Recommended Practice for Installation and Lubrication of Pumping Units

API RECOMMENDED PRACTICE 11G
FOURTH EDITION, NOVEMBER 1, 1994

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Exploration and Production Department

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FOREWORD

This recommended practice is under the jurisdiction of the API Committee on Standardization of Production Equipment and covers the installation of beam-type pumping units and the lubrication of pumping-unit reducers.

Purchase specifications for pumping units and pumping-unit reducers are given in API Standard 11E: *Specifications for Pumping Units.*

It is recommended that all manufacturers supply foundation prints, operation, installation, lubrication, and maintenance instructions for each pumping unit sold. These specifically written instructions should be considered as part of API Recommended Practice 11G and supersede any conflicting requirements in this recommended practice.

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Recommended Practice for Installation and Lubrication of Pumping Units

1 Installation of Pumping Units* Using Foundation Bolts and Grouting Between the Block and the Pumper Base

1.1 Pour concrete foundation block to certified drawing provided by pumping unit manufacturer or operator. Locate foundation bolts accurately, using grouting tubes. Finish top of foundation, level.

1.2 After the foundation has hardened, using a chalk line, strike a centerline from the center of the well tubing across the top of the foundation on centerline line as located by certified drawing.

1.3 The pumping unit manufacturer will provide the base with punched or scribed centerline marking on cross members at the front and rear of the base. On units with bolted-on extension bases, the centerline marking will be on the main base.

1.4 Set base on foundation, using wedges to support the base about 1 in. above the foundation. Line up center marks on the base with the chalked line on foundation.

1.5 Move base to or from well according to value shown on foundation print for dimension from base member to centerline of well.

1.6 Use wedges to level top of base. Check level both lengthwise and crosswise of base at several points along its length.

1.7 Manufacturer shall provide a means for attaching plumb line on a longitudinal centerline of samson post top.

1.8 After mounting samson post on base, drop plumb line from center of samson post top to centerline drawn on top of foundation. If plumb bob does not fall on centerline, readjust wedges or make other corrections.

1.9 The pumping unit manufacturer will provide a longitudinal adjustment of the walking beam on the center bearing, or of the center bearing on the samson post, as a means of accurately adjusting beam hanger with respect to centerline of the well.

1.10 After mounting walking beam on samson post and connecting pitmans to cranks, drop a plumb line at the center of the horsehead (out from the arc plate of the horsehead a distance equal to one half of the diameter of the wire line of the hanger) down to the center of the well tubing. Adjust walking beam longitudinally or laterally so that the plumb bob will be within 1/16 in. of the center of the well tubing. Check for proper tracking of wire line on horsehead.

1.11 Grout under the base and allow grout to harden before removing wedges.

1.12 Uniformly tighten all foundation bolts and check tightness of all structural bolts. After running unit for two weeks, recheck tightness of all bolts.

2 Installation of Pumping Units* Using Universal Clamps or Methods Other than Foundation Bolts

2.1 Because the pumper base is to set directly on the concrete block, the top of the block should be hand trowelled to an accurate, level, and plane surface.

2.2 After the foundation has hardened, using a chalk line, strike a centerline from the center of the well tubing across the top of the foundation on centerline as located by certified drawing.

2.3 The pumping unit manufacturer will provide the base with punched or scribed centerline marking on cross members at the front and rear of the base. On units with bolted-on extension bases, the centerline marking will be on the main base.

2.4 Set the pumper base directly on the top surface of the block without wedges.

2.5 Move base to or from well according to value shown on foundation print for dimension from base member to centerline of well.

2.6 A check for level will, in most cases, be found reasonably satisfactory if the block has been properly prepared. (See Par. 2.8 for additional details.)

2.7 Manufacturer shall provide a means for attacking plumb line on a longitudinal centerline of samson post top.

2.8 As noted in 2.6, in most cases a pumping unit set directly on the block will be found to be reasonably level and plumb. If this is not the case due to unavoidable mill tolerances on the height and squareness of the base beams, then it will be necessary to do some adjusting with wedges, and to either grout or shim in certain locations. If shims are used, it is advisable to weld them together and to the base beam to make certain that they stay in place.

2.9 The pumping unit manufacturer will provide a longitudinal adjustment of the walking beam on the center bearing, or of the center bearing on the samson post, as a means of ac-

*This recommended practice applies to pumping units with centrally mounted walking beams. These recommendations should be modified for units of special design, particularly those with end-pivoted beams.

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curately adjusting beam hanger with respect to centerline of the well.

2.10 After mounting walking beam on samson post and connecting pitmans to cranks, drop a plumb line at the center of the horsehead (out from the arc plate of the horsehead a distance equal to one half of the diameter of the wire line of the hanger) down to the center of the well tubing. Adjust walking beam longitudinally or laterally so that the plumb bob will be within $^1/_{16}$ in. of the center of the well tubing. Check for proper tracking of wire line on horsehead.

2.11 If wedges were used, as in 2.8, grout under the base and allow grout to harden before removing wedges.

2.12 Check tightness of all structural bolts. After running unit for two weeks, recheck tightness of all bolts.

3 Installation of Pumping Units on Reinforced Concrete Portable Foundation

3.1 Manufacturers of concrete portable foundations shall provide a foundation with these minimum specifications:

a. Concrete used shall have a 28 day minimum compressive strength 4,000 psi with a maximum water to cement ratio of 6.0:1.
b. Foundation design shall include reinforcing steel of sufficient size, quantity and placement, including prestressing if used, to provide a resisting moment twice the static bending moment with two point pick up of the foundation.
c. The size of the foundation will be determined by the physical dimensions of the unit but it should be of sufficient dimensions to adequately support and stabilize the pumping unit. The design of the foundation shall be such that the maximum soil bearing pressure at any point on the foundation will not exceed that bearing pressure recommended for the area. This pressure shall be calculated assuming a well load equal to the beam rating or the unit and including the gross weight of the unit and foundation.

3.2 Base orientation is commonly dictated by the prevailing wind. The unit is placed so that the prevailing wind will blow well leakage away from unit and prime mover. With engine prime mover, placement should provide maximum cooling for the engine radiator. Consideration must also be given to drainage at the well site. The foundation location should utilize natural drainage to drain water and well fluids away from the foundation. When the natural gradient is incorrect or nonexistent, the site should be graded to provide drainage away from the foundation.

3.3 Under most conditions the foundation area should be excavated to firm soil (about 4 in to 6 in.). Further compaction with a mechanical compactor to maximum possible density is desirable. Level in two directions. Fill with sharp sand or pea gravel to a minimum depth of 2 in. Carefully level this fill in two directions.

In some localities it is necessary to build an elevated mound of compacted earth, caliche or gravel. This mound should be firmly compacted and of sufficient area at the top to prevent movement of the fill material from beneath the base. Level in two directions and cover with a minimum of 2 in. of sand and pea gravel and again level in two directions. Where concrete portable foundations are to be installed over old foundations or walkways, all bolts and projections should be removed and a fill of 2 in. of sand or pea gravel should be placed between the old concrete and the new base.

3.4 Place the portable concrete foundation on the leveled fill, with centerline of foundations aligned with center line of well, and set back the proper distance from well tubing center. Level foundations carefully in two directions.

3.5 Using a chalk line, strike a centerline from the center of the well tubing across the top of the foundation. Mark on this centerline the distance from the well as specified by the certified foundation print. When no foundation print is available, the setback of the unit should be determined by measurement.

3.6 The pumping unit manufacturer shall provide the main structural base with punched or scribed centerline markings.

3.7 Set the pumping unit structural base on the concrete portable base and align structural base with the chalked centerline and distance markings.

3.8 Manufacturer shall provide a means of attaching a plumb line on the longitudinal centerline of the samson post top.

3.9 After the erection of the samson post on the structural base, drop plumb line from center of the samson post top. If the plumb bob does not fall within $^1/_4$ in. of the chalkline centerline, check the structural base for lateral level. If the structural base is found to be level and true, it will be necessary to shim under the feet of the samson post legs, or shim and grout between the unit base beams and the foundation top. If the samson post is one that is manufactured and shipped in individual pieces to be bolted together at the well site, misalignment can often be corrected by loosening the assembly bolts moving the center of the saddle bearing top over the chalk line, and retightening the bolts.

3.10 After mounting walking beam on samson post and connecting pitmans to cranks, the walking beam should be checked to be sure it is parallel to unit centerline. This can be done by measuring the distance from the inside edge of the pitmans to each crank face. This gap should be the same on each side. If the gaps are unequal, loosen bolts holding the walking beam to the samson post top. Swing the beam until

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the gaps are equal.

3.11 The pumping unit manufacturer shall provide for longitudinal adjustment of the walking beam so that the hanger bar can be accurately adjusted over the center of the well tubing. This recommendation applies to units with center mounted beams. Units with end pivoted beams do not have longitudinal adjustment and the whole unit must be moved to center hanger bar over well tubing.

3.12 Move the walking beam longitudinally until a plumb line held at the center of the horsehead (out from the arc plate one-half the thickness of the wireline) will center directly over the well tubing. An alternate method is to hang the rods on the hanger bar and adjust the walking beam until the polished rod centers in the pumping tee. (The stuffing box is unscrewed and slid up the polished rod out of the way.) When this method is used, it should be first determined that the wellhead is level and the tubing and polished rod are in a true vertical position and that the polished rod is neither crooked nor bent.

3.13 The pumping unit manufacturer shall provide for adjustment of the horsehead so that the tracks of the horsehead can be aligned with the wireline.

3.14 The horsehead should be adjusted so that the wirelines center on the tracks of the horsehead.

3.15 After a final alignment check has been made and necessary corrections made, install the foundation bolts and hold down clamps that may be required by the manufacturer's certified drawing. Where certified foundation print is not available, tiedowns should be placed as follows: One as near the well end of the unit as possible. One as near the rear samson post leg(s) as possible. One closely in front of the gear reducer or gear reducer sub base. One closely behind the gear reducer or gear reducer sub base. On some very large units it is desirable to place an additional tiedown between the front and rear samson post legs and directly under the gear reducer. If top mounted crossbeam clamps are used, they should extend beyond the center web of the base beam. On large units having main base beam centerlines more than 30" apart, two rows of tiedown bolts are recommended. Tighten securely.

3.16 Check tightness of all structural bolts and counterweight bolts. After two weeks of operation, recheck tightness of bolts.

3.17 Fill in on all sides of the concrete foundation with compacted earth to prevent water or well fluids from seeping under the concrete foundation. The slope of this fill should be less than the natural slump of the fill material. A spray coating of oil will serve to make this fill more watertight.

3.18 Most pumping unit bases and concrete foundations are not designed to take continuous flexing and movement. Such movement will cause fatigue failure and breakage. Exceptions to this general rule are certain units which are designed with heavier main base members which require support only at front and rear ends.

3.19 With single cylinder engines special consideration should be given to extension base setting. A one piece base of sufficient size and weight, auxiliary tiedowns, or earth anchors are often used. Proper care should be taken to avoid overloading these engines or to operating at "lugging" speeds to reduce the tendency to vibrate or bounce.

MAINTENANCE AFTER INSTALLATION

3.20 Foundation bolts should be checked at regular intervals to insure that unit does not move on foundation. All structural bolts should be checked for tightness.

3.21 Grade around foundation should be maintained to insure that drainage is away from foundation and water does not seep under foundation.

3.22 If concrete foundation shows evidence of rocking after installation, the fill can be thrown back and the foundation edge filled with sand. This sand will feed in under the foundation and arrest movement. This sand should be stirred with shovel or rake to insure free flow under the foundation. When movement stops, the compacted earth fill around the foundation should be restored.

3.23 Make sure the unit structure is not overloaded and is properly counterbalanced. A unit which is overloaded or out of balance will cause undue loads on the unit which are transmitted to the foundation.

3.24 Any unit set on other than a grouted concrete base must be checked for level, both transversely and laterally and stability while in motion.

4 Installation of Portable Wide Base Pumping Units on Board Mat Foundation

4.1 Base orientation is commonly dictated by the prevailing wind. The unit is placed so that the prevailing wind will blow well leakage away from unit and prime mover. With engine prime mover, placement should provide maximum cooling for the engine radiator. Consideration must also be given to drainage at the well site. The foundation location should utilize natural drainage to drain water and well fluids away from the foundation. When the natural gradient is incorrect or nonexistent, the site should be graded to provide drainage away from foundation.

4.2 Selected site should be graded level. An elevated mound of compacted earth, caliche or coarse gravel should be built having outside dimensions, at the top, at least 2 ft. greater on each side than the outside base beams. Slope of

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the mound sidewall should be less than the natural slump of the material used. The height of this compacted mound should be a minimum of 6 in. in firm soil. In soil having poor bearing qualities or if the location will have poor drainage, the thickness of this compacted pad should be increased. A 4 in. thick coarse gravel fill topped by a 2 in. thick sand fill should be placed uniformly on this pad. This fill should be carefully levelled in both directions.

4.3 Following the certified installation drawing, a mat of boards should be carefully placed on the sand fill and the level again checked in both directions. These boards should be placed at right angles to the direction of walking beam. 3 in. x 12 in. timbers are commonly used. Larger timbers would be required for larger units. In damp areas the use of treated boards is advisable. These timbers should be long enough to extend 12 in. beyond sides of unit base beams. For maximum support a solid mat should be employed, leaving 2 in. to 3 in. gaps between adjacent boards. Minimum support would be three or four boards with 2 in. to 3 in. gaps under the front samson post legs, three or four boards placed under the rear samson post legs and gear reducer, and three or four boards placed at uniform intervals under the prime mover extension base.

4.4 Using a chalk line, strike a centerline from the center of the well tubing across the top of the board mat. Mark on this centerline the distance from the well as specified by the certified foundation print. When no foundation print is available, the setback at the unit should be determined by measurement.

4.5 The pumping unit manufacturer shall provide the main structural base with punched or scribed centerline markings.

4.6 The structural base should be hoisted above the board mat and carefully lowered into position on the board mat. Any attempt to drag or slide the structural base into position will disturb board level and placement. This will make levelling of the base extremely difficult. The structural base should be carefully aligned with chalked centerline mark and well distance mark.

4.7 The manufacturer shall provide a means for attaching a plumb line on the longitudinal centerline of the samson post top.

4.8 After mounting samson post on base, drop a plumb line from center of samson post to centerline on board mat. If plumb bob does not fall on the centerline, the base should again be checked for level. If structural base is found to be true and level, it will be necessary to shim under the feet of the samson post legs. If the samson post is one that is manufactured and shipped in individual pieces and bolted together at the well site, misalignment can often be corrected by loosening the assembly bolts, moving the samson post top into position, and then retightening the bolts.

4.9 After mounting walking beam on samson post and connecting pitmans to cranks, the walking beam should be checked to be sure it is parallel to unit centerline. This can be done by measuring the distance from the inside edge of the pitmans to each crank face. This gap should be the same on each side. If the gaps are unequal, loosen bolts holding samson post bearing base to the samson post top. Swing the beam until gaps are equal and then retighten all bolts.

4.10 The pumping unit manufacturer will provide for longitudinal adjustment of the walking beam so that the hanger bar can be accurately adjusted over the centerline of the well. This recommendation applies to units with center mounted beams. Units with end pivoted beams do not have longitudinal adjustment and the whole unit must be moved to center hanger bar over well tubing.

4.11 Move the walking beam longitudinally until a plumb held at the center of the horsehead (out from the arc plate one-half the thickness of the wireline) will center directly over the well tubing. An alternate method is to hang the rods on the hanger bar and adjust the walking beam until the polished rod centers in the pumping tee. (The stuffing box is unscrewed and slid up the polished rod out of the way). When this method is used, it should first be determined that the wellhead is level and the tubing and polished rod are in a true vertical position and that the polished rod is neither crooked or bent.

4.12 The pumping unit manufacturer shall provide for adjustment of the horsehead so that the tracks of the horsehead can be aligned with the wireline.

4.13 The horsehead should be adjusted so that the wirelines track in the center of the horsehead.

4.14 Fill inside and outside the unit structural base with sand to a level at least 1 in. above top surface of the boards. If the unit or base flexes under load this sand will feed into the gaps created and stop flexing movement.

4.15 Install any tiedowns or holddowns recommended by manufacturer's certified print and tighten securely.

4.16 Check tightness of all structural bolts and counterweight bolts. After two weeks operation, recheck tightness of all bolts.

4.17 Most pumping unit bases are not designed to take continuous flexing or movement. Such movement will cause fatigue failure and breakage. Exceptions to this general rule are certain units which are designed with heavier main base members which require support only at the front and rear ends.

4.18 With single cylinder engines special consideration should be given to extension base setting. Auxiliary tiedowns or earth anchors are often used to minimize bounce

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and vibration. Proper care should be taken to avoid overloading these engines or to operating at "lugging" speeds to reduce the tendency to vibrate or bounce.

MAINTENANCE OF BOARD MAT FOUNDATION

4.19 Replace any sand that may have worked out from under boards, after loosening with rake or shovel any hard or crusted sand that would prevent flow or feed of new sand under boards or base beam members.

4.20 Make sure structural base is still level in a lateral direction. If level, check position of polished rod to be sure it still centers in pumping tee. Make necessary longitudinal adjustments of beam to center polished rod. If unit is not level in a lateral direction, it should be releveled.

4.21 Check tightness of all bolts, tiedowns and earth anchors.

4.22 Any unit set on other than a grouted concrete base must be checked for level, both transversely and laterally, and stability while in motion.

5 Lubrication of Pumping-Unit Reducers

5.1 This section covers lubrication procedure for pumping-unit speed reducers using either gears or roller chains and sprockets.

5.2 The recommendations apply only when the gears and chain drives are designed and rated in accordance with API standards. The oil operating temperature range for which they apply is from -50°F to +155°F.

5.3 It is not possible to adequately describe suitable lubricants by brief specifications or by SAE viscosity number or ISO* viscosity grade alone. Further, adequate lubrication instructions cannot be condensed sufficiently to be placed on a name plate on account of the many variables in operating conditions to which pumping units are subjected.

SELECTION OF OIL

5.4 The proper oil for pumping-unit speed reducers is best chosen with the advice of a representative of a reputable supplier of lubricants and should be based on the service conditions that are established by the design of the reducer and the service conditions of the particular installation. For the assistance of the lubricant supplier these conditions are summarized in Par. 7.1 through 7.10.

5.5 The areas in contact on gear teeth, and on chains and sprockets, are relatively small and therefore the unit pressures produced in transmitting peak loads are correspondingly high. The gears, chains and sprockets are designed to operate under these high unit pressures if the lubricant used is also capable of withstanding these unit pressures during the periods of peak loads.

5.6 The temperature of the air in the vicinity of the reducer is of considerable importance in selecting oil of the proper viscosity. The viscosity of oil decreases with increasing temperature, making it desirable, for a given application, to use an oil with a higher viscosity for high air temperatures than for low air temperatures. For low temperature operation, the oil should have sufficient fluidity to permit a free flow of oil through the lubricating channels.

5.7 The operating temperature of oil in pumping-unit reducers normally will be from air temperature to 25 F above the air temperature. The temperature rise of oil will be negligible in slow-operating, lightly loaded reducers and will reach the upper limit in heavily loaded reducers operating at the higher speeds. The temperature of the oil in a reducer will become equal to the air temperature when the pumping unit is stopped for any appreciable time. Because most pumping units will be stopped at times, the lowest temperature of oil in a reducer usually will be the lowest air temperature reached in the locality where the pumping unit is operating. This is an important consideration when selecting a lubricant with the proper viscosity and pour point.

5.8 For gear reducers straight mineral gear lubricants or EP gear lubricants are preferable to motor oils in that they separate quickly from water. Motor oils of equivalent viscosity may be used in an emergency, but practically all of them contain dispersants and detergents which may cause an emulsion to form if water is present.

5.9 Tables 1 and 2 show, for gear and chain reducers respectively, the permissible range of operating temperatures for each viscosity and type of lubricant listed. In each case the minimum temperature is based on the ability of cold oil to flow properly through the lubricating channels, and the maximum temperature is based on the ability of the hot oil to maintain adequate lubrication. The temperature ranges are wide to permit year-round operation with one viscosity grade of oil in localities where seasonal air temperature range will allow. The operator should select the grade best meeting his temperature range. If the summer to winter range is too great for a single viscosity grade, a summer and a winter grade are necessary.

5.10 It is suggested that name plates on pumping unit reducers carry at least a reference to the API Recommended Practice for Installation and Lubrication of Pumping Units.

CHANGING OIL

5.11 In order to obtain long life from a pumping-unit reducer it is necessary at all times that the oil be of suitable viscosity and free from foreign material, sludge, and water.

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Table 1—Viscosity Recommendations for Gear Reducers

1	2	3
Application*	SAE† Gear or Transmission Oil	AGMA‡ Oil
0F to 140F	90 EP	5 EP (ISO VG 220)
-30°F to 110°F	80 EP	4 EP (ISO VG 150)

*Operating temperature of oil in a gear reducer on a pumping unit normally will be from air temperature to 25°F above air temperature. The temperatures shown in the table are the limiting values between which satisfactory lubrication can be expected.
†Society of Automotive Engineers, Inc., 2 Pennsylvania Plaza, New York, NY 10001.
‡American Gear Manufacturer's Association, 1330 Massachusetts Ave., N.W., Washington, D.C. 20005.

Table 2—Viscosity Recommendations for Chain Reducers

1	2	3
Temperature of Oil in Chain Case, deg. F.*	SAE Viscosity Number	
	Automotive Engine Oil	Gear Oil
-50 to + 50	5W	†
-20 to + 80	10W	75‡
0 to +100	20W	80
+10 to +125	30	80
+20 to +135	40	—
+30 to +155	50	90

*Operating temperature of oil in a chain case on a pumping unit normally will be from air temperature to 25°F above air temperature. The temperatures shown in the table are the limiting values between which satisfactory lubrication can be expected.
†SAE gear oils are not recommended for use in chain reducers for this range of temperatures.
‡SAE 75 gear oil is not usually available.

5.12 To maintain proper viscosity, oil should be changed in the spring and fall if the seasonal air temperature range results in the temperature of the oil exceeding a range shown in Table 5.1 or Table 5.2.

5.13 The method used to determine how often oil should be changed to maintain the desired condition is a matter of policy with the individual company. Some operators periodically inspect reducers and take samples of oil for laboratory analysis to determine the percentages of water and solid material in the oil. Checks may also be made on viscosity and other properties such as acidity. Oil is then changed whenever the analysis shows that the limit set for any one of the various factors has been exceeded.

5.14 Other operators depend upon periodic visual inspection to determine when to change oil. An inspection includes a look inside the reducer case and an examination of a sample of oil that has been drawn off the bottom of the reducer case and allowed to settle. Oil is changed when an inspection shows: a, deposits on the surfaces inside the reducer; b, emulsification of oil; c, sludging of oil; d, contamination of the oil with foreign material such as dirt, sand or metal particles. Sludging and emulsification of oil are usually found if there has been an excessive accumulation of water in the reducer.

5.15 A small amount of water can accumulate in the bottom of the reducer. Such water should be drawn off to prevent accumulation to the point where it will be carried with the oil and cause emulsification or sludging.

5.16 The time interval between inspections to determine the condition of the oil depends upon operating conditions. Adverse conditions that may require inspection and change of oil as often as every three or four months include one or more of the following: a, intermittent operation; b, excessive dust; c, sulfur fumes; d, a combination oil high humidity with high variation in daily air temperature. Under the most favorable conditions of minimum daily and seasonal temperature changes, low humidity, and freedom of atmospheric dust, a reducer may operate through one or more years before the oil is contaminated or deteriorated to the point that an oil change is required.

5.17 After petroleum solvent is used for flushing, all of the flushing agent should be removed and the reducer immediately refilled with a suitable oil. If the reducer is not immediately returned to operation, the unit should be operated for at least 10 minutes, or longer if necessary, to insure that all surfaces are covered with a protective film of oil.

6 Lubrication Difficulties

6.1 Lubrication of pumping-unit reducers is a relatively simple problem if handled with the advice of a reputable supplier of lubricants and, under normal conditions, very little trouble is experienced. However, a combination of improper lubricant selection and extreme conditions of service may lead to any of the following difficulties which should be recognized and corrected.

a. Difficulty: Little or no oil being carried up by gears or chains and diverted into the bearing oil channels.

Cause	*Remedy*
Under high-temperature conditions, oil may be too thin.	Either modify with a heavier oil of the same quality, or drain and refill with an oil of proper viscosity.
Under low-temperature conditions, oil may be too viscous.	Either modify with a lighter oil of the same quality, or drain and refill with an oil of proper viscosity.
Oil level may be too low.	Fill to proper level.

b. Difficulty: Unit starts hard in cold weather.

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Cause	*Remedy*
Oil too heavy and too viscous.	Either modify with a lighter oil of the same quality, or drain and refill with a lighter oil.

c. Difficulty: Continuing and severe pitting or scuffing of gears in the presence of sufficient lubrication. (Some slight initial corrective pitting which soon stops is not abnormal).

Cause	*Remedy*
Gear may be overloaded, particularly at the load peaks. (This may be caused from improper application of the pumping unit, too large a subsurface pump, or incorrect counterbalancing.)	Reduce loading.
Oil may be of incorrect specification, or oil may have lost its lubricity through use, emulsification with water, or contamination with foreign material.	Drain, flush, and refill with proper lubricant.

d. Difficulty: Pitting of active and inactive surfaces of pins and bushings in chain reducers. (Sprocket teeth and exterior surfaces of chain rollers and link plates will not necessarily be pitted.)

Cause	*Remedy*
Corrosion due to the presence of water condensate, or other corrosive agent in the lubricant.	Drain, flush, and refill with proper lubricant.

e. Difficulty: Gears, sprockets, chains, or bearings are wearing or abrading (as distinguished from pitting or scuffing.)

Cause	*Remedy*
Dirty oil.	Drain, flush, and refill with proper lubricant.

f. Difficulty: Foam rises in box and, in some cases, leaks from shaft seals.

Cause	*Remedy*
Incorrect lubricant, or lubricant contaminated with kerosene from flushing operation.	Drain, flush, and refill with proper lubricant.
Oil level may be too high, particularly if unit is operating at high speed.	Lower oil to proper level.

g. Difficulty: Oil milky in appearance as opposed to normal bright characteristics.

Cause	*Remedy*
Oil may be emulsified with water, sometimes in combination with incorrect lubricant specification.	Drain, flush, and refill with proper lubricant.
Breather may be plugged.	Make sure that breather is open.

h. Difficulty: Heavy soapy sludge in case.

Cause	*Remedy*
Incorrect lubricant.	Drain, flush, and refill with proper lubricant.

i. Difficulty: Excessive rusting and general corrosion of gears, sprockets, chains, or bearings.

Cause	*Remedy*
Intermittent operation under humid conditions, water in case, improper lubricant, or deterioration of lubricant.	Drain, flush, and refill with proper lubricant. Some lubricants are available with rust-inhibiting agents.
Lack of ventilation.	Make sure that breather is open.

j. Difficulty: Sticky and insoluble deposits on gears and bearings.

Cause	*Remedy*
Oil operated too long.	Drain, flush, and refill with proper lubricant.
Improper lubricant.	Drain, flush, and refill with proper lubricant.

7 Basis for Selection of Lubricants

CONDITIONS ESTABLISHED BY GEAR DESIGN

7.1 A typical pumping unit geared reducer is an enclosed, but vented, gear box with the following characteristics:

API peak-torque rating, inch-pounds	6,400 to 912,000
Number of reductions	Double or single
Ratio, double reduction	25:1 to 32:1
Ratio, single reduction	9.4:1 to 11:1
Rpm. of low-speed shaft or crankshaft	4 to 30
Center, low-speed train inches	6 to 36
Face, low-speed train, inches	3 to 14
Gear hardness, Brinell	160 to 300
Type bearings, crankshaft	Roller or bronze
Type bearings, intermediate or high-speed shaft	Roller

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Lubricant capacity, gallons..4 to 90
Normal temperature rise above
surrounding air, deg. F..0 to 25*

7.2 Lubrication is by dipping of the low-speed gear, and of the intermediate gear of double-reduction units, which in turn carries oil up to pockets or channels leading to the bearings.

7.3 Gear loading is highly variable during the cycle but the peak loads are repeated on the same teeth of the low-speed gear.

CONDITIONS ESTABLISHED BY DESIGN OF CHAIN REDUCER

7.4 A typical pumping unit chain reducer is an enclosed, but vented, roller-chain drive box with the following characteristics:

API peak-torque rating, inch-pounds ......26,000 to 228,000
Number of reductions ....Double or single
Ratio, double reduction ....19:1 to 26:1
Ratio, single reduction ....6:1 to 14.55:1
Rpm. of crankshaft ....4 to 30
Center, low-speed train, inches................................13 to 42
Chain size, low-speed drive,
pitch and strands ....1-in. pitch triple strand to 2-in. pitch triple strand
Sprocket hardness, Brinell..................................225 to 400
Type bearings, crankshaft...................Roller, tapered roller, or bronze
Type bearings, intermediate or
high-speed shaft...Roller
Lubricant capacity, gallons..6 to 36
Normal temperature rise above
surrounding air, deg. F..0 to 25*

*Depending upon pumping speed and loading.

7.5 Lubrication is by dipping of the crankshaft chain and sprocket, and in the case of double-reduction units, the dipping also of the intermediate chain and sprocket which carry oil up to pockets or channels leading to reducer bearings.

7.6 Chain loading is highly variable during the cycle, but peak loads are repeated on the same teeth of the crankshaft sprocket.

CONDITIONS OF SERVICE

7.7 Pumping-unit reducers are normally exposed to weather—sun, rain, wind, heat, cold. Some units are exposed to hydrogen-sulfide fumes; and, in many instances, units are exposed to fine drifting sand. Air temperature can vary from -50°F to 126°F depending on location. Radiant sun heat contributes to temperature increases. In humid climates, temperature changes from day to night cause water-vapor condensation within drive enclosures.

7.8 Service can be continuous, or intermittent to the extent of a few hours per month.

7.9 Units are often operated by small operators in remote locations and with relatively infrequent attention. They may be distant from any source of lubricating oil other than a gasoline service station.

7.10 Operators tend, where possible, to run oil as long as one to three years without an oil change.

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