ROYAL PURPLE®

Gear Lubrication Manual

Introduction

Many gear boxes experience poor reliability and operate below maximum efficiency because they are poorly lubricated. This may be the result of using either the wrong gear oil for the application or an underperforming gear oil.

However, this problem often can be solved by upgrading to Royal Purple's high performance gear oils, each formulated with one of Royal Purple's synthetic, proprietary additive technologies, which are proven to make equipment run smoother, cooler, quieter, longer and more efficiently.

Royal Purple® offers a variety of R&O, EP, Synthetic and R&O Compounded Worm Gear oils, some of which can be used for multiple purposes, reducing the need to purchase multiple oils.

Royal Purple's high film strength gear oils gain their distinct performance advantages over other commercial gear oils because they are noncorrosive to both ferrous and nonferrous metals yet provide maximum protection against heavy loads, shock loads, low operating speeds and / or high operating temperatures.

Additionally, Royal Purple's gear oils not only outperform other commercial gear oils, but they exceed AGMA 9005-D94 performance standards, as shown in Table 2 (Pages 3-8).

Document Purpose

This brochure is meant to aid in the selection of the correct Royal Purple® gear oil. First, check the owner's manual or the template on the gear box to determine the correct AGMA gear oil type and viscosity or consult Tables 4-7 on Pages 7-9 of this brochure. Once the correct AGMA gear oil type and viscosity has been determined, select a Royal Purple® gear oil matching those requirements from those listed on Page 2.

AGMA Gear Oil Classifications

The American Gear Manufacturers Association (AGMA) published the AGMA 9005-D94 standards, which establishes four gear oil classifications. The gear oil classifications and the types of gears they are intended to lubricate are listed in below.

AGMA R&O Oils

Gears Lubricated: Enclosed helical, herringbone, straight bevel, spiral bevel and spur gears.

AGMA EP Gear Oils

Gears Lubricated: Enclosed helical, herringbone, straight bevel, spiral bevel and spur gears.

AGMA Synthetic Gear Oils

Gears Lubricated: Enclosed helical, herringbone, straight bevel, spiral bevel and spur gears.

AGMA R&O Compounded Worm Gear Oils

Gears Lubricated: Worm Gears

Royal Purple's Family of High Performance Gear Oils

The performance of each Royal Purple gear oil exceeds AGMA 9005-D94 performance standards.

A gear oil's performance is predominantly achieved by the additive technology used in its formulation.

Table 1 lists the exclusive performance advantages of Royal Purple's proprietary. synthetic additive technologies.

Table 1: Royal Purple's Synthetic Additive Technologies

Royal Purple Additive Technology	Used in AGMA Classification	Gives These Performance Advantages
Synerlec® additive technology	R&O gear oils	High film strength, noncorrosive, multi-functionality to perform in the widest variety of equipment.
DynaGlyde® additive technology	Worm gear oils	Slippery, non-rancid, synthetic fatty oil.
Synslide® additive technology	EP gear oils	Maximum film strength; maximum loads.
Purolec® additive technology	FDA & USDA oils	High purity and mild EP protection.

Royal Purple's Family of High Performance Gear Oils, Continued

Listed according to AGMA 9005-D94 classifications

Royal Purple R&O Gear Oils

with Synerlec® additive technology

Synfilm® GT

Synfilm® GT is a long life, high performance, synthetic lubricant that offers maximum protection to gears and bearings in high and low temperature service. Its low temperature fluidity makes it an excellent lubricant for low temperature gear boxes. Available in AGMA Grades 0 thru 8 (ISO Grades 10 - 680).

Synfilm®

Synfilm® is a long life, premium, multi-synthetic lubricant that not only excels in the lubrication of gear boxes that require an R&O oil, but also in compressors, pumps, steam turbines, motor bearings, air tools, etc. Available in AGMA Grades 0 thru 4 (ISO Grades 32 - 150).

Parafilm®

Parafilm® is an economical, high performance, para-synthetic oil that is recommended where a fully synthetic oil is not required. Available in AGMA Grades 0 thru 5 (ISO Grades 32 - 220).

Royal Purple R&O Compounded Worm Gear Oils

with DynaGlyde® additive technology

Synergy® Worm Gear Oil

Synergy® Worm Gear Oil is recommended for both cylindrical and double enveloping worm gears. It is a long life, non-phosphorus, noncorrosive, para-synthetic gear oil. It is compounded with a stable, synthetic fatty oil that does not turn rancid like the vegetable fatty oils in mineral worm gear oils. Available in AGMA Compounded Grades 7, 8 and 8A (ISO Grades 460, 680 & 1000).

Thermyl-Glyde® Worm Gear Oil

Royal Purple Thermyl-Glyde® Worm Gear Oil is a synthetic worm gear oil that provides superior performance in both cylindrical and double enveloping worm gears. It is a non-phosphorus, noncorrosive, high performance gear oil compounded with a stable, non-rancid, slippery, synthetic fatty oil. Available in AGMA Compounded Grades 7, 8 and 8A (ISO Grades 460, 680 & 1000).

Royal Purple EP Gear Oils

with Synslide® additive technology

Synergy®

Royal Purple Synergy® is a premium, long life, high performance, para-synthetic, EP gear oil. Being noncorrosive, it can be used where AGMA recommends using either an R&O or EP gear oil. Available in AGMA Grades 2 thru 8 EP (ISO Grades 68 - 1000).

Thermy-Glyde®

Thermyl-Glyde® is a high performance, noncorrosive, synthetic gear oil that gives superior performance in extreme service conditions, which require a tough, tenacious, slippery oil. Being noncorrosive, it can be used where AGMA specifies using either an R&O or EP gear oil. Available in AGMA Grades 2 thru 9 (ISO Grades 68 - 1500).

Royal Purple Synthetic Gear Oils

with Synerlec®, Synslide® or Purolec® additive technologies

Thermy-Glyde®

Thermyl-Glyde® with Synslide® additive technology is a noncorrosive, high performance, synthetic gear oil that gives superior performance under heavy, wet or shock loads in both high and low temperature service. Available in AGMA Grades 2 thru 9 (ISO Grades 68 - 1500).

Synfilm® GT

Synfilm® GT is a high performance, noncorrosive, synthetic lubricant that offers maximum protection to both gears and bearings and greatly extends oil drain intervals. Its low temperature fluidity makes it an excellent lubricant for low temperature service. Available in AGMA Grades 0 thru 8 (ISO Grades 10 - 680).

Poly-Guard® FDA

Poly-Guard® FDA is a premium, noncorrosive, synthetic oil that meets FDA and USDA purity requirements. Poly-Guard® FDA is recommended for the lubrication of gears, bearings, pumps, etc., in food processing plants, dairies, bakeries, etc. Available in AGMA Grades 0 thru 8 (ISO Grades 15 - 1000).

For detailed product information, contact Royal Purple for individual product sheets at 281-354-8600 or view them online at www.royalpurple.com.

AGMA 9005-D94 Gear Oil Requirements

Table 2 below shows a comparison between the AGMA's minimum performance standards for gear oils and the performance of Royal Purple's gear oils. Royal Purple lists at least two gear oils for each AGMA classification. Every Royal Purple gear oil greatly exceeds AGMA's 9005-D94 performance standards.
Note: This table spans across two pages.

Table 2

	AGMA Performance Requirements for R&O, Worm, EP and Synthetic gear oils		
Interpretation of AGMA Test Results	**ASTM Test**	**ASTM Number**	**AGMA Requirements**
ASTM D-445 determines an oil's viscosity of fluidity at a specific temperature. At the same temperature, a light ISO 32 oil has a lower viscosity than a heavier ISO 150 oil. When the temperature changes, the viscosity of each oil will change. When an oil's temperature increases it becomes more fluid, or thinner; When it temperature drops it becomes less fluid, or thicker. The oil temperature must always be given when reporting a viscosity. The three most common temperatures used to report viscosities are 40ºC, 100ºC and the oil's operating temperature.*Oil viscosity is expressed in either SUS (Saybolt Universal Seconds) or in cSt (centistokes). Centistoke viscosity is an international standard and is more widely used.*	Viscosity	D 445	Must Meet AGMA Grades
ASTM D-2270 determines the Viscosity Index (VI) of an oil. It is an empirical number used to measure an oil's ability to resist viscosity changes when the temperature changes. High VI oils have smaller viscosity changes than low VI oils when the temperature changes. *Viscosity Index cannot be used to measure any other quality of an oil.*	Viscosity Index	D 2270	R&O / Worm / EP 90 minimum Synthetic 120 minimum
ASTM D-943 is used by AGMA to evaluate the oxidation stability of R&O gear oils. This test measures an oil's ability to resist oxidation in a wet environment by heating an oil / water mixture to 203ºF and recording the number of hours it takes for the oil / water mixture to reach an acid number of 2.0. Although AGMA uses this test for gear oils, it can test the oxidation stability of steam turbine oils or any oil subjected to water contamination.	Oxidation Stability (R&O oils only)	D 943	AGMA No. / Hours min. 1 & 2 — 1500 3 & 4 — 750 5 & 6 — 500
ASTM D-2893 is a "dry air oxidation test" for EP gear oils only. The test normally is run for 13 days at 203ºF. To make the test more severe, AGMA increased the test temperature to 250ºF. A test temperature of 250ºF instead of 203ºF is more severe because the rate of oil oxidation doubles with every 18ºF increase in temperature. A gear oil that is oxidation stable in this 250ºF test will be more oxidation stable at the relatively low gear box temperatures of 140ºF to 180ºF. Gear oils that are oxidation stable reduce the frequency of oil changes, resulting in significant dollar savings to the user. The advanced oxidation stability of Royal Purple's oil can increase oil drain intervals up to 15,000 hours. This is six times longer than AGMA's recommended 2,500 hours oil change interval.	Oxidation Stability	D 2893 Modified	6% maximum viscosity increase at 250ºF
ASTM D-665 rust test is used by AGMA to determine a gear oil's ability to protect ferrous metals from rust in both fresh and saltwater environments.	Rust, Sea, H_2O	D 665B	24 hours in seawater
ASTM D-130 is normally run at 212ºF, but to make the test more severe AGMA increased the temperature to 250ºF. ASTM D-130 is used to determine the corrosiveness of a gear oil's EP additive to nonferrous metals. A polished copper strip is immersed in the 250ºF oil bath for three hours and the EP additive corrosiveness is determined by comparing the strip against ASTM pre-rated strips. ASTM rates the test strip as: 1 a or b; 2 a, b, c, d or e; 3 a or b; or 4 a, b, c or d. Ratings of 1 a or 1 b are the least corrosive.	Corrosion	D 130	1b maximum (3hrs/250ºF)

Royal Purple Gear Oil Performance for R&O, Worm, EP and Synthetic gear oils				
R&O Gear Oils	**R&O Compounded Gear Oils**	**EP Gear Oils**	**Synthetic Gear Oils**	**AGMA Gear Oil Classification**
Synfilm GT, Synfilm, Poly-Guard FDA, Parafilm	**Synergy, Thermyl-Glyde Worm Gear Oil**	**Synergy, Thermyl-Glyde**	**Thermyl-Glyde, Poly-Guard FDA**	**Royal Purple Gear Oils / Interpretaion of Royal Purple's Performance**
Meets R&O AGMA grades	Meets AGMA 7, 8, 8A	Meets EP AGMA grades	Meets "S" AGMA grades	Royal Purple meets AGMA grades.
100 Minimum	100 Minimum	100 Minimum	120 Minimum	Royal Purple R&O, EP and Worm Gear oils exceed test requirements.
AGMA No. / Hours min. 1 & 2 / 5000 3 & 4 / 4000 5 & 6 / 3000	Not required for AGMA worm gear oils.	Not required for AGMA EP gear oils. Royal Purple's Synergy and Thermyl-Glyde are noncorrosive.	Not required for AGMA synthetic oils.	Royal Purple's Synfilm®, Synfilm® GT and Parafilm® exceed AGMA's 500 to 1500 hours test requirements for R&O oils by going 3000 to 5000 hours before reaching a 2.0 acid number.
Not required. Royal Purple ran 0.71% (AGMA 5 typical)	Not required. Royal Purple ran 4.06% (AGMA 8A typical)	All AGMA grades 1.9% (typical)	All AGMA grades 1.7% (typical)	Royal Purple's Synergy® and Thermyl-Glyde® had excellent passes in this EP test. Although AGMA does not require worm gears to pass this test, Synergy® and Thermyl-Glyde® worm gear oils passed ASTM D-2893 @ 250˚F.
24 hours, no rust	24 hours, no rust	24 hours, no rust	24 hours, no rust	Royal Purple passed this test.
1a (typical)	1a (typical)	1a (typical)	1a (typical)	All Royal Purple gear oils have a 1a rating.

AGMA 9005-D94 Gear Oil Requirements, Continued

Table 2

Interpretation of AGMA Test Results	AGMA Performance Requirements for R&O, Worm, EP and Synthetic gear oils		
	ASTM Test	**ASTM Number**	**AGMA Requirements**
ASTM D-892 test is used to determine the foam tendency of a gear oil The test is run in three sequences. Each sequence measures foam 1) after blowing air through the oil for 5 minutes and 2) after the oil settles 10 minutes after blowing. • Sequence I cools oil from 120˚F to 75˚F to represent oil foaming at startup temperature. • Sequence II keeps the oil at 200˚F to represent oil foaming at operating temperature. • Sequence III cools sequence II oil to 75˚F to represent oil foaming during shutdown. AGMA gives a pass to all oils that: • Have a maximum of 75 ml of foam immediately after blowing for 5 minutes. • Have a maximum of 10 ml of foam after allowing the oil to settle for 10 minutes.	Foam	D 892	Seq. 5 min. 10 min. 1, 2, 3 75ml 10ml
I. R&O gear oils: ASTM D-2711 measures the water separating capability of R&O gear oils. The test requires mixing 45 ml of water with 405 ml of gear oil and stirring at 180ºF. After stirring, the mixture is allowed to settle for 5 hours. After settling, the amount of the 45 ml of water that separates from the oil is determined by recording: 1) The percent of water remaining in the oil. 2) The ml of oil/water emulsion. 3) The ml of free water that settled from the 45 ml of water during the 5 hours. The best pass for this test will have 1) minimum water in oil, 2) minimum emulsion and 3) maximum free water. (100 percent demulsibility of R&O oils would be 45 ml of water.) II. EP gear oils: ASTM 2711 Modified, Appendix X2 is used to measure the water separating capability of EP gear oils. The EP oil Modified test differs in that it requires mixing 90 ml of water with 360 ml of oil instead of 45 ml of water and 405 ml of oil in the R&O test. The X2 test procedure for EP gear oils is the same as it is for R&O gear oils. The same reporting method is used for the X2 Modified EP test as is used in the D-2711 R&O test. The percent of the 90 ml of water recovered gives the EP oil's water separating efficiency.	Demulsibility ASTM 2711 (R&O Gear Oils Only) ASTM 2711 Modified (EP Gear Oils Only)	D 2711	R&O EP H_2O, % max 0.5 2.0 Max Cuff, ml 2.0 1.0 Free H_2O,min 30 80
ASTM D-2783, known as the Timken Test, is used by AGMA to determine the load carrying strength of EP oils. In this test the load carrying strength of a gear oil is measured by the number of pounds needed to break down the oil film. AGMA requires all EP oils to have a minimum load carrying ability of 60 pounds. Royal Purple Synergy® and Thermyl-Glyde® carry a minimum of 100 pounds, which greatly exceeds that of most gear oils.	Timken, lbs.	D 2782	60 lbs. min. — EP oil only
AGMA uses this EP, or oil film strength, test as another means to denote heavy duty gear performance. This is a high film strength test that is run in stages from 1 to a maximum of 12 stages. The more stages passed, the higher the oil's load carrying ability.	FZG stages Number of stages to pass	Din 51354	"EP" Oils "S" oils 12 stages 10 stages

Royal Purple Gear Oil Performance for R&O, Worm, EP and Synthetic gear oils				
R&O Gear Oils	**R&O Compounded Gear Oils**	**EP Gear Oils**	**Synthetic Gear Oils**	**AGMA Gear Oil Classification**
Synfilm GT, Synfilm, Poly-Guard FDA, Parafilm	**Synergy, Thermyl-Glyde Worm Gear Oil**	**Synergy, Thermyl-Glyde**	**Thermyl-Glyde, Poly-Guard FDA**	**Royal Purple Gear Oils / Interpretaion of Royal Purple's Performance**
Seq. 5 min. 10 min. 1, 2, 3 0ml 0ml	Seq. 5 min. 10 min. 1, 2, 3 0ml 0ml	Seq. 5 min. 10 min. 1, 2, 3 0ml 0ml	Seq. 5 min. 10 min. 1, 2, 3 0ml 0ml	All Royal Purple gear oils had zero foam immediately after blowing and zero foam after 10 minutes of settling thereby exceeding AGMA requirements. No foam ensures better lubrication.
Ran for information only 0.5% 0.2 ml 42.0 ml	Ran for information only <0.1% (trace) 0.0 ml 85.5 ml	Ran for information only <0.1% (trace) 0.0 ml 86.0 ml	Ran for information only <0.1% (trace) 0.0 ml 89.5 ml	Royal Purple's Synfilm®, Synfilm® GT and Parafilm® have excellent water separation. Royal Purple's Synergy® and Thermyl-Glyde® readily separate from water.
Non EP — Not Required	Non EP — Not Required	100 lbs.	Non EP — Not Required Thermyl-Glyde: 100 lbs.	Royal Purple's Synergy® and Thermyl-Glyde® give maximum gear protection under all loads.
Not required for R&O gear oils	Not required for worm gear oils	12+	12+	Royal Purple's Synergy® & Thermyl-Glyde® exceed AGMA's maximum 12 stage pass.

AGMA 9005-D94 Gear Oil Requirements, Continued

Table 2

Interpretation of AGMA Test Results	AGMA Performance Requirements for R&O, Worm, EP and Synthetic gear oils		
	ASTM Test	ASTM Number	AGMA Requirements
ASTM D-2783 4-Ball Weld Test is used extensively, though it is not required by AGMA. It measures the kgf (kilogram force) load requirement to prevent metal-to-metal contact or seizing under heavy loads. The kgf is increased on a 10^x power logarithmic scale making the load increase higher than if measured on the linear scale. In this test, Royal Purple Synergy® and Thermyl-Glyde® high performance EP gear oils rate superior.	4-Ball Weld	D 2783	Not required by AGMA
AGMA does not require a specific filterability test but specifies that the gear oil must pass through a 25μ filter without removing any additives. Royal Purple gear oils passed through the renowned 25μ Pall Filter test without plugging the filter or using any additives.	Filterability	No Test	Must pass 25μ filter test, No Additive Loss
Royal Purple gear oils provide maximum protection to gears and bearings. Royal Purple gear oils are extremely oxidation stable and do not break down in service. In normal service: AGMA recommends changing oil every 2,500 hours or 6 months, whichever comes first.	Oil Change Interval	180-203ºF 100-108ºF	2,500 hrs. or 6 months max. 2,500 hrs. or 6 months max.

Royal Purple Gear Oil Performance for R&O, Worm, EP and Synthetic gear oils				
R&O Gear Oils	**R&O Compounded Gear Oils**	**EP Gear Oils**	**Synthetic Gear Oils**	**AGMA Gear Oil Classification**
Synfilm GT, Synfilm, Poly-Guard FDA, Parafilm	**Synergy, Thermyl-Glyde Worm Gear Oil**	**Synergy, Thermyl-Glyde**	**Thermyl-Glyde, Poly-Guard FDA**	**Royal Purple Gear Oils / Interpretaion of Royal Purple's Performance**
Not Applicable	Not Applicable	Not Applicable	Not Applicable	Royal Purple's Synergy® and Thermyl-Glyde® passed at 400 kgf. This superior film strength under load ensures maximum protection to gears and to bearings.
Passed 25μ filter test, No Additive Loss	Passed 25μ filter test, No Additive Loss	Passed 25μ filter test, No Additive Loss	Passed 25μ filter test, No Additive Loss	Royal Purple gear oils give superior performance without losing additive by filtration.
10,000 hrs. or 2 years max. 15,000 hrs. or 3 years max. Analyze oil every 5,000 hrs.	10,000 hrs. or 2 years max. 15,000 hrs. or 3 years max. Analyze oil every 5,000 hrs.	10,000 hrs. or 2 years max. 15,000 hrs. or 3 years max. Analyze oil every 5,000 hrs.	10,000 hrs. or 2 years max. 15,000 hrs. or 3 years max. Analyze oil every 5,000 hrs.	Royal Purple recommends oil drain intervals up to 15,000 hours or 3 years, whichever comes first.

AGMA Viscosity Ranges for Royal Purple's Gear Oils

Read horizontally in either direction to change from AGMA Grade, to ISO Grade, to SAE Grade, to Centistoke Viscosity @ 40ºC.

Table 3: Determining the Correct Lubricant Grade

AGMA R&O Oil Grade	AGMA R&O Worm Gear Oil Grade	AGMA EP Oil Grade	AGMA Synthetic Oil Grade	ISO Grade	SAE Grade	Viscosity Range cSt at 40˚C (104˚F) (Note: AGMA 13 = cSt at 100˚C)
0			0 S	—	—	28.8 to 35.2
1			1 S	46	75W	41.4 to 50.6
2		2 EP	2 S	68	80W	61.2 to 74.8
3		3 EP	3 S	100	85W, 75W90	90 to 110
4		4 EP	4 S	150	90	135 to 165
5		5 EP	5 S	220	90	198 to 242
6		6 EP	6 S	320	140, 85W90	288 to 352
7	7 Compounded	7 EP	7 S	460	140	414 to 506
8	8 Compounded	8 EP	8 S	680	140	612 to 748
—	8A Compounded	8A EP	—	1000	250	900 to 1100
9		9 EP	9 S	1500	—	1350 to 1650
10		10 EP	10 S	—	—	2880 to 3520
11		11 EP	11 S	—	—	4140 to 5060
12		12 EP	12 S	—	—	6120 to 7480
13		13 EP	13 S	—	—	190 to 220 (@100ºC)

Gears and / or Operating Conditions Requiring Special Consideration

1. Gear boxes with a brake or an overrunning clutch.
2. Gear boxes in a hot environment (ambient temperature over 200˚F).
3. Gear boxes where the oil is subjected to a high level of contamination.
4. Special equipment requirements such as found in a centrifuge.

When encountering these or other unusual conditions, please consult with Royal Purple's Industrial Technical Support Department at 888-382-6300.

Royal Purple® makes a tough, long life, energy efficient gear oil to meet the lubrication demands for virtually every type of industrial gear and service requirement. Each Royal Purple® gear oil greatly exceeds AGMA 9005-D94 performance standards. These high performance gear oils provide superior protection to gears and to bearings under hot, wet, cold, heavily loaded and shock load conditions. Each Royal Purple® gear oil is industry proven to make gear boxes run smoother, cooler, quieter, longer and more efficiently.

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