

American Chemical Technologies, Inc.

# NEPTUNE<sup>®</sup> AW SERIES HYDRAULIC FLUIDS

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No Sheen, High Performance, Water Soluble Hydraulic Fluids



AMERICAN CHEMICAL TECHNOLOGIES, INC.

# Neptune® AW Series Fluids

Neptune® AW Series hydraulic fluids are polyalkylene glycol (PAG) based and comply with U.S. EPA VGP.

Neptune® AW Series hydraulic fluids are the only chemistry fully compliant with the 2013 Vessel General Permit (VGP), U.S. EPA Clean Water Act and USCG Surface Force Logistics Center Environmentally Acceptable Lubricants (EAL) Standards. Neptune® AW hydraulic fluids outperform fully saturated synthetic esters, vegetable oils and bio-based polyalphaolefins (PAO). In addition, they last longer in your submerged equipment.



## Performance Advantages:

**Excellent Anti-Wear Performance** – Neptune® AW Series hydraulic fluids have exceptional load carrying anti-wear performance over a wide range of temperatures. They are rated as “anti-wear” (AW) fluids according to ASTM D7043 and FZG testing.

**Non-Sheening** – Neptune® AW Series hydraulic fluids are the only commercially available, environmentally friendly hydraulic fluids that pass the U.S. EPA 40 CFR 435 Static Sheen Test.

**Water Solubility** – Neptune® AW Series hydraulic fluids are heavier than water, dissolve completely, and leave no surface sheen, eliminating cleanup requirements.

**Aquatic Toxicity** – According to the U.S. Fish and Wildlife Service, Neptune® AW Series hydraulic fluids meet requirements as “Relatively Harmless” or “Practically Non-Toxic” to fish and other aquatic wildlife.

**Biodegradable** – Neptune® AW Series hydraulic fluids are “readily biodegradable” according to OECD 301B

**Hydrolytic Stability** – Unlike vegetable oil and fully saturated synthetic ester based environmentally friendly hydraulic fluids, Neptune® AW Series hydraulic fluids will not hydrolyze in the presence of water. This protects hydraulic systems from decreased equipment life and potential system failure due to the presence of harmful acids (increased Total Acid Number values) generated by the hydrolysis of vegetable oil or fully saturated synthetic ester based hydraulic fluids.

**High Waste Treatability** – Neptune® AW Series hydraulic fluids are highly waste-treatable. In tests simulating the discharge of industrial waste streams to un-acclimated municipal treatment plants (POTWs), Neptune®AW-32 fluid demonstrated no adverse impact on the proper functioning performance of the waste treatment systems, even at high discharge levels.

**Non-Sludge or Varnish Forming** – Neptune® AW Series hydraulic fluids are oxidatively stable and will not form sludge or varnish upon degradation as occurs with mineral oil and oil miscible basestock type hydraulic fluids. Neptune® AW Series hydraulic fluids can extend maintenance change out intervals, increase system cleanliness, and improve overall service life.

**Thermal Stability** – Neptune® AW Series hydraulic fluids are long-lasting products that resist thermal breakdown and are unaffected by a small amount of water contamination. When the fluid does eventually begin to degrade, the degradation components are soluble in the fluid and do not create water insoluble deposits and sludge.

**All-Weather Service** – With high viscosity indices and low pour points, Neptune® AW Series hydraulic fluids may be used year round, eliminating season changeovers. One Neptune® AW Series hydraulic fluid may replace multiple viscosity grade oils.

**Material Compatibility** – Neptune® AW Series hydraulic fluids are typically not soluble with petroleum-based oils. This allows the petroleum oil to be easily removed from the system pending the results of a compatibility study. The fluids are compatible with seals, hoses, and metals commonly found in hydraulic systems. Contact ACT for more detailed compatibility information related to paints, plastics, and elastomers.

**Fluid Compatibility** – Neptune® AW Series hydraulic fluids are fully compatible with other Neptune® lubricants. Neptune® AW hydraulic fluids and gear oils that meet the 2013 VGP having an ISO VG 10 - 220.

**Seal Compatibility** - Neptune® AW hydraulic fluids are compatible with many common and high-performance elastomers. Contact your local Neptune® distributor for additional information.

Ecologically friendly, sheen-free hydraulic fluids for use in equipment on or near Marine environments



### Typical Wear Performance\*

Four Ball Wear, ASTM D4172, mm wear scar (1200 rpm, 1 hour, 75°C [167°F], 40kg)	0.40
Four Ball EP Test, ASTM D2783	
Load Wear Index	43
Last Non-seizure, kg	100
Weld Load, kg	200
V104 Vane Pump Test, ASTM D7043, mg wear (1200 rpm, 100 hours, 66°C [150°F], 2000 psi)	< 5
Eaton Corporation 35 VQ25 Vane Pump Test**	
Industrial (I-286-S), Mobile (M-2950-S)	Pass

\*Typical properties, not to be construed as specifications.  
 \*\*Southwest Research Institute (SWRI)

### Typical Environmental Properties\*

Neptune® AW Hydraulic Fluids	32	46	68
Ready Biodegradability Test Method OECD301B	78%	76%	62%
Bioaccumulation log K <sub>ow</sub> OECD117	1.15 (non-bioaccumulative)		
Algae LC <sub>50</sub>	7000 mg/l (relatively harmless)		
Daphnid LC <sub>50</sub>	600 mg/l (practically non-toxic)		
Brine Shrimp LC <sub>50</sub>	700 mg/l (practically non-toxic)		
Freshwater fish LC <sub>50</sub>	800 mg/l (practically non-toxic)		

\*Typical properties, not to be construed as specifications.

### No-Sheen Performance Comparison

Clear visual comparison of fluid sheening characteristics is made possible by adding an illuminating agent to the hydraulic fluids, then adding the hydraulic fluids to water under a black light. In a comparison conducted under identical conditions, other hydraulic fluids quickly formed a visible sheen on the surface when added to water. In contrast, when a Neptune® AW Series hydraulic fluid was introduced into water, the hydraulic fluid sank immediately, leaving no sheen on the surface. The samples were then subjected to significant agitation. The Neptune® AW Series hydraulic fluid dispersed completely into the water; when the agitation stopped, there was still no sheen. When agitation of the other fluids ceased, surface sheens quickly reformed.

### Typical Physical Properties\*

Neptune® AW Hydraulic Fluids	32	46	68
Viscosity, ASTM D445			
@ 40°C (100°F), cSt	32.9	47.0	68.0
@ 100°C (212°F), cSt	7.13	9.88	13.9
@ 0°C (32°F), cSt	246	362	558
Viscosity Index, ASTM D2270	188	203	214
Pour Point, °C, ASTM D5950	-46	-40	-35
Specific Gravity @20°C (68°F), ASTM D4052	1.025	1.029	1.038
Weight (lbs/gal) @ 20 °C (68 °F)	8.529	8.546	1.036
(kg/l)	1.022	1.024	1.036

\*Typical properties, not to be construed as specifications.



Neptune® AW Series Hydraulic Fluid



AW 32 Mineral Oil Hydraulic Fluid



Fully Saturated Synthetic Ester Hydraulic Fluid



Biobased Polyalphaolefin (PAO) Hydraulic Fluid



Vegetable Oil Hydraulic Fluid

American Chemical Technologies, Inc.

# NEPTUNE<sup>®</sup> AW SERIES HYDRAULIC FLUIDS

The only hydraulic fluid chemistry fully compliant with the 2013 VGP, U.S. EPA Clean Water Act and USCG Surface Force Logistics Center EAL Standards

## A Global Source for Premium Synthetic Lubricants

American Chemical Technologies, Inc. (ACT) provides premium synthetic lubricants to a wide range of industries. Founded more than 30 years ago in the U.S., ACT has grown to become an international supplier of highly specialized products for industry and markets through a global network. Our commitment to advanced technology and personal service continues today as we set new standards for product performance and customer satisfaction.

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Outside of the U.S. and Canada, please call 1-517-223-0300 (U.S.)

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For An Authorized Distributor Visit:

[www.AmericanChemTech.com](http://www.AmericanChemTech.com)

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- EcoSafe<sup>®</sup> EHC Hydraulic Fluids for the Power Generation Industry
- EcoSafe<sup>®</sup> Revive<sup>™</sup> Premium Turbine Fluid Additive
- EcoSafe<sup>®</sup> TF-25 Turbine Fluid
- Neptune<sup>®</sup> AW Hydraulic Fluid
- Neptune<sup>®</sup> Gear Oils
- EcoGear<sup>®</sup> Gear Oils



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# PRODUCT INFORMATION

A PRODUCT OF AMERICAN CHEMICAL TECHNOLOGIES, INC.



## Neptune<sup>®</sup> AW Series

***100% Water Soluble and Readily Biodegradable Hydraulic Fluids***

### DESCRIPTION:

Neptune<sup>®</sup> AW Series fluids are a fully synthetic, non-aqueous hydraulic fluids that can be used in industrial, marine and mobile equipment, including high-pressure systems, systems with servo valves and all robotics. Neptune<sup>®</sup> AW Series fluids are formulated from a high VI, fully synthetic basestock, coupled with a non-metallic additive package that provides the properties demanded by today's high performance hydraulic systems, while at the same time satisfying the stringent criteria for biodegradability and toxicity. Neptune<sup>®</sup> AW Series fluids also have excellent low temperature properties, good shear stability and are resistant to oxidative and thermal degradation.

The increased performance which Neptune<sup>®</sup> AW Series fluids provide results in extended pump service life and reduced downtime along with lower maintenance costs. ***Additional bonus features include:*** non-sludge/varnish forming, high viscosity index, low pour point, excellent heat transfer, low foaming and complete compatibility with commonly used seals, hoses and metals.

If you want to add Neptune<sup>®</sup> AW Series fluids to a hydraulic system, call us and we will advise you regarding compatibility/solubility. Most "oil soluble" additives are not soluble in Neptune<sup>®</sup> AW Series fluids thus requiring a thorough and detailed plan prior to conversion. Your American Chemical Technology representative is trained and experienced in all aspects of conversion assistance.

Neptune<sup>®</sup> AW Series fluids qualify as EAL's for compliance with the VGP.

*Biodegradable* to greater than 60% by OECD301B

*Non-bioaccumulative* by having a  $\log K_{ow} < 3$

*Practically non-toxic* towards the most sensitive freshwater and saltwater species

AND . . .

cannot *Bioconcentrate* thus eliminating shoreline and sediment poisoning

### STORAGE AND HANDLING:

We believe Neptune<sup>®</sup> AW Series fluids have a low degree of hazard when used as intended. They are stable, non-corrosive and have high flash point materials that are compatible with nearly all commonly used materials in standard hydraulic systems. As with all products of this type, we recommend that good hygiene practices be observed, including: (1) avoid prolonged skin contact, (2) provide adequate ventilation, (3) do not ingest; and that all OSHA Standards pertaining to products of this type be observed.

# Neptune<sup>®</sup> AW Series

## PROPERTIES:

	<b>Test Method</b>	<b>N AW-10</b>	<b>N AW-15</b>	<b>N AW-22</b>	<b>N AW-32</b>	<b>N AW-46</b>	<b>N AW-68</b>
Viscosity @ 40°C	ASTM D445	8.77 cSt	13.97 cSt	20.45 cSt	32.93 cSt	46.96 cSt	67.97 cSt
Viscosity @ 100°C	ASTM D445	2.36 cSt	3.60 cSt	4.98 cSt	7.13 cSt	9.88 cSt	13.91 cSt
Viscosity Index	ASTM D2270	86	147	183	188	203	214
Pour Point	ASTM D97	-62 °C (-80 °F)	-56 °C (-70 °F)	-51 °C (-60 °F)	-46 °C (-51 °F)	-40 °C (-40 °F)	-35 °C (-31 °F)
Air Release @ 50°C	ASTM D3427	1.5 min			5.0 min	7.5 min	7.0 min
Specific Gravity @ 25°C	ASTM D1298	0.99 g/cm <sup>3</sup>	1.00 g/cm <sup>3</sup>	1.01 g/cm <sup>3</sup>	1.02 g/cm <sup>3</sup>	1.03 g/cm <sup>3</sup>	1.03 g/cm <sup>3</sup>
Density @77 °F	ASTM D1298	8.20 lbs/gal	8.30 lbs/gal	8.41 lbs/gal	8.48 lbs/gal	8.51 lbs/gal	8.56 lbs/gal
Flash Point	ASTM D92	123 °C (253 °F)	139 °C (282 °F)	145 °C (293 °F)	251 °C (483 °F)	255 °C (491 °F)	253 °C (487 °F)
Fire Point	ASTM D92	137 °C (279 °F)	161 °C (322 °F)	163 °C (325 °F)	275 °C (527 °F)	285 °C (545 °F)	285 °C (545 °F)
Cleanliness	ISO 4406:1999	18/17/14	18/17/14	18/17/14	18/17/14	18/17/14	18/17/14
Total Acid Number	ASTM D664	1.0 mgKOH/g	1.0 mgKOH/g	1.0 mgKOH/g	1.0 mgKOH/g	1.0 mgKOH/g	1.0 mgKOH/g
Rust Prevention	ASTM D665A	Pass	Pass	Pass	Pass	Pass	Pass
Copper Strip Corrosion	ASTM D130	1B	1B	1B	1B	1B	1B
Foam Tendency/Stability	ASTM D892						
Sequence I		0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Sequence II		0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Sequence III		0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
EP Properties	ASTM D2783						
Non-seizure Load					80 kg	100 kg	100 kg
Load-Wear Index					36.4	43.4	43.0
Weld Load					200 kg	200 kg	200 kg
Four-Ball Wear	ASTM D4172	0.4 mm			0.39 mm	0.38 mm	0.20 mm
Hydraulic Pump Wear	ASTM D7043				2.2 mg		
Eaton Pump Test	35VQ25A				Pass		
FZG Gear Test	ASTM D5182						
Pass Load Stage					10	11	
Fail Load Stage					11	12	

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# STAY ON COURSE



## NOT ON BLOCKS

**Neptune® PAGs last longer and  
comply with EPA VGP.**

Neptune series lubricants are the only fluid chemistry fully compliant with the 2013 VGP, U.S. EPA Clean Water Act and U.S. Coast Guard Surface Force Logistics Center EAL Standards. But why stop there? Neptune lubricants outperform fully-saturated synthetic esters, vegetable oils and bio-PAOs. And they last longer in your submerged equipment. That's a whole lot of upside. Let's talk today.

**[NeptuneEALs.com](http://NeptuneEALs.com)**



**AMERICAN CHEMICAL TECHNOLOGIES, INC.**

# PRODUCT INFORMATION

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## Neptune<sup>®</sup> AW

### Typical Environmental Properties

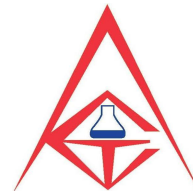
EPA 410.4 Chemical Oxygen Demand (COD)			
Neptune <sup>®</sup> AW-46		2110 mg O <sub>2</sub> /g	
Neptune <sup>®</sup> AW-46		2084 mg O <sub>2</sub> /mL	
EPA 405.1 Biological Oxygen Demand (BOD)			
Neptune <sup>®</sup> AW-46	BOD <sub>5</sub>	1.4 mg O <sub>2</sub> /g (0.05%)	
Neptune <sup>®</sup> AW-46	BOD <sub>5</sub>	20 mg O <sub>2</sub> /mL (1.0%)	
Neptune <sup>®</sup> AW-46	BOD <sub>10</sub>	140 mg O <sub>2</sub> /mL (6.7%)	
Neptune <sup>®</sup> AW-46	BOD <sub>15</sub>	840 mg O <sub>2</sub> /mL (40.3%)	
Neptune <sup>®</sup> AW-46	BOD <sub>20</sub>	1020 mg O <sub>2</sub> /mL (48.9%)	
Neptune <sup>®</sup> AW-46	BOD <sub>end</sub>	1180 mg O <sub>2</sub> /mL (56.6%)	
OECD Method 117, Bioaccumulation			
Neptune <sup>®</sup> AW-46	logP <sub>ow</sub>	1.155	“non-bioaccumulative”
OECD Biodegradability Test			
Neptune <sup>®</sup> AW-32	28 day	301A	301B
Neptune <sup>®</sup> AW-46			77.9%
Neptune <sup>®</sup> AW-68			75.8%
			61.8%
<i>A result of &gt; 60% is required to be classified as “readily biodegradable”</i>			
OECD Method 224, Bacteria inhibition			
			“no ecological doubt”
OECD Method 201, Algae Toxicity Test			
Neptune <sup>®</sup> AW-32	72 hour green algae	EC <sub>50</sub>	
Neptune <sup>®</sup> AW-46		4200 mg/L	“relatively harmless”
Neptune <sup>®</sup> AW-68		8100 mg/L	
		9200 mg/L	
OECD Method 202, Acute Aquatic Toxicity Test			
Neptune <sup>®</sup> AW-32	48 hour Daphnia magna	LC <sub>50</sub>	
Neptune <sup>®</sup> AW-46		492 mg/L	“practically non-toxic”
Neptune <sup>®</sup> AW-68		536 mg/L	
		737 mg/L	
OPPTA 850.1035, Acute Aquatic Toxicity Test			
Neptune <sup>®</sup> AW-32	96 hour Mysidopsis bahia	LC <sub>50</sub>	
Neptune <sup>®</sup> AW-46		593 mg/L	“practically non-toxic”
Neptune <sup>®</sup> AW-68		679 mg/L	
		889 mg/L	
OECD Method 203, Acute Aquatic Toxicity Test			
Neptune <sup>®</sup> AW-32	96 hour Pimephales promelas	LC <sub>50</sub>	
Neptune <sup>®</sup> AW-46		759 mg/L	“practically non-toxic”
Neptune <sup>®</sup> AW-68		918 mg/L	
		803 mg/L	

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## Neptune<sup>®</sup> AW

### *Brix° and Water by Karl Fischer*

VEE GEE<sup>®</sup> CDX-2 is used to determine the water content of field samples of Neptune<sup>®</sup> Gear Fluids.

The water content can be estimated by using the following conversion chart:

<u>Karl Fischer Water Content Weight %</u>	<u>NAW-32</u>	<u>Brix°</u> <u>NAW-46</u>	<u>NAW-68</u>
0%	66.0	67.0	68.3
5%	63.8	64.7	66.0
10%	61.5	62.4	63.7
15%	59.2	60.1	61.4
20%	56.9	57.8	59.1
25%	54.6	55.5	56.8

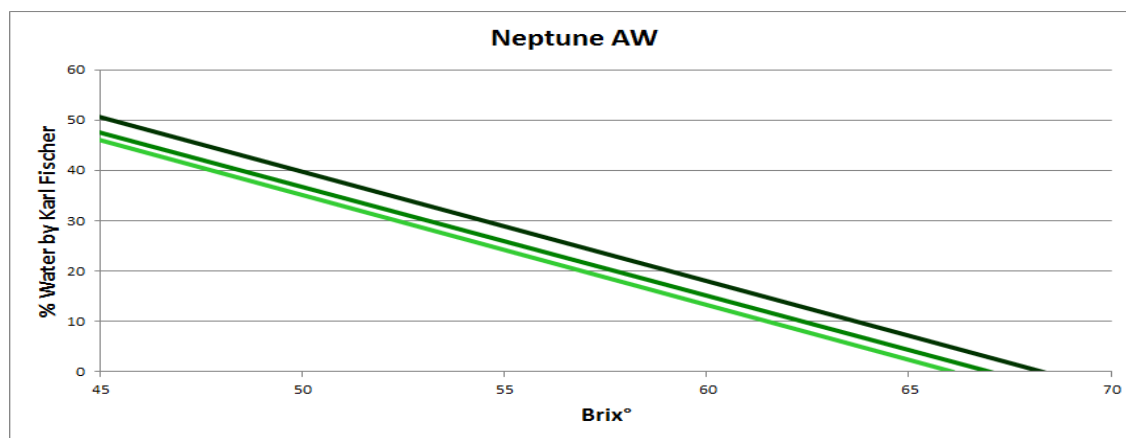
The water content can be estimated by using the following equation:

$$\% \text{ Water NAW-32} = -2.18 * \text{Brix}^\circ + 144.17$$

$$\% \text{ Water NAW-46} = -2.16 * \text{Brix}^\circ + 145.04$$

$$\% \text{ Water NAW-68} = -2.18 * \text{Brix}^\circ + 148.69$$

The water content can be estimated by using the following graph:



NAW-68 (dark green), NAW-46 (medium green), and NAW-32 (light green)

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## Neptune<sup>®</sup> AW-32

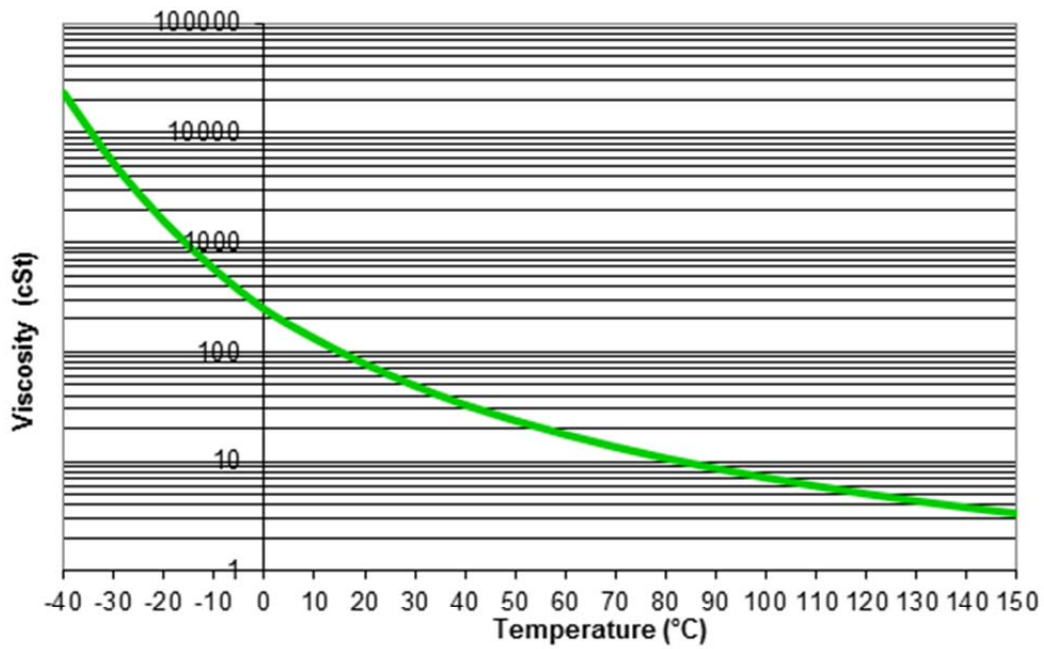
### *Thermal Characteristics*

#### DESCRIPTION:

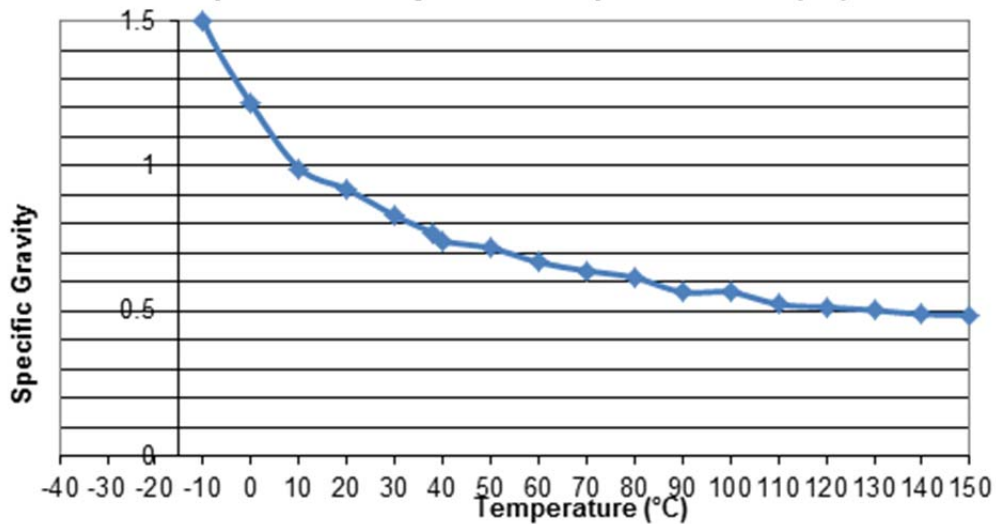
#### PROPERTIES:

	Test Method	NAW-32
Kinematic Viscosity	ASTM D445	
@ 0 °C		220.0 cSt
@ 20 °C		73.0 cSt
@ 40 °C		32.0 cSt
@ 60 °C		17.2 cSt
@ 80 °C		10.6 cSt
@ 100 °C		7.3 cSt
Specific Gravity @ 25 °C	ASTM D1475	1.026 g/cm <sup>3</sup> (8.54 lbs/gallon)
Specific Heat	ASTM E1269	
@ -25°C		2.034 J/g°K (0.4857 cal/g°C)
@ 0°C		2.049 J/g°K (0.4891 cal/g°C)
@ 20°C		2.078 J/g°K (0.4965 cal/g°C)
@ 40°C		2.119 J/g°K (0.5062 cal/g°C)
@ 75°C		2.209 J/g°K (0.5256 cal/g°C)
@ 100°C		2.279 J/g°K (0.5391 cal/g°C)
Thermal Conductivity	ASTM E1952	
@ 70°C		0.150 W/m°K (0.0867 BTU/ft °F)
@ 100°C		0.128 W/m°K (0.0740 BTU/ft °F)
Coefficient of Thermal Expansion	ASTM D1903	
@ 20 °C		510 x 10 <sup>-6</sup> /°C
@ 40 °C		600 x 10 <sup>-6</sup> /°C

### Viscosity Temperature Profile Neptune AW-32 (cSt, °C)



### Specific Gravity Profile Neptune AW-32 (°C)



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# PRODUCT INFORMATION

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## Neptune<sup>®</sup> AW-46

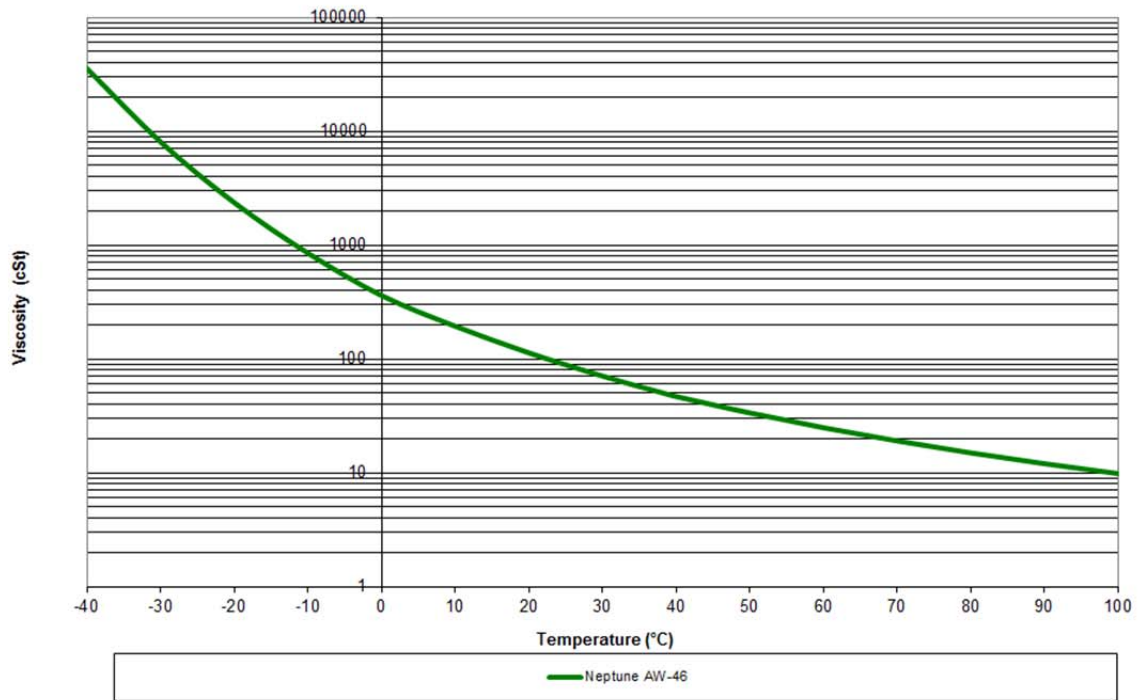
### *Thermal Characteristics*

#### DESCRIPTION:

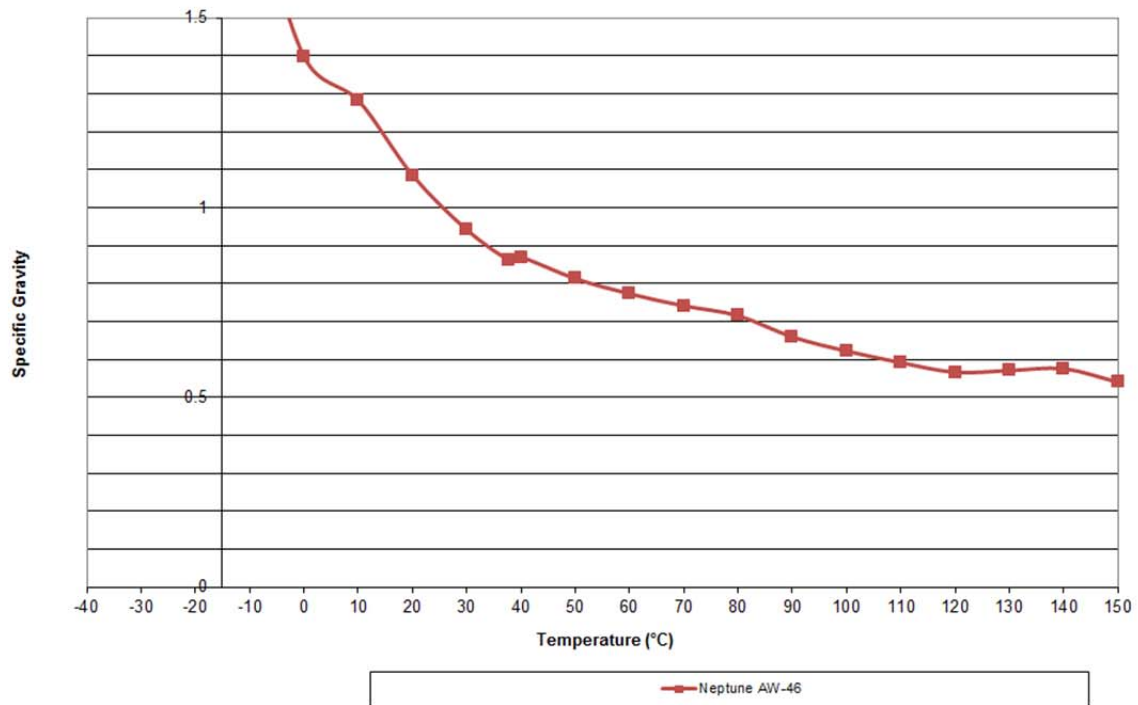
#### PROPERTIES:

	Test Method	NAW-46
Kinematic Viscosity	ASTM D445	
@ 0 °C		361.5 cSt
@ 20 °C		113.4 cSt
@ 40 °C		47.0 cSt
@ 60 °C		25.0 cSt
@ 80 °C		15.0 cSt
@ 100 °C		9.9 cSt
Specific Gravity @ 25 °C	ASTM D1475	1.036 g/cm <sup>3</sup> (8.54 lbs/gallon)
Specific Heat	ASTM E1269	
@ -25°C		1.993 J/g°K (0.4760 cal/g°C)
@ 0°C		1.991J/g°K (0.4754 cal/g°C)
@ 20°C		2.006 J/g°K (0.4790 cal/g°C)
@ 40°C		2.037J/g°K (0.4864 cal/g°C)
@ 75°C		2.133 J/g°K (0.5094 cal/g°C)
@ 100°C		2.231 J/g°K (0.5327 cal/g°C)
Thermal Conductivity	ASTM E1952	
@ 25°C		0.175 W/m°K (0.101 BTU/ft °F)
Coefficient of Thermal Expansion	ASTM D1903	
@ 20 °C		500 x 10 <sup>-6</sup> /°C
@ 40 °C		510 x 10 <sup>-6</sup> /°C

Viscosity Temperature Profile Neptune AW (cSt, °C)



Specific Gravity Profile Neptune AW (°C)



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# PRODUCT INFORMATION

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## Neptune<sup>®</sup> AW-68

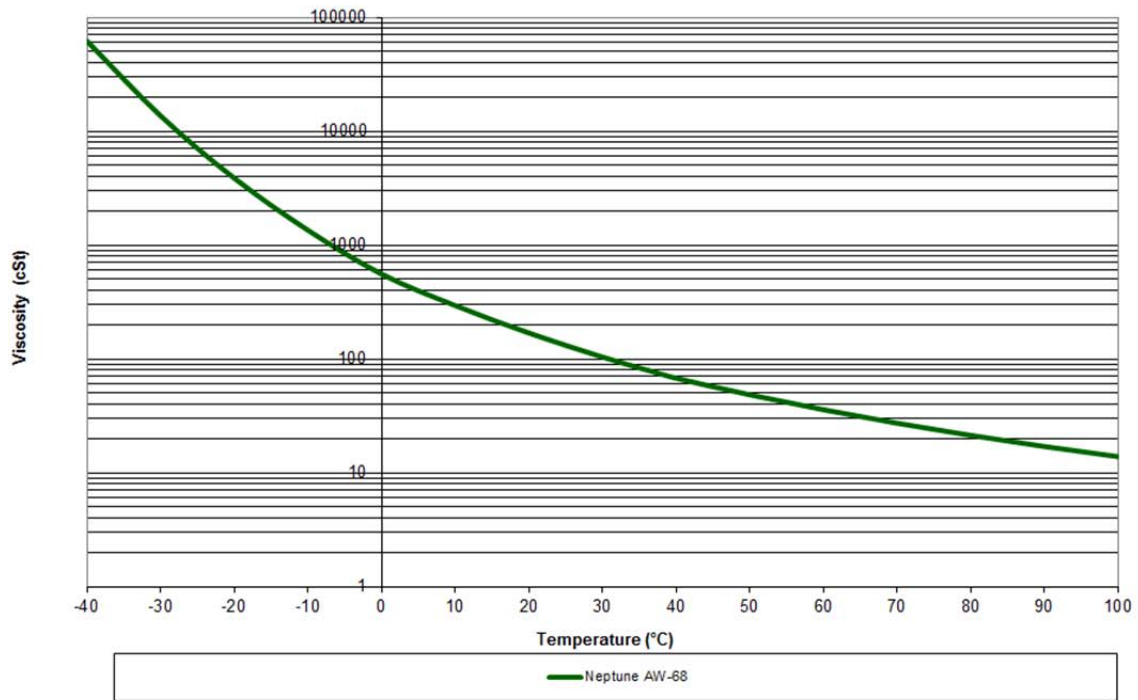
### *Thermal Characteristics*

#### DESCRIPTION:

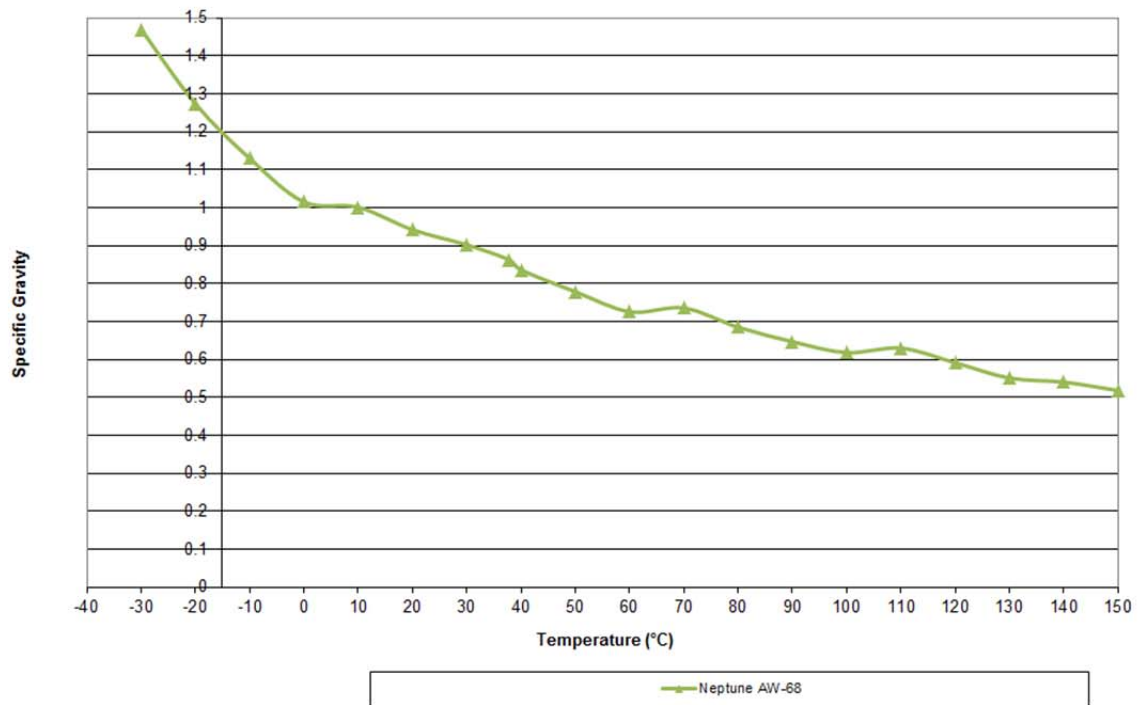
#### PROPERTIES:

	Test Method	N AW-68
Kinematic Viscosity	ASTM D445	
@ 0 °C		558.3 cSt
@ 20 °C		169.5 cSt
@ 40 °C		68.0 cSt
@ 60 °C		35.9 cSt
@ 80 °C		21.4 cSt
@ 100 °C		13.9 cSt
Specific Gravity @ 25 °C	ASTM D1475	1.036 g/cm <sup>3</sup> (8.62 lbs/gallon)
Specific Heat	ASTM E1269	
@ -25°C		1.839 J/g°K (0.4391 cal/g°C)
@ 0°C		1.884 J/g°K (0.4500 cal/g°C)
@ 20°C		1.924 J/g°K (0.4594 cal/g°C)
@ 40°C		1.954 J/g°K (0.4666 cal/g°C)
@ 75°C		2.021 J/g°K (0.4827 cal/g°C)
@ 100°C		2.067 J/g°K (0.4936 cal/g°C)
Thermal Conductivity	ASTM E1952	
@ 25°C		0.168 W/m°K (0.0971 BTU/ft °F)
Coefficient of Thermal Expansion	ASTM D1903	
@ 20 °C		490 x 10 <sup>-6</sup> /°C
@ 40 °C		510 x 10 <sup>-6</sup> /°C

### Viscosity Temperature Profile Neptune AW (cSt, °C)



### Specific Gravity Profile Neptune AW (°C)



The information contained herein is correct to the best of our knowledge. The recommendations or suggestions contained in this bulletin are made without guarantee or representation as to results. We suggest that you evaluate these recommendations and suggestions in your own laboratory prior to use. Our responsibility for claims arising from breach of warranty, negligence, or otherwise is limited to the purchase price of the material. Freedom to use any patent owned by American Chemical Technologies' or others is not to be inferred from any statement contained herein.

# PRODUCT INFORMATION

A PRODUCT OF AMERICAN CHEMICAL TECHNOLOGIES, INC.



## Neptune<sup>®</sup> and UCON<sup>™</sup> Trident<sup>™</sup>

### *Total Acid Number*

#### **DESCRIPTION:**

The Total Acid Number (TAN) is measured by either ASTM D974 (manual) or ASTM D664 (potentiometrically)

#### **PROPERTIES:**

	<b>Test Method</b>	<b>Standard</b>
UCON <sup>™</sup> Trident <sup>™</sup> AW Hydraulic Fluids	ASTM D664	0.6 mgKOH/g
Neptune <sup>®</sup> AW Hydraulic Fluids	ASTM D664	0.9 mgKOH/g
Neptune <sup>®</sup> EP Gear Fluids	ASTM D664	2.3 mgKOH/g
Neptune <sup>®</sup> Gear Fluids	ASTM D664	0.6 mgKOH/g

The Neptune<sup>®</sup> EP Gear Fluids have a higher starting TAN because the test is measuring the presence of the EP additive. To use TAN to monitor the life of the product, you would evaluate the change in TAN towards a value of 5.0 rather than an absolute TAN value as compared to a non-EP product.

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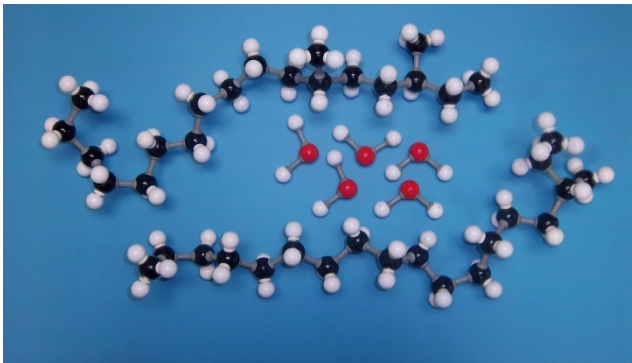
# Technical Bulletin

## Effects of water in Neptune<sup>®</sup> AW Hydraulic Fluids

Neptune<sup>®</sup> AW hydraulic fluids, UCON Trident<sup>™</sup> hydraulic fluids and Neptune<sup>®</sup> gear lubricants are manufactured from polyalkylene glycol (PAG) base stocks as anhydrous synthetic lubricants. Synthetic lubricants made from PAG base stocks differentiate themselves from mineral oil, vegetable oil, and ester base stocks with their solubility in water.

The reason for this difference is due to the chemical structure of the water soluble PAG base stock and the way water interacts with it. See Figure 1.

Mineral Oil and water



Neptune<sup>®</sup> or UCON Trident<sup>™</sup> and water

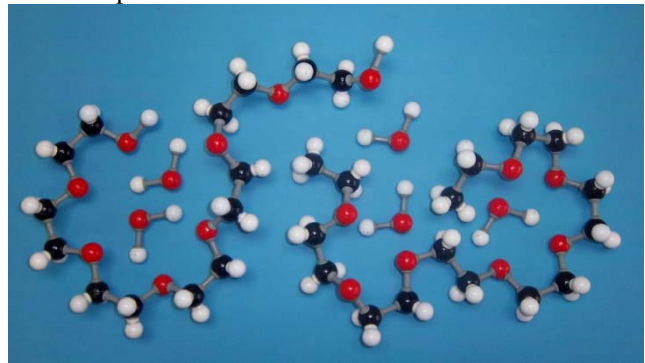


Figure 1: Model of water in a Mineral Oil and water in a water soluble PAG base stock. Carbon is black; Oxygen is red; Hydrogen is white. The diagram shows the expected interaction of five (5) water molecules to the respective base stock.

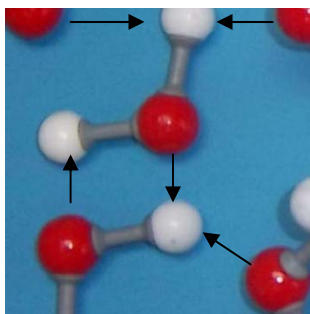


Figure 2 : Hydrogen bonding of water

Water seeks out places where it can share a hydrogen as shown in Figure 2. The connection must be oxygen-hydrogen-oxygen (RED-WHITE-RED). In a mineral oil, there are few sites for water to interact with the base oil. The result is that in mineral oil the water locates other water molecules and becomes “free water.” This Free Water can be separated by physical means, is a poor lubricant, and can carry ions that catalyze corrosion. Therefore, the upper acceptable limit for water in mineral oil fluids is legitimately very low.

Closer analysis of how water interacts with a water soluble PAG provides insight to their benefit as a lubricant.

## Effects of water in Neptune<sup>®</sup> and UCON Trident<sup>™</sup> Hydraulic Fluids

The oxygens in the PAG basestock form rings around the water. As shown in figure 3. Because the rings are formed from linear chains of PAG's, there is no barrier to the movement of water into or out of the ring.

American Chemical Technologies manufactures Neptune<sup>®</sup> and supplies UCON Trident<sup>™</sup> hydraulic fluids with between 1000 and 2000 ppm (0.1%-0.2%) water. This is directly tied to the purchase specifications of the PAG base stock. As the fluid is used in service, significantly larger amount of water can be contained in the system without any negative impact upon the performance characteristics of the hydraulic fluid.

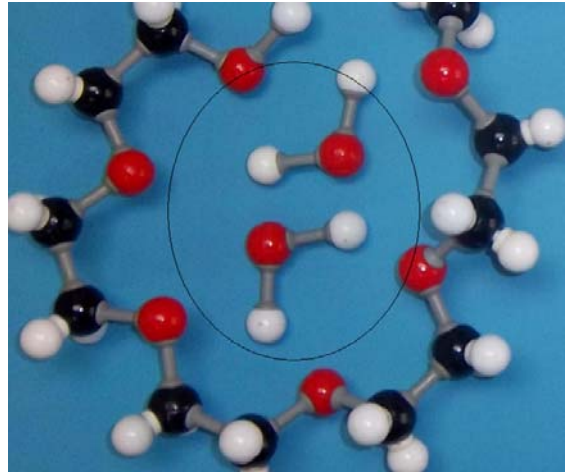


Figure 3 : Ring-structure of water soluble PAG's

Whereas most conventional oil soluble lubricants can only function as they repel water, Neptune<sup>®</sup> and UCON Trident<sup>™</sup> incorporate water into their internal structure. Metal parts lubricated with Neptune<sup>®</sup> and UCON Trident<sup>™</sup> resist corrosion as if they were in an anhydrous environment. Because the water is evenly distributed throughout the lubricant, typical failure mechanisms associated with emulsified water are not observed. Because the ether linkages are hydrolytically stable, incorporation of water does not result in rapid deterioration of the lubricant properties.

The following tests have been performed with PAG lubricating fluids where water is either part of the test or excessive amounts of water have been added:

ASTM D665 – Standard Test Method for Rust-Preventing Characteristics of Inhibited Mineral Oil in the Presence of Water

ASTM D943 – Standard Test Method for Oxidation Characteristics of Inhibited Mineral Oils (TOST test)

ASTM D4172 – Standard Test method for Wear Preventative Characteristics of Lubricating Fluid (Four-Ball Method)

Results found in the standard technical brochures for Neptune<sup>®</sup> and UCON Trident<sup>™</sup> products are independent of modest changes in water content.