

Electric Fuel Pumps

Models, Damage, Reasons

SERVICE
TIPS & INFOS



Motorservice Group.

Quality and service from a single source.

The Motorservice Group is the sales organisation for the global aftermarket activities of KSPG (Kolbenschmidt Pierburg). It is one of the leading suppliers of engine components for the independent aftermarket, including the premium brands KOLBENSCHMIDT, PIERBURG and TRW Engine Components, as well as the BF brand. Our comprehensive product range allows our customers to obtain engine components from a single source. As a problem solver for dealers and garages, Motorservice offers extensive service and the technical expertise that you would expect from the subsidiary of one of the largest automotive suppliers.

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KOLBENSCHMIDT



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The extent to which the technical methods and repair information described here will apply to future engine generations cannot be predicted and must be verified in individual cases by the engineer servicing an engine or the workshop operator.

Contents	Page
1 Introduction	4
2 Basic information	7
3 Types of damage	13
3.1 Overview	13
3.2 Contaminated fuel	14
3.3 Biodiesel/vegetable oil	30
3.4 Incorrect use/choice of fuel pump	32
3.5 Unsuitable installation	33
3.6 Mechanical damage	35
4 Tips on diagnosis	41
5 Tools and testing instruments	45
6 Appendix	50



1 | Introduction

1.1 Foreword

The heart of a vehicle

The electric fuel pump is an important component in the vehicle.

If the fuel pump is faulty or fails completely, it is often difficult for repair shops to determine an obvious cause of the damage.

Frequently, problems or failures reoccur shortly after a new pump has been installed, because while the faulty components may have been replaced, the actual cause of the damage has not been eliminated. This is why we need to take a holistic look at the fuel system.

Complaints we have received concerning PIERBURG fuel pumps have shown that the overwhelming majority of all electric fuel pumps that are the subject of a complaint are in fact in good working order.

When an electric fuel pump fails prematurely, this is almost always due to fuel that is contaminated, that contains water or is of poor quality.

The following are possible consequences of supplying contaminated fuel:

- Reduced flow rate
- Diminished pressure
- Low power
- Misfiring, or even
- Total failure of the electric fuel pump

Outside view

In the repair shop, a pump that is faulty or the subject of a complaint can only be assessed on the basis of its outward appearance and its delivery rate or delivery pressure (also see section 5.2).

In some cases, the decision as to whether a complaint is justified or not can only be made if the fuel pump is opened up and the damage inspected "from the inside".

However, in warranty cases and when handling complaints, repair shop staff do not have the authority to open a fuel pump.

Indeed, if the personnel of a repair shop or a parts dealer do open a fuel pump for which there is an ongoing complaint, the warranty is invalidated.

A peek inside

A key task of this brochure is to make it easier to determine what could have caused a fuel pump to fail.

With this in mind, a wealth of images show what it looks like inside pumps that have been handed in with a complaint.

The brochure provides assistance with diagnosis and determination of the causes. It is intended as an aid for repair shops and as information for dealers who handle faulty fuel pumps or complaints about fuel pumps on a daily basis.

Common problem scenarios are used to demonstrate what things look like inside a faulty or complained about pump, and what the causes of the problem could be.

This information makes it easier for repair shops to process their customers' complaints.

The content of this brochure brings together knowledge gained during service work by Motorservice, the aftermarket division of KSPG.

This brochure therefore focuses on the fuel pumps that are sold by Motorservice.



*Fig. 1: Damage by force
Damage is not always this obvious.*

1.2 General information on this brochure

- All pictures and diagrams in this publication are for the purpose of general illustration.
- Certain details may not always reflect the latest design status.
- We reserve the right to introduce technical modifications due to further development, without changing this publication.



Please note:

This brochure is intended exclusively for skilled workers.

Skilled workers are persons in possession of adequate knowledge, acquired through specialist training, experience and instruction, of

- safety regulations,
- accident prevent regulations
- directives and sound engineering practice (e. g. standards).

1.3 Pictograms and symbols

The following general pictograms and symbols are used in this brochure:



Draws attention to hazardous situations with a risk of personal injury or damage to vehicle components.



Information on environmental protection.



Indicates useful tips, explanations and additional information on handling.

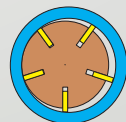
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Reference to sources and more extensive literature (see section 6).

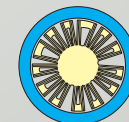


This type of damage is not recognisable from the outside. The damage symptoms marked in this way are only visible if the fuel pump is opened and therefore irreparably damaged.

Many of the diagrams contained in this brochure are, by necessity, extreme close-ups of very small components. Pictures of pump systems are accompanied by a pictogram of the model, to aid understanding of how the parts fit together. The various models are explained in section 2.2



Vane-type pump system



Side-channel pump system



Toothed ring pump system



Screw pump system

1.4 Safety instructions

- For safety reasons, work on the fuel system and on electric fuel pumps may only be carried out by qualified personnel.
- Personnel entrusted with this work must have read and understood this publication prior to commencing the work.
- The legal provisions and relevant safety regulations applicable in the country in question must be observed.
- Safety devices must not be disabled or bypassed.
- Ensure adequate ventilation at the workplace.
- Wear protective gear if necessary or if required by regulations.
- Safety regulations in the country in question also apply.
- Place removed parts in a clean place and cover.
- Only remove the transport closures of new fuel pumps immediately prior to installation.
- Never clean an open fuel system with compressed air.



Environment:

Dispose of process materials, detergents and waste materials in an environmentally friendly manner.



Attention:

Pay attention to the safety regulations concerning the handling of fuel and fuel vapours.

Fuel and fuel vapours are highly flammable.

During work on fuel pumps

- smoking,
- naked flame,
- naked light and
- activities that produce sparks are strictly forbidden.

1.5 Liability

The utmost care was exercised in researching and compiling all the information in this brochure. Nevertheless, errors may arise, details may be incorrectly translated, information may be missing or the information provided may have changed in the meantime.

We can therefore neither provide a warranty nor accept legal responsibility for the correctness, completeness, up-to-dateness or quality of the information provided. All liability on our part for damages, whether direct or indirect, material or immaterial, arising as the result of the use or misuse of information or incomplete/incorrect information in this brochure is therefore excluded, insofar as it is not the result of wilful intent or gross negligence on our part.

Repair shop personnel use the information contained herein solely at their own risk. Consequently, we are not liable for damages that result because repair shop personnel do not have the necessary technical knowledge, repair expertise or experience.

2.1 Fuel system

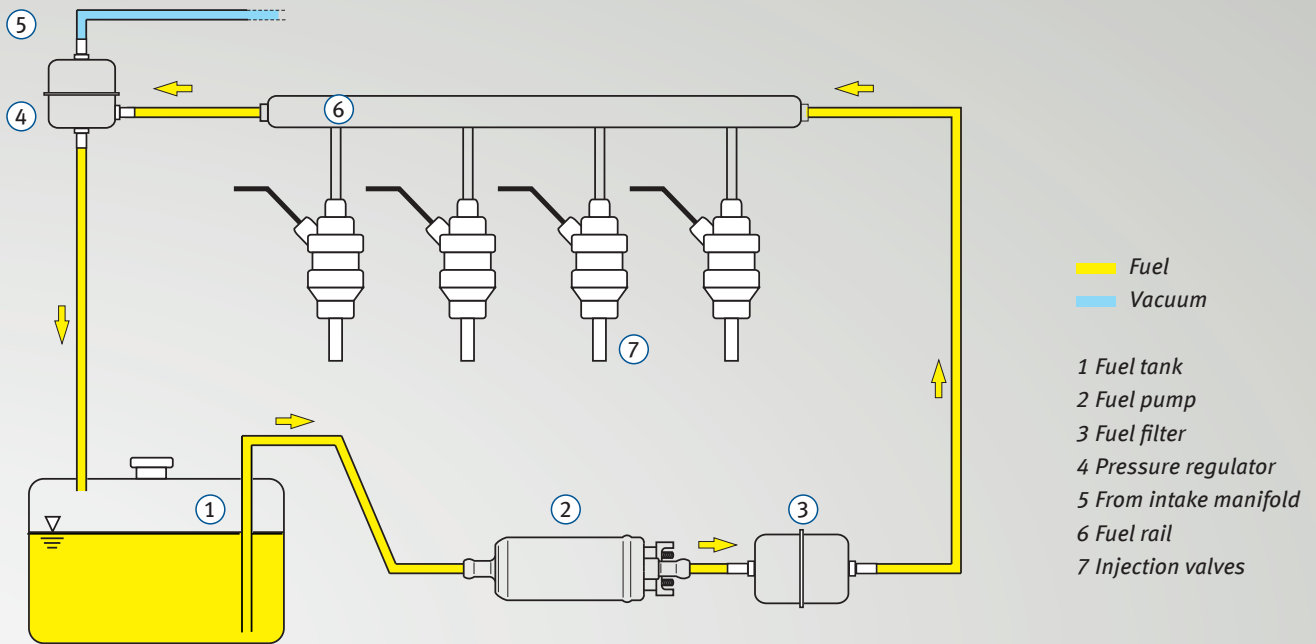


Fig. 2: Fuel system (petrol engine, schematic)

Petrol or diesel fuel is normally required for running vehicles and machines with a combustion engine.

The components used for this purpose are summarised by the term “fuel system”. The components of the fuel system have changed over the decades. The state of the art of modern fuel injection engines is shown in simplified form in Fig. 2.

The fuel pump sucks the fuel out of the fuel tank and delivers it to the fuel supply system with the necessary pressure. A coarse filter (“sieve filter”) is often situated in the fuel tank or in the suction pipe of the fuel pump.

A finer filter on the intake side could cause damage to the fuel pump due to cavitation*. There is also a risk of cavitation when other components are installed on the intake side, narrowing the cross section of the pipe.

The fuel filter on the thrust side of the pump protects the injection valves from contamination.

The pressure regulator controls the pressure to ensure the required level in the fuel rail. It is often controlled pneumatically by manifold vacuum.

From the fuel rail, the fuel is conveyed to the individual injection valves. All vehicle manufacturers have different versions of injection systems. Dealing with the individual systems in more detail would exceed the boundaries of this brochure. Excess fuel is conveyed back to the fuel tank.

The fuel pump is the “heart” of the fuel system. The engine must be supplied with sufficient fuel, whatever the operating state. If this does not happen, problems with driveability – and even vehicle breakdown – may occur.

The fuel pump is just one component of many in the fuel system, and is therefore only one possible source of trouble. Therefore, in the event of problems, the fuel system must be considered in its entirety. For just as it is in people with “heart trouble”, the actual cause may lie somewhere completely different.

The vast majority of problems in the fuel system are caused by contaminated fuel. There can be numerous reasons for this contamination, as shown in section 3.

* Cavitation is fuel vapour locks in liquids at low pressure. The resulting vapour bubbles implode again immediately, and in doing so can irreparably damage parts of the pump system.

2.2 Models

In modern electric fuel pump designs, the pump system sits directly on the shaft of the electric motor. The fuel flushes through the pump, simultaneously cooling and “lubricating” it.

Advantages:

- Fewer moving parts
- Compact design
- Small outer dimensions

Pump systems are available in various designs. Broadly speaking, they can be divided into *flow pumps* and *positive-displacement pumps*.

Flow pumps

With flow pumps, the fuel is transported by the centrifugal force of a rotor. They generate only minimal pressure (0.2 – 3 bar) and are employed either as the primary stage of a two-stage pump, or as a pre-feeder pump. The fuel flows freely through the flow pump without throttles or valves. The fuel could therefore flow back through the pump when the vehicle is stationary.

Flow pumps are not naturally aspirated, i.e. they must always be situated below the fluid level in the fuel tank (max. suction lift 0 mm). “Side-channel pumps” are a form of flow pump.

Positive-displacement pumps

With positive-displacement pumps, the fuel is conveyed through self-contained chambers.

They are used when higher system pressure is required (up to approx. 6.5 bar) – in conventional fuel injection systems, for example.

Unless there is leakage, the fuel cannot flow through the positive-displacement pump in the reverse direction when the vehicle is at a standstill.

Toothed ring, vane-type, roller-cell and screw pumps are all types of positive-displacement pump. Positive-displacement pumps are naturally aspirated only to a limited extent, i.e. they should be fitted below the fluid level of the fuel tank (max. suction lift 500 mm).

The fuel cannot be conveyed *through* a positive-displacement pump!

This means that if a fuel pump of this kind fails, it must be replaced. The installation of an additional fuel pump before or after (“in series”) will have no effect.

Depending on the installation location in the vehicle, we also distinguish between in-tank and in-line pumps.

The trend is currently heading towards in-tank pumps or complete pump modules, where other components, such as fluid-level sensors or diagnostic systems, are installed directly in or on the pump module.

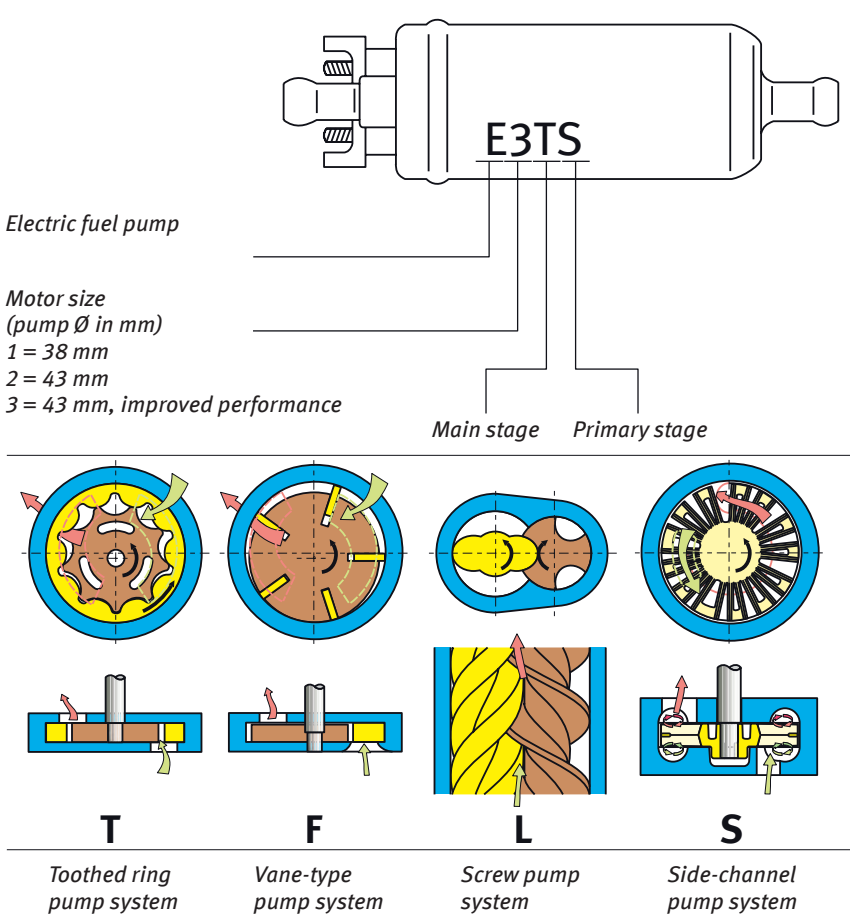


Fig. 3: PIERBURG codes of electric fuel pumps

Vane-type pump E1F

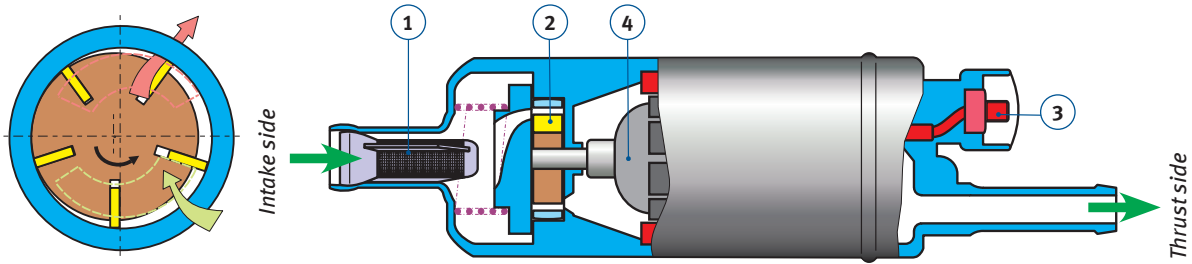


Fig. 4: Pump operating principle and cutaway schematic diagram of a vane-type pump

- | | |
|-------------------------|-------------------------|
| 1 Prefilter | 3 Electrical connection |
| 2 Vane-type pump system | 4 DC electric motor |

Side-channel pump E1S

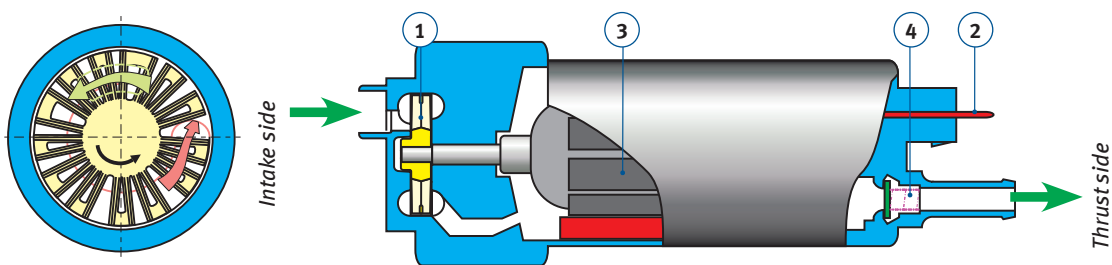


Fig. 5: Pump operating principle and cutaway schematic diagram of a side-channel pump

- | | |
|----------------------------|---------------------------------------|
| 1 Side-channel pump system | 3 DC electric motor |
| 2 Electrical connection | 4 Pressure-holding valve ¹ |

Screw pump E3L

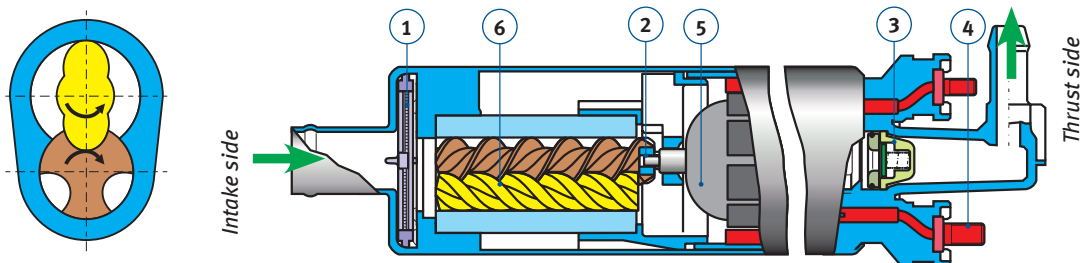


Fig. 6: Pump operating principle and cutaway schematic diagram of a screw pump

- | | |
|---------------------------------------|-------------------------|
| 1 Prefilter | 4 Electrical connection |
| 2 Coupling | 5 DC electric motor |
| 3 Pressure-holding valve ¹ | 6 Screw pump system |

¹The pressure-holding valve maintains a holding pressure in the fuel system, even when the ignition is off.

2 | Basic information

Toothed ring pump E2T/E3T

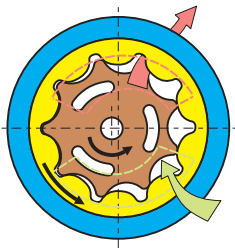
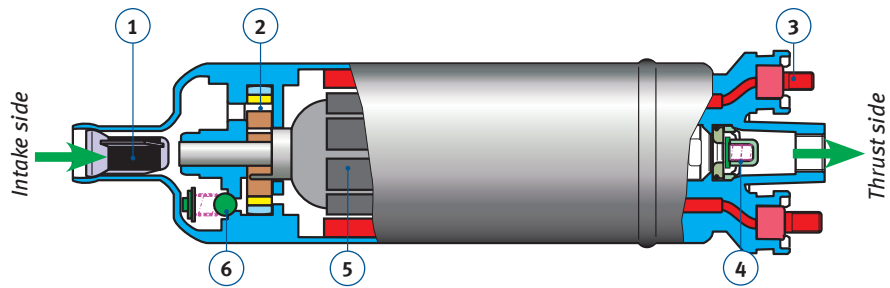


Fig. 7: Pump operating principle and cutaway schematic diagram of a toothed ring pump



- | | |
|----------------------------|--|
| 1 Prefilter | 4 Pressure-holding valve ¹ |
| 2 Toothed ring pump system | 5 DC electric motor |
| 3 Electrical connection | 6 Pressure limiting valve ² |

Toothed ring pump with side-channel pump E3TS

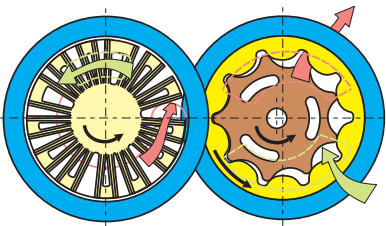
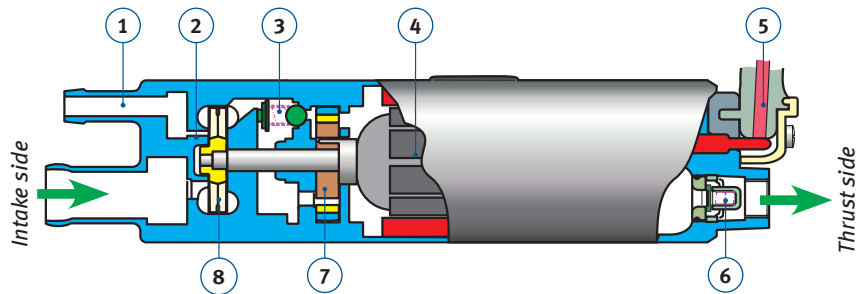


Fig. 8: Pump operating principle and cutaway schematic diagram of a two-stage pump

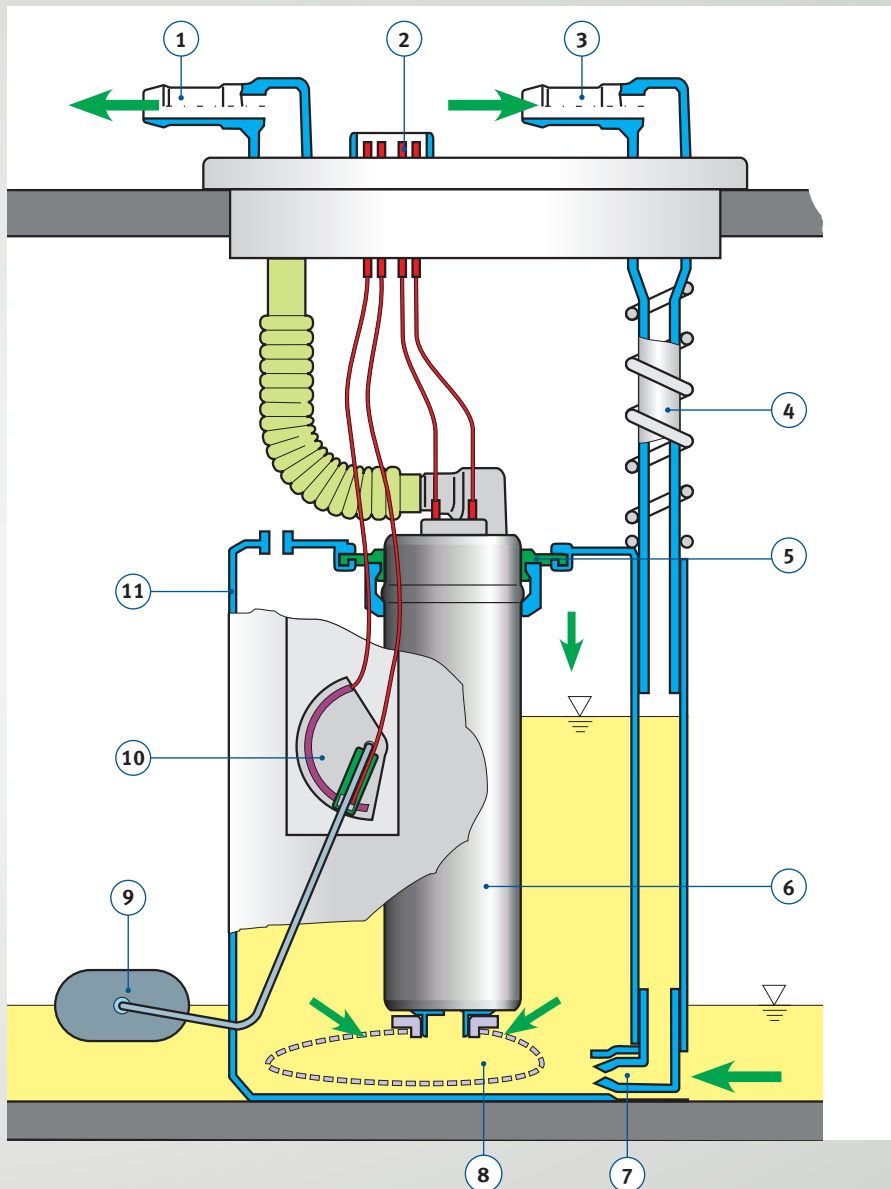


- | | |
|--|---|
| 1 Degassing connection | 5 Electrical connection |
| 2 Degassing hole | 6 Pressure-holding valve ¹ |
| 3 Pressure limiting valve ² | 7 Toothed ring pump system (pressure stage) |
| 4 DC electric motor | 8 Side-channel pump system (primary stage) |

¹ The pressure-holding valve maintains a holding pressure in the fuel system, even when the ignition is off.

² The pressure limiting valve opens if the pressure inside the fuel pump rises to an intolerable degree.

Fuel delivery module



- 1 Fuel delivery
- 2 Electrical connection
- 3 Fuel return
- 4 Telescopic tube
- 5 Suspension element
- 6 Fuel pump
- 7 Suction jet pump*
- 8 Intake strainer
- 9 Float for fuel level indicator
- 10 Sender unit for fuel level indicator
- 11 Reservoir ("swirl pot")

Fig. 9: Cutaway schematic diagram of a fuel delivery module

* The suction jet pump makes use of the Venturi effect: The fuel returning from the engine is squeezed through the nozzle of the suction jet pump, drawing the fuel with it out of the tank and into the reservoir.

2.3 Installation examples of electric fuel pumps illustrated in block diagrams

We distinguish between in-tank and in-line pumps, depending on how the fuel pump is installed in the vehicle.

- In-line pumps are inserted in the fuel line.
- In-tank pumps are installed in the fuel tank. In the case of in-tank pumps, other components, such as fluid-level sensors or diagnostic systems, can be installed directly in or on the pump module.

Mixed and special systems, such as semi-in-tank pumps (e. g. in the Golf II), are not described here.

One or two fuel pumps are connected in series, depending on requirements.

- A single fuel pump
- Two fuel pumps (pre-feeder pump, main pump)
Pre-feeder pumps deliver the fuel to the main pump under low pressure
- A single two-stage fuel pump

These installation options are illustrated in the adjacent diagrams.

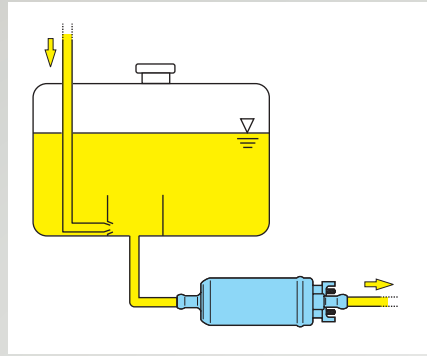


Fig. 10: In-line fuel pump

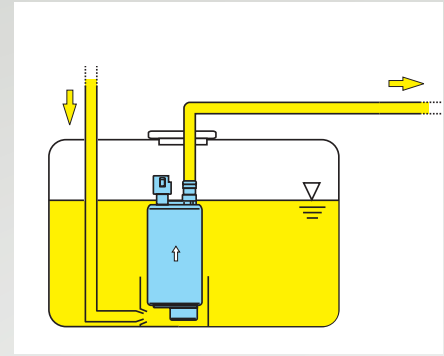


Fig. 11: In-tank fuel pump

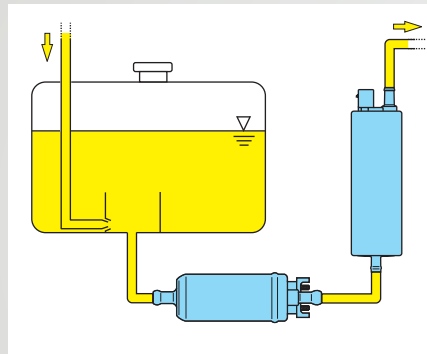


Fig. 12: In-line pre-feeder pump with in-line main pump

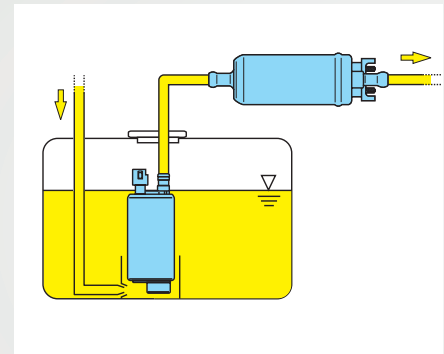


Fig. 13: In-tank pre-feeder pump with in-line main pump

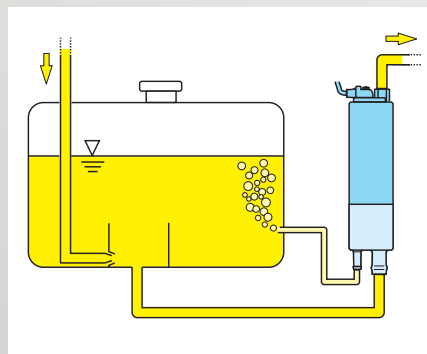


Fig. 14: In-line two-stage fuel pump

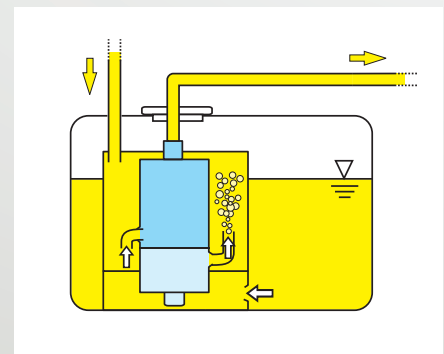


Fig. 15: In-tank two-stage fuel pump, fuel pump in reservoir ("swirl pot"); stages sealed against one another

3.1 Overview



*Fig. 16: Severely corroded electric fuel pump
A view that repair shops don't generally have the opportunity to see. In many cases, it is only by opening the fuel pump that we can determine why a pump – seemingly intact from the outside – has failed.*

The principal cause of malfunctions in or damages to electric fuel pumps is consequential damage brought about by fuel that is contaminated or contains water.

Other causes are poor-quality fuel, damage by force, or simply that the wrong type of fuel pump has been installed or it is being used for the wrong purpose.

In the sections that follow, you will find explanations of the various types of damage and their possible causes.

In order of frequency, these are:

- Damage through contamination (see section 3.2.1)
- Water damage (see section 3.2.2)
- Incorrect use or choice of fuel pump (see section 3.4)
- Poor fuel quality (see sections 3.2.3 and 3.3)
- Mechanical damage/ installation errors (see sections 3.5 and 3.6)

Please note that it is not always possible to single out one individual cause. For example, “rust particles”, which are the result of water in the fuel would, strictly speaking, also fall into the category of “damage through contamination”.

Likewise, a frequent characteristic of poor-quality fuel is an excessive proportion of water, which in turn leads to corrosion and damage through contamination. However, due to the common nature of “water damage”, a separate subsection is devoted to this subject.

The content of this brochure brings together knowledge gained during service work by Motorservice, the aftermarket division of KSPG.

This brochure therefore focuses on the fuel pumps that are sold by Motorservice. A key task of this brochure is to make it easier to determine what could have caused a fuel pump to fail, because “from the outside” it is mostly impossible to tell why a fuel pump no longer functions or why it performs inadequately.

In order to determine the cause of failure, in many cases the fuel pump must be opened and hence irreparably damaged.

The reading out of OBD fault codes in newer vehicles is also only a means of assistance. The component flagged up by the OBD is not always the one that is actually responsible for the damage.

For this, an expert with knowledge of the system is needed.

For this is the only way to avoid the situation whereby a symptom is indeed eliminated, but not the cause itself, allowing the problem to re-emerge after a hundred miles or so.

The complaints process has revealed that the overwhelming majority of all electric fuel pumps that are the subject of complaints conform to the manufacturer’s specifications.

To save time and avoid additional expense, Motorservice has developed a user-friendly tester for wholesale trade companies and importers (see section 5.2).

This enables the function of electric fuel pumps to be tested on site without destroying the pump.

As a result, unjustified complaints can be recognised without problem, and unnecessary returns and costs avoided.

3 | Types of Damage

3.2 Contaminated fuel

3.2.1 Damage through contamination

The most common cause of malfunctions in the fuel system or premature failure of fuel pumps is contamination by larger or smaller particles.

The effects of contamination are varied:

- Clogged filters
- Reduced flow rate
- Fuel pump is excessively noisy
- Pump runs dry
- Jammed pump system

Here are some possible causes:

- Rust or chalk particles (“water damage”, see section 3.2.2)
- Dirt entering the fuel tank from outside (e.g. on refuelling)
- Ageing of the fuel due to longer periods at standstill (build-up of deposits)
- Maintenance intervals (filter replacement) not complied with
- Poor fuel quality (see section 3.2.3)
- Old, porous fuel hoses
- Entry of dirt and water through a scuffed tank ventilation hose, or due to incorrect subsequent rerouting of the tank ventilation hose

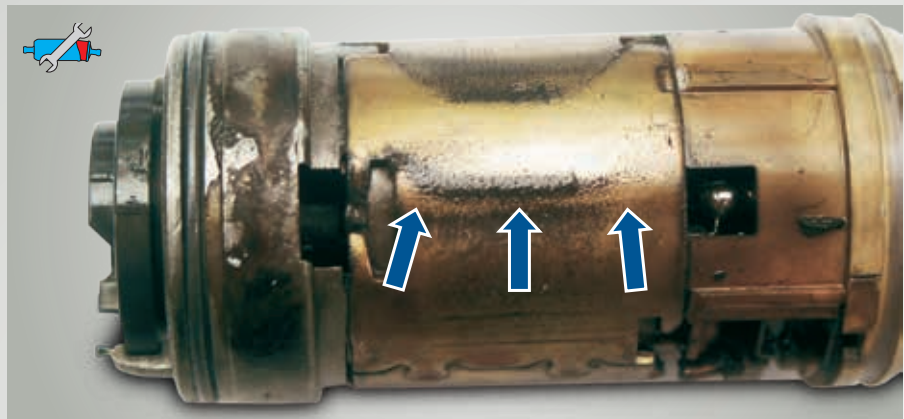


Fig. 17: Contaminated fuel pump

The illustration shows a severely contaminated fuel pump. The outer housing has been removed, and dirt particle deposits can be seen running down the side.



Fig. 18: A sectional view of the housing of an E3T toothed ring pump, clogged with debris



Fig. 19: A jammed pump system (trochoidal toothed ring) of an E3T toothed ring pump

Clogged filters

If fuel filters or sieves on the intake side are clogged with dirt, the initial symptoms are as follows:

- Inadequate delivery rate
- Insufficient pressure
- Excessive operating noise from the fuel pump
- Engine misfires (due to fuel vapour locks)

This can result in failure of the fuel pump and vehicle breakdown.

Most modern fuel pumps are flushed through with fuel, which lubricates and cools them. If this does not happen to a sufficient extent, e.g. because a prefilter or the sieve filter in the fuel pump inlet is blocked, there is a risk of “dry running”. Dry running very quickly leads to damages in the pump system.



Fig. 20: Friction welding caused by dry running



Fig. 21: Dry running has caused the plastic parts in the fuel pump to melt



Fig. 22: Sieve filter of an E1F vane-type pump. Left: clogged – Right: new

Fuel pumps in the E1F, E2T and E3T series are equipped with a built-in sieve filter on the intake side. This small “prefilter” provides protection against contamination. Tests on fuel pumps that were the subject of complaints have shown that this sieve filter is often clogged by dirt in the aspirated fuel.

When retrofitting an E1F, please note: For operation with diesel the sieve filter must be removed, as problems may occur at low temperatures due to the higher viscosity of diesel.



Fig. 23: Contaminated sieve filter of an E3T toothed ring pump

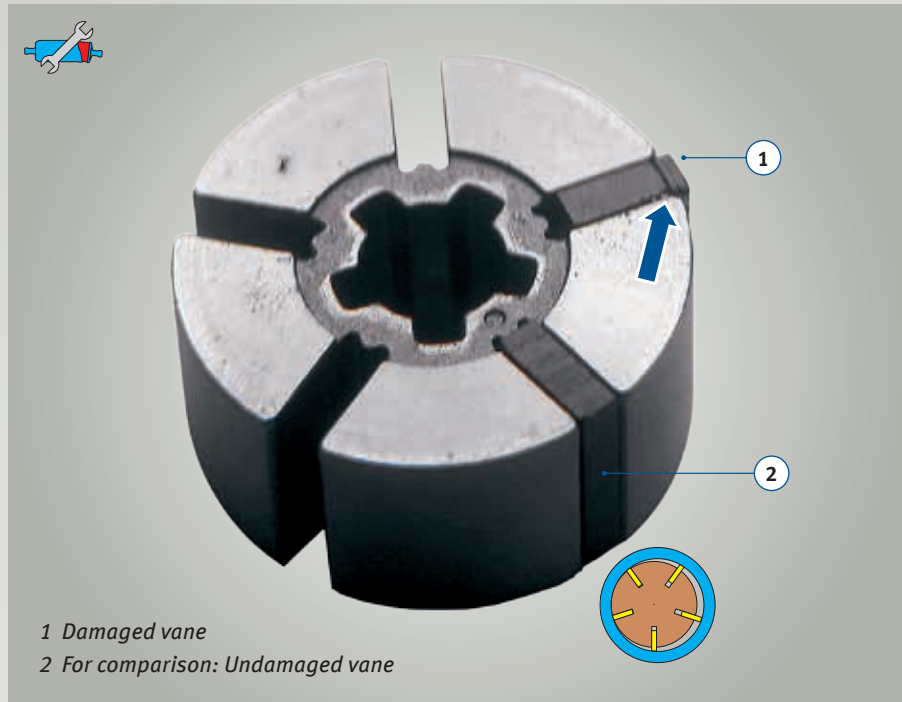
3 | Types of Damage

Jammed pump system

If aspirated foreign bodies enter the fuel pump, the rotating parts of the pump system are often jammed. In most cases, the pump then fails immediately.

Foreign bodies get into the fuel pump when either the fuel filters or the sieves on the intake side are damaged or missing.

When working on the fuel system, in particular, there is a risk of foreign bodies entering the fuel tank.



*Fig. 24: Pump system of a vane-type pump - Damage caused by foreign bodies
The upper right-hand vane has been seriously damaged by foreign bodies.
An undamaged vane is shown at the bottom right for the purpose of comparison.*



Fig. 25: Scratches due to foreign bodies

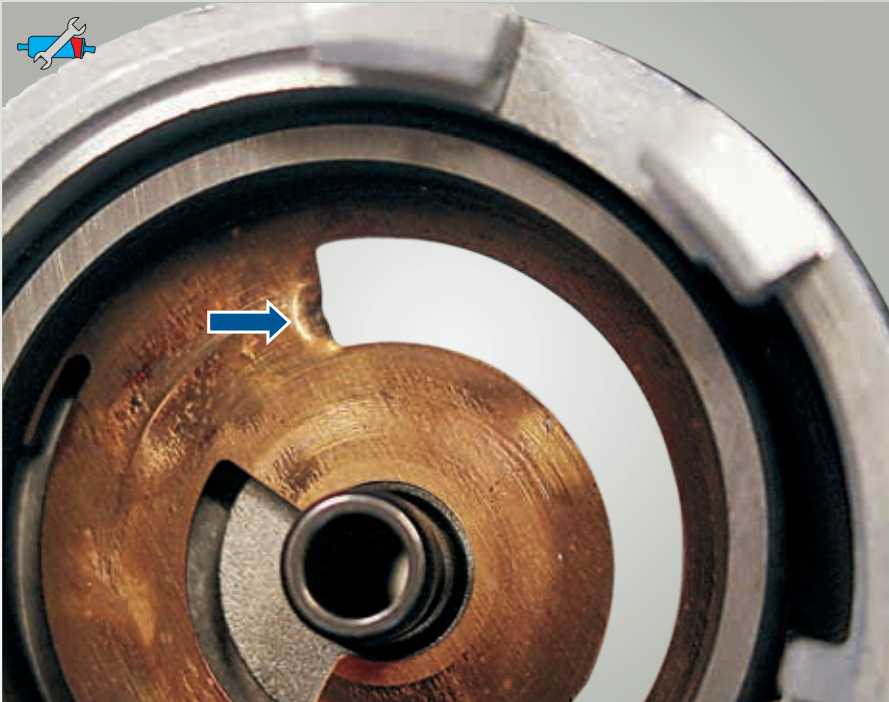


Fig. 26: E2T toothed ring pump damaged by foreign bodies

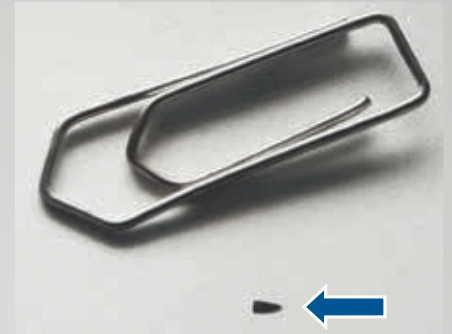


Fig. 27: Foreign body that caused the damage (shown with a paper clip to illustrate the size)

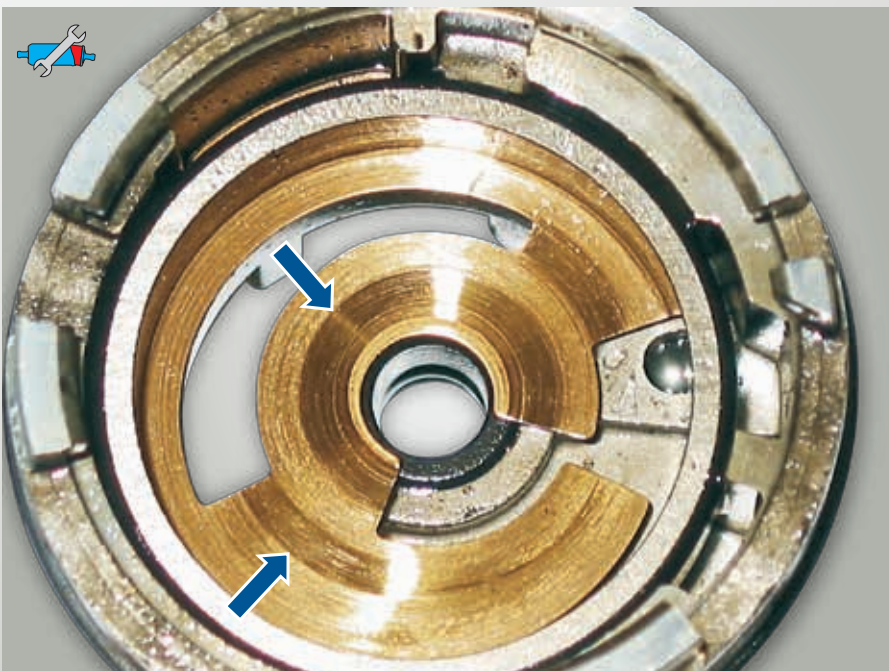


Fig. 28: Typical score marks made by foreign bodies

3 | Types of Damage



Fig. 29: Chips in the sieve filter
Here, metal chips have entered the fuel tank during work on the fuel system. The sharp-edged chips have damaged the sieve filter. As a result, dirt can get into the pump and jam the pump system.



Fig. 30: Contaminated pump system of a vane-type pump
The rotor is so clogged with dirt that the individual vanes (removed in this case) could no longer move. The pump still “runs”, but no longer supplies fuel.

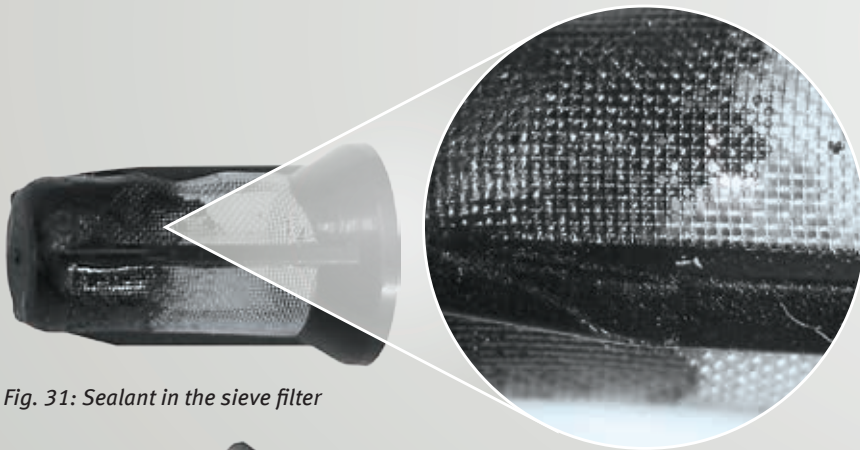


Fig. 31: Sealant in the sieve filter

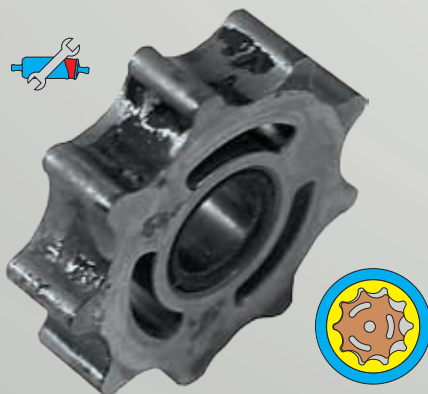
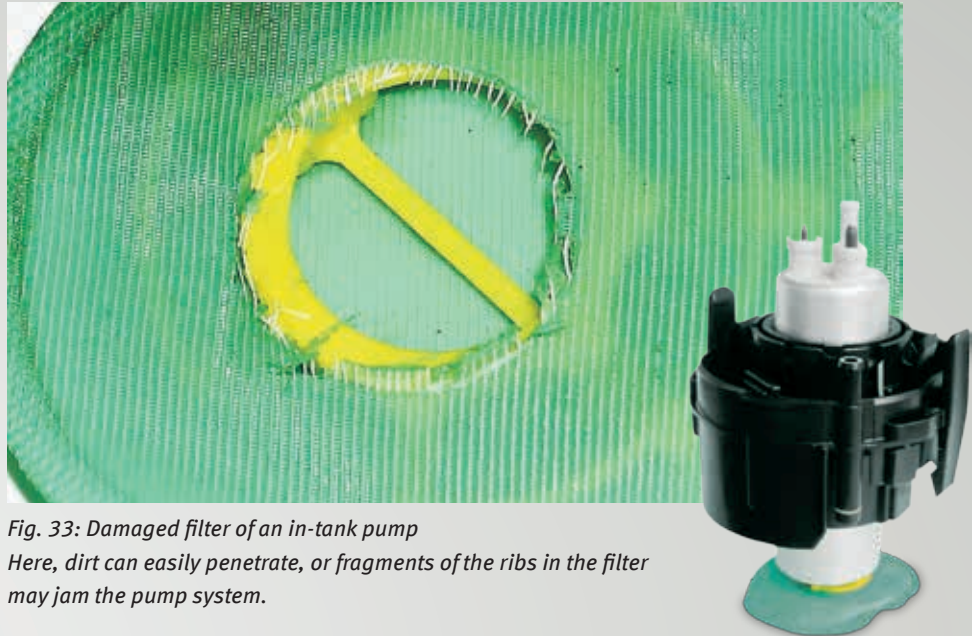


Fig. 32: Sealant in the pump system (trochoid gear)

Figures 31 and 32 show a situation where liquid sealant has entered the fuel tank during work on the fuel system. The sieve filter was unable to hold the sealant back, so it gummed up the pump system.

⚠ Attention:
 In-tank pumps often have a mesh-like filter on the intake side. Therefore, during installation, take care not to damage the filter, and particularly any ribs in the filter (also see section 3.6.2).



*Fig. 33: Damaged filter of an in-tank pump
 Here, dirt can easily penetrate, or fragments of the ribs in the filter may jam the pump system.*

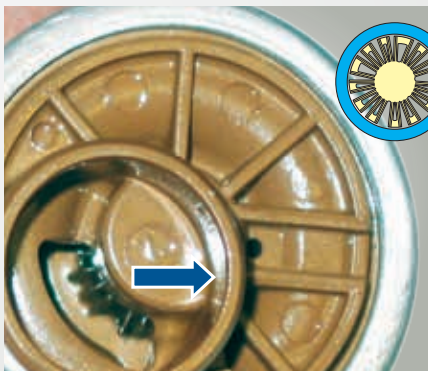


Fig. 34: The fins of the impeller of a type E1S side-channel pump have been destroyed by a foreign body (left).



The fragments were found in the filter.



Fig. 35: For comparison: View inside the suction nozzle of a side-channel pump with undamaged impeller.

3 | Types of Damage

3.2.2 Water damage (corrosion)

A particular type of damage through contamination is damage due to water in the fuel system.

Rust or chalk particles that are formed as the result of water in the fuel can clog the filter and cause the pump to run dry. Chalk and rust deposits on or in the fuel pump reduce the running clearance of the moving parts.

This restricted freedom of movement results in increased power consumption and a reduced delivery rate, and may even cause the fuel pump to jam.

At first glance, the expression “water damage” may appear unlikely in the context of fuel pumps. However, fuel can be contaminated by water in a variety of ways:

Formation of condensation in the tank

The ambient air always contains a certain amount of water, even the air above the fluid level in the fuel tank. The volume of this water is referred to as “relative humidity”.

Cooler air can hold less water than warm air, i.e. when the air cools, droplets of water may form from it to produce condensation.

This can be a problem for cars that spend a lot of their time in the garage.

When vehicles with a relatively empty tank are not driven for longer periods, the large quantity of air in the tank means that a larger volume of condensation can build up.



Note:

Fill the fuel tank completely if the vehicle is going to be stationary for a longer period.

Improper use

Fuel pumps are designed to convey fuel (petrol, diesel).

Cases actually exist where a fuel pump has been used as a “water pump”.

Fuel quality

Fuel may contain water even during the refuelling process.

Here are some possible causes:

- Varying fuel quality in some countries
- Refuelling from damp containers/ canisters
- Badly designed filling stations
- Biodiesel (see section 3.3)
- High proportion of alcohol
Alcohol absorbs water. When a certain limit is reached, this water is shed.



Note:

The subject of “fuel quality” is dealt with in greater detail in section 3.2.3.

*Fig. 36: Water damage to a vane-type pump
On the right for the purpose of comparison
is a fuel pump with comparable mileage,
which has not been exposed to water.*



Leaks in the fuel system

Splash water can penetrate the fuel system in a variety of ways:

- Refuelling in the rain
- Leaky or missing tank-cap seal
- Missing tank cap
- Through ventilation orifices of pneumatic valves that are exposed to splash water, e.g. valves in the ACF (activated carbon filter) system
- The fuel filler neck was not fitted following an accident or body repairs
- Scuffed tank ventilation hose or incorrect subsequent rerouting of the tank ventilation hose



Fig. 37: E3T toothed ring pump – with rust and chalk deposits



Fig. 38: For comparison: E3T toothed ring pump – In good condition despite a high mileage



Note:

This is how you can determine whether fuel contains water: Pour a little fuel into a fuel-resistant glass (test tube), taking it from as low a level in the fuel system as possible. After a while, the water precipitates.



Attention:

Pay heed to fire safety requirements!

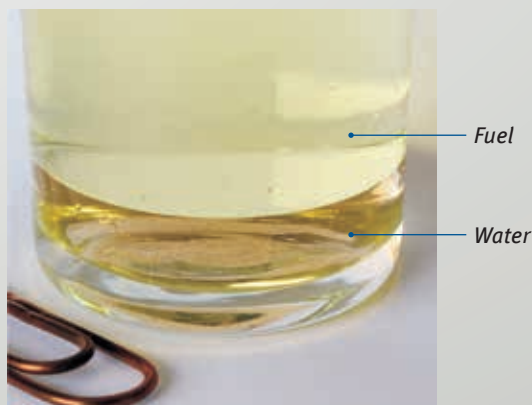


Fig. 39: Water in fuel

3 | Types of Damage

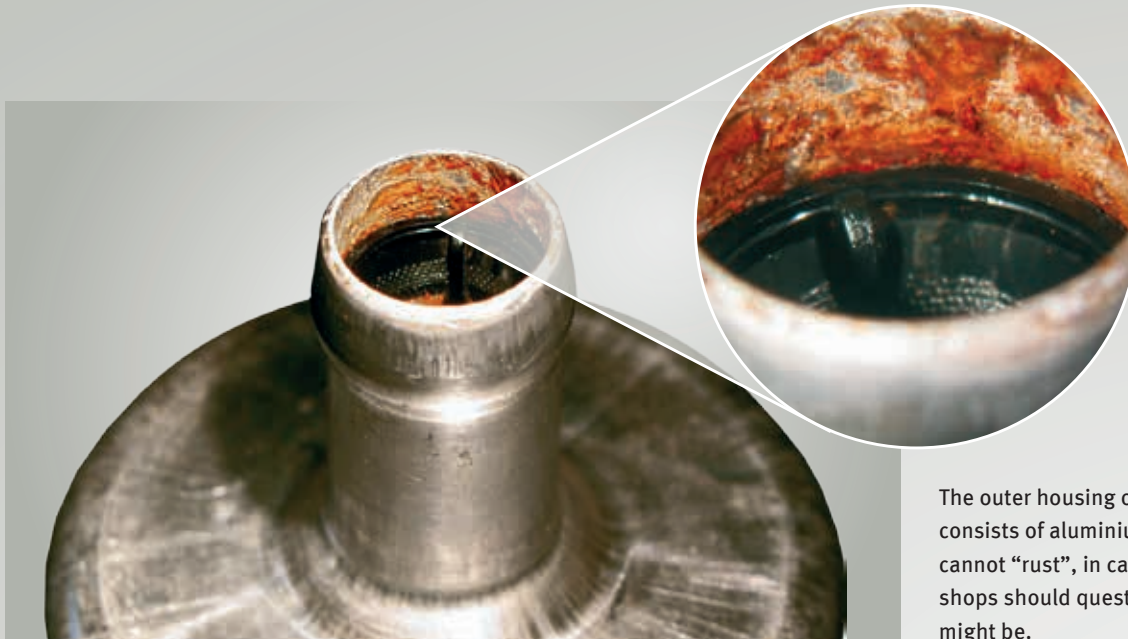


Fig. 40: Rusted inlet of an E1F vane-type pump

The outer housing of a fuel pump generally consists of aluminium. As aluminium cannot “rust”, in cases such as this repair shops should question what the cause might be.



Fig. 41: Left: Sieve filter clogged by rust. Right: New sieve filter

If the sieve filter on the intake side of a fuel pump displays rust or chalk deposits, this is an indication of water in the fuel.

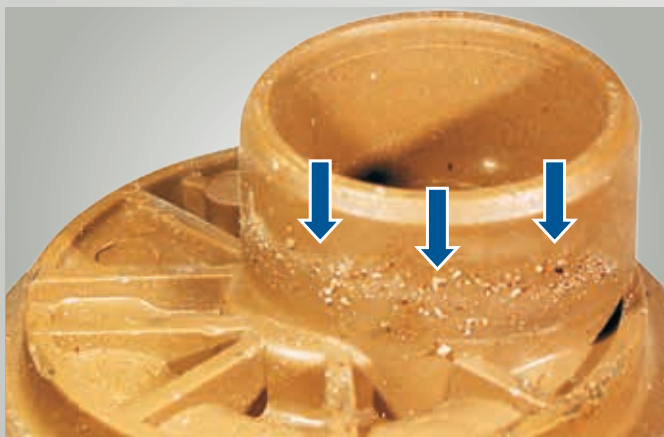


Fig. 43: Chalk deposits in the inlet of this in-tank pump

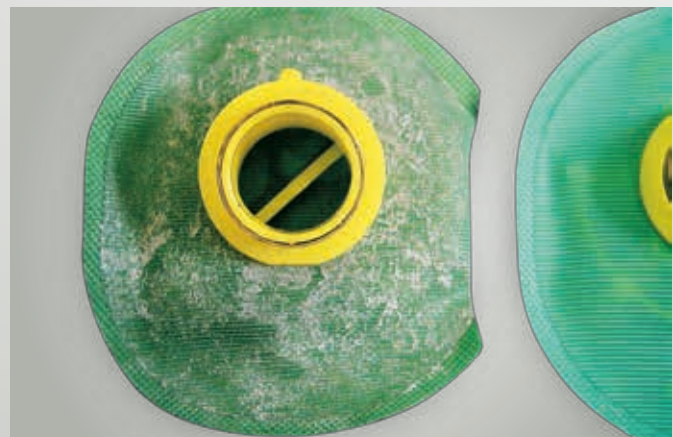


Fig. 42: Left: Chalk deposits on the filter of an in-tank pump. Right: A new filter for comparison



Fig. 44: Water in a fuel pump

In this case, there was a veritable “pool” of water in the pump. The pump system was so corroded that the water could no longer escape. This fuel pump was misused as a “water pump”.

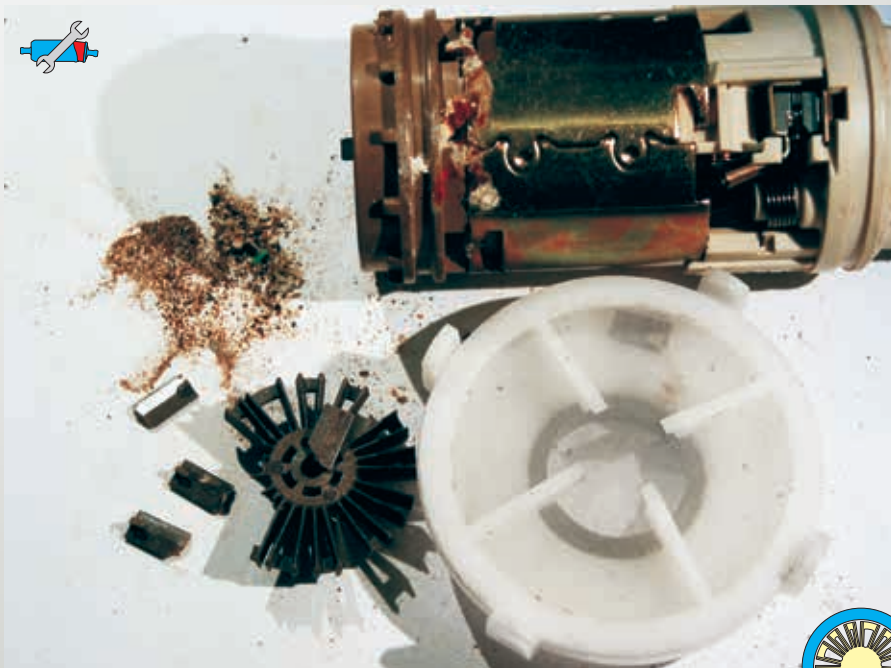
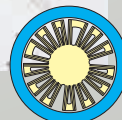


Fig. 45: Rust and chalk particles

If rust or chalk deposits grow to such an extent that they form particles or grains, they can jam or irreparably damage the rotating parts of the pump system, just like aspirated foreign bodies.

When this fuel pump was opened, it was found to contain “sandy” deposits of chalk, which had destroyed the fins of the impeller.

The fact that the sieve filter is undamaged proves that these particles could not have entered the pump – they must have formed inside it.



3 | Types of Damage



Fig. 46: Left: Corroded electrical contacts. Right: New condition



Fig. 47: Trochoidal toothed ring jammed by rust particles (microscopic image)



Fig. 48: Left: Severely rusted trochoidal toothed ring. Right: New condition

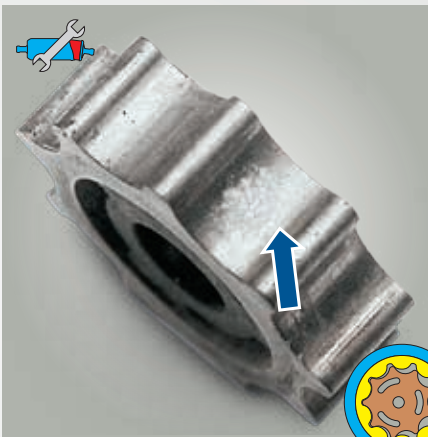


Fig. 49: Trochoid gear with chalk deposits



Fig. 50: Calcified outer bearing of a fuel pump

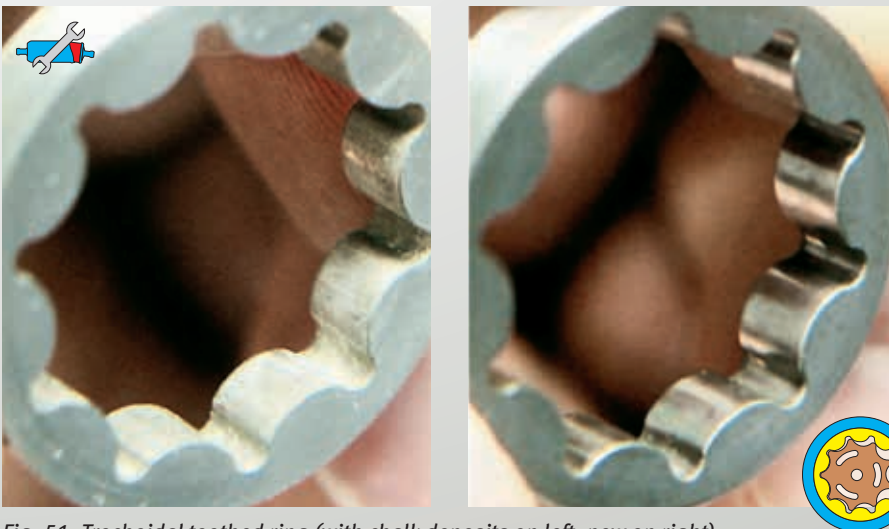


Fig. 51: Trochoidal toothed ring (with chalk deposits on left, new on right)

3 | Types of Damage



Fig. 52: The parts of a trochoidal pump system must mesh smoothly

There is a simple way to check the ease of movement of a trochoidal pump system:

When you roll the pump system over an even surface, as shown on the left, the toothed ring and gear must mesh smoothly.



Fig. 53: For comparison:
A rusty trochoidal pump system
Here, nothing can move.



Fig. 54: Screw pump (rusty on left, new on right)

3.2.3 Fuel quality

Non-compliance with standards

Fuel quality problems may have become rarer, but they are not out of the question. In some countries outside Europe, in particular, this problem still arises. Hence reports and rumours occur from time to time in the media about contaminated, poor-quality fuel abroad.

Refuelling from containers/canisters

Another reason for the penetration of water and dirt in the fuel tank is refuelling from containers that have previously been rinsed out or cleaned with water, but have not been sufficiently dried.

Badly designed filling stations

Non-compliance with the specified operating conditions during the construction or operation of filling stations may result in the penetration of water and contamination.

Ageing of the fuel

When vehicles are left to stand for longer periods, the air in the tank may give rise to oxidation. As the fuel reacts with atmospheric oxygen, a resinous product is formed (“gum” [3]), which can block or gum up the entire fuel system and pump.



*Fig. 55: Adhesion due to a non-compliant fluid
The illustration portrays the pump system of a type E3L screw pump. Residues of a green liquid are still running out of a housing that was cut open for the purpose of assessment. This “fuel” caused the pump system to stick together. The point where the pump’s two screw conveyors were stuck together can be clearly recognised from deposits on the screw conveyor (arrow).*



Fig. 56: Coating from poor-quality fuel

3 | Types of Damage

3.2.4 Released substances

A special instance of contamination occurs as the result of released chemical substances.

If low-quality materials are used when fitting new parts in the fuel system (e.g. replacement of fuel lines, filters), substances such as vulcanisation accelerators, additives and plasticizers can be released from them, and so get into the fuel. Such a case is illustrated in Fig. 57. Here, all pump components were covered with a yellow coating. This substance, which adhered firmly to the surface of the components, was crystalline and insoluble in water and fuel.

The commutators were not corroded or attacked by chemicals, but because of the non-conductive nature of the coating, the commutators were electrically insulated from the carbon.

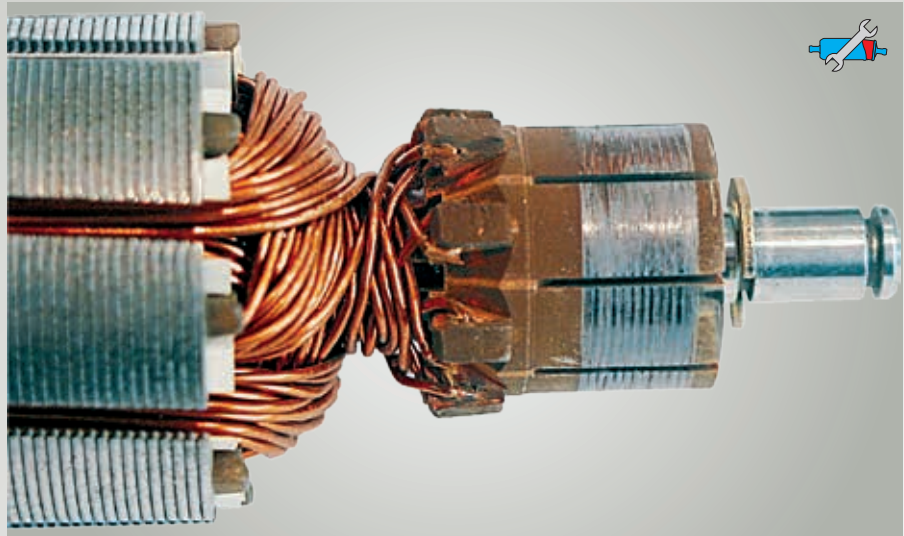


Fig. 57: Insulating layer caused by plasticizers in the fuel

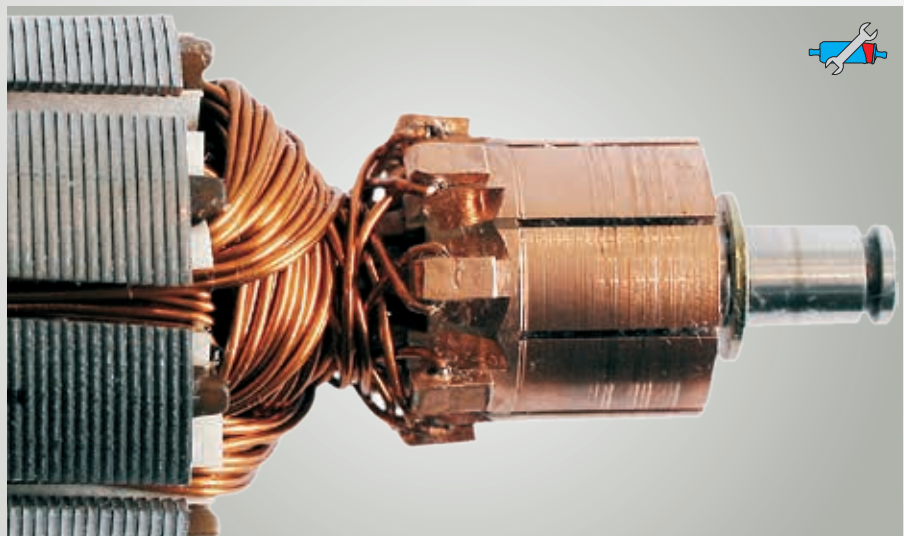


Fig. 58: For comparison: The same type of pump without this coating

3.2.5 What should I do if fuel is contaminated?

As explained in the previous sections, contamination can have a variety of causes.

Seek out the reason for the contamination!

- Flush the fuel system through with clean, quality fuel.



Note:

The fuel tank may need to be removed.

- Replace fuel filters regularly.
- Only use fuel-resistant materials for components that are exposed to fuel (e.g. rubber seals).
- Use quality materials.

- Adhere to the maintenance intervals specified by the vehicle manufacturer.
- Fill the fuel tank completely if the vehicle is going to be stationary for a longer period.
- Place removed parts in a clean place, and cover.
- Only remove the transport closures of new fuel pumps immediately prior to installation.
- Never clean an open fuel system with compressed air.

If you only treat the symptoms (e.g. replacing a damaged fuel pump), the cause will not be eliminated.

The problem will reoccur sooner or later.

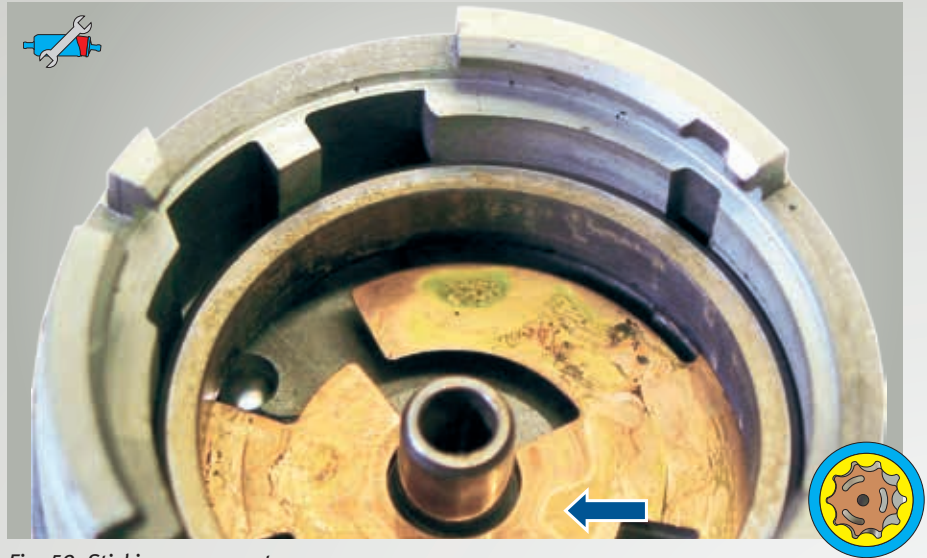
3 | Types of Damage

3.3 Biodiesel/vegetable oil

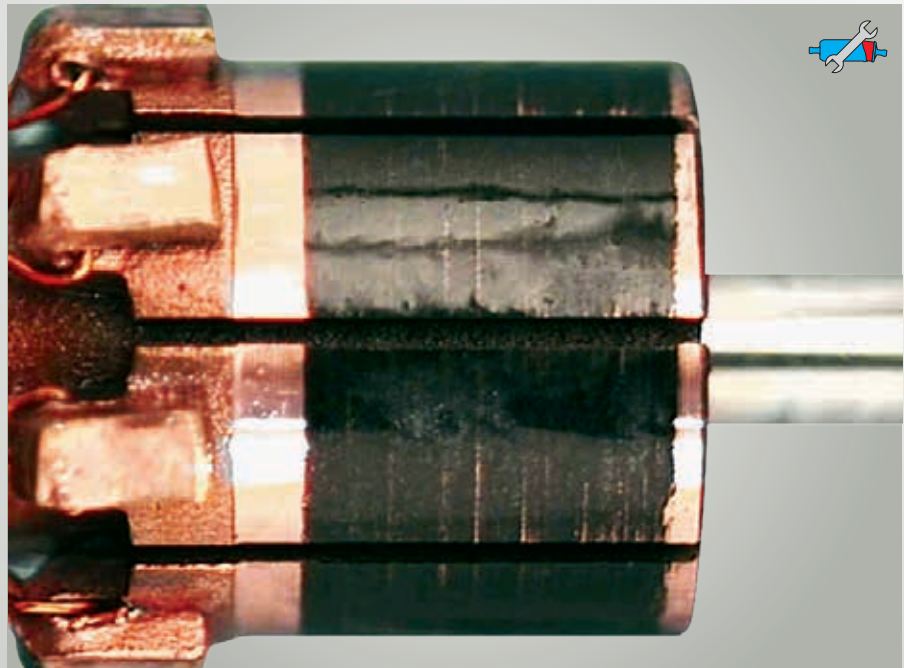
In the past, RME (rapeseed methyl ester) was primarily used as “biodiesel”. Since November 2003, the new DIN EN 14214 standard for “fatty acid methyl ester” (FAME) came into force. In addition to RME, this also permits mixtures with other oils, e.g. soya oil, sunflower oil and used edible fats (animal fat, fish oil, etc.). Running on biodiesel can cause damages and malfunctions to occur sooner and more frequently than is the case with other (“fossil”) fuels [2].

- In vehicles that have not been specifically approved to run on biodiesel by the manufacturer, seals and plastic parts in the fuel system can be adversely affected.
- Biodiesel reacts hygroscopically; in other words, it absorbs water from the ambient air. As well as corrosion, this can lead to the growth of bacteria.
- Oxidation takes place in biodiesel, which can cause fat molecules to flocculate, clogging filters and injection nozzles.
- The good biodegradability of biodiesel comes hand in hand with poor ageing resistance. This can result in clogged filters through deposited particles.

Attention: Biodiesel should only be used when the vehicle in question has been approved for this purpose by the vehicle manufacturer.



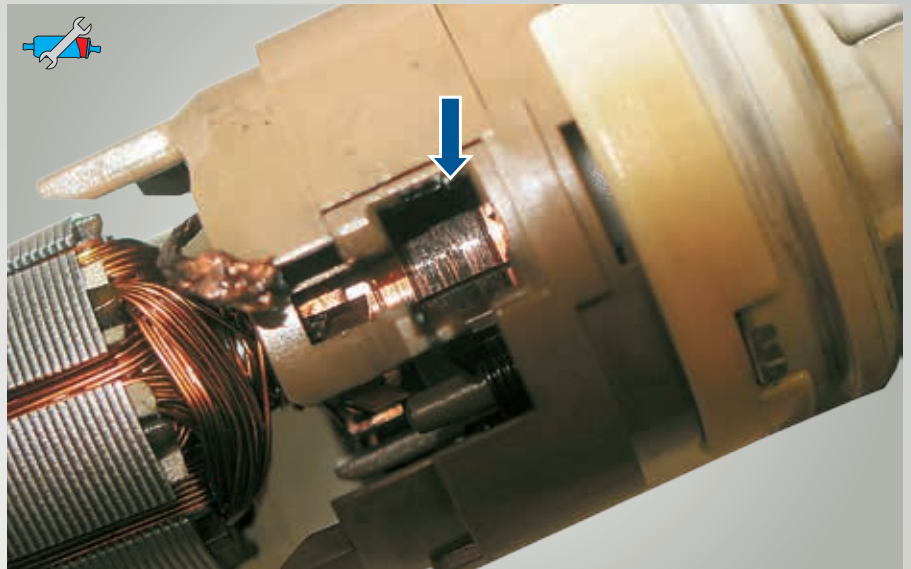
*Fig. 59: Sticking pump system
The boundary disc was stuck firmly to the trochoidal pump system.
The pump system was removed for this picture – but its outlines can still be clearly recognised in the glutinous mass.*



*Fig. 60: Damage caused by biodiesel
In this case, after just 3 hours of operation, RME (rapeseed methyl ester) had disintegrated the carbon brushes forming an opaque, insulating layer on the commutator (“pole changer”) – the pump failed.*

Quality management investigations at PIERBURG have revealed that when biodiesel is used, especially low-quality biofuels, the following malfunctions and damages can occur after just a brief period of operation:

- Deposits clog filters and jam pump systems
- Deposits have an insulating effect on commutators
- Seals and plastic parts are adversely affected
- Carbon brushes burn off after a short running time (“brush sparking”)
- Corrosion destroys metal parts



*Fig. 61: View of the mounting of sliding contacts
The carbon brushes have completely disintegrated and form a coating on the pole changer.*



*Fig. 62: Sliding contacts at approx. 9,500 miles
Left: Prematurely worn.
Right: Normal condition at this mileage*

Note:

“Brush sparking” refers to the formation of sparks on the commutator (pole changer) in electric motors. The carbon brushes provide the contact with the rotating part of the pump motor (rotor). In the brief moment when the carbon brushes short-circuit two blades with different charges, electrostatic

discharges occur, which are visible as sparks. A coating on the glide path with an insulating effect generates increased discharges, which can cause the carbon brushes to burn off prematurely.



*Fig. 63: Destroyed glide path of pole changer
Here, after the carbon brushes had burnt off, the springs that press the carbon brushes against the pole changer “gouged” their way into the glide path.*

3 | Types of Damage

3.4 Incorrect use/choice of fuel pump

Wrong pump

Time and again, an incorrect fuel pump for the intended purpose or electronic equipment is selected from catalogues during replacement or for retrofitting.

This then delivers too high or too low pressure.

Improper use

A more serious case is when a fuel pump is used in a manner for which it is not intended.

Fuel pumps are designed to convey fuel (petrol, diesel).

For most people, this goes without saying. Nevertheless, complaints are occasionally received concerning fuel pumps that have been used to convey other fluids (water, oil, battery acid).

Fig. 65, for example, shows a type E3T in-line pump, which is intended for installation outside the fuel tank in the fuel line, situated in the tank.

The rubber sleeve, which enveloped the fuel pump, has been dissolved by fuel and is blocking the fuel pump and the rest of the fuel system.



Fig. 64: Crystalline deposits caused by unsuitable fluids

In some cases, the cause of deposits such as these can only be determined through time-consuming chemical tests.



Fig. 65: In-line pump that was used as an in-tank pump



Fig. 66: Competitor's pump (left) and E3T with rubber jacket from PIERBURG

Rubber sleeve

This rubber sleeve compensates for the larger sizes of competitors' pumps, in order that fuel pumps sold by Motorservice can fit in existing mountings (see Fig. 66).

In addition, the rubber sleeve has the advantage of preventing vibrations from being transmitted to the body.

3.5 Incorrect installation

When retrofitting an electric fuel pump, in particular, certain points must be noted, as otherwise problems may occur in the fuel system or the fuel pump may suffer damages.

- Type E1F and E3L pumps are in-line pumps. They may only be inserted in the fuel line. Maximum suction lift: 500 mm
- The E1S is an in-tank pump which may only be installed in the tank. Maximum suction lift: 0 mm
- All modern pumps are driven by electric motor. The fuel flows through the drive, so that it simultaneously acts as a coolant. A flow must be constantly available to ensure perfect function and cooling.

- The pumps are wired in such a way that they pump continually while receiving current. When there is little or no fuel delivery current consumption rises, but virtually no cooling takes place. The result is a build-up of gas in the pump, problems in the supply of fuel to the engine and, later on, wear of the pump. This can be avoided by using a fuel return, for example.
- Install fuel pumps in a location where they are protected from dirt and splash water.
- In the case of type E1F electric fuel pumps, a sieve filter must be inserted in the fuel line before the pump on the intake side, to prevent damage through contamination. This filter must have a sufficiently large filter surface (depending on the application), and a mesh size of 60-100 µm (microns).

Paper filters are unsuitable, because the mesh size is too small.



Attention:

The sieve filter in the intake manifold connection must be removed for use in diesel engines.

- For type E1F fuel pumps, PIERBURG offers the 4.00030.80.0 fuel sieve filter – a filter that reliably protects the fuel pump from dirt and other foreign particles, preventing premature failure (see Fig. 67). The sieve filter should be replaced at the same maintenance intervals as the fuel filter.
- Choose the installation location in such a way as to ensure that the fuel pump is not subjected to excessive load due to heat (near the engine or exhaust) and vibration (rigid lines, installation under tension).



Fig. 67: Fuel sieve filter 4.00030.80.0

3 | Types of Damage

- When retrofitting an electric fuel pump, § 46 of the StVZO (German Road Traffic Licensing Regulations) requires the installation of a safety shut-off.



Note:

As long as the ignition is on, the pump delivers fuel. In order to prevent the carburettor from overflowing or fuel escaping from torn off lines when the engine comes to a stop with the ignition on (stalled engine, accident), the installation of a safety shut-off 4.05288.50.0 (see Service Information SI 0016/A) is absolutely essential. The safety shut-off stops the fuel pump “on engine OFF”.

- Dry running very quickly leads to damages in the pump system. To prevent this, the pump must be installed low (“wet”, below the fluid level) in the vicinity of the tank. At the same time, constrictions (“bottlenecks”) on the intake side must be avoided. If this is not possible, an E1S side-channel pump should be inserted in the tank as a pre-feeder pump.
- Only use fuel-resistant materials for components that are exposed to fuel (e.g. rubber seals).
- During assembly, take care to avoid material combinations that would provoke contact corrosion. The pump housing (aluminium) should not come into contact with galvanised surfaces, for example (see Fig. 72).
- Noise can occur due to resonance, depending on where a retrofitted fuel pump is installed. This can make it sound as though the fuel pump is faulty.
- Fuel lines that are routed under tension can also be the reason for excessive noise.

3.6 Mechanical damage

3.6.1 Installation errors

Inexpert installation or removal of a fuel pump can result in damages to the seal, housing or to electrical or fuel connections.

Tightening without counter-tightening

In type E2T and E3T toothed ring pumps, the mating component is often not counter-tightened against the pump housing when the fuel connecting line is tightened. This causes the entire pump cover to turn together with the connections in the housing. Consequently, the sealing ring beneath the cover is squashed. The twisting of the pump system often displaces or damages the O-ring that seals the housing from the cover. The pump then leaks from the flanged edge.

Note: When the connecting line is tightened, the lower hex nut of the fuel pump must be counter-tightened, as otherwise leaks can occur in the fuel pump.

Attention: Leaky fuel pumps increase the risk of fire!

All fuel pumps undergo quality controls and function checks at the factory before delivery. Damages such as these could only have occurred later as the result of improper handling.



Fig. 69: Twisted pump cover
There are markings on type E2T and E3T fuel pumps. These markings must be opposite one another. If they are not, the pump has been inexpertly handled and has been damaged as a result.



Fig. 70: Incorrect installation: Tightening without counter-tightening



Fig. 71: Correct installation: The lower hex nut of the fuel pump must be counter-tightened

3 | Types of Damage

Contact corrosion

Incorrect installation or retrofitting can entail the use of material combinations that encourage contact corrosion.

For example, the pump housing (aluminium) should not come into contact with galvanised surfaces.

If zinc-coated steel clips without insulation are fitted directly to the aluminium body of the pump, for instance, and electrolyte (splash water) is present, contact corrosion may be produced.

In the worst case, the pump body can leak due to pitting corrosion.

Attention:
Leaky fuel pumps increase the risk of fire!



Fig. 72: Contact corrosion due to incorrect material combination

3.6.2 Damage by force

Damaged housing

Improper handling (e.g. dropping) can cause damage to the fuel pump housing. Dropping the pump during assembly can result in cracks in the plastic, for example, causing the fuel pump to leak (see Fig. 73).

Attention:
Leaky fuel pumps increase the risk of fire!



Fig. 73: Housing damaged by force

Damaged connections

During inexpert assembly/removal, connections can be damaged or break off (see Figs. 74 and 75).



Attention:

A leaky fuel connection is an acute fire hazard!

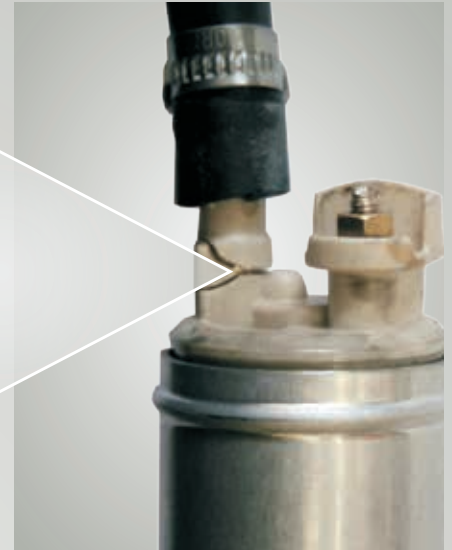
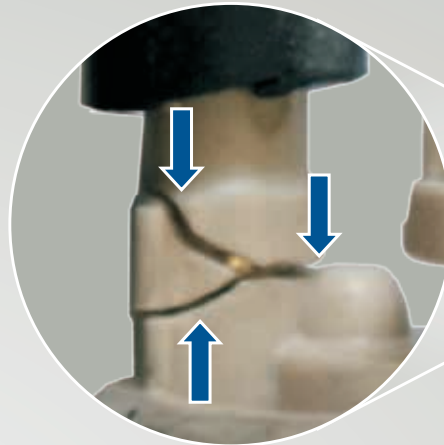


Fig. 74: Broken off hose connection

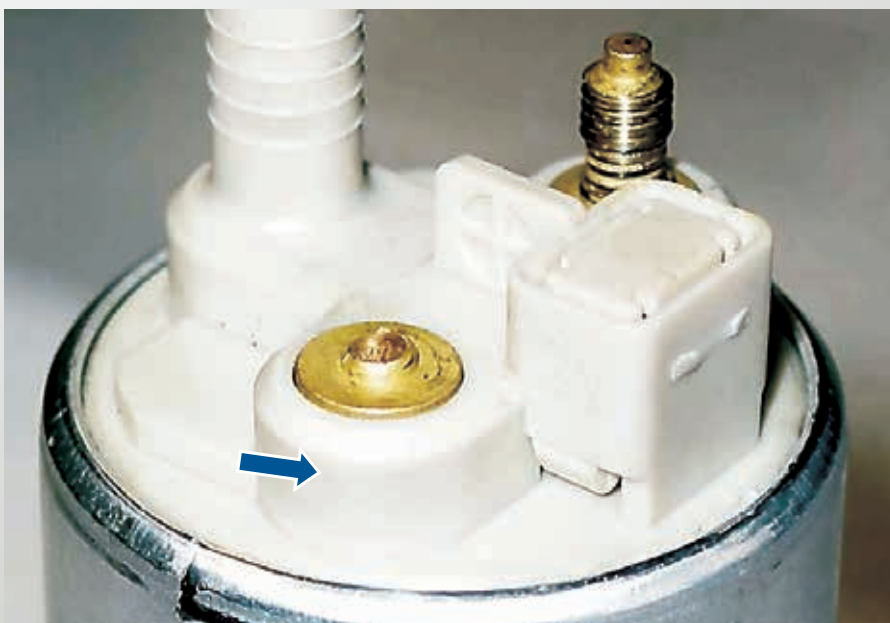


Fig. 75: Electrical contacts damaged by force

All fuel pumps undergo quality controls and function checks at the factory before delivery. Damages such as these could only have occurred later as the result of improper handling.

3 | Types of Damage

Damaged filters

In-tank pumps often have a mesh-like filter on the intake side.

Some filters have stiffening ribs to make them more sturdy.

If inexpertly installed, the filter and any ribs in it may be damaged (see Fig. 76).

Dirt can penetrate or fragments of ribs in the filter can jam the pump system.



Fig. 76: Broken stiffening ribs in the filter of an in-tank pump

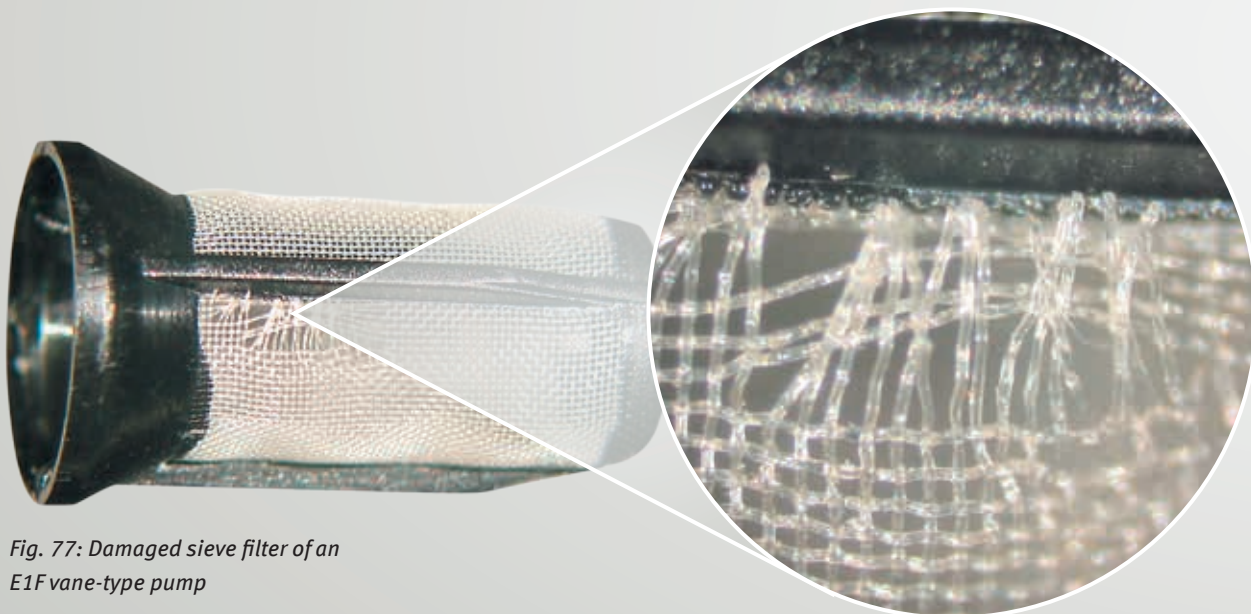


Fig. 77: Damaged sieve filter of an E1F vane-type pump

Fluid-level sensor detached from the fuel delivery module

In some fuel delivery modules, the fluid-level sensor mechanism is equipped with a damping device. This can break if the fluid-level sensor is moved by hand (see Fig. 78).



Attention:

Never move the arm of the fluid-level sensor by hand (see Fig. 79). Danger of breakage!



Fig. 79: Never move by hand

Bent fluid-level sensor on fuel delivery module

Inexpert installation can lead to a bent fluid-level sensor arm.

This can in turn cause the tank indicator to show an incorrect quantity of fuel.

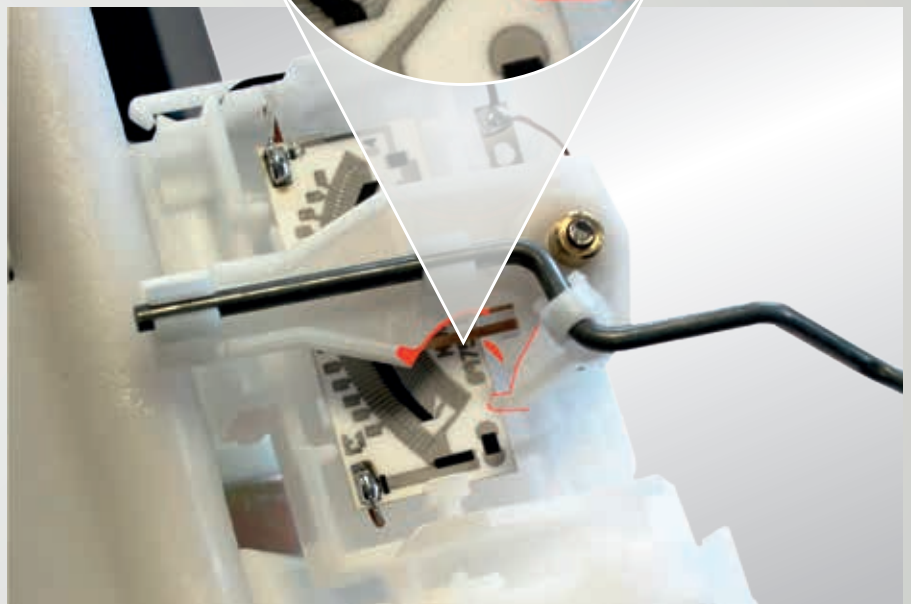


Fig. 78: Broken off fluid-level sensor

All fuel pumps undergo quality controls and function checks at the factory before delivery. Damages such as these could only have occurred later as the result of improper handling.

3 | Types of Damage

3.6.3 Damage in transit

Damage in transit is generally easily recognisable.

Outwardly visible signs are:

- Bumps and dents in the pump housing
- Broken off connections or attachments
- Dirty intake and outlet nozzles

 **Note:**

If the packaging is damaged, in particular, take care to determine whether the fuel pump itself has not suffered any damage in transit.

Only remove packaging and transport closures, e.g. plugs in new fuel pumps, immediately prior to installation.

 **Attention:**

Fuel pumps that have been dropped or damaged during installation must no longer be fitted.

Fig. 81: Particles of the broken permanent magnet on the rotor

The permanent magnet, which surrounds the rotor like a tube, has shattered. The fragments have jammed the pump. It appears that this fuel pump was dropped during installation.



Fig. 80: Broken permanent magnet (stator)



All fuel pumps undergo quality controls and function checks at the factory before delivery.

Damages such as these could only have occurred later as the result of improper handling.

4 Tips on diagnosis

Symptoms

- When the fuel system is damaged, the symptoms are almost always the same:
- Fuel pump does not run
- Fuel pump is noisy
- Fuel pump has an excessively low flow rate
- Inadequate delivery pressure
- Smell of fuel
- Escaping/leaking fuel
- Engine misfires
- Reduced engine power

Reasons

The reason for this is very often found to be contaminated or watery fuel, and sometimes the actual quality of the fuel (see section 3).

Causes

As described in the preceding sections, there can be a variety of causes for this contamination.

For this reason, we have summarised the causes once more in this section.



Damage symptoms that only become visible after opening and therefore destroying the fuel pump are shown in a different colour in the table.



Attention:

In warranty cases and when handling complaints, repair shop staff do not have the authority to open a fuel pump. If repair shop or parts dealer personnel do open a fuel pump for which there is an ongoing complaint, this invalidates the warranty.

Damage through contamination

Complaint	Damage symptom	Possible causes	Remedy/remarks
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Clogged prefilters, filters or sieves • Friction welded pump system caused by dry running 	<ul style="list-style-type: none"> • Dirt entered the fuel tank from outside (e.g. on refuelling) • Ageing of the fuel due to longer periods at standstill (build-up of deposits) • Maintenance intervals (filter replacement) not complied with • Poor fuel quality • Old, porous fuel hoses • Water damage • Dirt and water have entered through a scuffed tank ventilation hose, or due to incorrect subsequent rerouting of the tank ventilation hose 	<ul style="list-style-type: none"> • Measure the pressure and flow rate • Clean/replace clogged separator on intake side • Install a prefilter • Flush the entire fuel system through with clean, quality fuel • Replace the fuel pump • Refuel using quality fuel • Possibly install a supplementary filter/sieve in the filler neck • Heed maintenance intervals (filter replacement)
<ul style="list-style-type: none"> • Pump failure 	<ul style="list-style-type: none"> • Foreign bodies in the pump • Scratches/score marks on moving parts in the pump • Deposits in the pump 	<ul style="list-style-type: none"> • Damaged prefilters, filters or sieves • Clogged prefilters, filters or sieves 	<ul style="list-style-type: none"> • Replace pump and fuel filter • Clean fuel system before installing the new pump • Always replace filters according to vehicle manufacturers' specifications (note arrow for direction of flow)
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Coating in the pump 	<ul style="list-style-type: none"> • Use of low-quality materials, from which vulcanisation accelerators, additives and plasticizers can be released 	<ul style="list-style-type: none"> • Use quality materials

4 | Tips on diagnosis

Water damage

Complaint	Damage symptom	Possible causes	Remedy/remarks
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Chalk and rust deposits on the fuel pump • Chalk and rust deposits in the fuel pump • Clogged prefilters, filters or sieves • Friction welded pump system caused by dry running • Corrosion 	<ul style="list-style-type: none"> • Leaks in the fuel system • Refuelling in the rain • Leaky or missing tank-cap seal • Missing tank cap • Through ventilation orifices of pneumatic valves that are exposed to splash water, e.g. ACF valves • Formation of condensation in the tank • Cars that spend a lot of time in the garage • Fuel quality • Quality standards not complied with • Refuelling from containers/canisters • Badly designed filling stations • Biodiesel 	<ul style="list-style-type: none"> • Flush the entire fuel system through with clean, quality fuel • Remedy leaks in the fuel system • Replace the fuel pump • Refuel using quality fuel • Fill the fuel tank completely before leaving the vehicle stationary for longer periods

Incorrect use

Complaint	Damage symptom	Possible causes	Remedy/remarks
<ul style="list-style-type: none"> • Excessively high or low pressure 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Wrong pump 	<ul style="list-style-type: none"> • Select the right pump
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Dissolved rubber parts • Clogged prefilters, filters or sieves • Sticking pump system 	<ul style="list-style-type: none"> • Improper use 	<ul style="list-style-type: none"> • Proper use
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Chalk and rust deposits on the fuel pump • Chalk and rust deposits in the fuel pump • Clogged prefilters, filters or sieves • Friction welded pump system caused by dry running • Corrosion • Sticking 	<ul style="list-style-type: none"> • Pumping unsuitable fluids (e.g. water) 	<ul style="list-style-type: none"> • Proper use
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Friction welded pump system caused by dry running 	<ul style="list-style-type: none"> • Incorrect installation • Pump installed too high 	<ul style="list-style-type: none"> • Note installation conditions • Select the correct, protected installation location

Poor fuel quality

Complaint	Damage symptom	Possible causes	Remedy/remarks
<ul style="list-style-type: none"> • Insufficient pressure • Inadequate delivery rate • Excessive operating noise from fuel pump • Engine misfires • Pump failure 	<ul style="list-style-type: none"> • Chalk and rust deposits on the fuel pump • Chalk and rust deposits in the fuel pump • Clogged prefilters, filters or sieves • Friction welded pump system caused by dry running • Corrosion • Resinous product sticking or clogging the fuel system • Adversely affected seals and plastic parts • Burnt off carbon brushes • Deposits with an insulating effect on commutators 	<ul style="list-style-type: none"> • Badly designed filling stations • Fuel ageing • Poor fuel quality • Biodiesel 	<ul style="list-style-type: none"> • Visual inspection, odour check • Flush the entire fuel system through with clean, quality fuel • Clean/replace clogged separator on intake side • Replace the fuel pump • Refuel with quality fuel that conforms to the valid standards • Replace the fuel filter and possibly the injection valves

Mechanical damage/installation errors

Complaint	Damage symptom	Possible causes	Remedy/remarks
<ul style="list-style-type: none"> • Decreasing delivery pressure • Diminished delivery rate • Smell of fuel • Leaky pump 	<ul style="list-style-type: none"> • Pump leaking at pump cover • Markings are not aligned (see Fig. 69) 	<ul style="list-style-type: none"> • Inexpert installation/removal: Pump not counter-tightened when the connecting line was tightened 	<ul style="list-style-type: none"> • Replace the pump • The hex nut in the pump cover must be counter-tightened so that it cannot “twist” when connecting lines are tightened. The markings (see Fig. 70, arrows) must be aligned with each other • Note tightening torques
<ul style="list-style-type: none"> • Pump does not supply fuel 	<ul style="list-style-type: none"> • Damaged electrical connections 	<ul style="list-style-type: none"> • Inexpert installation/removal: Damaged electrical connections 	<ul style="list-style-type: none"> • Replace the pump • Proceed with care when affixing electrical connections • Note tightening torques
<ul style="list-style-type: none"> • Decreasing delivery pressure • Diminished delivery rate • Smell of fuel • Leaky pump 	<ul style="list-style-type: none"> • Leaky/damaged fuel connection 	<ul style="list-style-type: none"> • Inexpert installation/removal: Damaged fuel connection 	<ul style="list-style-type: none"> • Replace the pump • Proceed with care when tightening connecting lines
<ul style="list-style-type: none"> • Decreasing delivery pressure • Diminished delivery rate • Smell of fuel • Leaky pump 	<ul style="list-style-type: none"> • Pump is leaking • Pitting corrosion • Corrosion around mounting clips 	<ul style="list-style-type: none"> • Inexpert installation/removal: Contact corrosion due to incorrect material combinations 	<ul style="list-style-type: none"> • Replace the pump • Avoid galvanised mounting clips

4 | Tips on diagnosis

Further problems with similar symptoms Further problems with similar symptoms

Possible causes	Remedy/remarks
<ul style="list-style-type: none"> Faulty pressure regulator 	<ul style="list-style-type: none"> Check pressure and regulating function Replace faulty pressure regulator Check fuel system
<ul style="list-style-type: none"> Tank aeration/ventilation not working properly ACF filter or ACF lines filled with fuel 	<ul style="list-style-type: none"> Check and clean or repair if necessary Check lines (note manufacturer's instructions) Check function of ACF regeneration valve
<ul style="list-style-type: none"> Defective voltage supply to electric fuel pump Faulty fuse Open circuit Faulty pump relay 	<ul style="list-style-type: none"> Visual inspection Check voltage supply Check and replace if necessary Check and correct any faults Check and replace if necessary
<ul style="list-style-type: none"> Injection valve malfunctions Wrong injection times Wrong injection direction Leaky injection valves 	<ul style="list-style-type: none"> With the engine off, check the HC value in the intake manifold using a suitable device Check injection times, injection signal and tightness Clean valves or replace if necessary
<ul style="list-style-type: none"> The lambda probe is dirty or has deposits as the result of poor combustion or leaded fuel The lambda probe reacts too sluggishly, i.e. the lambda control is causing a "rich" mixture The lambda probe is damaged due to excessive exhaust temperatures resulting from incorrect mixture formation or misfiring There is a problem with the electrical earthing 	<ul style="list-style-type: none"> Check lambda probe and contacts
<ul style="list-style-type: none"> The fuel system has two fuel pumps one behind the other, one of which is defective 	<ul style="list-style-type: none"> Check function of both fuel pumps

Further tips on installation and diagnosis, particularly concerning the retrofitting of electric fuel pumps, can be found in the brochure **Service Tips & Infos: Fuel systems – Components and solutions for universal applications [6]**.

5 Tools and testing instruments

Motorservice offers a range of tools and testers that are required for working on fuel systems.

You can find further tools and testing instruments in the catalogue “Tools and Testing Instruments” [7] and in the OnlineShop on our homepage: www.ms-motorservice.com



Part no. 4.07373.10.0

Repair kit for fuel lines

Repairing fuel lines is often problematic if the required components are not available. By means of the repair kit, smaller defective spots on fuel lines can be repaired quickly and efficiently:

- Rusted-through areas on steel tubes
- Embrittled areas on plastic pipes
- Kinked plastic pipes
- Broken plugs, e.g. from disassembly during filter replacement
- Suitable for steel or plastic pipes with an outside diameter of 8 or 10 mm.

- Junctions of the different materials are possible (plastic pipe – steel tube; rubber hose – steel tube; rubber hose – plastic pipe).

Within scope of supply:

The most common connections for fuel filters, fuel pump connectors and fuel pumps.

Operating pressure: absolute max. 5 bar

Weight: approx. 2,560 g






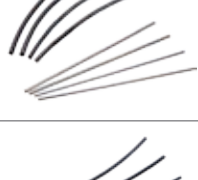
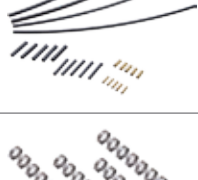

Package size:

510 mm x 320 mm x 60 mm



5 | Tools and testing instruments

Refill packages

PIERBURG no.	Fig.	Designation	Content (quantity)
4.07373.11.0		Refill pack 1 (SAE plug, straight)	SAE plug, straight, 7.89 - 8 (3); 9.89 - 10 (3)
4.07373.12.0		Refill pack 2 (SAE plug, angled)	SAE plug, angled 90°, 7.89 - 8 (3); 9.89 - 10 (3)
4.07373.13.0		Refill pack 3 (pipe connection, straight)	Pipe connection, straight, for Ø 8 mm (8); for Ø 10 mm (8)
4.07373.14.0		Refill pack 4 (pipe connection, angled/ T-connection)	Pipe connection, angled, for Ø 8 mm (3); for Ø 10 mm (3) T-connection for Ø 8 mm (1); for Ø 10 mm (1)
4.07373.15.0		Refill pack 5 (hose connection)	Normaquick double connection Ø 8 mm, S 5/16-6 (2); 10 mm, S 3/8-5/16 (2) Reducing connection, straight, Ø 10 - 8 mm (2)
4.07373.16.0		Refill pack 6 (steel tube/fuel hose)	Length of pipe, steel Ø 8 x 450 mm (2); Ø 10 x 450 mm (2) Fuel hose Ø 8 x 450 mm (2); Ø 10 x 450 mm (2)
4.07373.17.0		Refill pack 7 (lengths of pipe/sleeves)	Length of pipe, plastic Ø 8 x 50 mm, (5); Ø 10 x 50 mm (5); Ø 8 x 450 mm (2); Ø 10 x 450 mm (2) Single collar bushing Ø 6 x 0.4 x 22 (5); Ø 8 x 0.4 x 22 (5)
4.07373.18.0		Refill pack 8 (clamps)	Hose clamp 015,3-706 R (20); 016,6-706 R (20)



Part no. 4.07373.20.0

Fuel pressure test kit

This fuel pressure test kit enables the pressure and flow rate to be measured without dismantling the fuel pump.

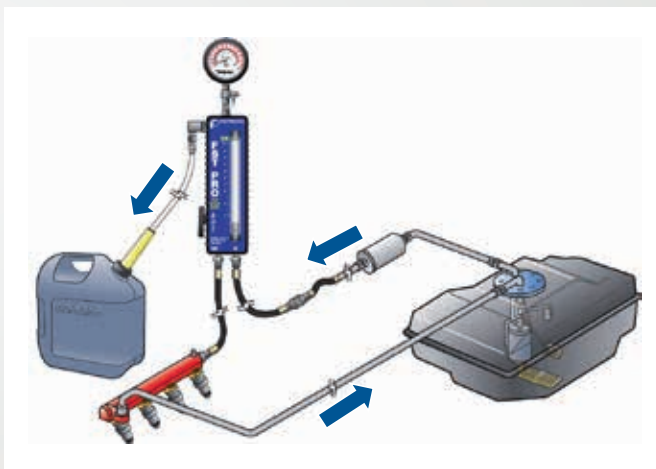
All common fuel delivery systems (petrol, diesel common rail, diesel pump-nozzle injector, diesel distributor pumps and diesel inline pump systems with and without return up to 8 bar/120 psi pressure) can be checked for faults using the fuel pressure test kit.

Specifications:
Max. pressure: 8 bar (120 psi)

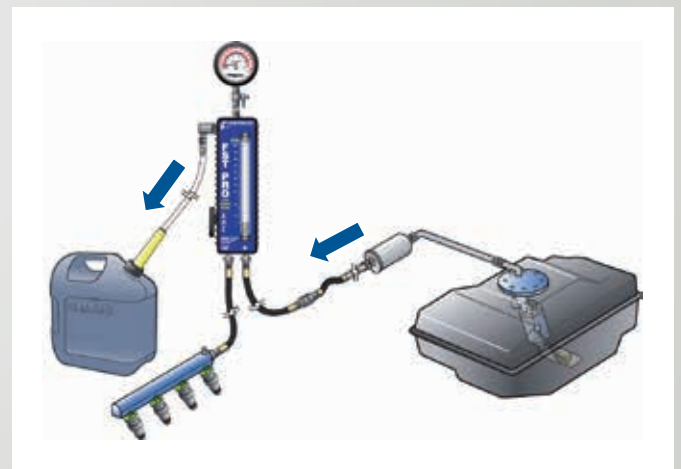
Extensive directions for use, with test instructions, value tables and guidelines for fault diagnosis are provided to assist with troubleshooting.

Note:
Not suitable for alternative fuels with high ethanol content.

Weight: approx. 4,800 g
Package size:
440 mm x 240 mm x 210 mm



Test setup in fuel system with return



Test setup in fuel system with return (demand-controlled)

5 | Tools and testing instruments



Part no. 4.07373.21.0

Toolkit to complement the fuel pressure test kit

Motorservice offers a set of 8 tools to facilitate the release of quick connectors, which are used by many vehicle manufacturers. The tools are curved to facilitate access to the connectors.

The set includes the sizes:

8 mm (5/16"), 9.5 mm (3/8"), 9.5 mm (3/8") cooling line, 9.5 mm (3/8") oil feed line

13 mm (1/2"), 16 mm (5/8"), 19 mm (3/4"), 22 mm (7/8")

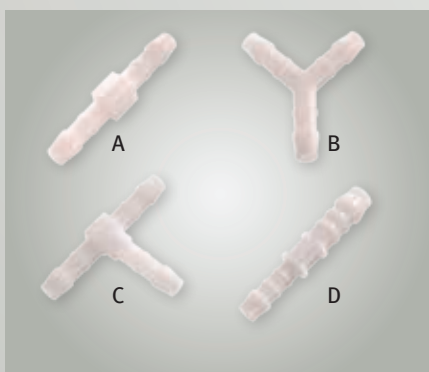
Weight: approx. 700 g

Package size:

250 mm x 60 mm x 230 mm



Hose connections



For part no., see table

Part no.	Description	Type	Diameter
4.07413.72.0	Hose connection GS 4	 (A)	4 mm
4.07414.03.0	Hose connection GS 6		6 mm
4.07414.02.0	Hose connection GS 8		8 mm
4.07413.65.0	Hose connection YS 4	 (B)	4 mm
4.07413.98.0	Hose connection YS 6		6 mm
4.07414.00.0	Hose connection YS 8		8 mm
4.07413.60.0	Hose connection TS 4	 (C)	4 mm
4.07413.99.0	Hose connection TS 6		6 mm
4.07414.01.0	Hose connection TS 8		8 mm
4.07414.86.0	Reduction adapter GRS 8/6	 (D)	6 mm/8 mm



Part no. 4.07371.04.0

Fuel hose Ø 3.5 mm

Fuel hose in cardboard box in accordance with DIN 73379 B



Note:
Not approved for use inside the tank.

- Wall thickness: 2.0 mm
- Length: 20 m
- Bore: NBR
- Braiding: CO

Weight: approx. 1,100 g
Package size:
315 mm x 125 mm x 320 mm

Areas of application	Temperature range
Commercially available fuels and mixtures with a maximum benzene content of 50%	-30°C to +50°C
Water, air, EL heating oil (extra light)	-30°C to +80°C
Diesel fuel (gas oil) with added RME	-30°C to +65°C



Part no. 4.07371.07.0

Fuel hose Ø 6.0 mm

Fuel hose in cardboard box in accordance with DIN 73379-2A

- Strength members: Polyester
- Cover: CR

- Wall thickness: 3.0 mm
- Length: 20 m
- Bore: NBR

Weight: approx. 2,300 g
Package size:
315 mm x 125 mm x 320 mm

Areas of application	Temperature range
Commercially available fuels, particularly super fuel with a maximum benzene content of 50%, suitable for E10	-30°C to +50 °C
Water, air, EL heating oil	-30°C to +90 °C
Diesel fuel with added RME	-30°C to +65 °C



Part no. 4.07371.06.0

Fuel hose Ø 7.5 mm

Fuel hose in cardboard box in accordance with DIN 73379-2A

- Strength members: Polyester
- Cover: CR

- Wall thickness: 3.0 mm
- Length: 20 m
- Bore: NBR

Weight: approx. 3,050 g
Package size:
315 mm x 125 mm x 320 mm

Areas of application	Temperature range
Commercially available fuels and mixtures with a maximum benzene content of 50%	-30°C to +50°C
Water, air, EL heating oil	-30°C to +80°C
Diesel fuel (gas oil) with added RME	-30°C to +65°C

5 | Tools and testing instruments



Part no. 4.00063.00.0



Fuel pump fitting tool

Auxiliaries for removing/fitting fuel pumps

With this low-cost tool, you no longer need to replace the complete fuel pump including mounting – now just the fuel pump itself is replaced.

The assembly instructions provided with the PIERBURG fuel pumps give detailed instructions for the application of the tool.

Weight: approx. 600 g

Package size:

150 mm x 55 mm x 55 mm

The tool can be used for the following fuel pumps:

PIERBURG no.	Manufacturer	Model
7.22013.02.0	BMW	5 Series (E39)
7.22013.57.0	BMW	X5 (E53)
7.22013.61.0	BMW	M5 (E39)
7.22013.69.0	BMW	7 Series (E65/66/67)
7.28303.60.0	Volkswagen	Golf IV, V; Passat 1.9, 2.0 TDI
7.50007.50.0	BMW	X5 (E53)

6 | Appendix

References and more extensive literature

[1] **Technical filter booklet**
Motorservice
50 003 596-01 (German)*

[2] **Biodiesel**
Marcus Taupp
Bayerische Julius-Maximilians-Universität Würzburg
Institute for Pharmacy and Food Chemistry
Professor of Food Chemistry
Prof. Dr. P. Schreiber

[3] **Chemistry of fuels and lubricants**
Prof. Dr. A. Zeman (em.)
Bundeswehr University Munich –
Mechanical Engineering Department –
Environmental Technology and
Chemistry

[4] **Emission control and OBD**
Motorservice
50 003 960-01 (German)*

[5] **Fuel supply for fuel injection engines**
Motorservice
Only available as PDF
see www.ms-motorservice.com

[6] **Fuel systems – Components and solutions for universal applications**
Motorservice
Only available as PDF
see www.ms-motorservice.com

[7] **Tools and testing instruments**
Motorservice
50 003 931-01 (German)*

* Available in further languages on request

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