Safe Handling and Storage of

Synfluid® Polyalphaolefins (PAO)

&

Synfluid® Metallocene Polyalphaolefins (mPAO)

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Chevron Phillips CHEMICAL

Performance by design.
Caring by choice.™

OPERATIONAL EXCELLENCE SYSTEM

April 1, 2021

Operational Excellence Policy

We will strive each day to conduct our business in a safe, secure, injury-free, and environmentally responsible manner. We are committed to comply with all laws and regulations applicable to our facilities and business activities and to comply with all voluntary programs to which we elect to subscribe. We will strive to make optimal use of the resources we consume and minimize emissions and waste. We will strive to limit the risks of our products throughout their lifecycle. We are committed to reducing risks in our operations to safeguard our employees, contractors, and the communities where we operate and engage in business activities. We will openly communicate our results and welcome the input of our employees and contractors, regulatory agencies, our communities, our customers, and other interested stakeholders.

We will accomplish this by integrating safety, security, health, environmental, reliability, and quality into our management processes using our Operational Excellence System (OE). OE will be used worldwide to: set goals for improvement; provide alignment of activities and resources; assess and manage risks; gain stakeholder input; and, rigorously audit our performance against operational objectives and compliance requirements.

Bruce Chinn
CEO
Chevron Phillips Chemical Company LLC

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TABLE OF CONTENTS

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PRODUCT STEWARDSHIP

Chevron Phillips Chemical Company LP ("Chevron Phillips Chemical Company") is committed to being a good product steward of the products we produce. We want anyone who comes in contact with one of our products to have access to information that will help them to understand its potential risk and how to use it safely. The thrust of our product stewardship program is the implementation of an Operation Excellence Management System (OEMS) initiative, which makes health, safety and environmental protection an integral part of our products. Successful implementation of this system must include a shared responsibility of all those who come in contact with a product throughout its life cycle. Chevron Phillips Chemical Company will continue to work with customers and others to help ensure that all who use and handle our products follow safe and environmentally sound practices.

The information contained in this technical bulletin is not intended to, nor does it, amend or replace the Chevron Phillips Chemical Company Safety Data Sheets (SDS's) for Polyalphaolefin (PAO) or Metallocene Polyalphaolefins (mPAO) products. The most current SDS's can be obtained from Chevron Phillips Chemical Company at www.cpchem.com or by calling (800) 852-5530. SDSs should be carefully examined prior to working with these products.

INTRODUCTION

This brochure is intended to be a quick reference guide to help Chevron Phillips Chemical Company customers select, handle, store and effectively use the various grades of polyalphaolefins (PAO) and metallocene polyalphaolefins (mPAO) safely and in a manner that protects the environment.

Everyone involved in handling and using the product has the responsibility to protect the integrity of the product, handle it safely, contain spilled product, recycle used or contaminated material and safely dispose of economically unrecyclable products.

This guide covers the following Chevron Phillips Chemical Company PAO and mPAO synthetic base oils:

Synfluid® Dimer C10	Synfluid® PAO 5 cSt	Synfluid® PAO 9 cSt
Synfluid® Dimer C12	Synfluid® PAO 6 cSt	Synfluid® PAO 10 cSt
Synfluid® PAO 2 cSt	Synfluid® PAO 6 HVI cSt	Synfluid® mPAO 65 cSt
Synfluid® PAO 2.2 cSt	Synfluid® PAO 7 cSt	Synfluid® mPAO 100 cSt
Synfluid® PAO 2.5 cSt	Synfluid® PAO 8 cSt	Synfluid® mPAO 150 cSt
Synfluid® PAO 4 cSt	Synfluid® PAO 8 HVI cSt	

PAO and mPAO products are produced through the hydrogenation of oligomers (such as dimers, trimers, tetramers). Synthetic base stocks are oligomers of small molecules, synthesized to a defined molecular weight and distribution. These oligomers are highly uniform and provide a low volatility fluid that performs at both high and low temperatures without forming gum or deposits in machinery.

PAO and mPAO are shipped to customers around the world. Products are shipped directly to customers in marine vessels, railcars and bulk trucks as well as in drums, IBCs, and ISO containers.

Chevron Phillips Chemical Company's products include a range of synthetic base oils which can be used in industrial gear oils, hydraulic oils, aviation lubricants, engine oils, compressor lubes, drilling fluids, heat transfer fluids, dielectric fluids, greases, and natural gas engine oils. These synthetic base oils provide a range of specific characteristics such as high-pressure stability, high viscosity index (VI), low toxicity, low volatility, oxidative stability, low-temperature fluidity, low flammability, hydrolytic stability, and high-temperature stability.

NOTE:
THIS BROCHURE DOES NOT AMEND OR REPLACE OFFICIAL PUBLICATIONS, SAFETY REGULATIONS NOW IN USE, MATERIAL SAFETY DATA SHEETS, OR COMMERCIAL TERMS OF SALE. CHEVRON PHILLIPS CHEMICAL COMPANY LP MAKES NO GUARANTEE OF THE ACCURACY OF THE CONTENTS OF THIS BROCHURE OR ANY WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, WITH RESPECT TO THE USE OF THIS INFORMATION OR ITS APPLICABILITY. THE USER ASSUMES ALL RISK AND LIABILITY ASSOCIATED WITH THE INFORMATION IN THIS BROCHURE.

PART 1

PROPERTIES, SPECIFICATIONS AND TEST METHODS

PRODUCT CHARACTERIZATION

Synonyms:	Synthetic Hydrocarbon Base Oil	Synfluid®
	Synfluid® Polyalphaolefin	Synfluid® PAO
	Synfluid® Metallocene Polyalphaolefin	Synfluid® mPAO
	Highly Branched Isoparaffinic Polyalphaolefin	PAO

Chemical Identity:	Synonyms:
1-Decene, Dimer, Unhydrogenated	Synfluid® Dimer C10
1-Dodecene, Dimer, Unhydrogenated	Synfluid® Dimer C12
1-Decene, Dimer, Hydrogenated	Synfluid® PAO 2 cSt
1-Decene, Dimer, Hydrogenated mixed with 1-Dodecene, Dimer, Hydrogenated; 1-Decene, Trimer, hydrogenated	Synfluid® PAO 2.2 cSt
1-Dodecene, Dimer, Hydrogenated	Synfluid® PAO 2.5 cSt
1-Decene, Homopolymer, Hydrogenated	Synfluid® PAO 4 cSt
1-Dodecene, Trimer, Hydrogenated mixed with 1-Dodecene, Homopolymer, Hydrogenated	Synfluid® PAO 5 cSt
1-Decene, Homopolymer, Hydrogenated	Synfluid® PAO 6 cSt
1-Dodecene, Trimer, Hydrogenated mixed with 1-Dodecene, Homopolymer, Hydrogenated	Synfluid® PAO 6 HVI cSt
1-Dodecene, Trimer, Hydrogenated mixed with 1-Dodecene, Homopolymer, Hydrogenated	Synfluid® PAO 7 cSt
1-Decene, Homopolymer, Hydrogenated	Synfluid® PAO 8 cSt
1-Dodecene, Trimer, Hydrogenated mixed with 1-Dodecene, Homopolymer, Hydrogenated	Synfluid® PAO 8 HVI cSt
1-Dodecene, Homopolymer, Hydrogenated and 1-Dodecene Trimer, Hydrogenated	Synfluid® PAO 9 cSt
1-Decene, Homopolymer, Hydrogenated	Synfluid® PAO 10 cSt
1-Octene, Homopolymer, Hydrogenated	Synfluid® mPAO 65 cSt
1-Octene, Homopolymer, Hydrogenated	Synfluid® mPAO 100 cSt
1-Octene, Homopolymer, Hydrogenated	Synfluid® mPAO 150 cSt

SDS and CAS Numbers:	SDS No.	CAS No.
Synfluid® Dimer C10	100000014083	17438-89-0
Synfluid® Dimer C12	100000014082	62132-67-6
Synfluid® PAO 2 cSt	100000010948	68649-11-6

Synfluid® PAO 2.2 cSt	100000105731	68649-11-6, 151006-61-0, 157707-86-3
Synfluid® PAO 2.5 cSt	100000013639	68037-01-4
Synfluid® PAO 4 cSt	100000010950	151006-62-1, 151006-63-2
Synfluid® PAO 5 cSt	100000014081	68037-01-4
Synfluid® PAO 6 cSt	100000010952	151006-62-1, 151006-63-2
Synfluid® PAO 6 HVI cSt	100000101638	151006-63-2
Synfluid® PAO 7 cSt	100000013642	68037-01-4
Synfluid® PAO 8 cSt	100000062776	151006-63-2
Synfluid® PAO 8 HVI cSt	100000014143	151006-62-1, 151006-63-2
Synfluid® PAO 9 cSt	100000014080	68037-01-4
Synfluid® PAO 10 cSt	100000100615	70693-43-5
Synfluid® mPAO 65 cSt	100000102086	70693-43-5
Synfluid® mPAO 100 cSt	100000100031	70693-43-5
Synfluid® mPAO 150 cSt	100000102070	

PHYSICAL AND CHEMICAL PROPERTIES OF PAO AND mPAO:

Safety Data Sheets (SDS) and Technical Data Sheets (TDS) for PAO and mPAO products are available from Chevron Phillips Chemical Company to provide customers with the physical and chemical properties of our products. Such information should be requested and studied prior to working with these products. SDS and TDS can be obtained from Chevron Phillips Chemical Company at www.synfluid.com and specific product questions can be sent to synfluid@cpchem.com. SDS can also be obtained from Chevron Phillips Chemical Company by calling (800) 852-5530. Specific questions about SDS can be sent to sds@cpchem.com.

RECOMMENDED TEST METHODS:

The following ASTM methods are recommended for the analysis of PAO and mPAO:

1. ASTM D 86 Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure
2. ASTM D 92 Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
3. ASTM D 97 Standard Test Method for Pour Point of Petroleum Products
4. ASTM D 150 Standard Test Method for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
5. ASTM D 156 Standard Test Method for Saybolt Color of Petroleum Products (Saybolt Chromometer Method)
6. ASTM D 189 Standard Test Method for Conradson Carbon Residue of Petroleum Products
7. ASTM D 287 Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)
8. ASTM D 445 Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (the Calculation of Dynamic Viscosity)
9. ASTM D 446 Standard Specifications and Operating Instructions for Glass Capillary Kinematic Viscometers
10. ASTM D 471 Standard Test Method for Rubber Property- Effect of Liquids
11. ASTM D 524 Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products
12. ASTM D 611 Standard Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents
13. ASTM D 892 Standard Test Method for Foaming Characteristics of Lubricating Oils
14. ASTM D 924 Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
15. ASTM D 971 Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method
16. ASTM D 972 Standard Test Method for Evaporation Loss of Lubricating Greases and Oils
17. ASTM D 974 Standard Test Method for Acid and Base Number by Color-Indicator Titration

18. ASTM D 1160 Standard Test Method for Distillation of Petroleum Products at Reduced Pressure

19. ASTM D 1169 Standard Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids

20. ASTM D 1209 Standard Test Method for Color of Clear Liquids (Platinum-Cobalt Scale)

21. ASTM D 1218 Standard Test Method for Refractive Index and Refractive Dispersion of Hydrocarbon Liquids

22. ASTM D 1296 Standard Test Method for Odor of Volatile Solvents and Diluents

23. ASTM D 1298 Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

24. ASTM D 1500 Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)

25. ASTM D 1748 Standard Test Method for Rust Protection by Metal Preservatives in the Humidity Cabinet

26. ASTM D 2266 Standard Test Method for Wear Preventive Characteristics of Lubricating Grease (Four-Ball Method)

27. ASTM D 2270 Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40°C and 100°C

28. ASTM D 2272 Standard Test Method for Oxidation Stability of Steam Turbine Oils by Rotating Pressure Vessel

29. ASTM D 2273 Standard Test Method for Trace Sediment in Lubricating Oils

30. ASTM D 2300 Standard Test Method for Gassing of Insulating Liquids Under Electrical Stress and Ionization (Modified Pirelli Method)

31. ASTM D 2500 Standard Test Method for Cloud Point of Petroleum Products

32. ASTM D 2710 Standard Test Method for Bromine Index of Petroleum Hydrocarbons by Electrometric Titration

33. ASTM D 2766 Standard Test Method for Specific Heat of Liquids and Solids

34. ASTM D 2879 Standard Test Method for Vapor Pressure-Temperature Relationship and Initial Decomposition Temperature of Liquids by Isoteniscope

35. ASTM D 2887 Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography

36. ASTM D 3427 Standard Test Method for Air Release Properties of Petroleum Oils

37. ASTM D 3829 Standard Test Method for Predicting the Borderline Pumping Temperature of Engine Oil

38. ASTM D 4052 Standard Test Method for Density and Relative Density of Liquids by Digital Density Meter

39. ASTM D 4176 Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)

40. ASTM D 5293 Standard Test Method for Apparent Viscosity of Engine Oils Between -5ºC and -35ºC Using the Cold-Cranking Simulator

41. ASTM D 5386 Standard Test Method for Color of Liquids Using Tristimulus Colorimetry

42. ASTM D 5800 Standard Test Method for Evaporation Loss of Lubricating Oils by the Noack Method

43. ASTM D 5950 Standard Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)

44. ASTM D 7042 Standard Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

45. ASTM E 659 Standard Test Method for Autoignition Temperature of Liquid Chemicals

46. ASTM E 1064 Standard Test Method for Water in Organic Liquids by Coulometric Karl Fischer Titration

PART 2

SAMPLING AND HANDLING

TRAINING

All employees involved in the handling, storage and use of PAO and mPAO should be trained to handle all elements of the job safely and in an environmentally acceptable manner. The content of the training should be designed to address all individual job requirements. Training may include:

1. All written procedures related to the job.
2. How to effectively use all equipment and materials needed to safely perform work.
3. Proper disposal of recovered material.
4. Responsibilities and procedures to clean up spill.
5. Repair of damaged containers.

RECOMMENDED PRACTICE FOR SAMPLING PAO AND mPAO

This information is provided for use in establishing sampling and handling procedures. This information should only be utilized in conjunction with an existing health and safety program and cannot be used as a substitute for expert safety and medical advice.

Glass containers are used when sampling PAO and mPAO products. The handling and transporting of glass containers is a safety hazard. Extreme caution should be taken when handling these containers. The following steps should be used when taking samples in a glass container:

1. Before collecting a sample, be sure the glass container is clean, and free of soaps and detergents.
2. Properly tag the sample container with sample description, date and time of sample, appropriate hazards, analysis required, and name of person taking sample.
3. Ensure metal flush bucket located under the sample point is grounded prior to use.
4. Open sample block valve slightly to purge sample point into a flush bucket until sample stream is clear, then close block valve. Use caution if product is hot.
5. Fill sample container approximately 25% and shake vigorously to scrub the container. Empty into flush bucket and repeat this step twice more.
6. Fill sample container approximately 75%.
7. Send sample to the laboratory for appropriate analysis.
8. Properly dispose of flush bucket contents and ensure sample block valve is closed.

STATIC ELECTRICITY AND GROUNDING

PAO and mPAO are characterized by high electrical resistivity (low conductivity) which can result in the buildup of excess static charge during transfer operations. PAO's are classified as low vapor pressure products under the API RP 2003 Guidelines (i.e., products with a flash point above 100 ^{o}F). If these products are handled at temperatures well below their flash points, flammable vapors will not develop. However, a condition for ignition may exist if these products are handled at temperatures near their flash points or are contaminated with intermediate or high vapor pressure products. Likewise, in transporting these products, a condition for ignition can exist when the previous load contained a flammable vapor which was not flushed from the vessel being loaded. This type of loading is commonly called "switch loading".

Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not by themselves be sufficient. Review all operations that have the potential of generating

an accumulation of electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, "Flammable and Combustible Liquids", National Fire Protection Association (NFPA) 77, "Recommended Practice on Static Electricity", and/or the American Petroleum Institute (API) Recommended Practice 2003, "Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents."

Grounding of railcars is required because the product accumulates static charges during transfer and handling. This may lead to a flashback or explosion. Personnel sampling the railcar should be aware that static charges are present. The shock does not normally cause injury but sudden movements after a shock could lead to injuries if, for example, the person is on top of the car and does not have a harness properly attached to a stationary bar.

PRODUCT LOADING AND UNLOADING REQUIREMENTS

WHEN LOADING OR UNLOADING A VESSEL OR BARGE:

Plan and control the loading and unloading of PAOs to limit personnel exposure and environmental releases. OSHA and the International Maritime Organization have published regulations applicable to personnel involved in the handling of chemical materials. Some of the key elements are:

1. Employee Training
2. Personal Protective Equipment
3. Warning Signs

Clean stainless steel tanks, rust-free mild steel tanks or suitably washed (not using soaps or detergents) steel tanks are acceptable for transport of PAO products. mPAO products require compartments with heating capability. Heating will be provided as required and per instructions. Barges and ships are carefully selected by Chevron Shipping to ensure that product quality is not negatively affected during transport.

Qualified contractors should be used to inspect, clean and repair barges and ships in which these products are shipped. The contractor should have facilities to dispose of residual product in an acceptable manner.

WHEN LOADING OR UNLOADING TANK CARS:

1. Use only tank cars that have not been cleaned with soaps or detergents unless an anionic/non-ionic free-rinsing has been used.
2. Use only clean, oil and dirt free, spark-resistant tools and implements.
3. Make sure the tank car's internal pressure has been relieved before removing the manhole or outlet valve cap.
4. Visually inspect hoses and fittings prior to use.
5. Ground the tank car before connecting any part of it to the unloading lines or equipment. Loading and unloading lines should be continuously bonded during loading and unloading.
6. Unload the car through the dome connection or through the bottom outlet.
7. Use of air pressure to unload tank cars is not recommended. If pressure must be used, the operator should demonstrate caution.
8. Use an approved pump to unload the tank car. If the car does not have an eductor pipe, insert a pipe through the open dome and pump its contents out that way.
9. Carefully vent the car through a flame arrester during both loading and unloading. The location of the tank car loading and unloading should be distant from ignition sources.
10. If unloading is interrupted, disconnect all unloading connections, close all valves tightly and securely apply all other closures.

11. Tank cars should be cleaned and prepared for shipment in accordance with DOT regulations prior to releasing.

Note: Loading lines used to transfer PAO products to the loading rack must be blown clear with nitrogen prior to loading a product different from the product last pumped through it. After loading dimer, the loading line is to be blown clear with nitrogen, and the filters may need to be changed to eliminate cross contamination.

Synfluid® mPAO tank cars are coiled and insulated. mPAO products are between 120 – 160° F when loaded into tank cars. Products may cool in transit and can be steamed to 100 – 180° F for ease of offloading.

WHEN LOADING OR UNLOADING TANK TRUCKS:

Open dome tank trucks are normally MC/DOT 307 or 407 type and are used to transport PAO and mPAO products. Use only tank trucks that have not be washed with soaps or detergents unless an anionic/non-ionic free-rinsing has been used.

The viscosity of mPAO products is such that they require a coiled and insulated vessel for storage and transportation. mPAO products are between 120 – 160° F when loaded into tank trucks. Care should be exercised depending on the weather conditions and number of days in transit. Tank trucks can be steamed to 100 – 180° F for ease of offloading.

Arranging for "In Transit Heat" of mPAO products is often appropriate via tank truck, especially during winter months. This system utilizes the tractor's radiator heat system as an aid in minimizing temperature loss during transportation.

Loading
Place wheel chocks in front and back of truck's rear wheels allowing ¾" clearance for ease of removal. Connect ground cable. Close bottom valve leaving the cap off to monitor for leakage while loading. Open dome cover and inspect interior for cleanliness. Flush loading spout and filter, if necessary. Purge trailers with nitrogen. Visually inspect trailer exterior for damage and inspection dates.
Open product line and start pump. Check bottom unload valve for leakage. When loading is complete, shut down pump, close product block valves and nitrogen purge line to clear spout. Remove spout, secure dome lid and seal dome cover. Check all top openings or valves for tightness. Raise loading ramp and secure spout. Replace bottom unload cap and ensure internal/external valves are in closed position. Seal bottom cap. Remove wheel chocks and ground cable.

Unloading
Place wheel chocks in front and back of truck's rear wheels allowing ¾" clearance. Connect ground cable. Relieve all tank pressure by opening a vent valve or slowly loosening dome cover bolts. Remove dome cover or outlet cap so air can enter the tank during unloading. Check internal and external valves making sure they are closed and remove unloading valve cap slowly to relieve any pressure. Check gasket in loading hose and connect to unloading valve. Open internal and external valves and start unloading pump.

After product transfer is complete, shut off unloading pump, close internal and external valves and remove unloading hose checking for possible product in the line. Close, tighten and cap all fittings. Remove wheel chocks and ground cable.

WHEN HANDLING DRUMS:

PAO are supplied in tight head steel, 55 gallon drums with a tare weight of approx. 37.8 lbs. Drums have a buff epoxy phenolic lining. All drums are fitted with one 2" and one ¾" bung on the head of the drum.

Transportation of drums
Depending on the size and destination of the delivery, drums can be transported in van trailers, less than full truckload trailers or ocean shipping containers. All drums should be secured to prevent movement during transportation.

Storage and handling of drums

Drums should be off-loaded from vehicles using forklift equipment, or other mechanical handling means.

Pallets may assist site handling where drum handling forklift attachments are not available.

To maneuver drums on site, some means of mechanical handling should be used in order to avoid rolling the drums. Rolling invariably involves rough handling which generally leads to denting and paintwork damage resulting in the onset of external rusting of the drum.

If practical, drums should be stored in a warehouse or protected from the weather, for example, by tarpaulin covers. If open site storage is unavoidable, polyethylene drum head covers can be used to keep drum heads clean and dry. Always stack drums on firm, level ground, preferably concrete and where spillage can be contained. In case of spillage, contain with sand or earth. The storage base should afford good drainage. Water accumulation will cause drum base rusting.

Drums should only be stored upright. It is advisable to stack the drums not more than two high with plywood or hardwood between the layers to avoid metal-to-metal contact.

Drum emptying
The more viscous mPAO products are usually heated to improve handling characteristics. Suitable heating methods include hot room, drum oven, immersion heaters or jacket heaters, either induction or radiant. Unvented drums of mPAO should never be heated. After loosening the bungs, drums can then be heated to the desired temperature.

To avoid injuries and accidents, it is important that drums are handled and emptied safely. Drums are equipped with two bungs that allow the product to be either pumped or poured out of the container. All safety procedures should be employed to maximize worker safety during drum handling and movement.

WHEN HANDLING IBCs:

PAO are supplied in a 275 gallon IBC with a tare weight of approx. 126 lbs. IBCs are HDPE receptacle on a tubular gavlanized steel cage. All IBCs are fitted with one 2” vent and one 2” valve.

Transportation of IBCs
Depending on the size and destination of the delivery, IBCs can be transported in van trailers, less than full truckload trailers or ocean shipping containers. All IBCs should be secured to prevent movement during transportation.

Storage and handling of IBCs
IBCs should be off-loaded from vehicles using forklift equipment, or other mechanical handling means.

If practical, IBC should be stored in a warehouse or protected from the weather, for example, by tarpaulin covers. Always stack IBCs on firm, level ground, preferably concrete and where spillage can be contained. In case of spillage, contain with sand or earth.

SAFETY REFERENCES

The following publications are excellent references for PAO and mPAO handling information:

NFPA 10 –
Standard for Portable Fire Extinguishers

NFPA 11 –
Standard for Low-, Medium-, and High-Expansion Foam Systems

NFPA 70 –
National Electrical Code®

NFPA 77 –
Recommended Practice on Static Electricity

PART 3

STORAGE DESIGN RECOMMENDATIONS

STORAGE TANKS

Storage tanks should be of welded steel construction. Underground storage tanks are not recommended because of the difficulty of locating leaks. However, some states require underground storage tanks. Diking, drainage, and tank supports should be designed to conform to local regulations. A rule of thumb commonly used for determining the size of storage facilities suggests that storage facilities be 1½ times the size of shipments received. The secondary containment requirements as well as tank layout and spacing requirements should be in accordance with NFPA 30. Rotating equipment such as pumps should be kept outside of the secondary containment area. Some facilities may require larger inventories, and thus storage facilities, because of seasonal transportation problems.

The storage tank inlet should be located at the bottom of the tank. Should a top inlet be desired, the fill pipe should be extended to a depth no greater than the diameter of the fill pipe from the bottom of the tank to minimize static charge accumulating during filling. The fill pipe should be connected electrically to both the tank flange and the transfer pipeline. The purpose of this electrical connection is to dissipate any static charge which may build up during filling.

PAO, mPAO and dimer storage tanks are kept under a nitrogen-blanketed atmosphere (10 in. H_2O). A nitrogen blanketing system is necessary in applications where the product is going to be stored for long periods of time and peroxides/carbonyls would present a problem in the process. A nitrogen system maintains a positive pressure and adds nitrogen as the product is withdrawn and the tank breathes. This prevents the introduction of air that can cause peroxide buildup in the product and keeps moisture from condensing in the tank. Free water will settle out in the bottom of the tank and will normally not be seen until the tank is stripped. Dissolved water up to the saturation level may be found in products. If water is a critical contaminant, the PAO, mPAO or dimer sample should be tested periodically and free water withdrawn through the sump.

All product storage tanks should have combination pressure relief/vacuum breaker valves. The combination pressure relief/vacuum breakers are designed to relieve to atmosphere to prevent over-pressuring as well as to open to atmosphere to protect against damage from low pressures (vacuum).

The generally recommended maximum long-term storage temperature for low viscosity PAO is 30°F below the product ‘s flash point or a maximum of 149°F, whichever is lower.

All mPAO products require coiled and insulated tanks. Storage tanks must be clean and dry before receiving this product. The product should be maintained at a temperature between 100 – 160° F and circulated once a week while steam is being applied and the tank is static. The maximum recommended handling temperature for mPAO is 185°F to ease pumping.

The pour points of mPAO products require these products to be stored in coiled and insulated tanks. Product lines should be insulated and steam-traced.

All of the lines and valves, as well as the tank, can be carbon steel. However, carbon steel lines will accumulate rust if allowed to remain empty for long periods of time. In this situation the first few gallons of product moved down the line may have a yellow to orange color and may contain particulates depending on the amount of rust that has accumulated.

Unlined carbon steel tanks may also accumulate rust above the liquid level. This rust, along with the condensate, will settle to the bottom of the tank and may not be seen until the tank is stripped. Rust can be avoided by having storage tanks lined with zinc, epoxy, or another coating that is compatible with these products.

Viton® and Teflon® gaskets and seal materials are recommended with PAO, mPAO and dimer products.

Specific bulk storage designs must conform to insurance underwriter’s codes and local

fire and building regulations. Critical design, placement, installation, and maintenance requirements are usually addressed in these codes and regulations and must be followed.

Inspect tanks periodically for leaks and service in accordance with API Standard 653.

Workers should never be permitted to enter an empty tank which has been used for PAO or mPAO products until the requirements of the OSHA Permit-required Confined Space Standard (29 CFR 1910.146) and the Safe Entry Recommendation of API Standard 2015 have been met, including, but not limited to, required concentrations for oxygen.

API AND ANSI DESIGN REFERENCES

American Petroleum Institute
1220 L Street, NW
Washington, DC 20005

Part I – Design:

API RP 520: *Sizing, Selection, and Installation of Pressure-relieving Devices in Refineries*

Part II – Installation:

API Standard 601: *Metallic Gaskets for Raised-Face Pipe Flanges and Flanged Connections (Double-Jacketed Corrugated and Spiral-Wound)*

API Standard 620: *Design and Construction of Large, Welded, Low-Pressure Storage Tanks*

API Standard 650: *Welded Steel Tanks for Oil Storage*

API Standard 653: *Tank Inspection, Repair, Alteration, and Reconstruction*

API Standard 2000: *Venting Atmospheric and Low-Pressure Storage Tanks; Nonrefrigerated and Refrigerated*

API RP 2003: *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

API Standard 2015: *Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks*

API RP 2028: *Flame Arresters in Piping Systems*

API RP 2210: *Flame Arresters for Vents of Tanks Storing Petroleum Products*

API RP 2350: *Overfill Protection for Storage Tanks in Petroleum Facilities*
American National Standards Institute
25 West 43rd Street, 4th Floor
New York, New York 10036

ANSI B16.21: *Nonmetallic Flat Gaskets for Pipe Flanges*

ANSI B31: *Interpretations of Code for Pressure Piping*

PARTICULATE MATTER

PAO, mPAO and dimer products should be free of particulate matter when shipped. However, some particulate matter may originate from outside contamination via the receiving-transfer system.

Particulate matter may be avoided by:

1. Paying careful attention to cleanliness.

2. Filtering product to remove particulate matter before use.

FILTERS

Since small amounts of foreign matter may enter storage tanks and transport vessels from various sources, a filter in the transfer piping between the storage tank and processing equipment is recommended. This can be accomplished by inserting a corrugated cellulose filter paper (5 μm) inside a woven polyester fiber (10 μm mesh) cartridge-type filter. Chevron Phillips Chemical Company uses a 2 μm filter paper in a steel case housing. Other types of product compatible filters might also be used. Flow rates and pressures should be used to determine the proper filter for specific situations. Inspect and renew filter cartridges periodically.

HOSES

Hard piping is preferred to the use of hoses where possible and practical. If hoses are needed for loading or unloading operations, they should be inspected and pressure tested at the intervals required by the various regulations. The preferred type hose would be a steel braided hose. A satisfactory type hose is Goodyear, rough-bore, style WH-7 with Viton® tube, or the equivalent. Multi-layered polypropylene and Teflon® are also recommended. U.S. Coast Guard regulation 33 CFR, Part 154.500 applies to hoses used for bulk transfers to and from tank vessels.

PUMPS

Liquid product can be transferred by pump or vacuum. For most product handling operations, centrifugal pumps with mechanical seals perform satisfactorily. The pump manufacturer can recommend the proper type of pump if the following parameters are known: 1) flow, in gallons per minute, 2) size and length of suction and discharge lines, 3) suction and discharge pressures, and 4) range of product temperatures during transfer. A drain valve should be installed at the lowest point in the system so that the pump and all piping can be completely drained and washed before any maintenance work is done. Totally enclosed fan-cooled (TEFC) motors are recommended. However, local fire and insurance codes should be consulted to determine if an explosion-proof motor must be used. Pump seals must be capable of meeting EPA emission standards - this requires tandem or double seals. Tandem seals enhance safety when pumping these products (at elevated temperatures). Demisting systems should be used to keep pump bearings lubed.

The following practices are recommended to minimize the possibility of pump leakage:

1. Mechanical seals in conformance with API RP 682.

2. Pumps in conformance with API Standard 610.

3. The pump should be designed so that pump bearings will be able to carry thrust at no flow. Consider selecting non-metallic (PEEK) wear rings to minimize damage if the pump runs dry.

4. The pump shaft should be highly polished.

5. Pumps should not be subjected to forces beyond specified pump tolerances.

6. Vibration monitoring with automatic pump shutdown may be applicable in certain situations.

VALVES

Full-bore ball valves are preferred for pigged pipelines. Gate valves, butterfly valves, or ball valves may be used for pipelines that are not pigged. These valves should be made of cast iron, case steel, or other recommended materials. Valves should be packed with the following graphite materials:

Garlock® EVSP Simplified (#9000/98)[1]
Garlock® 70# / 98 (-400 to 1200 ºF; 10,000 psi)[2]
Garlock® 1303 (good for steam)[2]
Slade® 3300G (-400 to 1200 ºF; 10,000 psi)[2]

[1] Most efficient packing is a flexible die-form ring with flexible braided end-rings.
[2] Used for field repacking.

PIPELINES

The following are recommended practices in engineering pipelines for PAO and mPAO products:

1. A minimum of flanged connections should be used to avoid potential leaks.

2. Lines should not be buried because of the difficulty of checking for leakage.

3. All lines should be sloped with drain valves at appropriate locations so that they can be completely drained for maintenance.

4. All newly installed pipelines should be pressure tested by an approved method before use.

5. Bellows valves for 2-inch and smaller lines are recommended to eliminate emissions from packing glands.

PART 4

HEALTH, ENVIRONMENT, FIRE, AND ACCIDENTAL RELEASE INFORMATION

Safety Data Sheets (SDS) for PAO and mPAO products are available from Chevron Phillips Chemical Company to help customers satisfy safe handling and disposal needs and OSHA Hazard Communication Standard requirements. Such information should be requested and studied prior to working with these products. The most current SDS's can be obtained from Chevron Phillips Chemical Company at www.cpchem.com or by calling (800) 852-5530. Specific questions about SDS's can be sent to sds@cpchem.com

PART 5

TRANSPORTATION INFORMATION AND REGULATORY PROFILE

Safety Data Sheets (SDS) for PAO and mPAO products are available from Chevron Phillips Chemical Company to provide customers transportation information and regulatory profile data. Such information should be requested and studied prior to working with these products. The most current SDS's can be obtained from Chevron Phillips Chemical Company at www.cpchem.com or by calling (800) 852-5530. Specific questions about SDS's can be sent to sds@cpchem.com.

REVISION STATEMENTS

This revision updates the following sections:

December 2022

1. Addition of PAO 2.2 in Introduction and Part 1
2. Addition of mPAO maximum handling temperature on page 11

Replaces PAO 2021 Final.doc

PART 6

APPENDIX

GLOSSARY OF TERMS, ABBREVIATIONS, AND ORGANIZATIONS

ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
Bonding	The connection of two or more conductive objects by means of a conductor (most commonly a wire or metal plate)
CFR	Code of Federal Regulations
Confined Space	An area that by design has limited openings for entry and exit. A confined space has unfavorable natural ventilation and is not intended for continuous worker occupancy.
DOT	Department of Transportation
EPA	Environmental Protection Agency
Grounding	The connection of one or more conductive objects to the ground: a specific form of bonding. Grounding is also referred to as earthing.
SDS	Material Safety Data Sheet
mPAO	Metallocene Polyalphaolefin
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
Peroxides	Compounds containing the -O-O linkage. They occur as impurities in many organic compounds, where they have been slowly formed by the action of oxygen.
PAO	Polyalphaolefin
Vapor Pressure	The pressure exerted by a volatile liquid while under defined equilibrium conditions. Vapor pressure is usually measured in millimeters of mercury (mm Hg).