VPAF 100 – Analysis Kit
INSTRUCTION GUIDE

Introduction

In hydraulic fluid power systems, power is transmitted through a liquid under pressure within a closed circuit.

The use of more and more sophisticated devices forces users to keep fluids under control, particularly in monitoring solid contamination.
The presence of solid contamination causes wear, less efficiency and life components reduction with not reliable functioning.

Fluids generally used in fluid power systems are:

1. Mineral oil – Synthetic oil - Vegetable oil
2. Water based emulsions - Water glycol

Their physical and chemical properties are influenced by following parameters:

- ✓ Working pressure
- ✓ Solid particles contamination
- ✓ Liquid contamination (other fluids or water)
- ✓ Modification of original additives

One of the simplest methods to keep fluids under control is to check solid particle contamination; for this reason is useful to have special devices such as a fluid contamination kit.

This manual shows the "*VPAF100*" kit content in order to give some suggestions about a simple and proper use.

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1. Description

Kit "VPAF 100" is assembled to allow static and dynamic fluid sampling in power systems.
The dynamic sampling is possible when the system has special devices such as valves, pressure reduction, points of sampling, etc.

Before making any sampling, system should be on and must have reached the working conditions in order to allow particles in the fluid to be homogeneously mixed both in the tank and the circuit.

1.1 Kit composition

MP ordering code	Description	Quantity
01089042	Bag	1 pz.
01089057	Monocular microscopy 100X	1 pz.
01089031	Electrical vacuum pump	1 pz.
01089032	Glass filtration apparatus ml 250	1 pz.
01089060	Sprinkler 500 ml with Swinnex filter	1 pz.
01089077	Glass Beaker 500 ml	1 pz.
01089061	Manual pump for fluid samples	1 pz.
01089037	Graduated cylinder in 50 ml	1 pz.
01089063	Valve for manual samples collection	1 pz.
01089039	Bottle for solvent fluid 500 ml	1 pz.
01089041	Bottles for sampling fluid 250 ml	3 pz
01089059	Tweezers	1 pz.
01089045	Membrane 0.8 µm ϕ 25 for Swinnex filter	100 pz
01089048	Membrane 1.2 µm ϕ 47 for samples	50 pz
01089062	Minimes tube 1 m	1 pz.
01089067	Minimes tube 2 m	1 pz.
01089065	Labels for bottles	50 pz
01089053	Sheet for membrane ϕ 47	50 pz
01089054	Adhesive for membrane ϕ 47	3 pz.
01089055	Instruction guide	1 pz.

1.2 Principal components technical data

Microscope
- ✓ Monocular microscope.
- ✓ Achromatic lens 10x. (100 magnifications)
- ✓ Focusing with knob.
- ✓ Revolving battery light.
- ✓ Rotating base, with vertical or inclined vision.
- ✓ Anti-dust cover.

Pump

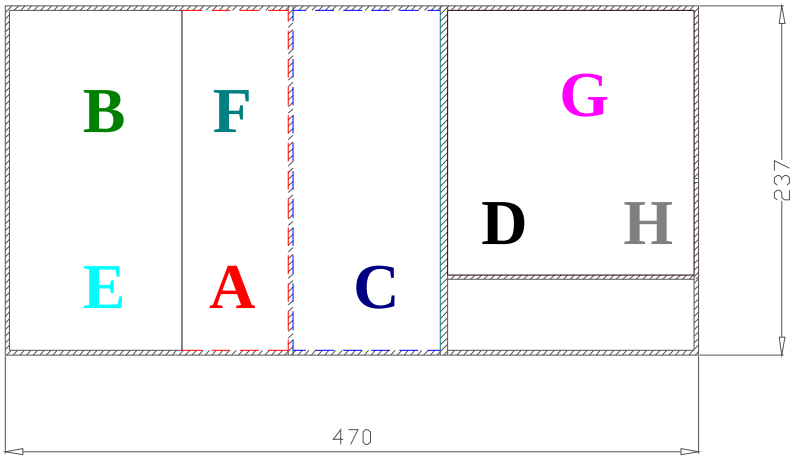
- ✓ single-phase 230 V 50 Hz
- ✓ Power absorbed: 50 W
- ✓ Current absorbed: 0.55 A
- ✓ Fuses: 2 - 1 A

Pumps are designed for:

- ✓ air, gases and vapours from + 5 to + 40 °C
- ✓ Keep purity of fluid also when a high precision is required.
- ✓ Functioning with a maximum overpressure of 2.4 bar.

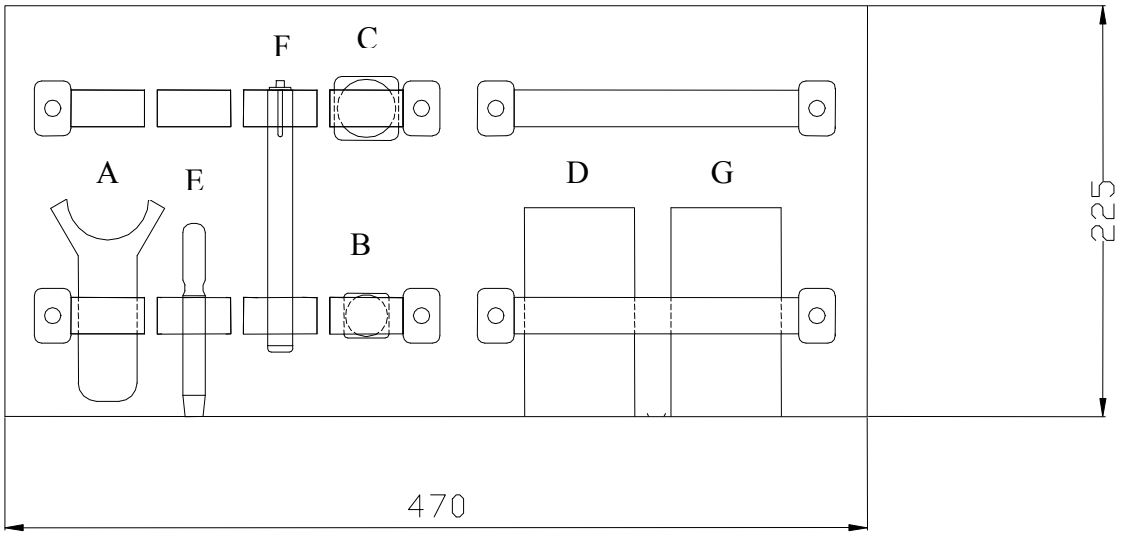
1.3 Kit components disposition (dimensions size 470*237*255)

Components disposition



A Nr. 3 Glass bottles in 250 ml for sample fluid.
B Bottle in 0.5 l.
C Electrical vacuum pump
D Plastic bottle for sample fluid 500 ml.
E Sprinkler
F Accessories
G Microscope
H Graduated cylinder in 50 ml.

Cover components disposition



A bottle-glass filtration apparatus blockage pincers
B Membranes ϕ 25
C Membranes ϕ 47
D Microscope
E Tweezers
F Accessories
G Sheet membrane

2. Use Instructions

Taking samples it is important to know:

- ✓ Plant characteristics (temperature, pressure, finest filtration degree, fluid type and viscosity, total hours of working, irregular functioning, important maintenance activities such as any fluid or pump replacement, etc.).
- ✓ Sampling point (before filter, after pump, from tank, etc.)

Sampling preferential method consists in taking fluid samples from the principal pipe of the hydraulic system while the system is on; in this way solid particles will be representative of contamination in the fluid.

Dynamic sampling should be chosen (when it is possible) instead of static sampling in tanks. [In-line sampling with turbulent flow (Reynolds number Re≥4000) and in plant or machine in working condition]
High-pressure pipe fluid sampling can be dangerous; if during a sampling, fluid penetrates under skin, contact a doctor.

An alternative method of sampling consists in taking a sample from tank of a hydraulic system in working condition. Samples should be taken for a qualitative and quantitative analysis.

Samples should be identified by the operator who takes one or more of them and should compile for each the data sheet and analysis request (see attached request for fluid analysis).
Qualitative and quantitative analysis of solid particles requires accuracy in taking samples and also in making the investigation (microscope observation and particle counting).

2.1 Static samples

Static samples are taken from tank in position α and β .

Samples type β are to be avoided (from balve valve or similar) because even if they are very easy and practical to be taken, they are not reliable concerrning the contamination level of the circuit.
Heavy solid particles can fall down in the tank by gravity, while small light particles may stay in suspension for a long period due to agitation flow of the fluid.

Samples type α (from filler breather, plugs, return filter) can be taken by hand pump at tank midair where the fluid is on movement and not beside the walls (See picture below).
A flexibe pipe is linked to the magnet telescopic stick (to keep metal particles); in this case the hose shouldn't bend or hit the walls.

Two bottles are necessary to take samples :

- Bottle A, to be used for flushing tubes before sampling (it can be re-used with the same function in the next sampling).

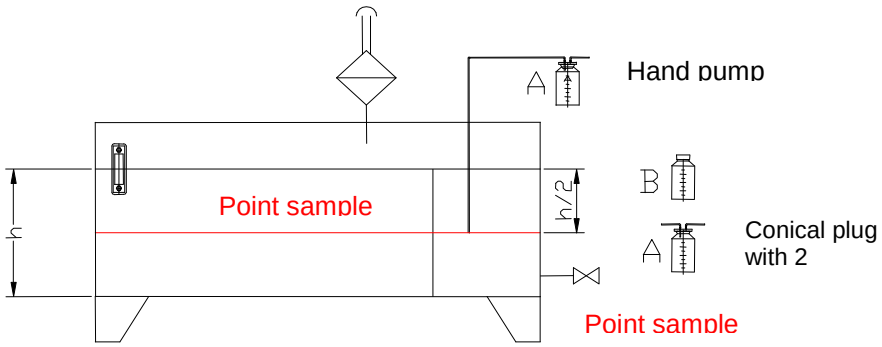
- Bottle B, to be used to collect the sample.

Connect conical plug with 2 rubber connections at the hand pump and bottle; flush flexible hose by pumping 200 ml of filtered solvent. Empty the bottle from solvent.

Draw about 500 ml of fluid with flexible tube and discard this fluid.

Sample a minimum quantity of fluid (at least 75% of bottle volume) using hand pump; keep attention in sampling to avoid environmental and maintenance contamination.

Identify the sample.

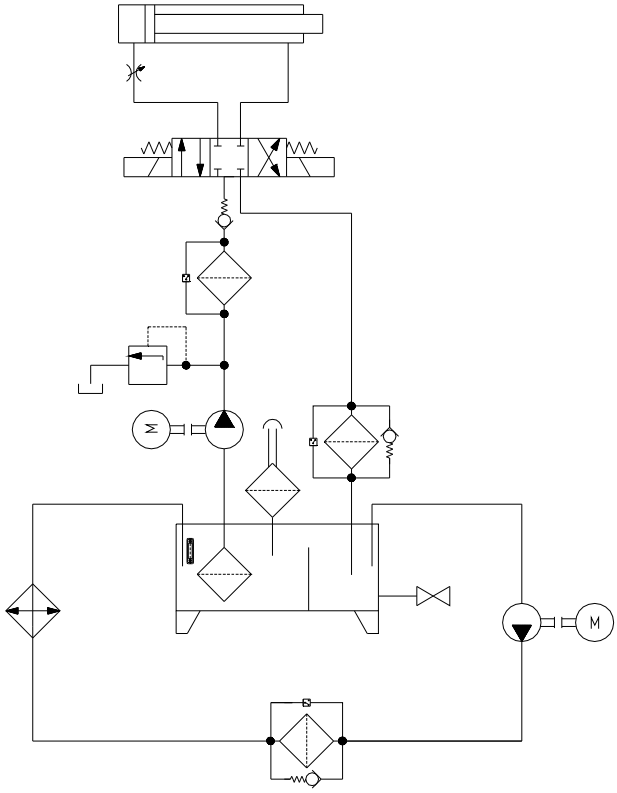


2.2 Dynamic samples

In mobile or stationary plants there are some suitable point sampling (usually mini-mess or valves). Several point for sampling may be available, so it is important to well define the field analysis:

1) To determine contamination classes and filter efficiency (quantitative particles analysis), samples upstream and downstream the finest system filter must be taken; if this type of sampling is not possible due to the lack of devices or difficult points, it could be chosen another point (ex. after pump) comparing critically the different alternatives.

2) To determine the nature of solid contamination, verify the acidity degree of the fluid or water content; in-line sampling is suggested taking in mind the advices above specified.



2.3 Membrane execution

Once taken the sample and made its identification, connect blockage pincers with glass bottle & glass filtration apparatus, rubber adapter, membrane ϕ 47 mm 1.2 μm and electrical vacuum pump.
Shake vigorously sample fluid for at least 1min.
Pour 100 cc of the fluid and turn on the electrical vacuum pump (take schucko socket and adaptor).
When the volume of fluid is filtered, skim membrane with solvent (for instance ether of petroleum) with sprinkler mounting Swinnex filter (use membrane ϕ 25 mm 0.8 μm).
Put adhesive sheet on the membrane using tweezers and set adhesive on the sheet membrane.
Compile the sheet membrane and make a microscope analysis.
Skim accurately glass filtration apparatus with sprinkler mounting Swinnex filter before making any new analysis with a new sample. After, put a new membrane.

2.4 Microscope analysis

Microscope analysis allows determining nature and sizes of solid particles inside the fluid.
Table below shows a statistical list of contaminants inside the fluids.
"**Other**" indicates for example paints, additives precipitation, residuals, etc.
Colour, geometric shape and particles brightness constitute some of parameters to classify contaminants.

Nature of contaminants	
Bright metal	
Dark metal	
Silica	
Rubbers and plast	
Fibres	
Other	

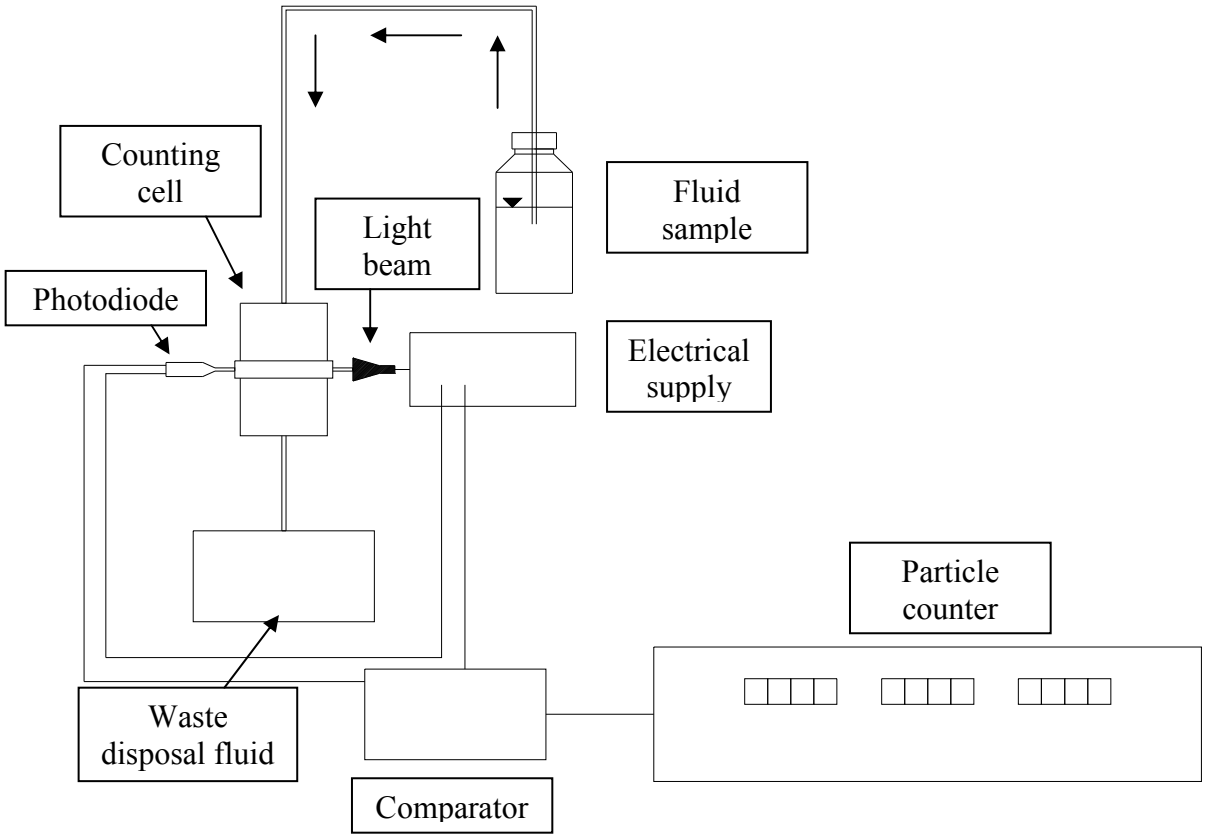
2.5 Particles Quantitative analysis

After determination of the nature (and sizes) of particles inside the fluid, it is useful to know quantitatively contamination inside system.
Determination of quantitative contamination is done or by taking fluid sample from system (preferably in working conditions) and following the sample fluid analysis with automatic particle counter or with portable particle counter that linked directly to the system.
They give immediately results according to standard ISO 4406 or NAS 1638.
Both particle counters, portable or not , have values and counter indications.
Briefly, as a negative point, the portable particle counters need a minimum pressure to work correctly and, as a positive one, they provide immediate results.

As before specified, not always fit pressure point are available on plants or sometimes it is necessary to have adaptors, valves, pressure reducers, etc.

Automatic particle counters used in Laboratory give results on fluid samples in static condition different from the ones on working exercise (decantation of particles, different temperature, different solubility of water and dissolved air, etc.).
Analysis requires caution (agitation, de-aeration of sample, ambient temperature, local conditioning) and must be done by qualified personnel.
This method is historically tested and have not operational and safety problems on plants.

Lab particle counter scheme



Fluid passes through counting cell.
Light emission varies proportionally to different particles sizes and it is revealed by photodiode and transmitted to comparator.

3. Normative references

ISO 4406 Hydraulic fluid power – Fluids - Method for coding the level of contamination by solid particles.

ISO 4407 Hydraulic fluid power – Fluid contamination – Determination of particulate contamination by the counting method using a microscope.

ISO 3722 Hydraulic fluid power – Fluid sample containers – Qualifying and controlling cleaning methods.

ISO 4021 Hydraulic fluid power – Particulate contamination analysis – Extraction of fluid sample from lines of an operating system.

ISO 5598 Fluid power systems and components – Vocabulary.

4. Definitions

Definition list.

Clean bottle for sampling: Bottle sample accurately cleaned and controlled according to ISO 3722.

Fluid sampling, conduit: Sampling of fluid in a section where there is turbulent flow.

Fluid sampling, tank: Sampling of fluid from system tank during working conditions.

Sampler: Device that allows sampling a representative quantity of fluid from hydraulic system.

Turbulent flow: Flow where the particles of fluid in every point quickly vary speed and direction. Flow can be turbulent when Reynolds (Re) number is greater of 2300; it is turbulent when Re≥4000.

$Re = \rho vd/\mu = vd/\nu$
where:

ρ : Fluid density in kg/m^3
v : Average fluid velocity in m/s
d : Pipe internal diameter in mm
μ : Dynamic fluid viscosity in cP
ν : Kinematic fluid viscosity in mm^2/s

Particle dimension: Particle dimension determined with measurement with micrometric ocular with calibrated reticule.

Clean fluid: Compatible fluid with particle counting method and with bottle used and that contains less of 10% particles greater than dimension specified for cleanliness levels required.

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