POSITIVE DISPLACEMENT FLOWMETERS

MOD.

INSTALLATION OPERATION AND MAINTENANCE

PETROL INSTRUMENTS S.r.l. - 04011 APRILIA (LT) - ITALY
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General

"PETROL" PD flowmeters are instruments capable of measuring the volume of flowing liquids with a standard accuracy of ± 0.5% of reading for general purposes and of ± 0.2% of reading for fiscal transactions.

"PETROL" PD flowmeters have been employed since many years by different industries (such as ship-building, steel making, power generation plants, refineries and depots, chemical, pharmaceutical, textile industries etc.) of many countries and have always satisfied the users for their good performances and dependable service during the years.

This manual has been prepared for people responsible of their installation and, at the same time, for people responsible of their maintenance and service.

INVOLVED PERSONNEL ARE KINDLY REQUESTED TO READ CAREFULLY THE PRESCRIPTIONS CONTAINED IN THIS MANUAL, MAINLY THOSE RELEVANT TO PD FLOWMETERS INSTALLATION BEFORE THEIR START-UP.
PD flowmeters are mainly composed of the measuring unit assembly and of the reading unit (see dwg.1).

The reading unit, available in different models, is that required for the specific application.

The measuring unit assembly is composed of three main sub-assemblies, namely:

- The outer housing;
- The inner housing assembly;
- The coupling assembly.

The outer housing is the part that withstands the liquid pressure and its construction is in accordance to maximum expected pressure of flowing liquid.

The inner housing assembly is the part that accurately measures the volume of flowing liquid through the revolutions of the rotors ("roots" type mechanism).

The coupling assembly is the part through which the number of rotors revolutions is transmitted to the reading unit where are displayed the volumes metered.
3 Application Limits

PD flowmeters must be used only within the limits specified in the name-plate, i.e. only for the liquid, the flow rate, the temperature, the max pressure and the viscosity specified in the name-plate (see dwg.1).

IT IS THEREFORE REQUESTED TO ACCURATELY CHECK THE NAME-PLATE BEFORE FLOWMETER START-UP.
mod. 51, 11, 12, 22, 53, 13, 14, 24

mod. 16, 18, 28

Name-Plate

Reading Unit

dwg.1 - PD Flowmeters
4

Installation Instructions

PRECAUTIONS

The majority of PD flowmeters failures are caused by infiltration of solid particles from the outer housing flanges during "inoperative conditions".

It is therefore very important:

• to remove the flanges protection only immediately before the instrument installation;
• to absolutely prevent the entering of solid particles into the measuring unit assembly during installation.

INSTRUCTIONS

1. During flowmeter installation avoid that deformation and/or stresses are induced into the outer housing from the connecting pipes. If threaded holes for anchoring purpose are available on the PD flowmeters outer housing, provide for a strong anchoring to avoid vibrations;

2. Check that actual flow direction is the same indicated by the arrow stamped on the flowmeter outer housing and/or is in accordance to the "in" and "out" nameplates attached to the inlet and outlet flanges of the flowmeter itself;

3. The PD flowmeter must be mounted with the rotor shafts in horizontal position and the counter dial must be in a vertical position (see dwg. 1a). In any case, on the glass of the counter are glued several drawings which clearly show the correct mounting position of the PD flowmeter. In case the counter dial is required to be positioned horizontally or inclined at 45°, the flowmeter will be equipped with a proper 90° or 45° angle adaptor.
dwg. 2a

Flow Direction

Valve
Strainer
PD Flowmeter

By-pass

dwg. 2b

Flow Direction

Valve
Strainer
PD Flowmeter

By-pass

dwg. 2c

Flow Direction

PD Flowmeter
Strainer
By-pass

dwg. 2d

Flow Direction

Valve
Strainer
PD Flowmeter

By-pass

dwg. 2e

Flow Direction

Air Eliminator
Valve
PD Flowmeter

By-pass

dwg. 2 - Installation Examples
4

Installation Instructions

4. For the measure of very viscous liquid at ambient temperature it is recommended to provide heating for both the line and the flowmeter (if necessary jacketed type PD flowmeters are available).

5. It is recommended to provide enough space on the rear side of flowmeter (i.e. on the opposite side of the reading unit) for rear-cover removal as well as for inner housing assembly removal (dwg. 2a).

6. It is good practice to install a strainer just before the flowmeter. However if plant configuration does not permit the direct coupling of flowmeter and strainer, it is imperative to clean thoroughly, before flowmeter installation, the spool pipe used for strainer and flowmeter connection.

7. In case of new lines and specially in case of new and long lines, flush accurately the lines themselves, by pumping liquid, before flowmeter installation, should such operation be impractical, remove the inner housing assembly from outer housing during the start-up.

INSTALLATION EXAMPLES

1. Wherever possible, install the flowmeter on a by-pass, as shown in dwg. 2b and dwg. 2c for its easier disassembly and inspection.

2. When an appreciable quantity of solid particles is expected to be present in the flowing liquid, install two strainers in parallel for alternate use as shown in dwg 2d, or install a “duplex” type strainer;

3. When gas bubbles are expected in the flowing liquid, install an air eliminator as shown in dwg.2e.
1. For new lines let the liquid flow through the by-pass in order to completely wash away any scale trace. Scale remaining in the lines might cause unusual wear of bearings and of timing gears;

2. In case PD flowmeter is not installed on a by-pass or in case the line doesn’t have a by-pass, remove the inner housing assembly from the PD flowmeter outer housing flanged to the piping and let the liquid flow through the line until the line itself is completely clean and any trace of scale has been washed away. Once the line flushing has been completed, re-install the inner housing assembly into the outer housing and proceed with the PD flowmeter start-up.

3. To start-up flowmeter open first the inlet valve and then open slowly the outlet valve.

4. In case of Jacketed PD flowmeter in order to avoid any damage to the instruments, the operator has to be sure that the heating liquid or vapour has already properly heat the liquid to be measured.

AVOID TOO HIGH FLOW RATES AS WELL AS TOO SHORT OPENING AND/OR CLOSING CYCLES.
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Start-up and Operating Instructions

4. During initial service periods check frequently the strainer screener, eventually cleaning it to avoid clogging.

5. PD flowmeters maintain an high accuracy for long periods of time when operating within the flow rate range for which they have been realized. It is recommended to operate the flowmeter only within the flow rate limits specified in the name-plate.

6. If flowmeters are installed in cold places and so coben measuring water in such cold places, it is recommended, once the measuring cycle has been completed, to drain completely, through the proper drain plugs, the liquid remained inside the instrument to avoid damages to the housing and/or rotors deformations due to liquid freezing.

7. Should the line where the PD flowmeter is installed be subject to periodic flushing with high temperature steam and/or vapor, it is strongly recommended during the flushing phase, that inner housing assembly is removed from the outer housing flanged to the piping, to avoid that sudden mechanic and thermic shocks may damage the components of the measuring mechanism.
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Failure Analysis

Failure of the flowmeter reading unit may be caused by:

1. Solid particles inside the inner housing assembly;

2. Rotors interference due to excessive wear of bearings and/or of timing gears;

3. Failure of movement transmission system due to:
   - excessive wear of transmission gears for models 51, 11, 12, 22, 53 and 13 or of fork-type coupling for models 14, 24, 16, 18 and 28;
   - wear of magnetic transmission components;

4. Misoperation of the reading unit.

In case of flowmeter reading unit failure it is necessary to inspect the instrument following step-by-step the listed maintenance procedures, replacing, where needed, damaged parts with new parts.
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**Inspection Procedures**

**models 51-11-12-22-53-13-14-24**

1. To check the measuring unit assembly it is convenient to inspect at first the inner housing assembly.
   To do that it is enough to remove the flowmeter rear cover and check, by hands, whether the timing gears rotate freely or not (dwg. 3a).

2. In case the timing gears rotate freely and the counter does not move, it is necessary to check the transmission system and the reading unit.
   The reading unit, mainly composed of the reduction gear assembly and of the counter, may be easily inspected removing the counter itself, which may be of standard type or of an equivalent type. In any case the counter is removed unscrewing the four bolts as shown in dwg. 3b.
   If the counter rotate freely it is necessary to rotate again the timing gears of the inner housing assembly to check whether the trouble is in the reduction gear assembly, which can now be easily inspected, or in the magnetic transmission.
   Should be necessary to inspect the magnetic transmission it is suggested to remove the inner housing assembly following the procedures mentioned under following item 3.
   Doing that it is also possible to inspect the transmission gears for models 51, 11, 12, 22, 53 and 13 or the fork-type coupling for models 14 and 24. Magnetic transmission is then removed unscrewing the eight bolts which provide its coupling to the front cover of the outer housing.
dwg. 3a

Reduction Gear Assembly

Mounting Bolts

Counter

Inner Unit Assembly

Outer Rear Cover

Side-Plate Bolts

Rotors

Guide

dwg. 3c

dwg. 3b

dwg. 3d

dwg.3 - Inspection Procedures
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**Inspection Procedures**

*models 51-11-12-22-53-13-14-24*

3. At contrary, should the rotation of timing gears be not free and uniform, it is necessary to pull-out the inner housing assembly from the outer housing and to proceed to its inspection. Inner housing assembly is pulled-out from the outer housing taking it from the timing gears (dwg. 3c). Should such operation results difficult, do not force on timing gears because the bearings might be damaged. In this case please use the two threaded holes, worked-out in the inner rear cover close to the timing gears, on which the bolts of the outer housing rear cover may be mounted. Once the inner housing assembly is removed it is possible to provide to its maintenance in accordance to the procedures mentioned under item 9.

4. The PD flowmeter re-assembly is made just reversing the disassembly procedures. It is the case to point-out that the inner unit assembly is equipped with an its own "anti-rotational" pin having its seat in the outer housing front cover. In re-positioning the inner housing assembly inside the outer housing it is necessary that this coupling is correctly made. Furthermore before mounting the rear cover of the outer housing check that the counter is properly operating by rotating the timing gears with the hands. It is also recommended to replace the PD flowmeter gaskets before its mounting.
The measuring unit is shown as exploded view in dwg. B.

The numbers mentioned in the drawing, and which will be referred to hereinafter, are those identifying the components listed in the legend.

To check the reading unit, mainly composed of the reduction gear assembly and of the counter, disassembly the adaptor of the counter (82) unscrewing the relevant fixing bolts (81). In this way either the reading unit either the magnetic transmission are removed and can be therefore easily inspected.

It is just the case to mention that the counter is disassembled from the reading unit unscrewing the relevant four fixing bolts.

Should the reading unit and the magnetic transmission be properly operating it is necessary to check the measuring unit. To do that it is necessary to remove the outer front cover (72) of the PD flowmeter, unscrewing the relevant fixing bolts (79).

In this way either the fork-type movement transmission system either the timing gears of the inner housing assembly can be inspected. It is therefore possible to check if the timing gears rotate freely and steadily.

In case the rotation of the timing gears is not free and steady it is necessary to pull-out the inner housing assembly from the outer housing to proceed to the relevant inspection and maintenance.
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Maintenance
models 51-11-12-22-53-13-14-24

The inner housing unit is shown as exploded view in dwg. A.

In case the rotation of the rotors is not free and uniform it is necessary to check the following:
1. eventual wearing of the timing gears;
2. eventual wearing of the bearings, normally evidenced by an excessive clearance between rotors shafts and the relevant bearings;
3. rotors axial clearance, which shall be of few centesimal units;
4. eventual solid particles between the rotors preventing their rotation.

To check the rotors conditions it is necessary to disassemble the inner housing assembly into its main components. To do that, it is enough to unscrew the inner housing cover, timing gears side, and remove it from the inner housing assembly together with the rotors, as a single sub-assembly (dwg. 3c). Before doing this operation it is necessary for PD flowmeters mod. 51 and mod. 11 to remove the rotor gear positioned on the front cover side of the inner housing assembly.

It is now possible to check:
1. the actual conditions of the rotors and eventually eliminate any seizing marks;
2. the actual conditions of the bearings, either those mounted on the inner unit assembly front cover either those mounted on the inner unit assembly rear cover;
3. the actual conditions of the inner surface of the front and of the rear covers, and eventually eliminate any seizing marks;
4. the uniformity of rotor shafts dimensions, front cover side, in their coupling to the bearings.
dwg. 4a

Lapping Bar

Surface Plate

Sandpaper

dwg. 4b
dwg. 4c

dwg.4 - Maintenance Procedures
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Maintenance
models 51-11-12-22-53-13-14-24

In case even the front cover of the inner unit assembly has to be inspected, it is enough to remove it unscrewing the relevant fixing bolts. In making the maintenance of the inner housing assembly it is recommended not to disynchronise the rotors, if possible. To do that and in case it is necessary to check and/or to replace the timing gears, it is convenient to clamp on a vise the sub-assembly rear cover-rotors (dwg. 4a), inserting between the rotors a thickness gauge of some centesimal units, that, in case of need, may be also replaced by a simple paper. In case the rotors have to be disassembled, for example for their replacing and/or to check the uniformity of the rotors shafts dimensions and/or to check the dimensions of the rotors themselves and/or for rear cover bearings replacement, it is suggested to proceed as follows when re-assembling the inner housing assembly.

1. install separately the two rotors inside the inner housing and check that they rotate freely;
2. install contemporarily the two rotors inside the inner housing and check that they do not interfere;
3. in the conditions of the above item 2) mount the first timing gear on its shaft;
4. to mount the other timing gear proceed as follows:
   a) block the rotor on which the first timing gear has been already mounted with a soft material;
   b) push with hands the rotor on which the timing gear has to be mounted against the other rotor, inserting between them a thickness gauge of about 0.1 mm;
   c) in the conditions of the above item b) mount the second timing gear;
   d) check that the clearances between the rotors and between the rotors themselves and the inner housing are uniform;
   e) In case the bearings have been replaced it is recommended that the same are aligned with a proper lapping bar (dwg. 4b) and that the inner surface of the covers has been made perfectly plane (dwg. 4c).
The inner housing is shown as exploded view in dwg. B. To disassemble the rotors it is recommended to proceed in the following way:

- remove the inner cover (50), timing gears side, unscrewing the relevant fixing bolts (66);
- remove the shaped rotors plate (48) unscrewing the relevant fixing bolts (49). To do that it is necessary to slightly push upward the rotors to avoid that the plate may damage, by blowing, the centering pins between body and cover (13);
- mark the relative position of timing gears by making a recognizing sign on them. Such marking is necessary for the correct re-assembly of rotors;
- pull-out the rotors from inner housing assembly, using the timing gears as pullers.

The actual conditions of the rotors and the wear conditions of the timing gears and of the bearings may now be properly evaluated.

It is just the case to mention that rear cover is disassembled following the same procedures mentioned hereinabove.

The purpose of the timing gears is to synchronise the rotors and their relative position is established by the centering pins (34).

Should timing gears be replaced it is recommended to use particular care in the re-positioning of the new gears.

The timing gears are removed by unscrewing the relevant fixing bolts (37).
8 Maintenance models 16-18-28

Should be necessary to replace the bearings (22, 59), those must be removed from the relevant covers together with the bearing holders (23, 60). To facilitate such operation it is, recommended to mount a screw on the threaded holes of the bearing holder and to use them to remove the system bearing/ bearing holder.

Inner housing re-assembly procedures are just the reverse of rotors disassembling procedures above mentioned.

However the utmost care and attention must be placed to the following points:

- check that the clearances, i.e. the distance between the rotors and the distance between the rotor and the inner unit body are uniform;
- check that rotor position is that corresponding to the recognizing marks previously made on the timing gears.

The PD flowmeter re-assembly procedures are just the reverse of the disassembly procedures above mentioned for the check of the measuring unit assembly and of the reading unit.

The utmost care must however be put in re-assembly the outer front cover to avoid damages to the fork-type coupling (43, 45) between the inner housing assembly and the reading unit.
Spare Parts

Parts found worn or damaged must be replaced with new parts, to order spare parts make reference to the attached exploded-view drawings.

When placing the order please specify:

a) flowmeter model, printed on the name plate;

b) flowmeter serial number, printed on the name plate;

c) item number and description of the parts, as mentioned in the attached exploded-view drawings (dwg. A and dwg. B).
10 Storage

PD flowmeters are normally supplied packed inside wooden cases that may be easily handled without damaging the instruments.

For cases handling all types of motor machinery and/or hand machinery generally available at storage houses may be used.

It is however recommended to avoid cases superimposing except in case of equal dimensions and similar gross weight.

No special precautions have to be taken for short periods of storage. It is however recommended that cases are possibly stored in a closed warehouse and anyway not left in open areas exposed to rain, sand and wind.

In case of long periods of storage, cases must be stored in a closed warehouse. In addition, PD flowmeters maintenance procedures must be strictly followed immediately after equipment unpacking and/or immediately before their installation and/or start-up.

It is in any case imperative that at least the measuring units are removed from the outer housings and duly checked according to their specific maintenance procedures, before PD flowmeters start-up.
## Troubleshooting Table

### FAILURES FOR PD FLOWMETERS WITH MECHANICAL COUNTER

<table>
<thead>
<tr>
<th>FAILURE</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>The liquid flows regularly but the PD flowmeter does not count</td>
<td>Mechanical counter failure</td>
<td>Check the correct operation of the mechanical counter</td>
</tr>
<tr>
<td></td>
<td>Connection between magnetic transmission and mechanical counter</td>
<td>Check the correct operation of the reduction gear assembly</td>
</tr>
<tr>
<td></td>
<td>Connection between PD flowmeter and reduction gear assembly</td>
<td>Check the correct operation of the magnetic transmission</td>
</tr>
<tr>
<td>The liquid does not flow through the PD flowmeter</td>
<td>Rotors failure</td>
<td>Disassemble and inspect the rotors</td>
</tr>
<tr>
<td></td>
<td>Foreign bodies stuck between the surfaces of the rotors</td>
<td>Remove foreign bodies and restore the surface of the rotors.</td>
</tr>
<tr>
<td></td>
<td>Timing gears blocked</td>
<td>Check the correct operation of the timing gears</td>
</tr>
<tr>
<td></td>
<td>Strainer clogged</td>
<td>Clean the strainer</td>
</tr>
<tr>
<td>The liquid leaks from the junction between the front cover and / or rear and the body</td>
<td>O-ring damaged; cover screws not properly screwed</td>
<td>Replace the O-ring and tighten the screws of the covers</td>
</tr>
<tr>
<td></td>
<td>Lack of accuracy</td>
<td>Replace the bushings and / or timing gears</td>
</tr>
</tbody>
</table>
## FAILURES FOR PD FLOWMETERS WITH ELECTRONIC COUNTER

<table>
<thead>
<tr>
<th>FAILURE</th>
<th>CAUSE</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>The liquid flows regularly but the PD flowmeter does not count</td>
<td>Electronic counter failure</td>
<td>Check the correct operation of the mechanical counter</td>
</tr>
<tr>
<td></td>
<td>Connection between magnetic transmission and mechanical counter</td>
<td>Check the correct operation of the pulse transmitter</td>
</tr>
<tr>
<td></td>
<td>Connection between PD flowmeter and reduction gear assembly</td>
<td>Check the correct operation of the magnetic transmission</td>
</tr>
<tr>
<td>The liquid does not flow through the PD flowmeter</td>
<td>Rotors failure</td>
<td>Disassemble and inspect the rotors</td>
</tr>
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<td>Foreign bodies stuck between the surfaces of the rotors</td>
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</tr>
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<td>The liquid leaks from the junction between the front cover and / or rear and the body</td>
<td>O-ring damaged; cover screws not properly screwed</td>
<td>Replace the O-ring and tighten the screws of the covers</td>
</tr>
<tr>
<td>Lack of accuracy</td>
<td>Bushings and / or timing gears worn</td>
<td>Replace the bushings and / or timing gears</td>
</tr>
</tbody>
</table>
# "A" Spare Parts List

models 51-11-12-22-53-13-14-24-16-18-28

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body of the instrument</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cover of the instrument</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Motor assembly</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Gear assembly</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Transmission assembly</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Sensor assembly</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Connection assembly</td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**
- **Legend:**
  - Body
  - Motor
  - Gear
  - Transmission
  - Sensor
  - Connection

**Notes:*
- Always use genuine parts for replacement.
- Ensure all parts are securely tightened.
- Refer to the product manual for detailed installation instructions.