

MANUAL
on application of
XADO gel-revitalizants
No. ИЭ 24.6-25612000 - 005-2004

Kharkov
Ukraine
2011

INTRODUCTION

Chemical Concern XADO provides industries, agrarian-industrial enterprises, power engineering and transportation with energy and resource saving, and environmentally friendly XADO-technology®.

The essence of the XADO-technology® is that a layer of metal-ceramic coating on work surfaces of parts is formed as a result of physicochemical processes, which allows not only to prevent wearing, but also to recover normal operation of a mechanism, which has been exploited over a long period of time.

Ordinary friction couple “metal – metal” is substituted for a low-wearing couple “cermet – cermet” with parameters of microhardness up to 750 kgf/mm², roughness R_a up to 0.06 microns and with high corrosion resistance.

The uniqueness of the XADO-technology is that the recovery of such a mechanism and its reliable protection from further wearing takes place during regular use.

Discovery of the revitalization phenomenon is based on unique physicochemical processes, which take place at certain conditions in areas of friction. In short, nature of these processes is based on the following: load in friction couples during mechanism operation take place. Excess energy directed at destruction is separated due to super loads in places of local contacts between surfaces. If a revitalizant is introduced into the friction zones, special conditions emerge in the overloaded zones, in the result a new covering appears instead of destroying the old one.

XADO-technology ® products include the following: XADO revitalizing substances, which are made in the form of XADO gel-revitalizants, XADO lubricating greases, XADO lubricating pastes and preparations for wash-down of lubricating systems of vehicle internal-combustion engines and transmission units.

XADO gel-revitalizants (or Gel-revitalizant) under various names are manufactured in compliance with the standards TY Y 24.6-25612000-002-2002, depending on the type of a unit or mechanism of manufacturing equipment or transportation means.

General information

XADO gel-revitalizants are designed for renewal and effective protection from wear of various units and mechanisms without their shutdown for repair and dismantling by step-by-step introduction of a calculated amount of gel to regular oils.

XADO gel-revitalizants are compatible with any type of oil or fuel; they do not chemically react with them, and do not change their viscosity, or other physical properties.

XADO gel-revitalizants are compatible with any admixtures, additives, metal conditioners, remetalizing substances, etc, independently of their application.

XADO gel-revitalizants are certificated by the State Committee of Ukraine on Standardizing, Metrology and Certification (Conformity certificate in the State Registrar No. UA 1.007.0042715-05).

In the process of revitalization, a metal-ceramic layer is formed on the surface of friction pairs, formed on the matrix of the metal upper layer. Protective metal-ceramic covering is formed on the friction surface, made of any type of metal or their alloys.

Application of XADO revitalizants is possible on any working mechanism. However, if the mechanism is in a critical condition (100 % wear of parts or presence of macromechanical damages on part surfaces in the form of chips, cracks, deep hairlines, burrs, etc), then worn or damaged parts shall be replaced.

Basic characteristics of the obtained cermet coating are as follows:

- Micro-hardness up to 650-750 kgf/mm²;
- High corrosion stability;
- Roughness R_a makes up to 0.06 micron.

Increase of XADO gel-revitalizant concentration at the first stage of the treatment is not advised.

Treatment of mechanical systems, which consist of several mechanisms, with different designation and accuracy, but with a common lubrication system with oil polishing filters, shall be done only with the XADO gel-revitalizants for steering boosters by application of the greatest rated amount of the gel-revitalizant per one liter of oil in comparison with the rest of mechanisms.

Treating mechanisms and assemblies with a wick method of lubrication and application of XADO revitalizants is not recommended.

It is necessary to ensure the specified and constant concentration of XADO revitalizants in regular oil during treatment. Therefore, when calculating the dosage, it is necessary to take into account possible losses of oil (leakage, burn-off loss of above 0.5 % per hour per of oil chamber nominal capacity, etc.).

In case of need to carry out treatment of assemblies and mechanisms with XADO composition-revitalizants with increased oil consumption, their treatment procedure should be planned individually and coordinated with technicians of the XADO Chemical Concern.

At present, the XADO Chemical Concern produces the following XADO gel-revitalizants in compliance with the standards TY Y 24.6-25612000-002-2002:

- **XADO gel-revitalizant for gasoline engines;**
- **XADO gel-revitalizant for diesel engines;**
- **XADO gel-revitalizant for gear boxes, transfer cases and differentials;**
- **XADO gel-revitalizant for cylinders;**
- **XADO gel-revitalizant for high pressure fuel pumps;**
- **XADO gel-revitalizant for power steering pumps;**
- **XADO gel-revitalizant for compressors and bearings;**
- **XADO gel-revitalizant for household devices and motor equipment; and,**
- **XADO gel-revitalizant for barrels of rifled arms.**

The following units and mechanisms of manufacturing equipment and vehicles can be treated with XADO gel-revitalizants:

Compressors of different types and designations.

The treatment results in:

- reduction of time for reaching an operation pressure (raising productivity) up to 30%;
- increase of lubricant pressure;
- decrease and stabilization of lubricant operation temperature;
- decrease of electrical energy consumption to 36%;
- decrease of noise and vibration level; and,
- increase of lifetime by 1.5 – 2.5 times.

Industrial reducers, final drives, central reducers, gear clusters, and transmissions for trucks and tractor engineering.

The treatment results in:

- recovery of shape of parts and wear protection;
- wear compensation on contact spots of toothed gear wheels up to 1.6 mm;
- decrease of lubricant operation temperature;
- decrease of electrical energy consumption to 25%;
- decrease of noise and vibration level; and,
- increase of lifetime by 1.8 - 3 times.

Hydraulic systems: hydraulic pumps, hydromotors and hydrodistributors of all types, hydraulic actuators of transportation facilities steering wheels.

The treatment results in:

- recovery of parts shape and wear protection;
- increase of hydraulic pumps productivity;
- elimination of hydraulic distributors flow;
- decrease of vibration acceleration;
- increase of operation pressure and efficiency of hydraulic units;
- decrease of hydraulic motors flow; and,
- increase of service life of hydraulic units by up to 2.5 times.

Frictionless and friction bearings of all types.

The treatment results in:

- elimination of friction surfaces wearing;
- decrease of radial clearances up to 0.02 mm;
- decrease of axial clearance of frictionless bearings up to 0.01 mm;
- increase of service life in hostile environments by up to 10 times; and,
- decrease of noise and vibrations level .
-

Machine tools and equipment.

The treatment results in:

- recovery of geometrical parameters of parts;
- increase of machine tools accuracy;
- improvement of treated parts surfaces quality;
- stabilization of operation of machine-tools hydraulic systems;
- decrease of electrical energy consumption to 20%;
- decrease of noise and vibration level; and,
- increase of lifetime by up to 3 times.

Forging hammers, presses and punches.

The treatment results in:

- increase of compression in principal motion cylinders of pneumatic hammers;
- increase of operation productivity of pneumatic hammer compressors;
- decrease of clearances, and recovery of ways of hammers, presses and punches;
- decrease of electrical energy consumption during hammers and presses operation;
- decrease of vibration level; and,
- wear protection and increase of mechanical presses' sliding bearings lifetime by up to 2.5 times.

Smoke exhausters and blow fans.

The treatment results in:

- recovery of shape and wear protection of bearing supports;
- decrease of electrical energy consumption to 14 %;
- decrease of noise and vibration level of bearing supports; and,
- increase of service life in hostile environments and at exposure of high temperatures (up to 400°C) by up to 5 times;

Open tooth and chain gears.

The treatment results in:

- wear elimination and shape recovery of rubbing parts;
- increase of service life in a hostile environment by up to 5 times; and,
- decrease of noise and vibration level.

Follower systems of different configurations.

The treatment results in:

- increase of surface layer hardness on follower's working surfaces;
- keeping of given accuracy of follower systems for a long period;
- increase of service life of follower system parts at hostile environments exposure by up to 2 times; and,
- operation stability of hydraulic systems.

Internal-combustion two-cycle and four-cycle engines.

The treatment results in:

- wear recovery and protection against wear of rubbing parts;
- recovery of part shape;
- fuel economy during idling up to 30 %;
- oil pressure increase;
- equalization and increase of compression in engine cylinders;
- bringing of engine capacity up to 100 %;
- decrease of noise and vibration level up to 10 times;
- capability to exploit engine at emergency oil leakage up to 300 km; and,
- decrease of CO and CH content by 2 to 10 times.

Cylinder and piston groups of internal-combustion two-cycle and four-cycle engines.

The treatment results in:

- increase of compression in cylinders;
- recovery of cylinders shape, elimination of scores;
- wear elimination and recovery of rubbing parts shape
- protection against wear of rubbing parts at «cold start»;
- decrease of noise and vibration level;
- increase of engine capacity;
- fuel economy; and,
- decrease of CO and CH content.

High-pressure fuel pumps (HPFP) for diesel and gasoline engines.

The treatment results in:

- recovery of shape and protection against wear of rubbing parts of all types of HPFP, injectors and pump-injectors;
- reliable protection against non-qualitative fuel;
- decrease of fuel consumption;
- decrease of noise and vibration level;
- increase of engine capacity; and,
- decrease of toxic components emission.

1. Procedure of treatment of all types of compressors with XADO gel-revitalizant.

1.1. Operable compressors, which do not have parts with 100 % wear and mechanical damages, are subject to treatment.

1.2. Before beginning the treatment, it is necessary to wash down or replace filter elements in the compressor lubricating system to eliminate oil leakage and, if necessary, to measure compressor's critical performance characteristics:

1.2.1. Time, during which the compressor fills a separate closed receiver up to working or fixed pressure, shall be determined. The measurement is carried out using a stopwatch.

1.2.2. Vibration level in fixed points in vertical, horizontal and axial directions is measured. Measurements of vibration parameters (vibration acceleration, vibration rate, and vibration displacement) are carried out with the help of a vibration meter. Metering vibration in bearing assemblies locations is recommended.

1.2.3. Noise level in fixed points is measured. Measuring is carried out with the help of an audio-noise meter on a fixed distance from noise sources for want of extraneous noise sources.

1.2.4. Power consumption (or current consumption) of electric motor on the unloaded compressor is measured. The measurement is taken with the help of a clamp-on ammeter, a wattmeter or a multi-measurement instrument.

1.2.5. Oil pressure is measured at a fixed operation temperature. The measurements are carried out with the help of a standard manometer.

1.2.6. A work-temperature schedule of a lubricating system is determined. Oil temperature is measured with the help of a liquid-filled thermometer or standard device.

1.3. Compressors should be treated with the "XADO gel-revitalizant for compressors and bearings" in 3 stages without replacement of oil according to the following Procedure:

1.3.1. Prepare the "XADO gel-revitalizant for compressors and bearings" as follows: 1.2 ml per 1 liter of standard oil per one stage of treatment.

1.3.2. Pour a small amount of standard oil (1 part of the Gel per 5 - 10 parts of oil) heated up to 40 - 60°C in a separate bulb, dissolve the measured quantity of the "XADO gel-revitalizant for compressors and bearings" in it, which is to be put into a casing of the compressor.

1.3.3. If a lubricator is used for lubrication of a cylinder and piston group, the XADO gel-revitalizant for compressors and bearings is similarly dissolved in another bulb (1.2 mL per 1 liter of oil for the lubricator) and poured in a capacity of oil for a lubricator required for maintenance of the compressor operation during 200 hours.

1.3.4. For example, oil consumption through a lubricator per hour makes 0.225 L, thus, for 200 hours of continuous operation it makes 45 L. The calculated quantity of the Gel-revitalizant required for constant concentration maintenance will make: 45 L x 1.2 mL = 54 mL. If the lubricator is lacking, then treat the compressor only with the gel-revitalizant by putting it into a casing of the compressor.

1.3.5. Intermix thoroughly each composition until a homogeneous mixture is obtained.

1.3.6. Introduce the first composition into the compressor casing.

1.3.7. The second composition should be introduced through the lubricator in small doses (it is recommended to carefully stir the composition before introducing each oil dose) in process of the oil consumption by it during 200 operating hours.

1.3.8. Turn the compressor on and let work in normal conditions without overloads.

1.4. Carry out the second and third stages of compressor casing treatment with an interval of 8 hours of its total non-failure operation similar to the first stage.

1.5. Treatment of the compressor is considered finished after the compressor has worked for 400 hours counted from the beginning of the first stage treatment.

1.6. After finishing the treatment of the compressor, engineering measurements indicated in item 1.2 are performed, if necessary.

Note:

1. Carrying out treatment of cylinder and piston groups of compressors, which include piston rings made from non-metals, with XADO revitalizants is not recommended.

2. During the first 200 operating hours, it is necessary to replenish consumed oil with additional quantity of the XADO gel-revitalizant diluted in it on the basis of 1.2 mL per one liter of added oil for maintenance of constant concentration XADO revitalizants in compressor's standard oil in case of heightened oil consumption.

3. New compressors or ones with small wear (up to 10 %) are treated with a smaller quantity of the XADO revitalizant. Treatment through a case is carried out in 2 stages, and the one through a lubricator is carried out during 130 hours.

4. It is recommended to treat turbocompressors with the XADO gel-revitalizant for compressors and bearings in 4 stages with the norm of consumption: 0.9 mL gel per 1 liter of regular oil for one stage of treatment. The life-length between the stages shall be not less than 8 hours. The complete cycle of treatment shall be not less than 450 hours.

2. Procedure of treatment of industrial, onboard and central reducers as well as gear clusters of trucks and tractors with XADO gel-revitalizant.

2.1. Efficient reducers, which do not have parts with 100 % wear and macro-mechanical damages, are subject to treatment with the XADO revitalizants.

2.2. It is necessary to eliminate oil leakage and, if necessary, to measure basic technical features of the work of a reducer and parameters of toothed gear wheels before treating reducers or transmissions.

2.2.1. The vibration level in fixed points should be measured (it is recommended to measure on bearing supports). The measurements are taken in vertical, horizontal and axial directions with the help of a vibration meter (vibration acceleration, vibration rate, and vibration displacement).

2.2.2. Noise level in fixed points should be measured. It should be measured with a sound level meter.

2.2.3. Consumed power (or consumed current) of an electric motor when idling and at fixed load at identical temperature of oil should be measured. The measurements are carried out with the help of a clamp-on ammeter, a wattmeter or a multi-measurement instrument.

2.2.4. A temperature schedule of oil is determined. Measurements are taken with the help of a liquid-filled thermometer.

2.2.5. Metering of tooth thickness of toothed gear wheels (see Appendix 3) is performed. Measuring of tooth thickness is carried out with gear tooth caliper of any type with the scale interval of no more than 0.05 mm.

2.2.6. Technical state of contact patches of designated teeth of tooth gears of a reducer (availability and dimensions of damages) is fixed visually or with the help of a camera.

2.2.7. Additional measuring of the clearance of a toothed side is recommended to be performed when wear of tooth thickness is more than 0.3 mm. Measuring of side clearance is carried out with the help of a lead plate between gear wheels during rotation. After that the lead plate is measured on the residual depth with the help of a micrometer or a thickness indicator with the scale interval of not more than 0.01 mm.

2.3. Reducers and gear clusters are to be treated with the XADO gel-revitalizant for gear clusters and reducers" in 3 stages without oil replacement in compliance with the following procedure:

2.3.1. Pour a small amount of a regular oil heated to 40 - 60°C in a separate bulb (1 part of dissolved gel per 5 - 10 parts of oil), add the calculated quantity of the XADO gel-revitalizant for gear clusters and reducers (3.0 mL per 1 liter of standard oil for one stage).

2.3.2. Intermix thoroughly the components to obtain a homogeneous mixture.

2.2.3. Shut down the equipment, open an access cap or an oil filler of the reducer gearbox and introduce the prepared mixture by any convenient way into a work area of the reducer or directly on work surfaces of the tooth gear wheels. Close and fix the access cap. Turn on the equipment and let the reducer work for total 8 hours.

2.3.4. The second and third stages of the reducer treatment are carried out similar to the first one in 8 hours of total reducer operation after each stage.

2.4. The treatment of the reducer is considered completed after 400 hours of total non-failure operating time calculated from the beginning of the first stage of the treatment.

2.5. Measurements of basic parameters indicated in item 2.2 are carried out after ending the treatment, if necessary.

2.6 Mechanical gear clusters and transmission units of vehicles with the useful capacity of the engine up to 5.0 liters are treated with the XADO gel-revitalizant for gear clusters and reducers in one step by direct introducing of the gel into the oil-filler neck of a gear cluster, transfer box or bridge reducer, in compliance with the rate of application given in Table 1 of the Procedure. The complete cycle of the treatment of a gear cluster and transmission units

of vehicles with a useful capacity of the engine of up to 5.0 liters shall be not less than 50 hours of non-failure operating time or not less than 1,500 km of haul.

Table 1

Capacity of the oil reservoir of a unit, liters	Number of tubes of the XADO gel-revitalizants for gear clusters and reducers to treat the unit, pcs	Unit treatment schedule
1-2	1	Once
2-5	2	Once
5-8	3	Once

Note:

1. The measurements according to items 2.2.1 - 2.2.3 are carried out at a constant torque on the output shaft of the reducer.
2. It is permitted to treat reducers, in the system of which filtration of oil is not used, by a single application of the XADO gel-revitalizant fore reducers and gear clusters directly at work surfaces of pinions based on 9.0 mL gel per 1 liter of a regular oil of the reducer.
3. Treatment of new reducers or reducers with minor wear (up to 10 %) is carried out in 2 stages at the consumption norm of 3.0 mL of the gel per 1 stage of treatment or in case of single introduction: 6.0 mL of the gel per 1 liter of a regular oil.

3. Procedure of treatment of hydraulic systems and steering boosters of vehicles with XADO gel-revitalizant.

3.1. Hydraulic systems of industrial equipment and transportation means, which do not have units and mechanisms with extreme wear and macro-mechanical damages, are subject to treatment with XADO revitalizing substances.

3.2. It is necessary to eliminate leakage of hydraulic fluid and, if necessary, to measure basic operation features of hydraulic systems prior to the treatment with a XADO revitalizant.

3.2.1. Pressure in the hydraulic system. The measurements are taken with a manometer at fixed temperature of hydraulic fluid.

3.2.2. Operation temperature of oil (hydraulic liquid) in a hydraulic system. The measurements are taken with the help of a liquid-filled thermometer or a standard device for temperature measuring .

3.2.3. Productivity (output) of hydraulic pumps. The measurements are carried out with the help of an oil flow meter at fixed pressure and temperature of hydraulic fluid. To determine the capacity of hydraulic pumps with the consumption rate of hydraulic fluid over 15 L/min, it is allowed to take measurements by determining the time

needed to fill a measuring vessel with the hydraulic fluid at fixed pressure and temperature of the hydraulic fluid.

3.2.4. Capacity of flow-overs of hydraulic fluid with hydraulic motors operating during a fixed time period. The measurements are taken with the help of a measuring vessel with a graduated scale at fixed pressure and constant temperature of hydraulic fluid at the output of the hydraulic motor.

3.2.5. Hydraulic machine vibration level. The measurements are carried out with the help of a vibration meter at set points and at fixed operational modes of the hydraulic machines.

3.2.6. For power systems, productivity of hydraulic pumps of power hydraulic systems is determined indirectly by the response speed of such a power mechanism. Time of fixed motion of power hydraulic cylinders is gauged at constant pressure and working temperature of oil.

3.2.7. Capacity of hydraulic fluid leakages through hydraulically actuated valve can be determined indirectly by comparison of the value of the loaded power cylinder moving with the hydraulically actuated valve in neutral provided that all valves are in working order.

3.2.6. Other load and control characteristics of a hydraulic drive are gauged if needed.

3.3. Hydraulic systems can be treated with the XADO gel-revitalizant for steering boosters in 3 stages without oil replacement as follows:

3.3.1. Prepare the XADO gel-revitalizant for steering boosters: 1.0 mL of the Gel per 1 liter of the hydraulic fluid per one stage.

3.3.2. Pour some working fluid for a hydraulic system heated up to 40 - 60°C in a separate bulb (1 part of the dissolved Gel per 5-10 parts of oil) and add the calculated quantity of the XADO gel-revitalizant for steering booster (1 mL of the Gel per 1 liter of regular oil per 1 stage).

3.3.3. Intermix thoroughly the composition to obtain a homogeneous mixture and introduce it into a tank for hydraulic fluid.

3.3.4. Start up the hydraulic system, ensure load with the pressure of up to 50 % of the maximum one and let it work for 2 hours. Then, continue using with the rated load as designed.

3.3.5. Complete the second and third treatment stages with an 8-hour interval of total non-failure operating time of the hydraulic system similar to the first stage.

3.3.6. The treatment of the hydraulic system is considered completed after 350 operating hours from the beginning of the first stage.

3.4. Re-measure the critical parameters of the hydraulic system performance indicated in item 3.2 upon completion of the treatment, if needed.

3.7. To reduce the cost of treatment of bulk hydraulic systems, which work with large quantities of hydraulic fluid, it is recommended to treat them individually on special benches in compliance with an individual procedure (see Appendix 2 of the present Manual).

3.8. Treatment of new hydraulic machines or those with minor wear (up to 10 %) is carried out according to the mentioned-above procedure in 2 stages.

3.9 Treatment of steering boosters of vehicles is done by single introduction of the XADO gel-revitalizant for steering booster into the hydraulic fluid of a steering booster in compliance with the standards, given in Table 1 of the present Procedure. The complete cycle of the treatment of a steering booster shall be not less than 50 hours of non-failure operating time or not less than 1,500 km of haul.

Table 1

Capacity of the oil reservoir of a unit, liters	Number of tubes of the XADO gel-revitalizants for steering boosters, pcs	Unit treatment schedule
1-2	1	Once
2-5	2	Once
5-8	3	Once

4. Procedure of treatment of oil lubricating bearing assemblies with XADO gel-revitalizant.

4.1. Bearings with wear less than 100 % without defects and mechanical damages are subject to treatment by "XADO revitalizants".

4.2. Before the beginning of the treatment, it is necessary to eliminate oil leakage and, if necessary, to measure critical performance characteristics of bearing units.

4.2.1. Value of the radial space (or radial play) of a bearing. It is measured with the help of a rack with a measuring indicator, the scale interval of which is not more than 0.01 mm. The measurements are taken by forced displacement of the shaft in the radial direction towards the location of the indicator leg placed on the shaft landing surface (or by forced displacement of one of the bearing cages) and a readout of the indicator results. For frictionless bearings with an internal bore diameter of more than 15 mm, as well as for friction bearings, it is permitted to measure the radial clearance with the help of a set of probes.

Note:

1. For thrust bearings, an axial play is measured instead of the radial clearance.

4.2.2. Value of the axial slackness of the bearing (maximum axial movement of one of bearing cages regarding the other). It should be measured only in radial ball and spherical bearings with the help of a rack and a measuring indicator, the scale interval of which is no more than 0.01 mm. The measurements are taken by forced axial displacement of the shaft or the bearing cage towards the indicator leg and readout of the indicator results.

4.2.3. Value of the shaft radial and (or) face runout of the bearing assembly. The measurement is carried out with the help of a display rack with a measuring indicator, the scale interval of which should not be more than 0.01 mm. The measurements are taken by rotation of the unloaded shaft with the indicator leg placed on its radial and (or) end surface and further readout of the indicator results.

4.2.4. Vibration level of the bearing or bearing assembly. The measurements of vibration acceleration, vibration rate and vibration displacement in fixed points of a bearing unit in vertical, horizontal and axial directions of each bearing support are carried out with the help of vibration meters of various types.

4.2.5. Noise level during bearing assembly operation at fixed load. The measurements are carried out with the help of audio-noise meters of various types in specific places at fixed distances from the source of the maximum noise provided the lack of unwanted sounds.

4.2.6. The oil operation temperature is gauged after a fixed time of work of a bearing unit under specific load at identical ambient temperature. The measurements of temperature are carried out with a liquid-filled thermometer.

4.2.7. Measurements of current consumption or power consumption by an electric motor in idling or at fixed load are carried out for units containing bearing units and an electric drive. The measurements are carried out with the help of a clamp-on ammeter, a wattmeter or a multi-measurement instrument.

4.3. Bearings lubricated with oil are treated with the XADO gel-revitalizant for compressors and bearings in 3 stages without oil replacement according to the following procedure.

4.3.1. Pour a small amount of standard oil (1 part of the dissolved Gel per 5-10 parts of oil) heated up to temperature 60°C in a separate bulb, add the calculated quantity of the XADO gel-revitalizant for compressors and bearings" (1.2 mL per 1 liter of standard oil for 1 treatment phase) and intermix components carefully.

4.3.2. Introduce the made mixture to the oil chamber of the bearing unit, start up the mechanism and let it run in a regular mode.

4.3.3. Carry out the second and third treatment phases similar to the first stage after an 8-hour interval of total bearings operation.

4.4. The treatment is considered completed after 400 hours of the total non-failure operating time of bearings from the beginning of the first stage.

4.5. Repeat measurements of basic technical parameters of the bearing operation indicated in item 6.2 upon completion of the treatment cycle, if required.

4.6. New bearings or bearings with minor wear (up to 10 %) are treated according to the same procedure, but only in 2 stages.

5. Treatment procedure for open tooth and chain gears with XADO gel-revitalizant.

5.1. Open tooth and chain gears with the wear rate of less than 100 %, which do not have damaged and deformed parts, lubricated both with grease and dosed oil lubrication are subject to treatment.

5.2. Measuring of basic operational parameters of tooth and chain gears as well as geometrical dimensions of the parts are made before the treatment, when necessary.

5.2.1. Vibration level of bearing supports is measured. Measurements of vibration acceleration, vibration rate and vibration displacement in fixed points of a bearing unit cage in vertical, horizontal and axial directions of each bearing support are carried out with the help of vibration meters of different types.

5.2.2. Noise level is measured. The measurements are carried out with the help of audio-noise meters of various types in specific places at a fixed distance from the source of maximum noise provided the lack of unwanted sounds.

5.2.3. Measurements of radial plays of bearing supports of tooth and chain transmissions are carried out with the help of a rack with an indicator, the scale interval of which is no more than 0.01 mm. The measurements are performed with forced displacement of the shaft in radial direction towards the indicator leg placed on the shaft and readout of the indicator. For frictionless bearings with the bore diameter more than 15 mm as well as for friction bearings, it is allowed to perform measurements of the radial clearance with the help of a set of probes.

5.2.4. Measurements of thickness of gear teeth and sprockets (see Appendix 2 of the present Manual) are taken. Measurements of tooth thickness of gear are carried out with gear tooth calipers of any type with the scale interval of no more than 0.05 mm.

5.2.5. Measurements of diameters of working surfaces of rollers or chain bushes are made. The measurements are carried out with the help of micrometers or indicator lever staples with the scale interval of no more than 0.01 mm.

5.3. The XADO gel-revitalizant for gear clusters and reducers is selected for lubrication of open tooth gearing or chain transmission, in case of dosed lubrication

5.4. Pour the required amount of oil into a separate bulb, which is enough to provide work for 400 hours total.

5.5. Introduce a calculated amount of the XADO gel-revitalizant for cluster gears and reducers into this oil, heated up to the temperature of 40-60 °C based on the calculation of 9 mL gel per one liter of prepared oil. Intermix the components thoroughly until completely dissolved.

5.6. Start up the transmission, having lubricated with the prepared solution and let it run as regular.

5.7. Upon the complete use of the prepared composition, the treatment of a transmission is over. Further, to lubricate the transmission, use oil without a XADO composition.

5.8. In case of necessity, the results of measurement of operational parameters and shape of parts of open tooth and chain transmissions before and after the treatment with the XADO revitalizants, technical acts are issued.

5.9 To treat new open tooth or chain transmissions, or the ones with the wear rate of up to 10 %, which are lubricated with oil, it is enough to prepare the lubricant in compliance with paragraph 5.10 and use the capacity required for 250 hours total.

Note:

1. For well worn-out pinions, sprockets, and chains, it is permitted to apply the XADO gel-revitalizants for cluster gears and reducers directly upon the worn work surfaces to increase the restoration effect.

6. Procedure of the treatment of machine-tools with XADO gel-revitalizants.**6.1. General procedure of treatment of lathes with XADO gel-revitalizants.**

The following operable assemblies and gears of turning machine tools, which do not have completely worn-out or damaged parts, are subject to treatment:

- Spindle assemblies;
- Gear boxes;
- Feed gear-boxes;
- Feed screws of machine tools;
- Ways of machine tools; and,
- Hydraulic systems.

6.1.1. Spindle assembly and a gearbox of turning machine tools, which have a common lubricating system, are treated with the XADO gel-revitalizant for compressors and bearings. The treatment is made in three stages without replacement of oil with the consumption norm of 3 mL of the gel-revitalizant per one liter of regular oil per one stage of treatment.

It is necessary to eliminate leakage of oil before the beginning of treatment.

Measuring of critical operational parameters for each assembly is performed when required:

- **Value of end and radial runout of spindle landing surfaces.** It is measured with the help of an indicator rack with a measuring indicator, the scale interval of which is not more than 0.01 mm. The measurements are carried out by rotation of the unloaded shaft with the leg of the indicator placed on its radial and (or) end surface and readout of the indicated readings.
- **Radial and axial clearances of the spindle bearings.** The measurements are carried out with the help of a rack with a measuring indicator, which scale interval is not more than 0.01 mm, with forced displacement of the spindle in radial or axial directions to the leg of the indicator placed on the landing (radial or end) surface of the spindle and readout of indicator results.
- **Level of vibration of bearing assemblies.** Measurements of vibration acceleration, vibration rate and vibration displacement in fixed points of the casing of the bearing assembly in vertical, horizontal and axial directions of each bearing support are carried out with the help of vibration meters of different types in an idling of the unloaded spindle.

- **Power consumption or current consumption** by the electric motor in idling and fixed modes of cutting. Measure consumed power (or current consumption) of the electric motor in an idling and at fixed load at identical temperature of oil. The measurements are carried out with the help of clamp-on meter, wattmeter or multi-measurement instrument for measuring of electric networks' parameters.
- **Surface roughness of the billet** turned by one and the same tool with identical cutting modes. Roughness value is measured with the help of a profile meter of any type.
- **Taper and out-of-roundness of the pilot billet** made by one and the same tool at identical cutting modes. Taper and out-of-roundness of the billet is measured with a micrometer or lever staple with a measuring indicator, which scale interval is not more than 0.01 mm.
- **Thickness of selected and marked teeth of the tooth gearbox.** Carry out measuring tooth thickness of tooth gears (see Appendix 3). Measurements of tooth depths are carried out with gear tooth calipers of any type with scale interval not more than 0.05 mm.
- **Technical condition of contact areas of the marked teeth of the tooth gears.** It is fixed visually or with the help of a photographic camera (availability and dimensions of damages).
- **Noise level.** The measurements are carried out with an audio-noise meters of any type on fixed distance from a noise source and fixed operational modes of the machine tool for want of extraneous noise sources.
 - **The first stage of treatment.**
 - A) Pour a small amount of oil (1 part of the introduced gel per 5-10 parts of oil) heated up to 40 - 60°C in a separate vessel. Add the calculated quantity of the XADO gel-revitalizant for compressors and bearings (3 mL of the Gel per 1 liter of the machine tool standard oil). Intermix the components carefully until a homogeneous mixture is obtained.
 - B) Introduce the prepared mixture into the lubricating system of the disabled machine tool.
 - C) Start up the machine tool and ensure its total 8-hour non-failure operation in a nominal mode.
- **The second and third stages** of the assembly treatment are carried out similar to the first stage with 8-hour interval of total running time of the machine tool as designed.
 - Treatment of a transmission and spindle assembly with the XADO revitalizant is considered finished after 400 hours of total non-failure operating time of the machine tool calculated from the beginning of the first stage.
 - Measuring of the basic performance parameters are carried out after ending the treatment indicated in item 6.1.2, and outcomes of measurements are arranged in a form of technical act.
 - New spindle assemblies or ones with the rate of wear up to 10 % are treated in accordance with the given Procedure in 2 stages.

Note:

1. XADO revitalizants do not have any influence on operation of friction clutches, which work in oil reservoirs of transmissions.
2. Filling-up oil reservoirs of a spindle assembly with lubricating oil shall be made pursuant to instructions.

6.1.2. Mechanisms of transmissions and feed gearboxes with a self-contained lubrication system are treated with the XADO gel-revitalizant for gear clusters and reducers. The treatment is completed in three stages without replacement of oil with the norm of consumption of 3 mL of the gel-revitalizant per 1 liter of standard oil per one treatment stage.

It is necessary to measure basic operating parameters and geometrical dimensions of teeth of each unit before the treatment and after it:

- **Thickness of the selected and marked teeth of tooth gears.** Measure thickness of teeth of tooth gears (see Appendix 3). The measurements of teeth depth are taken with the help of gear tooth calipers of any type with the scale interval of not more than 0.05 mm.
- **Technical condition of tooth contact areas of tooth gears.** They are fixed visually or with the help of a camera (availability and dimensions of damages).
- **Vibration level.** Measurements of vibration acceleration, vibration rate and vibration displacement in fixed points of the transmission casing or feed gear-box in vertical, horizontal and axial directions of a bearing support are taken with the help of vibration meters of different types in a mode of idling and unloaded spindle of the machine tool.
- **Power consumption or current consumption** by the electric motor in idling. Measure power consumption (or current consumption) of an electric motor in idling at identical oil temperature. The measurements are taken with the help of a clamp-on current meter, wattmeter or multi-measurement instrument for metering of parameters of electric networks.
- **Noise level.** The measurements are carried out with the help of audio-noise meters of any type on fixed distance from a noise source and at fixed operational modes of the machine tool provided the lack of unwanted sounds.

Measurements of basic operation parameters and teeth geometrical dimensions of each unit are taken before the treatment, if necessary:

- **The first stage of the treatment:**

- A) Take a small amount of oil (1 part of the introduced gel per 5-10 parts of oil) heated up to 40 - 60°C in a separate vessel. Add the calculated quantity of the XADO gel-revitalizant for cluster gears and reducers (3 mL of the Gel per 1 liter of the machine tool standard oil) in this oil. Intermix the components carefully until a homogeneous mixture is obtained.
- B) Introduce the prepared mixture into the lubricating system of the disabled machine tool.
- C) Start up the machine tool and ensure its total 8-hour operation in a regular nominal mode.

- **The second and third stages** of the assembly treatment are carried out similar to the first stage with 8-hour interval of total running time of the machine tool in a regular mode.
- Treatment of a transmission and (or) a feeding box with the XADO revitalizant is considered to be completed after 400 hours of total non-failure operating time of the machine tool calculated from the beginning of the first stage.
- Repeat measurements of the basic performance parameters after finishing the treatment. Outcomes of measurements shall be arranged in the form of a technical act.
- New spindle assemblies or ones with rate of wear up to 10 % are treated in accordance with the given Procedure in 2 stages.

Note:

1. The XADO revitalizants do not have any influence on operation of friction clutches, which work in oil reservoirs of transmissions.
2. Filling-up oil reservoirs of transmissions and feeding boxes with lubricating oil is done pursuant to instructions.

6.1.3. Spindle assemblies with a self-contained oil lubrication system. The treatment is carried out with the XADO gel-revitalizant for compressors and bearings in three stages without replacement of oil according to the norm of consumption 1.2 mL of the Gel per 1 liter of a standard oil per one treatment phase.

It is necessary to perform metering of basic performance parameters of the unit before treatment and after it:

- **Value of end and radial runouts of landing surfaces of the spindle.** It is measured with the help of a display rack with a measuring indicator, the scale interval of which is not more than 0.01 mm. The measurements are carried out by rotation of the unloaded shaft with the leg of the indicator placed on its radial and (or) end surface and readout of the indicator results.
- **Radial and axial plays (clearances) of the spindle bearing.** The measurements are carried out with the help of a rack with a measuring indicator, which scale interval is not more than 0.01 mm, with forced displacement of the spindle in radial or axial directions to the leg of the indicator placed on the landing (radial or end) surface of the spindle and readout of the indicator results.
- **Vibration level of bearing units.** In idling of an unloaded spindle, measurements of vibration acceleration, vibration rate and vibration displacement in fixed points of a casing of a bearing unit in vertical, horizontal and axial directions of each bearing support are done with the help of vibration meters of different types.
- **Power consumption or current consumption** by an electric motor in idling and fixed cutting modes. Measure the electric motor power consumption (or current consumption) in idling and at fixed load at identical temperature of oil. The measurements are carried out with the help of a current clamp-on meter, wattmeter or multi-measurement instrument for metering of parameters of electric networks.

- **Surface roughness of a billet**, cut with the same tool at identical cutting modes. Surface roughness is measured with a profile recorder of any type.
- **Taper and out-of-roundness of the reference billet** made by one and the same tool at identical cutting modes. Taper and out-of-roundness of the billet is measured with a micrometer or lever staple with a measuring indicator, which scale interval is not more than 0.01 mm.

The first treatment phase:

A) Take in a separate vessel a small amount of oil (1 part of the introduced gel per 5-10 parts of oil) heated up to 40 - 60°C. Add the calculated quantity of the XADO gel-revitalizant for compressors and bearings (3 mL of the Gel per 1 liter of the machine tool standard oil) into this oil. Intermix the components carefully until a homogeneous mixture is obtained.

B) Introduce the prepared mixture into the lubricating system of the spindle of the disabled machine.

C) Start up the machine tool and ensure its total 8-hour non-failure operation in a regular mode.

- **The second and third stages** of the assembly treatment are carried out similar to the first stage with 8 hours interval of total running time of the machine tool in a regular mode.

- Treatment of a transmission and spindle assembly with the XADO revitalizant is considered completed after 400 hours of total non-failure operating time of the machine tool calculated from the beginning of the first stage.

- Repeat measuring of basic performance parameters after ending treatment, outcomes of measurements shall be arranged in a form of technical act.

- New spindle assemblies or ones with coefficient of wear up to 10 % are treated in accordance with the given Procedure in 2 stages.

Note:

1. Filling-up oil reservoirs of a spindle assembly with lubricating oil are made pursuant to operating instructions.

6.1.6. Lead screws, which are oiled, are treated with the XADO gel-revitalizants for gear clusters and reducers without replacing oil, by introducing the gel into the lubricating oil of a screw pair based on the calculation of 9 mL gel per 1 liter of a regular oil:

- Before treating and after it, if required, measure the axial play in the pair "screw-nut", determine the degree of wear and the possibility to treat it with the XADO technology.
- Treatment of the lead screw is considered to be finished after total 550 hours of non-failure operation.

- Treatment of new lead screws or those with the wear of up to 10 % comprises 300 hours of total work.

Note:

1. Filling-up with lubricating oil is made pursuant to operating instructions.

6.1.7. Treatment of slides in cutting machines.

Slides of cutting machines without “saddle-shaped” wear, projections as well as other damages of working surfaces over 0.1 mm deep are subject to treating with XADO revitalizants. Before treating with the XADO technology and in case of availability of wear and damages of large depth on work surfaces of slides, it is recommended to eliminate these defects by machine work (planning or grinding) and then to perform the treatment with a corresponding XADO composition-revitalizant.

The treatment of slides of a machine tool by the XADO revitalizing composition allows excluding one of the types of finish-machining slides, namely scraping. The XADO treatment of machine tools slides is most effective as a preventive measure: it allows to protect from wearing, to increase microhardness of working friction surfaces up to 750 kg/mm² and also to ensure a high corrosion stability.

The following types of lubricants are applied for slides of metal-cutting equipment:

- Centralized circulating system for lubrication slides with oil.
- Lubrication of machine tools slides with consistent greases.
- Periodic lubrication of slides with oil manually.

Centralized system of oil lubrication.

Slides of machine tools with a circulating system of oil lubrication are treated with the XADO gel-revitalizant for compressors and bearings by brining a required quantity of the gel into an oil bath based on 6 mL per 1 liter of standard oil per all operation cycle.

The order of treatment completion:

A) At visual inspection, determine technical condition (availability of cavities, chips, and scores) of all friction surfaces, rate of wear and capability for treatment with the XADO technology.

B) Measurement of flatness and straightness of the machine tool ways with a special control rulers or prisms are made before the treatment and after it, if necessary.

C) The machine tool should be started up into operation and exploitation in a nominal mode after carrying out measurements and bringing necessary quantity of the Gel into oil.

D) A complete cycle of ways treatment makes not less than 550 hours of total non-failure operating time of a machine tool.

E) Measurements of flatness and straightness of the machine tool slides are performed, technical condition of accessible friction surfaces is visually evaluated and a comparative analysis is carried out after ending the treatment, as required.

F) It is recommended once a year as a preventive measure to treat the slides at the consumption norm of the gel-revitalizant 6 mL per one liter of regular oil during 200

operation hours to increase service life at further use and also for new machine tools or those with minor wear of slides (up to 10 %).

Note:

1. Filling-up lubricating oil is made pursuant to operating instructions, as required.

Lubrication of ways of machine tools with consistent greases.

Treatment of machine-tool slides, which are oiled on the periodical basis (from a separate oil reservoir) is made with the XADO gel-revitalizant for compressors and bearings by adding it to the lubricating oil based on the calculation of 6.0 mL per 1 liter of oil.

Treatment procedure:

A) Visually examine all the friction surfaces, determine their technical condition (presence of cavities, chips, and burrs), the degree of wear and the possibility of treatment with the XADO Technology;

B) Perform measurements of flatness and straightness of machine-tool slides with a special control rulers or prisms.

C) Upon completion of measurements and introduction of the required amount of the gel into the oil, lubricate the slides with the received composition and start up the machine as designed;

D) Complete treatment cycle of slides shall be not less than 550 hours of the total non-failure operating time of the machine.

E) Start up the machine tool and continue to exploit it in a normal mode.

F) Periodical lubrication of the slides throughout the treatment cycle shall be not less than twice a shift or once during 4-hour work of the machine tool.

G) As a preventive measure or to increase the resource at further use after completion of the treatment with XADO revitalizants of new machine tools as well as those with a mild wear of slides (up to 10 %), it is recommended once a year during 200-hour non-failure operating time to treat slides using 6 mL of the gel-revitalizant per one liter of a regular oil.

6.1.8. **Hydraulic systems of lathes** are treated in accordance with Procedure No. 3 of the present Manual.

**6.1. General treatment procedure of milling machines
with the XADO gel-revitalizant.**

Any operable assemblies of milling machines, which do not contain parts with 100 % wear and mechanical damages, are subject to the treatment. The milling machine assemblies are as follows:

- Gear-boxes and spindle units;
- Spindle turrets with lubricating grease;

- Feeding box, pinions, and bracket bearings;
- Lead screws of crosscut and longitudinal movement;
- Machine tool slides; and,
- Hydraulic systems.

6.2.1. **Gear boxes and spindle units**, which have a common lubricating system, are treated with the XADO gel-revitalizant for compressors and bearings in three stages without replacement of oil by introducing it into an oil bath based on 3 mL of the gel per 1 liter of standard oil per 1 treatment phase.

Measurements of the following basic operational parameters of each assembly are taken prior to the treatment, if necessary:

- **Value of end and radial runout of spindle landing surfaces.** It is measured with the help of a display rack with a measuring indicator, the scale interval of which is no more than 0.01 mm. The measurements are carried out by rotation of an unloaded spindle with the leg of the indicator installed on its radial and (or) end surface and readout of the indicator results.

- **Radial and axial play (gap) of spindle's bearings.** The measurements are carried out with the help of a rack with a measuring indicator, the scale interval of which is no more than 0.01 mm, forced displacement of the spindle in a radial or axial direction to a side of the indicator's leg mounted on a landing (radial or end) surface of the spindle and readout of the indicator results.

- **Vibration level of bearing assemblies.** Measurements of vibration acceleration, vibration rate, and vibration displacement in fixed points of the bearing assembly body in vertical, horizontal, and axial direction of each bearing support are taken with the help of vibration meters of different types in the regime of idling of the unloaded spindle.

- **Power consumption or current consumption** of an electric motor in idling and fixed cutting modes. Measure power consumption (or current consumption) of an electric motor in idling and at fixed loads at the identical temperature of oil. The measurements are taken with the help of a clamp-on meter, wattmeter or multimeric device to measure parameters of electric circuits.

- **Roughness** of billet surfaces, milled by the same instrument at identical cutting modes. The value of the roughness is measured with a surface finish gage or a surface analyzer of any type.

- **Nonflatness** of the milled surface of a billet made by the same tool at identical cutting modes. The nonflatness is measured with the help of control rulers or a rack with a measuring indicator.

- **Thickness of selected and marked teeth** of pinions of a gearbox. Perform measuring of the thickness of tooth-gear teeth (see Appendix 3). The measurements of teeth thickness are taken with gear tooth calipers of any type with the scale interval of not more than 0.05 mm.

- **Technical condition of tooth contact areas of the marked teeth of tooth-gears.** It is fixed visually or with the help of a camera (availability and dimensions of damages).

- **Noise level.** The measurements are taken with audio-noise meters of any type on identical distance from a noise source and fixed operational modes of the machine tool provided the lack of unwanted sounds.

The first stage of treatment.

A) Take a small amount of oil (1 part of the introduced Gel per 5-10 parts of oil) heated up to temperature 40 - 60°C in a separate bulb. Add the calculated quantity of the XADO gel-revitalizant for compressors and bearings into this oil – 3 mL of the gel per 1 liter of standard oil in the machine tool. The components are carefully mixed before obtaining homogeneous mixture.

B) Introduce the prepared mixture into a lubricating system of the machine tool when the latter is disabled.

C) Start up the machine tool and ensure its total operation during 8 hours in a nominal mode.

- **The second and third treatment phases** of the assembly are carried out similar to the first stage with an 8-hour interval of total non-failure operating time of the machine tool in a nominal mode.

- Treatment of the gear box and spindle unit with the XADO revitalizant is considered completed after 400 hours of the machine tool total non-failure operating time calculated from the beginning of the first stage.

- Measurements of basic performance parameters are taken after finishing the treatment, if necessary.

- New spindle assemblies or ones with the rate of wear up to 10 % are treated in accordance with the Procedure in 2 stages.

Note:

1. The XADO revitalizants do not influence operation of friction couplings working in oil reservoirs of gearboxes.

2. Filling-up oil in an oil reservoir of the machine tool is made pursuant to instructions.

6.3. General treatment procedure for surface-grinding machines with the XADO gel-revitalizant.

Operable assemblies and gears of grinding machine tools, which do not have completely worn or damaged parts, are subject to the treatment, viz:

- Hydraulic systems of machine tools;
- Bearings of spindles of grinding wheel assemblies;
- Slides of machine tools.

6.3.1. **Hydraulic systems of surface-grinding machine tools** are treated in accordance with procedure No. 3 of the present Manual.

6.3.2. **Bearings of spindles of grinding wheel assemblies**, which works in oil reservoirs, are treated in accordance with procedure No. 6.1 (item 6.1.3).

6.3.3. **Slides of surface-grinding machine tools** are treated in accordance with procedure No. 6.1 (item 6.1.7).

6.4. General treatment procedure of circular grinding machines with the XADO gel-revitalizant.

Operable assemblies of circular grinding machines, which do not have completely worn or damaged parts, are subject to the treatment. The following are mechanisms of circular grinding machines:

- Hydraulic system of the machine tool;
- Gears of the grinding wheel assembly and the workhead; and,
- Slides of the machine tool.

6.4.1. **Hydraulic systems of circular grinding machines** are treated in accordance with procedure No. 3 of the present Manual.

6.4.2. **Bearings of spindles of grinding wheel assemblies and headstocks** working in oil bath are treated in accordance with procedure No 6.1 (item 6.1.3).

6.4.3. **Slides of circular grinding machines** are treated in accordance with procedure No. 6.1 (item 6.1.7).

6.5. General procedure of treatment of internal grinding machines with the XADO gel-revitalizant.

Operable assemblies and mechanisms of internal grinding machines, which do not have completely worn or damaged parts, are subject to the treatment.

- Hydraulic systems;
- Gears of chucking heads and spindle bearings;
- Spindle bearings of footstocks; and,
- Slides in machine tools.

6.5.1. **Hydraulic systems of internal grinding machines** are treated in accordance with procedure No. 3 of the present Manual.

6.5.2. **Gears of chucking heads and spindles of internal grinding machine** working in oil reservoirs are treated in accordance with procedure No. 6.1 (item 6.1.1).

6.5.3. **Slides of surface-grinding machines** are treated in accordance with Procedure No. 6.1 (item 6.1.7).

6.6. General procedure of treatment of centerless grinders with XADO gel-revitalizant.

Operable assemblies of centerless grinders, which do not have parts with 100 % wear and mechanical damages, are subject to the treatment. Such assemblies in centerless grinders include:

- Hydraulic systems of a tool;
- Mechanisms of grinding wheel assemblies and heads of driving plates;
- Reducers of driving devices and gears of gear boxes.

6.6.1. **Hydraulic systems** of centerless grinding machines are treated in accordance with procedure No. 3 of the present Manual.

6.6.2. **Mechanisms of grinding wheel assemblies and heads of driving plates** working in oil reservoirs are treated in accordance with procedure No. 6.1 (item 6.1.1).

6.6.3. **Reducers of driving devices and gears of gearboxes** of centerless grinders are treated in accordance with procedure No. 2 of the present Manual.

6.7. General procedure of treatment of coordinate boring machines with XADO gel-revitalizant.

Operable assemblies of coordinate boring machines, which do not have parts with 100 % wear and mechanical damages, are subject to the treatment. Such assemblies in coordinate boring machines include:

- Spindle assembly;
- Main drive gear;
- Hydraulic system; and,
- Machine tool slides.

6.7.1. **Treatment of coordinate boring machines** is carried out with the XADO gel-revitalizant for steering boosters in three stages without replacement of oil at the consumption norm of 1.2 mL of the Gel per 1 liter of standard oil for one treatment phase.

Measurements of basic performance parameters of the assembly (similar to procedure No. 6.1, item 6.1.3 of the present Manual) are performed before the treatment and after it, if necessary:

- Value of end and radial runouts of a landing surface of a spindle;
- Axial and radial plays (gaps) of spindle bearings;
- Vibration level of bearing assemblies;
- Power consumption or current consumption in idling and at fixed cutting modes;
- Roughness, taper and out-of-roundness of the pilot billet made by the same cutting tool with identical cutting modes.

6.7.2. **Main drive gears** of coordinate boring machines are treated in accordance with procedure No. 6.1, item 6.1.2.

6.7.3. **Hydraulic systems** of coordinate boring machines are treated in accordance with procedure No. 3 of the present Manual.

6.7.4. **Slides** of coordinate boring machines are treated in accordance with procedure No.6.1, item 6.1.7.

7. Procedure of treatment of forging hammers and presses with XADO gel-revitalizant.

7.1. Operable assemblies, which do not have parts with 100 % wear and mechanical damages, are subject to the treatment.

7.2. The following assemblies and mechanisms in hammers, presses, and punches are subject to treating with XADO revitalizants:

- Compressors of air hammers;
- Hydraulic systems of hydraulic hammers and presses;
- Slides of forging hammers, presses and title block; and,
- Cylinders of main drives of hammers.

7.2.1. **Compressors of air hammers** are treated in accordance with procedure No. 1 of the present Manual.

7.2.2. **Hydraulic systems of hydraulic hammers and presses** are treated in accordance with procedure No. 3 of the present Manual.

7.2.3. **Slides of forging hammers, presses and title block** are treated in accordance with procedure No. 6.1 (item 6.1.7).

7.2.4. **Cylinders of main drives of hammers** are treated in 3 stages by adding the XADO gel-revitalizant for compressors and bearings to lubricating systems of cylinder and piston groups - 1.2 mL of the Gel per 1 liter of lubricating oil per one treatment phase.

The first treatment stage:

A) Pour a small amount of oil (1 part of the introduced gel per 5-10 parts of oil) heated up to 40-60°C in a separate bulb. Add the calculated quantity of the XADO gel-revitalizant for compressors and bearings (1.2 mL of the Gel per 1 liter of standard oil) in this oil. Mix the components carefully until a homogeneous mixture is obtained.

B) Introduce the prepared mixture to the lubricating system of a disabled unit.

C) Start up the hammer and ensure its total operation during 8 hours in a nominal mode.

The second and third treatment stages are carried out similar to the first stage with an 8-hour interval in the operation of the hammer in a nominal mode.

Treatment of main drive cylinders with the XADO gel-revitalizant is considered completed after 400 hours of the total non-failure operating time of the machine tool from the beginning of the first stage.

If the wear of a cylinder working surface is considerable (or comes to marginal) or there are damages over 0.1 mm deep on a cylinder work surface, additional treatment of the cylinder

work surface is recommended to be performed before carrying out the main treatment by applying a thin layer of the XADO gel-revitalizant for cylinders in the following order:

- Dismantle the cylinder of main drive partially to ensure access to its work surface;
- Wash contamination off the cylinder surface and wipe it dry;
- Apply a thin even layer of the XADO gel-revitalizant on work surfaces of the cylinder by any available way;
- Assemble the cylinder and ensure the reciprocal motion of the cylinder piston during 20-30 minutes in idling.
- Start up the unit and let it run at a nominal mode for not less than 400 hours after its additional treatment through a lubricating system in 3 stages.

Notice:

1. Two stages of treatment of new cylinders of main drive or for those with minor (up to 10 %) wear are sufficient.

8. Procedure of treatment of diesel engines of industrial designation (for tractors, diesel locomotives, vessels, diesel generators etc.) with XADO gel-revitalizant.

8.1. Operable diesel engines including those with turbo-supercharging, which do not have parts with 100 % wear and mechanical damages, are subject to the treatment.

8.2. It is recommended to eliminate oil leakages and reasons for increased oil consumption as burn losses before the treatment.

8.3. Measurements of the basic performance parameters of the engine are carried out if necessary:

8.3.1. Value of compression in each cylinder. It is measured with a compression meter or compressograph. The order of compression measuring is given in Appendix 4.

8.3.2. Combustion pressure in each cylinder. The measurements are taken with a maximeter (for example, type KY model 55201 for diesel locomotive engines). The order of realization of combustion pressure measuring in the engine cylinders is given up in Appendix 5 of the present Manual.

8.3.3. Capacity of consumable fuel in idling or fixed operational modes per a unit of time. The measurements are carried out by determination of differences of fuel residual capacities for a fixed interval of the engine run. It is allowed to perform measurements of an engine non-failure operating time at fixed modes with identical fuel contents.

8.3.4. Oil pressure at fixed engine temperature in idling or definite revolutions.

8.3.5. Engine power. The measurements are taken on a special bench.

8.4. The engines are treated with the XADO gel-revitalizant for diesel engines in three stages without replacing oil according to the following procedure:

8.4.1. Make sure to wash centrifugal filters before the treatment.

- 8.4.2. Warm the engine up to operation temperature.
 - 8.4.3. Introduce the necessary quantity of the XADO gel-revitalizant in oil filler of the engine (on the basis of 0.9 ml per 1 liter of a standard oil per one stage).
 - 8.4.4. Start the engine up and let it run in idling not less than 2 min.
 - 8.4.5. Continue running of the engine in a nominal mode without overloads.
 - 8.4.6. Start up the following treatment phase of the engine after 8 motor-hours engine operation.
- 8.5. The second and third treatment phases of the engine are carried out pursuant to requirements of items 8.4.2 - 8.4.5.
- 8.6. Treatment of the engine is considered completed after total non-failure operating time not less than 400 motor-hours from the beginning of the first treatment phase.
- 8.7. Measuring basic performance parameters of the engine indicated in item 8.3 after finishing the engine treatment, as required,
- 8.8. If cylinders wear is considerable (comes to marginal) or there are damages with the depth of more than 0.1 mm on a work surface of cylinders, before starting the main treatment, it is recommended to realize an additional treatment of the cylinder work surface by applying a thin layer of the XADO gel-revitalizant for cylinders in the following order:
- 8.8.1. Partially dismantle the engine providing access to the work surfaces of cylinders.
 - 8.8.2. Wash off contamination from the surfaces and wipe them dry.
 - 8.8.3. Apply a thin even layer of the XADO gel-revitalizant for cylinders onto the work surface of the cylinders by any possible means – 25 mL of the Gel per 1 liter (1000 cm³) of the cylinder useful capacity;
 - 8.8.4. Assemble the engine and ensure the reciprocal motion of the cylinder piston during 20-30 minutes in idling.
 - 8.8.5. Start up the engine, treat it through a lubricating system in 3 stages (items 8.1 - 8.5 of the present Procedure) and run it in a nominal mode for not less than 400 hours without overloads.

Note.

1. To maintain constant concentration of the XADO revitalizant in a regular oil of an engine, it is necessary to add oil to be burned with an additional amount of the XADO gel-revitalizant for diesel engines into it for the first 200 non-failure operating hours based on the calculation of 0.9 mL per one liter of the added oil.
2. Two treatment stages are sufficient to treat new diesel motors or those with minor (up to 10 %) wear.
3. There should be enough oil for the period of complete cycle of the engine treatment to achieve the maximum effect, i.e. not less than 400 motor-hours.
4. Additional (supplementary) filtering elements in the lubricating system of an engine can lower the revitalization efficiency.

5. Diagnostics of engines and determination of parts wear rate at available capability are carried out with the help of the procedure of pneumatic testing.

6. Additional treatment of cylinder surfaces with the XADO gel-revitalizant for cylinders, if partial dismantling of the engine is unavailable, is recommended to be performed by applying the Gel on walls of the warmed engine cylinders through an injector's aperture (or glow plug) with any possible means, for instance, with the help of a medical non-rigid PVC pipe.

9. Procedure of treatment of diesel internal-combustion engines with the capacity of an oil system of up to 30 L with XADO gel-revitalizant

9.1. Operable diesel engines (including those with turbo-supercharging), which do not have parts with a 100 % wear and mechanical damages, are subject to the treatment.

9.2. Before the treatment, it is recommended to eliminate leakage and reasons of increased burn-loss of oil.

9.3 In case of necessity to determine the efficiency of the treatment, measure basic work parameters of the engine before and after completion of the full treatment cycle.

9.3.1. Compression value in each cylinder. It is measured with compression meter or compressiongraph. The order of compression measuring is described in Appendix 4.

9.3.2. Amount of used fuel in idling or at fixed work modes per unit of time. Measuring is done by determining the difference between the residual amounts of fuel at a fixed period of engine running. It is permitted to measure time of the engine operation at fixed engines with the same amount of fuel.

9.3.3. Oil pressure at fixed temperature of the engine in idling or at defined revolutions.

9.3.4. Engine power. It is measured at a special bench.

9.4. Diesel engines of vehicles are treated with the XADO gel-revitalizants for diesel engines in three stages without replacing the oil and in compliance with the following procedure:

9.4.1. Warm up the engine until the work temperature.

9.4.2. Introduce the necessary amount of the XADO gel-revitalizant into the oil-filler neck of an engine in compliance with Table 1.

9.4.3. Start up the engine and let it run in idling for not less than 2 minutes.

9.4.4. Continue using the engine in a nominal mode without overloading.

9.5. The second and third stages of the engine treatment shall be done in compliance with item 9.4 after 150-250 km of haulage between the stages.

9.6. Engine treatment is considered to be completed after the haulage of not less than 1500 km from the beginning of the first stage of the treatment.

Note:

1. To achieve the maximum efficiency of the treatment, there should be enough oil for the period of complete cycle of the engine treatment, i.e. not less than 400 motor hours.
2. Additional (supplementary) filtering elements in the lubricating system of an engine can lower the revitalization efficiency.
3. To achieve maximum effect on proving operational parameters of the diesel engine, it is recommended to treat the high-pressure fuel pumps, described in Procedure 11 of the present Manual together with the treatment of the oil system.
4. New engines or those with the wear up to 10 % are treated in one stage in compliance with Table 1 of the present Manual.

Table 1

Oil reservoir capacity of an engine, L	Number of tubes of the XADO gel-revitalizant for diesel engines, pcs	Treatment schedule by stages	Number of tubes to treat a new engine, pcs
3 – 10	3	1 + 1 + 1	2
11 – 20	6	2 + 2 + 2	4
21 – 30	9	3 + 3 + 3	6

10. Procedure of treatment of gasoline four-cycle internal-combustion engines with the capacity of an oil system of up to 30 L with XADO gel-revitalizant

10.1. Operable gasoline engines (including those with turbo-supercharging), which do not have parts with a 100 % wear and mechanical damages, are subject to the treatment.

10.2. Before the treatment, it is recommended to eliminate leakage and reasons of increased use of oil burning.

10.3 In case of necessity and to determine the efficiency of the treatment, measure basic work parameters of the engine before and after completion of the full treatment cycle.

10.3.1. Compression value in each cylinder. It is measured with compression meter or compressiongraph. The order of compression measuring is described in Appendix 4.

10.3.2. Amount of used fuel in idling or at fixed work modes per unit of time. Measuring is done by determining the difference between the residual amounts of fuel at a fixed period of engine running. It is permitted to measure time of the engine operation at fixed engines with the same amount of fuel.

10.3.3. Oil pressure at fixed temperature of the engine in idling or at defined revolutions.

10.3.4. Engine power. It is measured at a special bench.

10.4. Diesel engines of vehicles are treated with the XADO gel-revitalizants for gasoline engines in three stages without replacing the oil and in compliance with the following procedure:

10.4.1. Warm up the engine until the work temperature.

10.4.2. Introduce the necessary amount of the XADO gel-revitalizant into the oil-filler neck of an engine in compliance with Table 1.

10.4.3. Start up the engine and let it run in idling for not less than 2 minutes.

10.4.4. Continue using the engine in a nominal mode without overloading.

10.5. The second and third stages of the engine treatment shall be done in compliance with item 9.4 after 150-250 km of haulage between the stages.

10.6. Engine treatment is considered to be completed after the haulage of not less than 1,500 km from the beginning of the first stage of the treatment.

Note:

1. To achieve the maximum efficiency of the treatment, there should be enough oil for the period of complete cycle of the engine treatment, i.e. not less than 1500 km of haulage.
2. Additional (supplementary) filtering elements in the lubricating system of an engine can lower the revitalization efficiency.

Table 1

Oil reservoir capacity of an engine, L	Number of tubes of the XADO gel-revitalizant for gasoline engines, pcs	Treatment schedule by stages	Number of tubes to treat a new engine, pcs
3 – 10	3	1 + 1 + 1	2
11 – 20	6	2 + 2 + 2	4
21 – 30	9	3 + 3 + 3	6

11. Procedure of treatment of two-cycle internal-combustion engines (motorcycles, boats, and domestic appliances)

11.1. Operable two-cycle engines, which do not have parts with a 100 % wear and mechanical damages, are subject to the treatment.

11.2. Two-cycle engines with an integrated fuel system and lubricating systems are treated by stage-by-stage introduction of the XADO gel-revitalizant for household and motor devices into the fuel tank in compliance with the following procedure:

- 11.2.1. Warm up the engine until the work temperature.
- 11.2.2. Squeeze the contents of one bag into the fuel tank. It is allowed to preliminary dissolve the contents of the bag in a small amount of oil or gasoline at the temperature of 20 °C and introduce the composition into the fuel tank.
- 11.2.3. Use the engine in a nominal mode.
- 11.2.4. Upon consuming the fuel in the fuel tank, fill it up full and introduce the contents of the second bag in a similar mode.
- 11.2.5. The contents of the third bag are introduced in the same way at the next refueling.
- 11.2.6. The treatment of the engine is considered to be completed upon the non-failure operating time of not less than 30 hours or the haulage of not less than 1500 km.
- 11.3. Two-cycle engines with separated fuel systems and lubricating systems are treated by stage-by-stage introduction of the XADO gel-revitalizant for household and motor equipment into the lubricating system of an engine in compliance with the following procedure:
 - 11.3.1. Warm up the engine until the work temperature.
 - 11.3.2. Squeeze the contents of one bag into the oil-filling neck. It is allowed to preliminary dissolve the contents of the bag in a small amount of oil at the temperature of 40 °C and then introduce the composition into the lubricating system of the engine.
 - 11.3.3. Start up the engine and let it run in idling for 2 minutes.
 - 11.3.4. Run the engine in a nominal mode.
 - 11.3.5. When the non-failure operating time of the engine is not less than 3 hours or the haulage is 150-250 km, the second bag with the gel is introduced in the similar way into the lubricating system of the engine.
 - 11.2.6. The treatment of the engine is considered to be completed upon the non-failure operating time of not less than 30 hours or the haulage of not less than 1500 km.

Note:

1. When treating engines with the useful capacity of over 1.0 L (1,000 cm³), double the recommended dose.

12. Procedure of treatment of high-pressure fuel pumps (HPFPs) with XADO gel-revitalizant.

- 12.1. Operable high-pressure fuel pumps of any types, which do not have parts with 100 % wear and mechanical damages, are subject to the treatment.
- 12.2. It is recommended to treat HPFP's with the fuel that corresponds to the season!
- 12.3. Order of HPFP's treatment is as follows:
 - 12.3.1. Treatment of HPFP's is carried out with the XADO gel-revitalizant for HPFP's in one stage by depositing the necessary quantity of the Gel into a fuel tank.

12.3.2. Prepare the necessary quantity of the XADO gel-revitalizant pursuant to Table 1 depending on the engine useful capacity and introduce into the fuel tank with a minimum amount of fuel.

12.3.3. Fill the tank with fuel.

12.3.4. Let the engine run in a nominal mode.

12.3.5. Revitalization is considered finished after 80 motor-hours of the mechanism or 4000 km of haulage.

Note:

1. Improvement of the operation (abatement of noise, vibrations, and exhaust opacity) already after 10 hours of HPFP's work is a characteristic attribute of the revitalization beginning.
2. It is necessary to double the recommended norm in case of strong wear of the mechanism (more than 50 %).
3. If, after 10 hours of operating time, improvement does not take place, the most probable cause is an error in diagnostic.
4. Additional (supplementary) filtering elements can lower down the efficiency of the revitalization.

Table 1.

**Consumption rate of XADO gel-revitalizant
for HPFP's of industrial diesel engines**

Useful capacity of diesel engine, L	XADO gel-revitalizants for HPFP's per a fuel tank (9 mL tubes), pcs
Up to 5	1
5-15	2
15-30	3
30-75	4
75-100	5
100-140	6
140-175	7
175-200	8
200-225	9
225-260	10
260-300	11

Consumption rate of XADO gel-revitalizant per 1 liter of standard oil to treat industrial equipment and internal-combustion engines having with the capacity of oil systems of over 30 liters

No.	Treated Mechanism	XADO gel-revitalizant	Amount of the XADO gel-revitalizant per 1 liter per one treatment stage	Number of treatment stages
1	Compressors of piston types	Gel-revitalizant for compressors and bearings	1.2	3
2	Turbo-compressor	Gel-revitalizant for compressors and bearings	0.9	4
3	Industrial reducers	Gel-revitalizant for gear clusters and reducers	3.0	3
4	Gear clusters and transmission units for vehicles with the engine useful capacity up to 5.0 liters	Gel-revitalizant for gear clusters and reducers	6.0	1
5	Hydraulic systems of industrial designation	Gel-revitalizant for steering boosters	1.0	3
6	Bearings, working in oil reservoirs	Gel-revitalizant for compressors and bearings	1.2	3
7	Diesel internal-combustion engines (capacity of oil system over 30 L)	Gel-revitalizant for diesel engines	0.9	3
8	High-pressure fuel pumps	Gel-revitalizant for high-pressure fuel pumps	Table 1	1
9	Cylinders of internal-combustion engines	Gel-revitalizant for cylinders	25 mL per 1 liter of cylinder useful capacity	1

Procedure for recovery repair of axial- and radial-piston hydraulic machines on a hydraulic test bench with XADO gel-revitalizant

Hydraulic machine treating with the XADO revitalizants at marginal wear of over 100 % (the decrease of capacity performance factor exceeds 15-18 %) is inexpedient.

Diagram of a test bench for pumps restoring repair

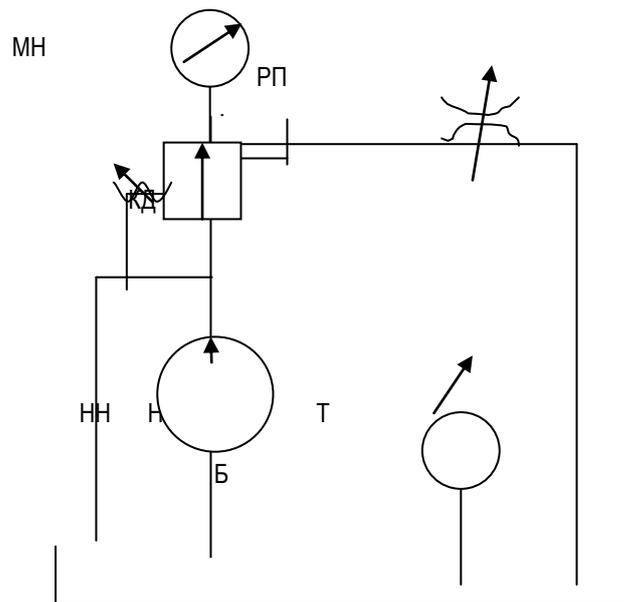
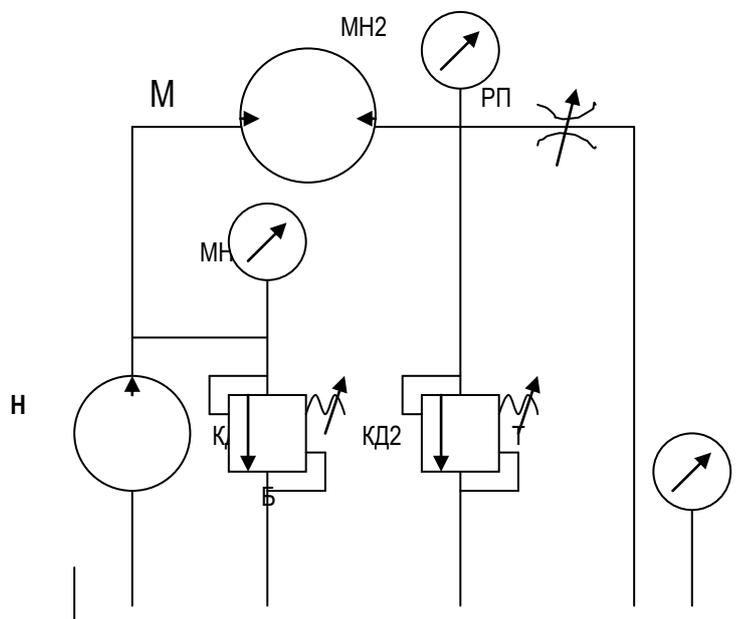


Diagram of a test bench for recovering repair of hydraulic motors



where H - pump to be repaired; MH - manometer;
M - hydraulic motor to be repaired; T - thermometer;
ПП - flow regulator; Б - tank with oil;
КД - pressure valve;

1. It is necessary to carry out measuring of the following basic controlled performance parameters of hydraulic motors:

- working pressure in the system;
- full efficiency factors for hydraulic motors (by measuring leakages from drain ports);
- mechanical wastage for hydraulic motors (according to pressure difference); and,
- productivity.

Check-up of parameters shall be monitored at various operation and temperature diagnostic modes (performance characteristics of hydraulic machines are determined at 30°C by the manufacturer).

2. Capacity of hydraulic fluid (oil) for the hydraulic test bench is determined based on the following formula:

$$V_M = 100 V_H$$

Where V_H – useful capacity of a hydraulic machine (L),

V_M – capacity of oil in the test bench oil tank (L), but not less than 35 L.

3. Oil operating temperature should be maintained within 40 - 60°C.

4. Quantity of the XADO Gel for hydraulic systems is determined based on 1 mL per 1 liter of operating fluid per one stage.

5. The treatment is carried out in 3 stages with an 8-hour interval. Two stages of the treatment are sufficient for new hydraulic machines (with purpose of time reducing and running-in quality increase, higher technical parameters reaching, as well as to increase wear-resistance and friction pair life duration).

6. It is recommended to provide load conditions for a hydraulic machine during the treatment with the XADO revitalizants as follows:

The 1-st stage of treatment:

0 – 2 hours $P = 0.5 P_{nom}$;

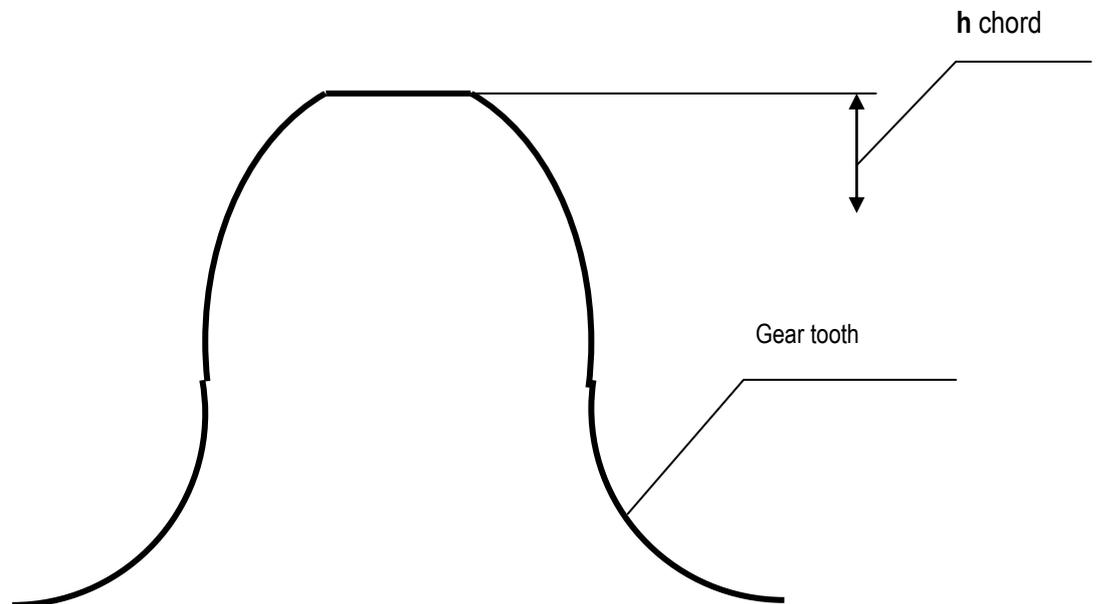
2 – 8 hours $P = 1.0 P_{nom}$;

The 2-nd and 3-rd stages of the treatment are carried out similar to the 1-st stage.

Rotation frequency of a hydraulic machine during the treatment should be 80 – 85 % from the nominal frequency of rotation.

7. Complete cycle of the treatment shall make not more than 350 hours from the beginning of the first stage.

DIAGRAM
Of measuring tooth thickness of involute straight gear



Tooth thickness (S_{tooth}) is measured on the constant chord, the height (h_{chord}) of which is determined for straight and oblique spur involute straight gear is determined based on the following formula:

$$h_{\text{chord}} = 0.748 m, \text{ where } m - \text{tooth module.}$$

Measuring of tooth thickness is done with the help of gear tooth calipers: $\sqcup 3H$ type, performance specification TY 2-034-773-89 (or other types).

Notice!

Measuring of tooth thickness along the pitch circle chord is allowed.

Measuring of compression in cylinders of internal-combustion engines

1. Warm the engine up to working temperature.
2. For gasoline engines, detach pipes from plugs and take them aside; turn off the Hall sensor, stop fuel supply to the cylinders, and unscrew all the plugs.
For diesel engines, detach from sprayers and avert high-pressure delivery pipes. Do not bend them sharply (it is recommended to detach delivery pipes both from sprayers and from high-pressure fuel pipes).
3. In case of the presence of unit injectors, they should be dismantled before compression measuring.
4. In diesel engines with swirl-chamber carburetion (indirect-injection diesel engines), it is enough to unscrew filament plugs before measuring compression.
5. Turn the crankshaft of the engine with a starter or any other driver (motor-generator, etc.) to remove particles of scale, unburned fuel, etc. from the engine cylinders.
6. Join the compression meter to wholes for sprayers or filament plugs through a special adapter (it is a part of the compression meter set).

Note.

1. A casing of a used sprayer can be used as an adapter. At that, it is necessary to take out a pulverizer, springs, shims, etc. Insert the casing of the sprayer in its normal position and fix it, then attach the compression meter to the outlet of the fuel injection pipe.
7. Turn the engine with a starter or with any other driver (motor-generator, etc.) until the indicator of a compression meter stops indicating pressure increase. At that, crankshaft rotation frequency must not considerably differ from the starting 150 – 250 rpm.
8. Record indications of a compression meter, null them and start measuring other cylinders following the same procedure.

Procedure of combustion pressure measurement in cylinders of diesel engines

1. Warm up the engine to working temperature.
2. Set the engine revolution speed, when maximum power is achieved, and create load for the engine.
3. Attach a maximeter to an engine cylinder through a special gauging valve. If such a valve is lacking, install it when the engine is disabled.
4. Open the valve tap of the first cylinder and record maximum readings of the manometer.
5. Close the valve and dismount the gage.
6. Null the indications of the maximeter.
7. Measure combustion pressure in other cylinders following the same procedure.