The use of **GEOlube® Quenchant A** can minimise the residual stress, and therefore distortion levels, produced during the quenching phase of thermal treatment without sacrifice of mechanical or inter-granular corrosion properties. Age hardening of the components then proceeds as for water quenched items, irrespective of whether natural or artificial aging procedures are used.

Ferrous Quenching

For ferrous heat treatment, **GEOlube® Quenchant A** has been successfully used for the induction and flame hardening of components such as gears, shafts, steering racks and other items of variable geometry and steel composition. **GEOlube® Quenchant A** has also found application during the quenching of a wide variety of component size / chemistry combinations, from shaker, pit, integral quench or continuous furnaces employing either oxidising or protective atmospheres.

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Advantages

Advantages of **GEOlube® Quenchant A** are as follows:

- Eliminate fire risks due to the relatively high concentration of water.
- Eliminate smoke, soot and oil quenchant residues, making a cleaner working environment and easier equipment maintenance.
- High degree of flexibility since optimum conditions for a specific material or component may be determined by control of concentration, bath temperature and / or agitation.
- Minimise the replacement and control requirements common to PVA and soluble oil quenchants due to deterioration and / or oxidation.
- Minimise the residual stress, distortion and soft spotting associated with water quenching of aluminium based materials.
- Produce clean components ready for further processing - drag out losses are reduced compared to oil and no degreasing is necessary.
- The quenchant is fully soluble in water (below its cloud point) and easily mixed to the operating concentration.
- Good anti-corrosion properties, protecting the quenching system.
- Extended lifetime due to low levels of drag out and bath deterioration.

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Quenching Action

The quenching action of a **GEOlube® Quenchant** solution depends on the characteristic of inverse solubility. At ambient temperatures the liquid organic polymer is fully soluble in water. Above the separation temperature however, the polymer becomes insoluble and will precipitate out of solution. Once cooled below the separation temperature, the polymer will once more dissolve. This solubility variation results in a 3 stage cooling cycle similar to the behaviour noted for water or oil quenchants.

- When a hot metal component is either immersed in, or flooded with, a **GEOlube® Quenchant** solution, a thin film of polymer is deposited upon the component surface because the inversion temperature has been locally exceeded. The presence of this film slows down the initial rate of cooling, analogous to the vapour blanket stage in water or oil quenching.
- After a short period of time the polymer film becomes active and a period of rapid cooling ensues, equivalent to the nucleate boiling phase in conventional liquid quenching. During this period, the presence of the even polymer film ensures uniform surface heat extraction characteristics, thereby reducing the thermal stresses and distortion associated with the quenching process.
- Finally, when the temperature falls below the separation temperature, the polymer layer re-dissolves and heat transfer is by convection / conduction, as with other quenching fluids at these temperatures.

	Quenchant A
Separation temperature, °C	**74**

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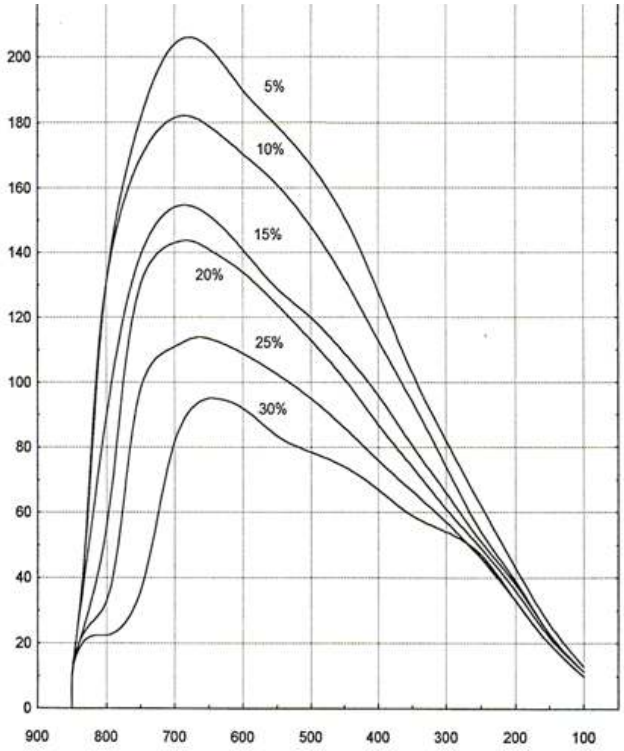
Control of Cooling Characteristics

The cooling rates of **GEOlube® Quenchant A** may be varied to suit particular metallurgical conditions by varying the solution concentration. The variation in quench performance with concentration arises from the increase in liquid polymer layer thickness, at the component surface, with increase in concentration.

Typical data for GEOlube® Quenchant A (20°C, Inconel 600 probe Ø12.5mm, moderate agitation)



At a dilution of 3 - 5 %, the solution has improved wettability when compared to water, and quench properties equivalent to a well agitated water - or even brine - quench may be achieved.

Concentrations around 15% achieve cooling rates similar to, or slightly in excess of, those for fast mineral oil quenchants and are thus suitable for low hardenability materials.

Increasing the solution concentration to 30 - 35% reduces cooling rates to those of the medium/slow speed quench oils, producing conditions suitable for a range of direct hardening and case / hardening steels.

Solutions of 40% and above have been used in aluminium heat treatment when replacing hot water quenches.

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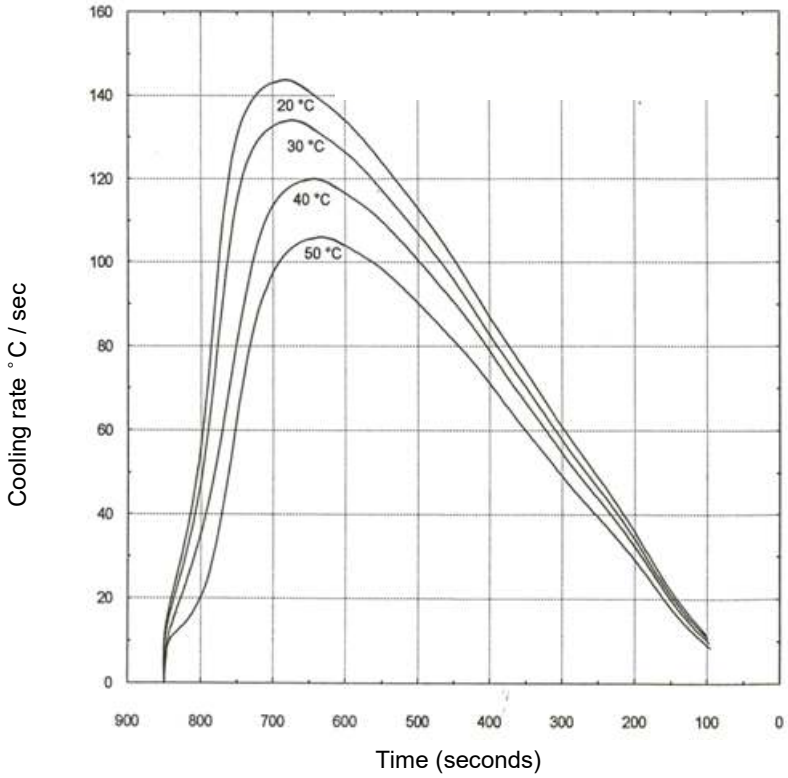
The range of bath operating temperature is normally limited to between ambient and 50°C since higher temperatures may promote bulk tank inversion (as a result of the inverse solubility effect), which must be avoided.

Variation in bath temperature will also modify the cooling behaviour of the quenchant. The diagram below illustrates this effect. Therefore, close control of the desired bath temperature should be maintained.

Typical data for GEOlube® Quenchant A (20°C, Inconel 600 probe Ø12.5mm, moderate agitation)



Agitation must always be incorporated into a polymer quenching system design to ensure that local overheating and starvation do not occur.

Additional variation of the quench performance may however be accomplished by suitable agitation control as follows:

- Optimum rate 43 m^3 / min.
- Directed up through the load
- Liquid volume re-circulated once every 2-5 minutes

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Use of GEOlube® Quenchant A

To obtain the noted advantages, it is essential that the quenching characteristics of both the specific material / component combination and the furnace equipment are appreciated so that appropriate quenchant conditions may be achieved. Furthermore, appropriate jigging and spacing procedures must be applied. In this respect, the following points should be noted:

Quenchant must have free access to all component surfaces and wet them simultaneously in order to develop an even polymer film with consequent uniform surface heat extraction properties.

Depending on component size and geometry, parts should be suspended either vertically or horizontally with spacers used where necessary to ensure free quenchant access.

Equipment mechanisation is advisable to ensure satisfactory and repeatable quench transfer characteristics with large or heavy components.

Polymer quenchants require closer temperature control than other quench systems; therefore, it should ne noted that:

The associated temperature rise in oil is approximately halved when using polymers.

It is recommended that the quenchant system be fitted with an appropriate heat exchanger.

In order to maximise the benefits of polymer quenching and to minimise the risk of bulk tank inversion, it is recommended that a load (kg) / quench volume (l) ratio of 1:12.5 be employed. If this is not achievable, then a minimum ratio of 1:10 is acceptable.

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Conversion Procedures

When **GEOlube® Quenchant A** is introduced into an existing system, it will, in all likelihood, be replacing one of the following classes of fluids:

Water

No special conversion procedures required unless surfaces are painted - see section on compatible coatings.

Brine

Salt residues should be removed by flushing system with fresh water.

Polyvinyl Alcohol (PVA)

Residual PVA should be flushed with fresh water. Insoluble films of PVA should be cleaned from the equipment as completely as possible prior to introducing **GEOlube® Quenchant A**.

Soluble Oil

Residual soluble oil should be removed by flushing the system with warm water or the application of a steam cleaning technique. This is critical since the soluble oil will emulsify in **GEOlube® Quenchant A** and reduce quenching speed.

Petroleum Oil

This quenchant should be drenched from the system, following which sludge and varnish should be removed from the tank and heat exchanger surfaces. Unless the degree of agitation within the system is high, petroleum oils will not emulsify in **GEOlube® Quenchant A** and thus, because of their lower density, will move to the bath surface. Significant volumes should be skimmed off to reduce the potential fire hazard. Minimal amounts may be allowed safely to burn off.

GEOlube® Quenchant A has a solvent action on petroleum oil degradation products, consequently heat exchanger surfaces will be cleaned and made more efficient. Similarly, these products will be removed from the packing glands of pumps and system seals, so periodic checks for leaks resultant from the removal of these films are recommended.

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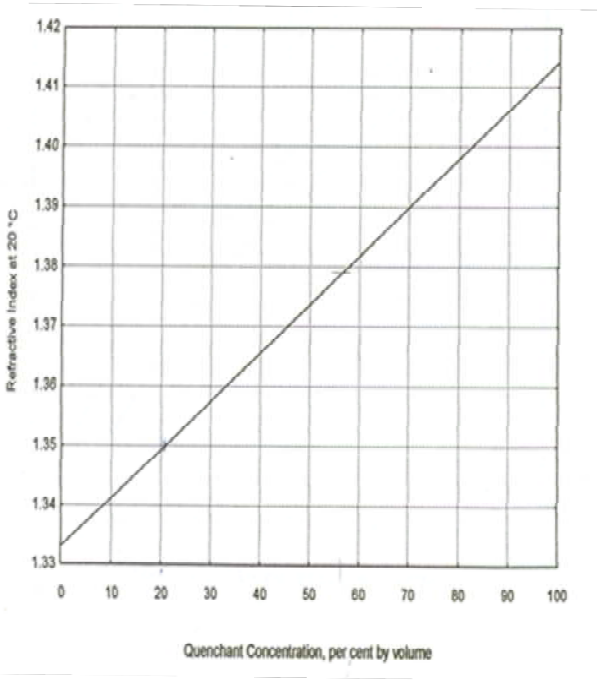
Maintenance of Quenching Systems Containing GEOLUBE® Quenchant A

Determining Fluid Concentration

To retain optimum bath performance, the appropriate concentration of **GEOlube® Quenchant A** in water must be regularly monitored and maintained. There are a number of different procedures available to do this.

Refractive Index

Concentration may be readily determined by measurement of refractive index, the direct relationship being shown below.



Where a direct reading refractometer is not used, the Brix Number or refractive index reading can be converted to % **GEOlube® Quenchant A** by using the chart on the next page.

Direct reading refractometers are available from Bellingham and Stanley Limited, Polyfract Works, Lonfield Road, Tunbridge Wells, Kent, TN2 3EY, UK.

Adjustment of concentration

Where the concentration has fallen, the chart below enables the user to calculate the **GEOlube® Quenchant A** top up to bring the concentration to the required level.

The equation below is for use where the concentration of has increased and therefore a water top up is necessary:

$$\text{Water Top Up} = \mathbf{C - \left[Q + \frac{(100-R)}{R}\right]}$$

Where:

C = system capacity
Q = original volume of undiluted **GEOlube® Quenchant A** in the system.
R = refractometer reading of % **GEOlube® Quenchant A** in the system.

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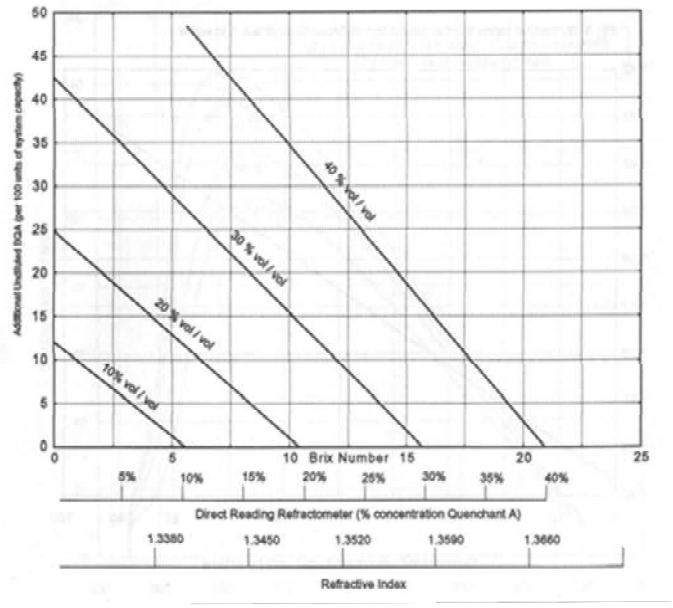
Conversion chart for Brix and Refractive Index to % GEOlube® Quenchant A

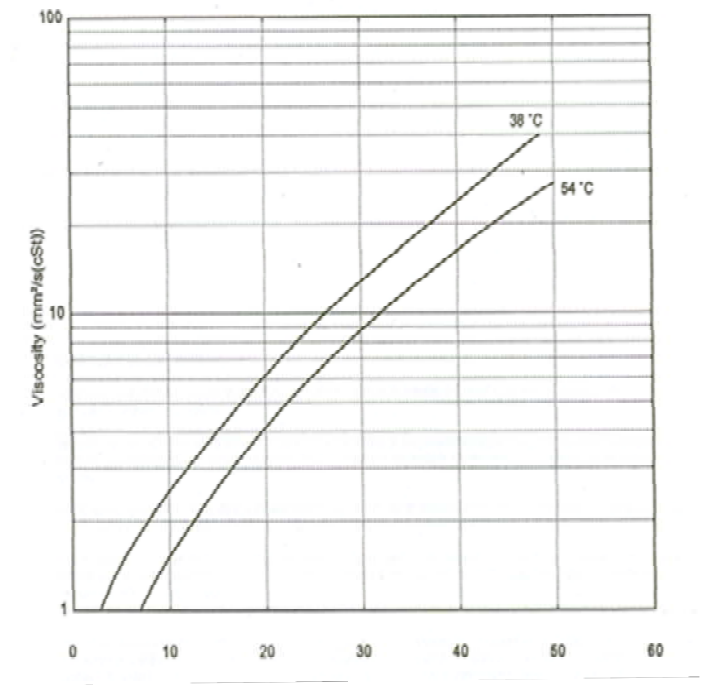


Example: Brix No.10

- Required concentration of **GEOlube® Quenchant A :** 20% vol/vol
- System capacity: 5000 litre
- Additional **GEOlube® Quenchant A** to be added to the system:

5 x 5000 = 250 litre
100

Viscosity



A useful double-check on concentration may be achieved by the measurement of the kinematic viscosity. The diagram on the left indicates the direct relationship between viscosity and quenchant concentration.

It should be noted that accurate temperature control is essential when making determinations. A viscosity check every 2 or 3 months is recommended.

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Other Polymer Quenchants

Residual quenchant should be flushed from the system with fresh water as completely as possible prior to introducing **GEOlube® Quenchant A**.

The water content of **GEOlube® Quenchant A** will swell cork or leather gaskets and seals, which may result in leakage. On conversion to **GEOlube® Quenchant A** these materials should be replaced with natural or synthetic rubber.

Corrosion Inhibition

GEOlube® Quenchant A contains a corrosion inhibitor package at a level suitable for the protection of copper, aluminium, cast iron, steel and brass. However, incompatibility may be encountered with copper and its alloys in the presence of furnace atmospheres containing ammonia.

The inhibitor package is not designed to overcome problems associated with the use of hard water or water with a high dissolved salt content. Under these circumstances, **GEOlube® Quenchant A** should be diluted to the working concentration with de-ionised or distilled water. The use of additional corrosion inhibitor is not recommended. It should be noted also that the corrosion inhibitor may be depleted in service. Advice on the methods for periodic checking of inhibitor level to ensure its maintenance at the correct operating level is available from your local GEO sales office.

GEOlube® Quenchant A does not confer corrosion protection to the surface of the heat treated components. After removal from the quench tank, aluminium components should be given an agitated water rinse of appropriate duration to remove any residual quenchant. With a salt bath installation, this procedure will give the additional benefit of removing any adherent salt deposits.

Compatible Coatings

In view of the corrosion protection offered by **GEOlube® Quenchant A** solutions, coatings should rarely be necessary. However, if they are to be employed, it is important to ensure that they are compatible with the products.

GEOlube® Quenchant A will soften and lift most phenolic coatings and, whilst filters may be used to remove the main particles, it is recommended that questionable coatings be removed prior to initial system fill. Generally, a two- pack epoxy based or PU paint system will be satisfactory for use up to 65°C.

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Contamination and Fluid Life

Salt Bath Heating

GEOlube® Quenchant A is recommended for use in conjunction with nitrite / nitrate salt mixtures.

Salt contamination will increase the quench speed of **GEOlube® Quenchant A** but this is not detrimental to material properties providing it is kept within established limits. A further effect of salt is to distort refractometer readings, therefore bath maintenance should be performed with care. If a sufficient concentration is achieved, the organic polymer in **GEOlube® Quenchant A** may be salted out of solution.

In production systems with salt bath heating, the salt content of the **GEOlube® Quenchant A** will have to be periodically measured and the refractometer readings adjusted accordingly.

When the bath becomes heavily contaminated or exceeds established limits, **GEOlube® Quenchant A** may be recovered by following the procedure below:

Heat the fluid above the cloud point, it will separate into two phases, the salt being preferentially contained in the water phase. The contaminated water phase can then be drawn off and replaced with fresh water. The inhibitor level should also be checked and adjusted as necessary.

A more detailed explanation of the use of **GEOlube® Quenchant A** in conjunction with salt bath heating can be obtained through you local GEO sales office.

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Other Contaminants

The table below identifies the effect of a number of other contaminants on the quench speed of **GEOlube® Quenchant A** as indicated by the GM Quenchometer results of a 11.2 volume % **GEOlube® Quenchant A** solution.

Contaminant	Quenchometer Time (seconds)
None	**8.1**
1% synthetic cutting fluid	**8.5**
1% general purpose cutting oil	**12.6**
1% soluble oil	**18.7**
1% petroleum oil	**17.9**
1% general purpose grease	**20.1**
1% inorganic washing machine compound	**5.2**

Foaming

Under conditions of high agitation **GEOlube® Quenchant A** may be subject to slight foaming which is of no consequence in the heat treatment operation. However, when air is entrained, foaming will be aggravated, particularly when drawn in through circulating pumps. Therefore, inlet ports of pumps should be covered in fluid at all times.

If the system cannot be operated without air entrainment, the addition of a suitable antifoam agent can often be of benefit. Consult your local GEO sales office for advice.

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Storage and Handling

The solution of organic polymer in water constituting **GEOlube® Quenchant A** is stable and non-flammable. The corrosion inhibitor package employed makes it safe for use with common metallic materials of construction.

These products are normally shipped, stored and used in steel containers and associated equipment. **GEOlube® Quenchant A** freezes at around 0°C and become highly viscous below 20°C, therefore room temperature storage is recommended. A centrifugal pump will be satisfactory for handling viscosities up to about 500 centistokes. For higher viscosities, a positive displacement pump is suggested. The pump motor and piping diameter must be sized adequately for the maximum viscosity expected to be handled.

For intermittent service, full-bore ball valves will minimise pressure drops in the piping system.

Since **GEOlube® Quenchant A** is safe to store and handle, bulk storage tanks may be located inside a building. If outside storage is planned, an underground tank or a heated and insulated tank should be considered in cold climates. The storage tank may be vented directly to the atmosphere.

In prolonged and quiescent storage, evaporation and condensation of moisture may cause a layer of diluted solution to form at the liquid surface. Therefore, samples should be taken from the bulk of the stored product and not from the surface region, or alternatively the liquid should be circulated prior to sampling to ensure homogeneity.

Product Compliance

GEOlube® Quenchant A conforms to the Halal requirements in accordance with Islamic Law. (Copy of Halal Certificate available on request).

Registration & Regulatory Information: Please refer to the safety datasheet.

Handling & Storage: This product can be stored for up to 5 years at ambient storage temperature and conditions without any deterioration. Please refer to the safety datasheet for more details.

Miscellaneous: Various pack types available; please contact your local GEO Specialty Chemicals representative for further information.

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