Technical Information

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Quenchants – Monitoring and Maintenance

FTI 912, Date: 01/2020

Quenchants – Introduction

Quenchants are media which dissipate the heat from hot components in a controlled manner. To quantify this principal demand, the relatively simple-to-measure physical value of cooling duration and the resulting cooling rate are used. With this value, it is possible to determine the exact cooling speed required to achieve the required micro-crystalline structure or in other words, the required hardness.

Further specifications depending on the type of quenchant used can include corrosion protection for machines and components, low foaming, low flammability, little smoke and vapour, a high flashpoint and high thermal stability.

A whole variety of substances can be used as quenchants. However, irrespective of this, routine maintenance and monitoring is absolutely essential to maintain the defined performance of a quenchant over its entire lifespan.

The subject of this Technical Information is water-miscible quenchants and hardening oils. It should provide guidance on all aspects of their use ranging from creating fresh mixtures to refilling and finally to disposal.

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1. Storage of Quenchants

1.1 Water-miscible quenchants

In appropriate conditions, water-miscible quenching concentrates can be stored for about one year in their original, sealed containers.
Appropriate conditions include dry, frost-free, indoor locations which are not subject to direct sunshine, other radiated heat or temperature fluctuations and where temperatures do not exceed 40 °C.
If storage tanks are used, these should be routinely and often checked for contamination and correspondingly cleaned if necessary. The use of stainless steel storage tanks is recommended for water-miscible quenchants.

1.2 Quenching oils

In appropriate conditions, quenching oils can be stored for about two years in their original, sealed containers.
Again, appropriate conditions include dry, frost-free, indoor locations which are not subject to direct sunshine, other radiated heat or temperature fluctuations and where temperatures do not exceed 40 °C.
After original containers have been opened, suitable measures must be taken to avoid the ingress of dust, dirt, water, etc. and the contents should be used as quickly as possible.

2. Use of Quenchants

2.1 Water-miscible quenchants

Water-miscible quenchants are suitable for use in spray and dip-bath applications.

In dip-bath lines, the quenchant is in a tank into which the components to be treated are lowered. Normally, the quenchant is kept moving by circulation pumps or propellers. Ideally, this movement should take the form of a flow which accesses the entire component surface.

In spray quenching lines, the quenchant is sprayed through nozzles onto the surface of the component usually directly after induction or flame heating. These nozzles draw quenchant from a tank integrated into the line or from a central system.

Customized quenching lines and/or their peripheral units can optimize the hardening process (see Section 4). These may include:

- Filtering systems
- Oil separation systems
- Temperature control systems

Water-miscible quenchants are generally used at room temperature or at temperatures up to 70 °C.

2.1.1 Mixing guidelines

Quenching concentrates are normally diluted with water to concentrations of 5 to 20 %. The mixing procedure and the selection of the most suitable concentration should be based on the current state-of-the-art and the corresponding technical product information recommendations.
When mixing a concentrate with water, the following should be observed:

a) Mixing water

The quality of the mixing water is of decisive importance to the performance of a water-miscible quenching line.
It is recommended to follow the guidelines of the German TRGS 611 for water-miscible metalworking fluids.
Although these are not binding for water-miscible quenchants, they offer useful orientation.

As TRGS 611 states, mixing and topping-up water should have a nitrate content of under 50 mg/l. If drinking or potable water is used, this parameter is generally met.

Among other factors, water hardness determines the foaming behaviour of the mixture. If soft water (hardness <8 °dH) is used, pronounced foaming may occur. Water with a hardness significantly of over 20 °dH can lead to the precipitation of lime soaps, a deterioration of corrosion protection, a reduction in stability and after longer use, to salt deposits on machine elements. The optimum hardness of the mixing water is between 10 and 15 °dH. Soft water can be “hardened” by, for example, the addition of calcium acetate and hard water can be “softened” by the addition of fully demineralized water.

The chloride content of the mixing water should not be over 30 mg/l because, during use, an enrichment of the solution/emulsion can occur which in turn can cause corrosion on machinery and the components. A countermeasure, again, is the addition of fully demineralized water.

Water analysis data of the local drinking water can be obtained from the water supplier.

If well water is used, which is not subject to drinking water regulations, make sure that the bacterial count is under 10^3 because otherwise, excessive bacteriological contamination may occur.

The temperature of the mixing water should not be lower than 10 °C because this may lead to mixing problems. It is also recommended that the concentrate temperature is between 15 and 20 °C.

b) Mixing water-miscible quenchants

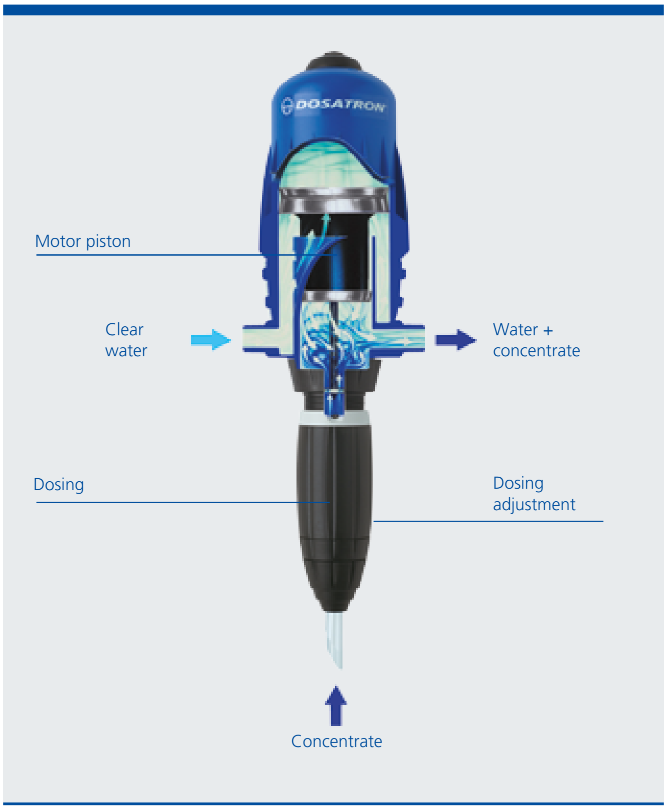
When manually mixing water-miscible quenchants, always add the concentrate to the water in line with the manufacturer’s recommendations. Ideally, the mixture should be churned or circulated to assist homogenization. Small quantities can be mixed in a separate, clean container. The final concentration should be checked with a suitable method, for example, with a refractometer. The use of automated mixing devices (see Fig. 1) is recommended for larger and/or re-occuring quenchant dilutions.

Such devices can be added as stationary equipment to quenching lines or used as mobile equipment on corresponding tanks.

If the mixing system is connected to drinking water circuits, make sure that all provisions of DIN EN 1717 are observed, for example, by the installation of backflow preventers.

Even though a defined mixing ratio or concentration can be set on automatic mixing devices, it is nevertheless recommended that the final concentration is checked and, if necessary, adjusted.

Any possible product-specific conversion parameters such as the refractometer factor must be observed. The corresponding data can be found in the technical product information sheets.



Source: Dosatron International S.A.S

2.2 Quenching oils

Quenching oils are mostly used for dip-bath applications. The oils are in quenching tanks into which the components to be treated are lowered. This can take place automatically or manually in batches on support frames or as loose components off a conveyor belt.

Customized quenching lines and/or their peripheral equipment can optimize the hardening process (see Section 5). These may include:

- Inert gas atmospheres
- Circulation or churning equipment
- Filtering systems
- Heating systems
- Extraction systems.

As a rule, quenching oils are used at temperatures between 40 and 90 °C. Some types of oils can even be heated to 200 °C and more. There is always a danger of fire when using quenching oils. In addition and depending on product quality, quenching with oils can create vapours which may be hazardous to health.

3. Monitoring of Quenchants

3.1 Water-miscible quenchants

The characteristics of water-miscible quenchants can be detrimentally affected by a number of disruptive factors. The routine monitoring of quenchants is necessary to ensure maximum economy and the lowest possible hazard potential for people and the environment. Here, once again, the German TRGS 611 which is primarily intended for water-miscible metalworking fluids, can offer useful guidance. All tests and the resulting measures should be coordinated with the quenchant manufacturer.

To attain the objectives of economical use and cost reductions when using water-miscible quenchants, it is essential that the characteristics of the product in use are maintained for as long as possible. Apart from the quality of the product itself and the quenching process being used, the service life of a quenchant is largely defined by the monitoring, the maintenance measures taken, their scope and their frequency. With the use of today’s centralized systems, it has become much easier to achieve highly economical quenchant service life compared to individually-filled heat treatment lines. However, it has also been found that operators of individually-filled systems can also achieve astonishingly acceptable quenchant service life by implementing the recommendations of the quenchant manufacturers and also those issued by professional and trade organizations. The monitoring and maintenance measures of fluids during their use, i.e. analyzing the condition of the quenchant and the use of maintenance equipment, is immensely important.

This is not just of importance in terms of service life optimization. Legislation also requires operators to keep quenchants in good condition as part of safety-at-work provisions.

To comply with these, the operator should create a monitoring plan which documents target and measured values. Table 1 (see Page 5) shows a list of the most important test methods for water-miscible quenchants.

3.1.1 On-site testing

The following lists a number of simple on-site tests which an operator can perform:

a) Visual checks

Two important checks which should be performed daily are in the forefront. The first is a visual check of the fluid levels in the quenching tanks. Insufficient quenchant in the tanks can lead to poor churning or circulation of the fluid and can cause quenchant foaming if the circulation pumps draw air. Insufficient quenchant can also cause other problems such as inadequate heat dissipation and thus inconsistent heat treatment results.

Another test is the evaluation of the appearance and odour of the quenchant. If optical or olfactory changes to the quenchant are detected, these may indicate a deterioration of quenchant performance. Such changes must be thoroughly investigated and the causes established. Normally, quenchants must not display discoloration or tramp oil presence. A rust-brown colour and a slightly burnt odour should be treated as normal. These are result of the heat treatment process.

Table 1 – Test methods for water-miscible quenchants

Analysis	Test method	Recommended insprection intervals, frequency
Quenching characteristics ivf	FLV-A-18*	When necessary
Appearance and odour	Visual and sensory	Daily
Chloride content	Potentiometrical titration; ICP	When necessary
Electrolyte content	Conductivity measurement	When necessary
Tramp oil	Stability test in line with DIN 51367	When necessary
Bacterial count, bacteria, fungi, yeasts	Dip slide method	If necessary weekly
Concentration	Refractometer, viscosity, titration	Daily, at least weekly
Corrosion	Chip-filter-test (DIN 51360-2)	When necessary
Nitrite content	Test strips, photometry	Weekly (in line with German TRGS 611)
pH value	Electrometrically DIN 51369, pH strips	At least weekly (in line with German TRGS 611)
Water hardness	Test strips, Ca & Mg content with ICP	When necessary

* FUCHS LUBRICANTS GERMANY GmbH test procedure

Changes to the quenchant can have a number of causes which are generally highlighted by any of the other monitoring parameters listed in the following.

b) pH value measurement

The pH value of the quenchant should be measured at least once a week (ref: TRGS 611). The simplest method involves the use of test strips (Fig. 1) which use colour to indicate the pH value. They can be used at any time and need no maintenance or calibration. However, test strips usually have an expiration date and using strips that are too old can lead to false readings.

Fig. 1 – pH test strips

An important point when using test strips is the correct handling of the strips. For example, the test strips must be dipped into clean quenchant and not through any floating tramp oil. The specified time-delay when evaluating the colour of the test strip must also be observed.

The advantages of this test method are speed and simplicity and that no additional reagents are needed. It is therefore a reliable method because few mistakes can be made.

A somewhat more accurate but also more cost-intensive alternative is an electronic pH test meter. Either as a handheld instrument or as stationary laboratory equipment, it is important to know how to handle the pH electrode and that the instrument requires routine calibration prior to measuring. Additionally, care must be taken that the measuring head (diaphragm) is clean and not contaminated with tramp oil to avoid false readings.

An important aspect of pH measurements and their documentation is to establish a quenchant pH value trend in the tanks over the product's service life in order to allow timely corrective measures.

c) Measuring concentration

The concentration of extremely small or heavily contaminated quenchant tanks or those with high drag-out rates, should be checked daily, otherwise on a weekly basis. A number of simple methods are available. One of these is the handheld refractometer (Fig. 2)

Fig. 2 – Correct use of a handheld refractometer

Handheld refractometer

Bearing in mind the product-specific refractometer factor (to be found in Product Information material), concentration measurement is based on the refraction of light (Refractive Index) through the medium being measured. The reading, represented by a clear dividing line on the scale, is multiplied by the product-specific refractometer facor to give the concentration of the quenchant in the tank (Fig. 3).

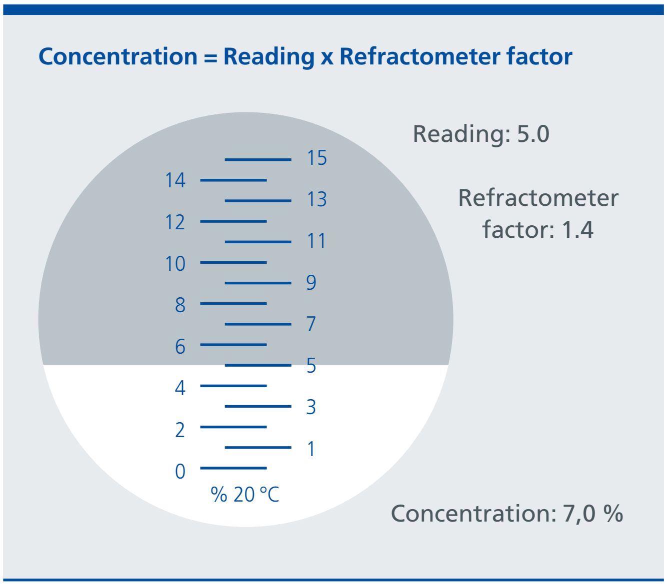
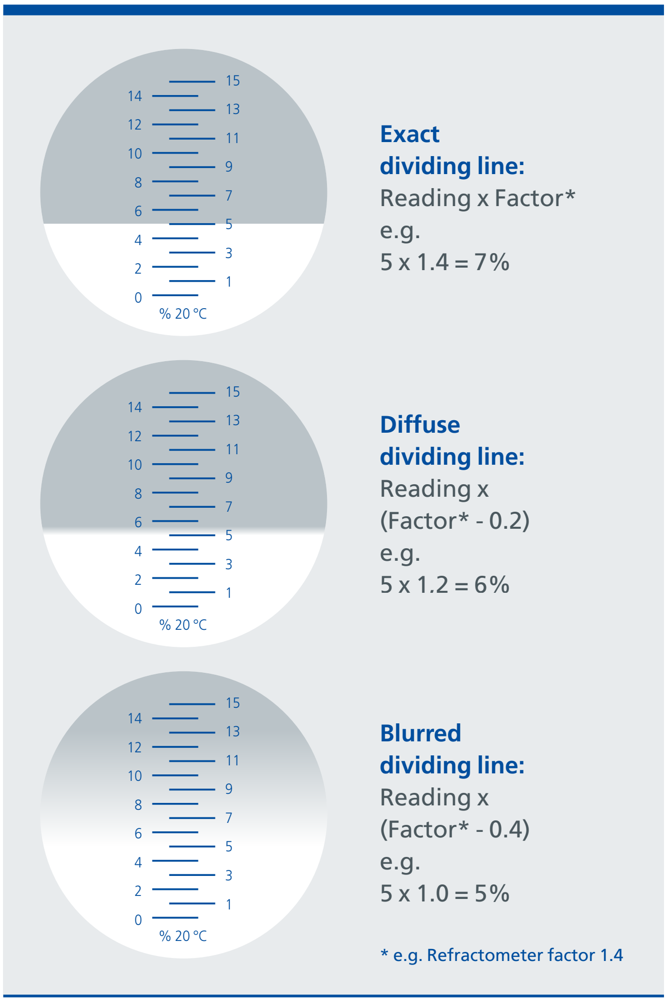


Fig. 3 – Handheld refractometer scale with reading: calculating concentration



Exact dividing line:
Reading x Factor*
e.g.
5 x 1.4 = 7%

Diffuse dividing line:
Reading x (Factor* - 0.2)
e.g.
5 x 1.2 = 6%

Blurred dividing line:
Reading x (Factor* - 0.4)
e.g.
5 x 1.0 = 5%

* e.g. Refractometer factor 1.4

Fig. 4 – Handheld refractometer scales with various dividing lines; determining concentration

Before using a handheld refractometer, it is essential that the zero-point is set with pure water. A heavily polluted, oil-contaminated or unstable solution can cause the dividing line to appear blurred which in turn leads to inaccurate readings (Fig. 4).

Normally, concentration measurements with a handheld refractometer directly after the sample has been taken and after perhaps eight hours, generate the same values. However, if the solution is not stable, large deviations can occur.

Digital handheld refractometer

As opposed to the previous handheld refractometer, digital handheld refractomters are battery-powered opto-electronic instruments. Only a few drops of the solution are required for the measurement. Measurement only takes a few seconds and the reading is shown on a digital display. Multiplied by the product-specific or condition-independant factor, this gives the concentration of the quenchant.

Note:
Using a refractometer value is a simple method of establishing the concentration of a quenching tank. It should be noted that the required refractometer factor to determine concentration changes over the life of the quenchant. The factor given in Product Information literature only applies to fresh mixtures. For this reason it is recommended that concentration is measured by viscosmetry or that the concentration is measured by a test laboratory.

Titration

Another method of determining concentration is titration. This is a quantitative test method and involves a colour indicator being added to a sample of unknown concentration. Using a burette, a titrant solution (such as 0.1 mol/l HCl) is added drop by drop to a defined quantity of the sample until the equivalence point is reached, indicated by a colour change. Concentration is then calculated by using the volume of titrant solution used and the product's specific titration factor.

d) Kinematic viscosity

A more reliable and accurate method of determining concentration is the routine measurement of kinematic viscosity at 20 °C. Additionally, this can also provide an up-to-date refractometer correction factor. The combination of fast on-site refractometer tests and the determination of the correction factor via viscosity provides process monitoring which can minimize any concentration fluctuations caused by ageing. The viscosity measurement intervals should reflect the stresses which the quenchant is subject to.

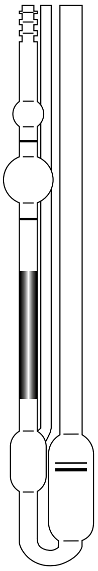


Fig. 5 – Ubbelohde Viscosimeter for measuring kinematic viscosity according to DIN 51562-1

Kinematic viscosity is determined by the time the (quenching) medium passes through a Ubbelohde capillary tube (Fig. 5). Multiplied by the capillary constant, this gives the kinematic viscosity.

$$v = k \times t$$

v: Kinematic viscosity
t: Time
k: Capillary constant

Kinematic viscosity can be measured by a test laboratory or independently by the customer. Concentration in smaller and/or highly stressed quenching lines should be checked frequently. In such cases, independant measurements performed by operators are a benefit.

The actual concentration of the fluid is then calculated using the product-specific correction factor.

The correction factor to determine concentration by using a handheld refractometer is calculated as follows:

$$\text{Factor} = \frac{\text{Viscometric concentration}}{\text{Handheld refractometer factor}}$$

e) Cooling characteristics

In addition to determining concentration by viscometry and a handheld refractometer, it is recommended that cooling characteristics are regularly checked, especially in larger and highly-stressed lines.

Fig. 6 – Apparatus to measure cooling time

Measuring cooling curves (Fig. 6) serves to determine whether cooling characteristics correspond to quenchant concentration. This serves to identify ageing influences in good time and also whether countermeasures (such as adding concentrate) are necessary. Another benefit is that quenchant service life can be significantly increased.

f) Nitrite content (Nitrate content)

As also stated in TRGS 611, the nitrite content of the quenchant should be measured during use. Nitrite is a reaction component which, together with secondary amines, can create carcinogenic nitrosames. Contamination by other media, such as by nitrate-contaminated mixing or topping-up water can never be fully excluded. To protect employees against exposure to nitrosamines, TRGS 611 requires the regular measurement of nitrite content. This can be done by using test strips.

The threshold value of < 20 ppm nitrite applicable to metalworking fluids is soon reached in the heat treatment field. Because of this, our polymer quenching concentrates never contain secondary amines. The use of additional inhibitors eliminates the possibility of nitrosamine formation. In such cases, TRGS 611 allows the specified threshold to be exceeded.

Note:
No evaluation of nitrite content regarding the use of water-miscible quenchants in the heat treatment industry has been made up to now. As a result, we recommend contacting local health and safety officials if questions arise.

g) Nitrate content

As nitrite can also formed from the nitrate in mixing or topping-up water, this should also be tested regularly. According to most drinking water provisions, a maximum of 50 ppm nitrate is permissible. As a rule, most nitrate concentrations are between 10 and 20 ppm. However, in intensively-farmed regions, significantly higher concentrations than 20 ppm can be found.

There is no need to monitor nitrate content on a weekly basis. However, the value should be routinely measured or obtained from the local water supplier and then documented.

Nitrate content can be determined with test strips. Apart from the simple visual evaluation of such test strips, a so-called Reflectoquant can perform this operation automatically. This may be an interesting alternative if the operator has a large number of individually filled quenching tanks.

g) Water hardness

Another measurement which can be of benefit but not mandatory for individually filled systems requiring very high topping-up quantities is determining water hardness.

Fig. 7 – Water hardness test strips

This can be the case if well water is used to mix quenchant solutions.

Here again, this can be done with test strips in a simple and economical procedure to monitor any increase in water hardness (Fig. 7).
Especially if the system is subject to high evaporation losses, very high water hardness can result.

However, today's water-miscible quenchants can withstand high degrees of water hardness. The real problem is that quenchant tanks and their nozzle systems can be affected by deposits and gumming which diminish spray performance and which are work-intensive to clean. All in all, such problems and excess water hardness can also affect the service life of the quenchant.

Far more important is that water hardness can diminish optimum corrosion protection which, if the quenchant concentration is unintentionally low, can lead to costly downtime for maintenance work. This applies in particular to highly-stressed quenching lines which are operated continuously.
If water hardness measurements and the possibility of adding demineralized water can eliminate a source of problems, then these measures can increase the service life of the quenchant solution.

3.1.2 Monitoring plan / Documentation

All monitoring procedures should be part of a monitoring plan which contains information about the monitored parameter, the testing interval, corresponding measures taken and, if possible, product-specific information.

On one hand, all measured values could be listed in a chart or the values could be presented graphically as shown in Figure 8.

Gebrauchtwerttabelle
Name Kunde: XXX
Produkt: XXX

Fig. 8 – Measured value documentation

Graphic presentation allows the development of all measured values and any fluctuating tendencies in the quenchant to be viewed at a glance.
The parameters that need to be measured and the monitoring intervals are quenching line-specific and should be discussed and set out in advance.

3.2 Quenching oils

As opposed to water-miscible quenchants, quenching oils have an almost unlimited service life if they are properly maintained. Bacterial contamination cannot occur because of the absence of water.

Apart from analytical monitoring (Table 2), the maintenance of quenching oils should focus on the following points:

- Smaller, dragged-in impurities should be continuously removed by filtering systems.
- Larger impurities such as scale should be removed on a regular basis.
- The operating temperature of the oil should be monitored.

3.2.1 Table 2 – Test methods for quenching oils

Analysis	Test method	Recommended test interval	Provides information on:
Appearance and odour	Visual and sensory	Daily	Contamination, dragged-in tramp oils
Density	DIN 51757	When necessary	Dragged-in tramp oils
Colour	DIN ISO 2049	When necessary	Ageing, contamination, dragged-in tramp oils
Solid impurities	Particle counter (incl. ISO 4406) or gravimetric measurement (ISO 4405)	Depending on contaminant drag-in during quenching	Degree of contamination
Flashpoint	DIN EN ISO 2592	When necessary	Dragged-in solvents
Fluid contaminants	IR spectrometry or with neutralization number	When necessary, generally every three months	Dragged-in tramp oils
Air release properties	DIN ISO 9120	When necessary	Cooling properties, dragged-in tramp oils
Metal content	Inductively coupled plasma spectrometry (ICP), X-ray fluorescence spectroscopy (XRF), Atomic absorption spectoscopy (AAS)	When necessary	Additive level, solid or dissolved impuities
Neutralization number	DIN 51558	When necessary, generally every three months	Ageing, Additive level
Foaming	FLV-S 12* ASTM D 892	When necessary	Foaming behaviour, Additive level
Evaporation losses	DIN 51581-1	When necessary	Evaporation losses
Saponification number	DIN 51559		Additive condition, dragged-in tramp oils
Viscosity	DIN 51562	Every three months	Dragged-in tramp oils, ageing
Water content	Karl- Fischer water content (DIN 51777)	If problems occur	Dragged-in emulsions,cleaners or water

* FUCHS LUBRICANTS GERMANY GmbH test procedure

4. Maintenance of Quenchants

The maintenance of quenchants is just as important as their monitoring. Maintenance can take the form of adding maintenance products or by the use of special hardening lines and/or their peripheral units.

Is maintenance worthwhile?
Monitoring and maintenance leads to increased quenchant service life, lower consumption and reduced waste disposal costs. It also has a positive effect on the health and safety of employees who have contact with quenchants. The cost savings which can be achieved make a contribution to the competitiveness and future success of heat treatment companies.

4.1 Preventative measures

To reduce and simplify the maintenance of quenchants, decisions can be made in advance regarding the selection of the quenching line machinery, quenchant tanks and the corresponding peripheral equipment.
These are usually constructional solutions which in many cases generate little or no additional expenses but which can significantly reduce and/or simplify subsequent monitoring measures during operation.

a) Type of quenchant

At the planning stage, there should be clarity regarding the type of quenchant which should be used. It is not absolutely necessary to know the manufacturer of the quenchant but which type of quenchant is being considered (water-miscible quenchants or quenching oils). This decision alone has a major influence of future monitoring and maintenance costs.

b) Selection of hardening lines and their peripherals

Depending on what is planned, lines should be considered which increase the life of the quenchant (for example, inert gas atmospheres or filtering systems). Maintenance systems and the benefits to the life of the quenchant are listed in Section 4.2.

c) Interior walls of quenching tanks

The interior walls of such tanks should not be coated (painted, galvanized, etc) because these coatings may be dissolved or dislodged and this may lead to filtering problems.

d) Location of quenchant tanks in induction or flame-hardening lines

Already at the planning stage, quenching line operators should make sure that all quenchant and return tanks are easily accessible to simplify later maintenance and cleaning operations.

e) Settling areas in quenchant tanks in induction or flame-hardening lines

If the use of fluid maintenance equipment is planned, it may be worthwhile to create so-called settling areas in the tanks so that tramp oils can float to the surface prior to being removed.

4.2 Maintenance equipment for quenchants

4.2.1. Hardening in inert gas atmospheres

The purpose of inert gas atmospheres is to stop the quenchant coming into contact with oxygen and to avoid oxidation. Inert gas atmospheres increase the service life of quenchants. Normally, these processes is used to harden components which have already been heated up in inert gas atmospheres.

4.2.2 Separating solids

Of all the mechanical separating processes, filtration is the most commonly used method. Depending on the filter's pore size, all types of solid impurities can be removed. The filtration process is principally dependent on the type of quenchant used (water-miscible or oil) and the projected quantities of solid impurities which have to be removed.

4.2.3 Separating tramp oils from water-miscible quenchants

These days, operators have a large choice of equipment which can either be permanently installed in quenching lines or used as mobile units. When such machinery is selected, the quantity of quenchant which has to be de-oiled must be considered as well as the potential investment costs.
To avoid subsequent "surprises", we recommend that practical trials are performed on the quenching line before a final decision is made.

The VDI Guideline 3397, Part 2 provides an overview of all the different maintenance equipment available to separate solid and fluid impurities. The suitability of the equipment depends on the process in question and ultimately, the individual case parameters.

4.3. Maintenance products for quenchants

The following sections describe measures which can increase the service life of quenchants. However, the use of any such additives can change cooling characteristics. We therefore recommend that such measures are accompanied by analytical monitoring and/or trial quenching runs.

4.3.1 Additives for quenching oils

High performance quenching oils are base oils containing a high level of additives. These additives improve the properties of the quenching oils. For example, these can postpone the ageing of the oil or alter its cooling characteristics.

By routinely analyzing the quenching oil, it is possible to determine whether any of its values change. If this happens, the original quenching oil is normally replenished with additives. Depending on the type of quenching oil and its additives, it is also possible to add an additive concentrate. This is normally the more cost-effective option because the amount of additives is not large.

Apart from restoring original additive levels, additives may also be added to adjust certain characteristcs. This would, for example, eliminate the need to fully exchange the entire quenching oil if any specific requirements changed.

4.3.2 System cleaners for water-miscible quenchants

This type of cleaning is normally undertaken in induction and flame hardening lines but can also be used for larger quenching tanks if certain adjustments are made. The service life of a water-miscible quenchant is primarily influenced by the thorough cleaning and disinfection of the system. Satisfactory service life can only be achieved by a sensible combination of system cleaning and disinfection prior to a quenchant being replaced.

While quenchant tanks can be cleaned with high-pressure cleaners, cleaning the fluid circuits is a complex procedure. Simple mechanical cleaning still requires subsequent disinfection.

System cleaners are a good alternative to clean and disinfect difficult-to-access or inaccessible areas. These products contain special wetting agents which can reach such areas. They dislodge deposits as well as fungal and bacterial growths. The emulsifiers in the cleaners dissipate tramp oils and keep dirt in suspension. The microbiocides in the system cleaners do the actual disinfection work. When using system cleaners, it is important to maintain their correct concentration and the time they are used. Manufacturer’s recommendations should be adhered to.

The following general procedure should be observed:

- Add system cleaner before the quenchant is drained
- Circulate for 8 to 24 hours
- Pump the tank empty
- Clean the tank mechanically
- Flush the system with water
- Empty
- Refill the systems

As regards fungal contamination, this may not be fully eliminated by system cleaners. One problem could be fungal bio-films which may not be fully dislodged by the system cleaner. Any remaining fungi can then contaminate any freshly refilled quenchant. In these cases and after consultation with the manufacturers, we recommend repeated treatment of the fresh quenchant with a fungicide.

4.3.3 Preservatives for water-miscible quenchants

Treatment is most often necessary in induction and flame-hardening lines. Water-miscible quenchants can contain substances which encourage microbiological growth. Excessively high bacterial counts can permanently damage and shorten the service life of water-miscible quenchants.

Preservatives for water-miscible fluids are divided into two groups:

- Bacteriacides are agents to combat bacterial contamination
- Fungicides are agents to combat fungal contamination

4.3.4 De-foamers for water-miscible quenchants

The use of de-foamers is only recommended if the cause of the foaming is either not known or known but cannot be remedied in the short term. Such cases can include fluctuating water quality, dragged-in substances resulting from process alterations, a change of quenchant, etc.

De-foamers should be added to where good mixing can take place. Do not add de-foamerd upstream of filters because these can remove the de-foaming agents.

The concentrations recommended by the de-foamer manufacturers must be observed. Excessively high concentrations can negatively influence air-release properties and any foam becomes even more stable.

Before adding de-foamers to water-miscible quenchants, the de-foamer should first be diluted with water and only then be added to the quenchant. This generates the optimum effect because the de-foamer mixes with the quenchant more rapidly.

4.3.5 Other service products

This category includes all special products which are tailored to meet an operator’s requirements and which should be used as instructed by the manufacturers. These products can be used to increase pH value or increase corrosion protection.

5. Disposal of Quenchants

According to European waste product legislation, water-miscible quenchants and quenching oils are allocated a Waste Code and a hazard classification. This hazard classification takes the form of asterisks (*). According to Paragraph 48 of the German Circular Economy Act, such wastes are thus hazardous.

Table 3 lists a number of quenching oils and water-miscible quenchants along with a description and their respective Waste Code and hazard classification.

Table 3 – Examples of Waste Codes

Example	EU Waste code	Description
Unusable and used quenching oils	12 01 07* (halogenfrei)	Halogen-free, mineral oil-based metalworking oils
Unusaable and used synthetic quenching oils	12 01 10*	Synthetic metalworking oils
Unusaable and used water-miscible quenchants	12 01 10* (halogen-free)	Halogen-free metalworking emulsions or solutions
Used water-miscile quenchants contaminated with barium chloride or cyanides. Cases involving dragged-in salts from salt baths.	16 10 01*	Water-based fluid wastes which contain harzardous substances

5.1 Reasons for the disposal of water-miscible quenchants

The application criteria for water-miscible quenchants are governed by how they are used and the demands made on them. If these criteria are no longer fulfilled during a product's use, or the quenchant can no longer be used for some other reason, it must be treated or disposed of.

It is the operator's call to decide if a quenchant has reached the end of its useful service life and has to be disposed of.

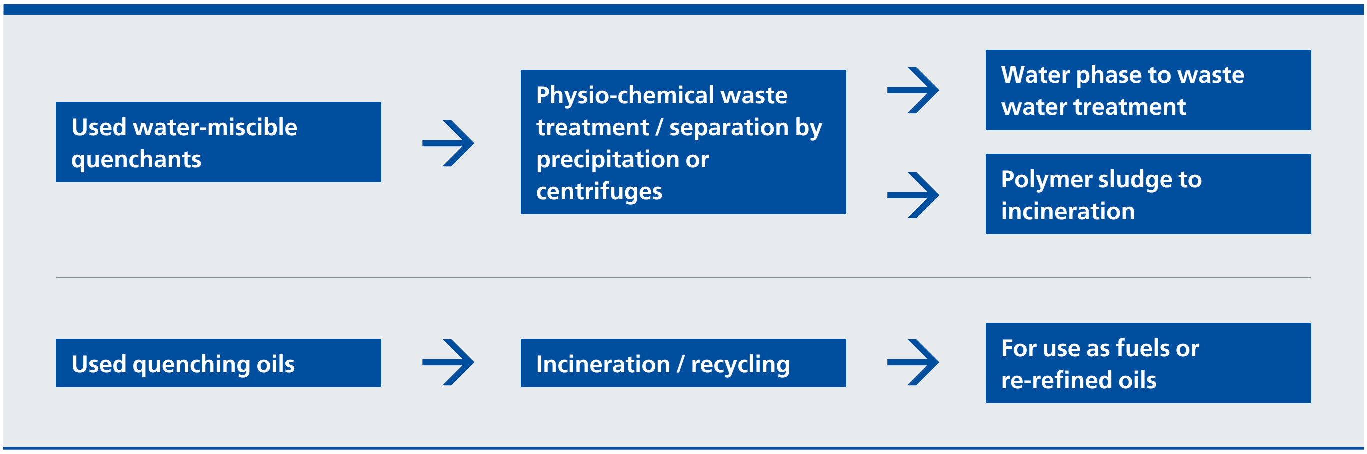
The following lists a number of general application criteria which can lead to disposal:

- Excessively low pH value
- Excessively hard water
- Excessive contamination with solid impurities
- Excessively abrupt cooling characteristics
- Excessive foaming
- Excessive bacterial and/or fungal contamination
- Excessive tramp oil content
- Contamination with other substances / impurities
- etc.

5.2 Reasons for the disposal of quenching oils

If properly monitored and maintained, quenching oils have a very long service life. However, despite corresponding maintenance measures, there may be reasons for disposing of the oil. The following lists a number of disposal reasons:

- Dragged-in water
- Inadvertant contamination with other lubricants
- Dragged-in cleaners or water-miscible emulsions
- Excessively high contamination with solids
- Ageing due to oxidation



6. Frequent Practical Problems – Causes and Remedies

6.1 Water-miscible quenchants

Problem	Cause	Countermeasure
Deposits	Dragged-in tramp oil	Remove tramp oil, avoid drag-in taking place, eliminate cause, replace some or all the quenchant
	Dragged-in tramp oil or other fluids such as cleaners or corrosion preventives	Replace some or all the quenchant
	Inadequate cleaning	Remove deposits, optimize filtration
	Microbiological decomposition bi-products	Use bacteriacides, clean and disinfect prior to replacing the quenchant
	Concentration too low or too high	Adjust concentration by adding concentrate or diluting
Filtering problems	Blocked filters	Add wetting agents, check water hardness
	Fungal leaching	Conservation with biocides, clean and disinfect the system
	Lime soaps	Add demineralized water
	Tramp oils	Remove tramp oil, check compatibility
Unpleasant odours	Serious contamination of the quenchant tank	Optimize cleaning concept
	Longer quenching line shutdown	Promote circulation and provide ventilation
	Inadequate circulation system ventilation	
	Outside contaminants entering the quenchant tanks	Train employees
	pH value too low	Correct pH value with additives
Skin problems	pH value too high	Check concentration and reduce by adding water if necessary
	Concentration too high	
	Bacterial contamination too high	Use a suitable bacteriacide Observe any skin protection plans
Instability, abrupt quenching, crack formation, quality problems	Concentration	Add concentrate until specified concentration is reached
Corrosion	pH value too low	Add a pH value booster
	Concentration too low	Check concentration and adjust accordingly
	Chloride values too high	Add demineralized water, replace some or all the quenchant
	Electrical conductivity too high	
Long cooling times, insufficient hardness	Concentration too high	Reduce concentration by adding water
Foaming	Mixing water too soft	Increase water hardness
	Poor air release properties	Add de-foaming agent
	Excess aeration	Check quenchant volume, capacity, circulation rate and pumps and top-up if necessary
	Microbiological decomposition by-products	Circulate and ventilate regularly, check concentration and pH value and, if necessary replace some or all the quenchant
	Dragged-out defoamer	Add de-foaming agent
	Dragged-in tramp oils	Remove tramp oils regularly
	Concentration too high	Reduce concentration by adding water
Poor heat treatment results	Contaminationn of the tanks too high	Improve filtration, remove scale

6.2 Quenching oils

Deposits / Excess oil drag-out	Ageing / Oil quality	Replace some or all the quenchant
Flaming	Water	Evaporate any water present
Unpleasant odours	Ageing / Oil quality	Replace some or all the quenchant
Abrupt quenching characteristics	Water	Evaporate any water present
Changed quenching characteristics	Ageing	Replace some or all the quenchant

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