Press Release

PN 0036

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Afterburner

Emission control by using secondary air

The blowing in of secondary air is a reliable method for reducing cold-start emissions from gasoline / petrol engines.

Pierburg, who have many years of experience as OE supplier where *secondary air* is concerned, provide information on components, causes of failure and remedies.

The first secondary air systems were already used at the beginning of the seventies. And although they are used in large quantities nowadays not much is known about the details.

Why secondary air?

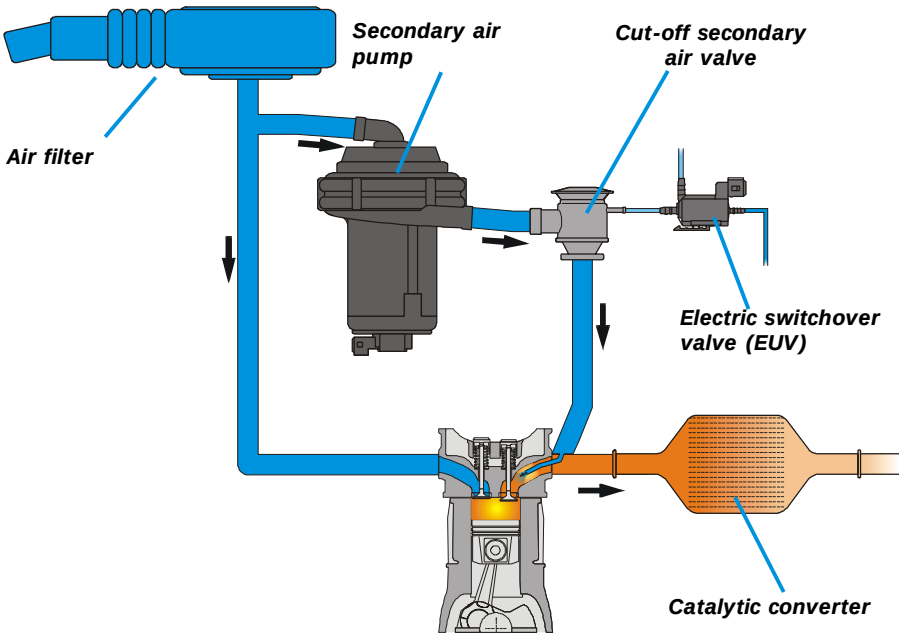
The reliable cold start of a gasoline/petrol engine requires a "rich mixture" – a mixture with excess fuel.

But since the monolith of the catalytic converter has not yet reached its working temperature during a cold start, a large quantity of monoxide and unburnt hydrocarbons is produced between a cold start and the activation of the lambda control – even on low-emission petrol vehicles.

To reduce these cold-start emissions there are only two practicable strategies, namely an upstream catalytic converter or blown-in secondary air.

The disadvantage of an upstream catalytic converter is that it has to be cooled down again during the warm-up phase. This is achieved by a mixture enrichment at full load – resulting however in an increase in fuel consumption and higher exhaust emissions at full load.

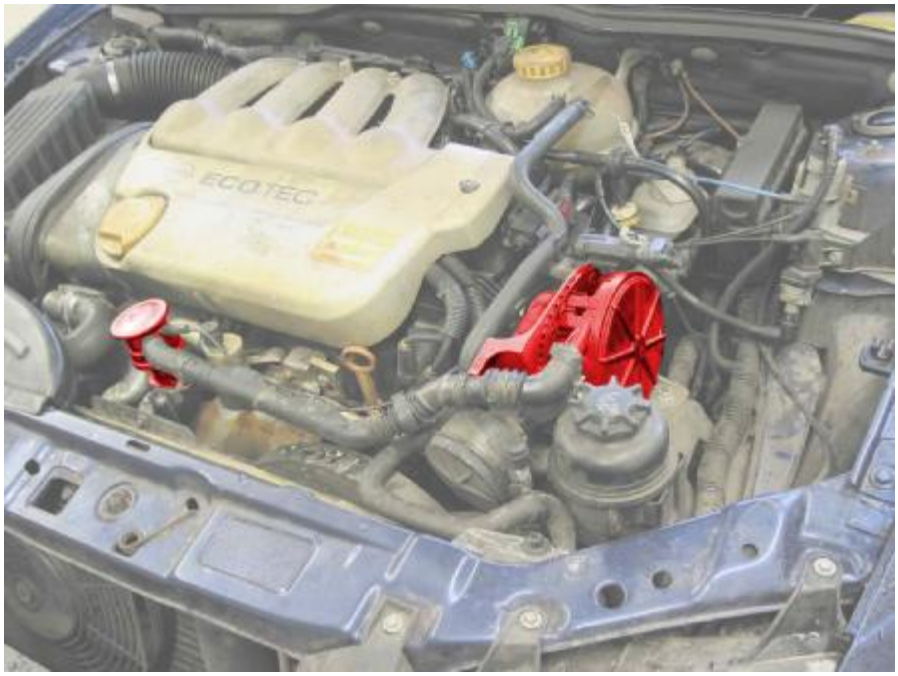
Such disadvantages are avoided by blowing in secondary air.



Principle of blowing in of secondary air

By blowing high-oxygen ambient air ("secondary air") into the exhaust manifold causes a post-oxidation ("catalytic post-combustion") of the pollutants.

Although the secondary air system is only activated for a maximum of 90 seconds after a cold start, HC and CO emissions are considerably reduced during the cold start phase.



Secondary-air valve and secondary air pump in Opel Tigra (highlighted)

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Simultaneously the starting time of the catalytic converter is significantly reduced due to the heat released by the post-oxidation.

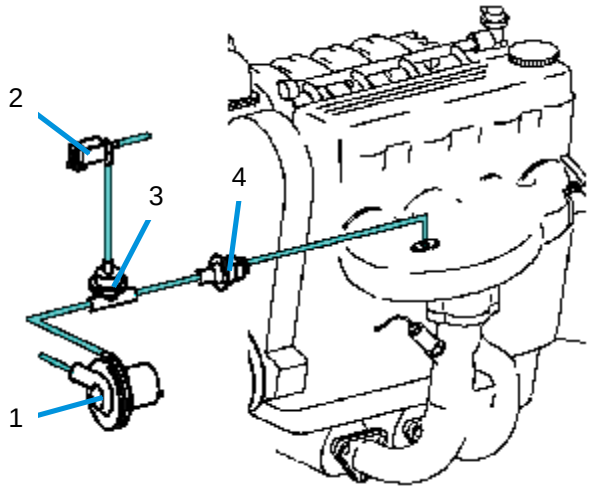
By the way: Because diesel cars always run with excess air, thus lean, – even during a "cold start" – there has never been any necessity to blow in secondary air.

Components of the Secondary Air System

According to state-of-the-art technology, the air is supplied by an electric secondary-air pump (SLP) that blows air in the exhaust manifold.
This requires appropriate piping between clean air side (behind the air filter) and exhaust manifold.

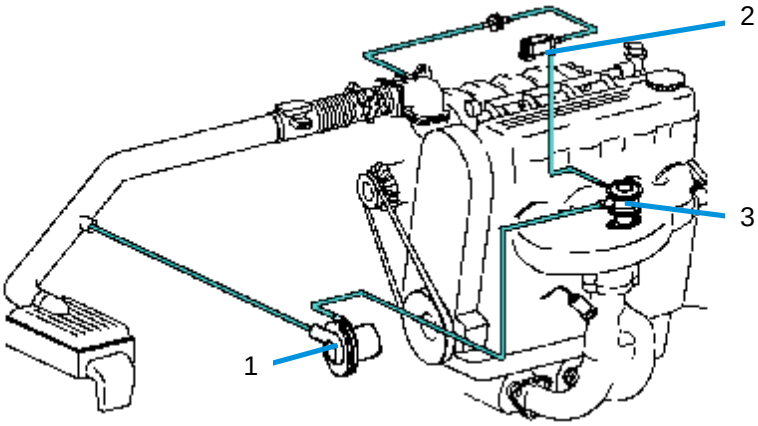
Secondary air pumps are high-speed, one- or two-stage blowers.
An air filter is incorporated when the air induction is not effected through the intake air system but directly from the engine compartment.

Depending on the vehicle generation, additional components, such as electric switchover valves, cut-off and non-return valves are installed in the secondary air system.



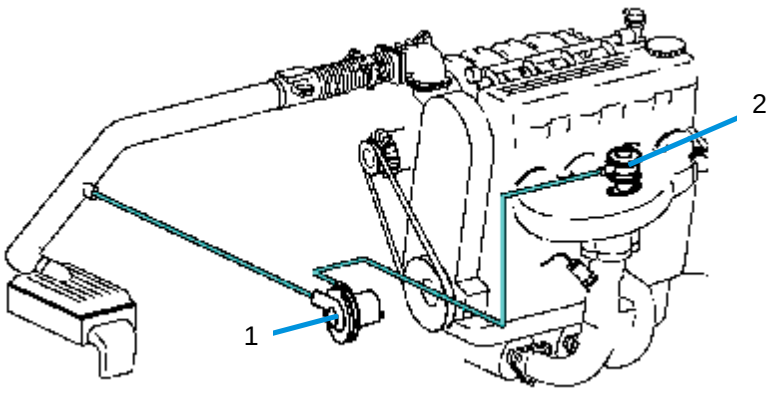
Older system (approx. 1993 – 1997)

1) Secondary air pump
2) Electric switchover valve (EUV)
3) Shut-off valve
4) Secondary air non-return valve



Newer system (since about 1995)

1) Secondary air pump
2) Electric switchover valve (EUV)
3) Cut-off secondary air valve



Latest system (since about 1998)

1) Secondary air pump
2) Secondary-air valve

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The *shut-off valve* prevents air from arriving in the exhaust manifold after the cold start phase, as a result of which the lambda signal would be falsified. It is a pneumatically actuated valve. The required setting force is achieved by a vacuum taken from the induction pipe.

After the coldstart, the engine management assumes the time-dependent setting of the shut-off valve to passage via an electric switchover valve.

The *electric switchover valve (EUV) – a small switch for vacuum-controlled components*

The *non-return valve* prevents pressure peaks being generated in the exhaust branch, e.g. misfires in the "front" part of the secondary air system cause damage and stops exhaust gas or condensate arriving in the secondary air pump. In opposite direction, the non-return valve opens as a result of the pressure from the secondary air flow.

The shut-off valve and non-return valve are frequently combined in one component, the "*cut-off secondary air valve*".

More recent types of secondary-air valves (since about 1998) are opened by the pressure from the secondary air. Consequently, the pneumatic actuation by an electric switchover valve is no longer necessary.

Secondary air pumps are now provided with their own small air mass sensor, the plausibility of which is monitored by the control unit. In this way, permanent monitoring can be achieved by way of on-board diagnostics.

Secondary air shut-off valve (approx. 1993–1997)

Secondary air non-return valve (approx. 1993–1997)

The cut-off secondary air valve combines shut-off valve and non-return valve (since about 1995)

The latest generation of secondary-air valves no longer needs any pneumatic actuation – as can be seen by the omission of vacuum hose connection (since about 1998)

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Secondary Air System and OBD

Before vehicles were equipped with component monitoring systems, the failure of a component in the secondary air system often remained almost unnoticed.

However, since the introduction of on-board diagnostic systems – known as "OBD" – every malfunction is "a case for the repair shop".

On American on-board diagnostics, the function of the secondary air system is monitored with the aid of the lambda control.

Two different methods are used in this case:

The secondary air pump is activated for about 90 seconds immediately *after the cold start*. The secondary air blown in is not post-controlled. When the Lambda probe is ready for operations and emits usable probe signals, these are compared with the set-point values.

As soon as operating temperature is reached, monitoring is carried out during an idle phase when the engine is *at operating temperature*. The secondary air pump is switched on for this check. The Lambda probe thus records a lean mixture. The control unit compares the probe signal with the set-point values.

With European on-board diagnostics, called EOBD, the secondary air system is only checked with regard to the electric connection of the secondary air pump, but not for its effect.

An incorrectly functioning secondary air system is therefore often only detected by an unusual whistling noise from the secondary air pump or by a varying idle speed in cold running phase.

Think outside the Box

Due to the fact that the *actual cause of damage* often remains unnoticed during the repair, the secondary air pump is consequently only replaced. The origin of the damage remains on the vehicle, however, and may cause a further failure of the secondary air pump.

The actual cause is frequently due to the ingress of moisture and dirt into the secondary air pump on the suction-side or exhaust-side.

A secondary air pump should really be installed as high and dry as possible, but due to the absence of such locations, car manufacturers often place the secondary air pump behind one of the front wheel houses, i.e. low and damp. Moisture and dirt have no problem getting in, especially if the pump is provided with its own filter integrated into the housing or if the induction pipe is not tight.

Secondary "soot" pump?
The interior of a secondary air pump should not look like this.

Secondary "water" pump?
From time to time, we receive secondary air pumps as warranty returns which are still filled with aggressive exhaust-gas condensate. Since the non-return valve is intended to prevent this, it must be defective.

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For this reason, the filter and induction pipe should always be checked when replacing the secondary air pump to see whether dirt and water have accumulated there.

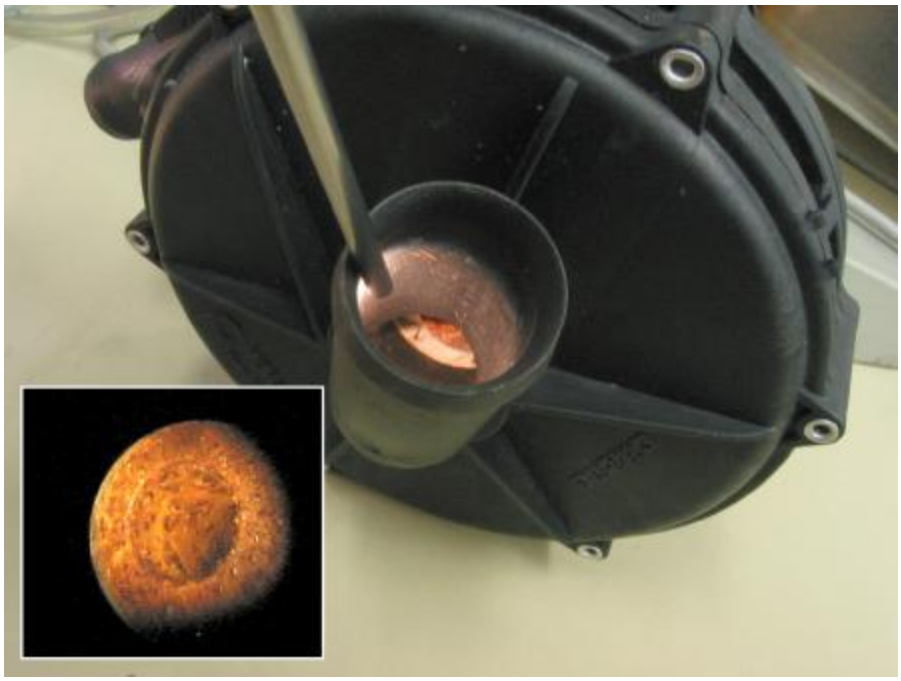
In most cases, damage to the secondary air pump is caused by exhaust-gas condensate in the pump.

One possible cause can be a stuck non-return valve or one that no longer closes completely.

But even a defective shut-off valve or its actuation by way of an electric switchover valve can contribute towards exhaust-gas condensates reaching the secondary air pump.

If it is stuck in its closed state, the blowing in of secondary air is not possible at all. A permanently open non-return valve allows exhaust gas and, as a result, impurities to enter the system and to extend to the shut-off valve.

So, if there are any problems with secondary air systems just "think outside the box" and view the system as a whole. The OBD system often captures only the symptoms – the causes need to be detected by the expert.



If a secondary air pump "whistles" its interior often looks like this. Water has caused corrosion. The origin of the water must be checked in each individual case.

Cut-off secondary air valve
left: stuck by deposits – right: in new condition

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Diagnostics Tips

A quick check of the secondary-air valve can be carried out with a simple "finger test":

You need only to loosen the connecting hose on the non-return valve leading to the secondary air pump and wipe through the opening with one finger.

If there are deposits on this side of the valve, the non-return valve is leaky and must be replaced.

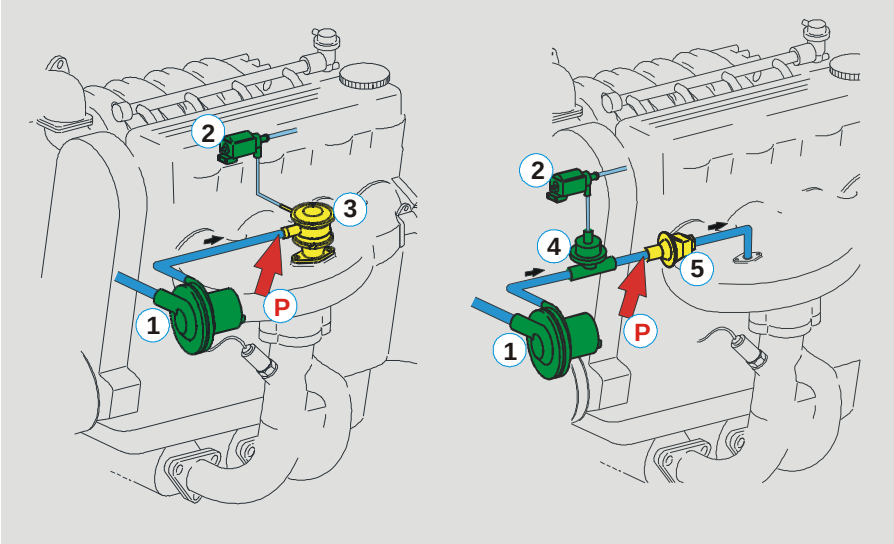
In this case, the secondary air pump may already be damaged and should therefore also be checked.

The secondary air pump can be checked acoustically:

After starting the cold engine (engine temperature below 50°C), the secondary air pump runs for max. 90 seconds. Its must function audibly but without whistling noises.

Prior to replacing a defective pump, however, first check whether such noises are caused by a loose fastening element or if the pump is simply rattling in its fixtures.

Caution: The secondary air pump is not suitable for permanent operation.



Two variants of the secondary air system

All other components of the secondary air system (hose line between pump and shut-off valve, its elbow connection and the two vacuum lines of the electric switchover valve) should finally be at least visually checked for damage and leaks.

1) Secondary air pump
2) Electric switchover valve (EUV)
3) Cut-off secondary air valve (ca. 1995 à)
4) Secondary air cut-off valve (approx. 1993 à 1997)
5) Secondary air non-return valve (approx. 1993 à 1997)

P) Check point for quick check

www.msi-motor-service.com

Quick check on a secondary-air valve on BMW 520i (highlighted)