KOLBENSCHMIDT PIERBURG GROUP

SECONDARY AIR SYSTEM –

Electrical Secondary Air Pump and Secondary Air Valve

PIERBURG

Technical description

In 1990 vehicle emissions in Germany were reduced significantly by mandating all new cars to have a 3-way catalytic converter. Subsequently, as emissions regulations grew even stricter, the gap between what a 3-way catalytic converter could achieve and, what government regulations required, grew. It soon reached a level where additional exhaust gas after-treatments systems were needed, to meet regulations. In the early nineties, Pierburg GmbH was one of the first OEM suppliers to develop a secondary air pump. Since then Pierburg has evolved a secondary air system that includes the pump and the associated air valve.

In the past 15 years, expectations for secondary air components have increased substantially. Secondary air pumps are expected to be light, quiet and very compact in size. Secondary air valves are expected to be reliable, even under extreme conditions. In addition the ever-stronger emissions regulations need to be met.

Why secondary air? On gasoline engines with stoichiometric operation, today's catalytic converters are able to reach conversion rates of over 90 percent but only once the converter reached its light-off temperature of 300 to 350 °C. On the other hand 80 percent of the emissions in the test cycle are generated immediately after cold start. The reason being that during this period the catalytic converter is not fully operable. Here is where secondary air brings its benefits. Injecting secondary air into the exhaust manifold initiates an exothermal oxidation of the unburnt hydrocarbons (HC). Consequently, HC and CO emissions are reduced during cold start while at the same time the light-off time of the catalytic converter is shortened. Fig. 1 illustrates such a secondary air system.

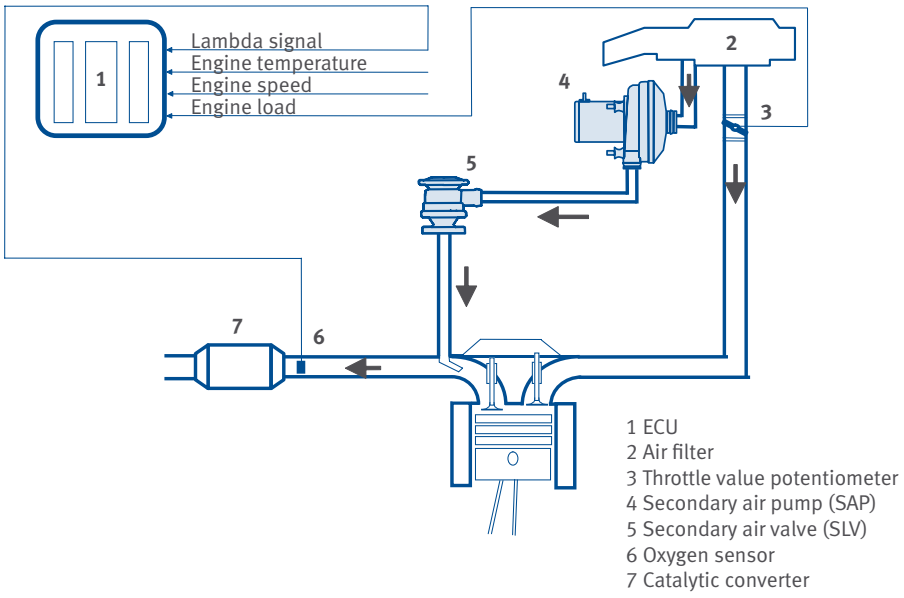


Fig. 1: Schematic structure of the secondary air system

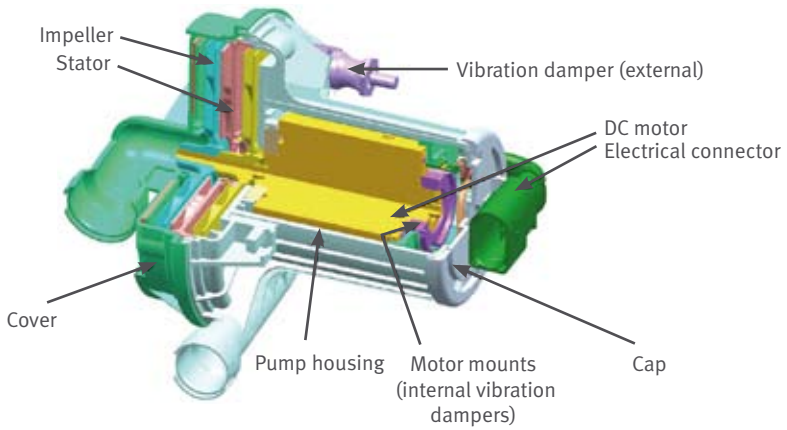


Fig. 2: Secondary air pump

Secondary air pump

The functional principle of the secondary air pump (fig. 2) is that of a radial pump. The housing material is plastic, and it is driven by a DC motor. The housing components are welded and therefore sealed against splash water as well as dust contamination. In addition the motor compartment is sealed off from the pump unit to protect the DC motor from any corrosive exhaust condensate and ensure, among various other measures, low-noise operation of the secondary air pump.

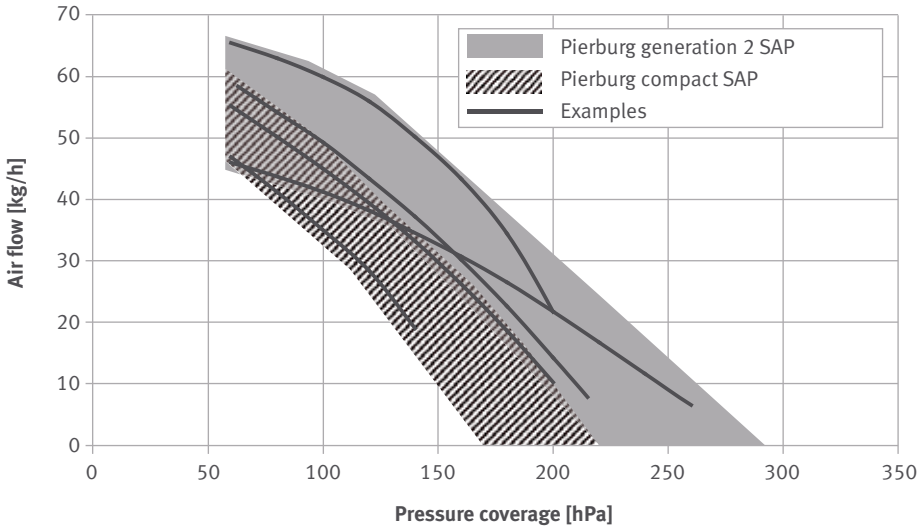
As an experienced automotive system supplier Pierburg has over years continuously advanced the development of secondary air systems, and is therefore now offering the most advanced secondary air system technology on the market. We are market leader in valve and pump technology. Extensive calculations, pressure and speed simulations have brought substantial improvements in pump and impeller geometry and have led in turn to a new member in the Pierburg secondary air pump family, the size optimized compact secondary air pump. Acoustic measurements on every production pump ensure an extraordinary high quality standard. By switching to sound power measurements in 2003 this standard was raised yet again.

Thanks to the modular design and availability of DC motors with varying outputs and the supplement of a compact design, it is now possible to supply sufficient secondary air to both, high-displacement gasoline engines and vehicles with limited space for packaging. Indeed, a broad range of engines can now be covered.

Fig. 3 shows the flow characteristics covered by Pierburg's secondary air pumps. The range of air flow and pressure coverage was increased due to new motor and impeller design.

Secondary air pumps can either be engine or chassis mounted. Depending on the mounting location, pump insulation will be required. When chassis mounted, insulation is very important to avoid vibration from the pump not being transmitted into the chassis and causing structure borne noise. To avoid such transmissions, Pierburg designed a modular system of brackets, and vibration absorbing elements to ensure that the secondary air pump does not interact with its mounting location.

Fig. 3: Flow characteristics, realized by Pierburg secondary air pumps



Secondary air valve

The function of the secondary air valve is to prevent backflow of exhaust gases into the secondary air blower or the environment. At the same time it ensures that fresh (secondary) air can flow into the exhaust manifold when the secondary air system is engaged and prevents uncontrolled inflow beyond the operation of the secondary air system. Pierburg offers three different valves for this application:

A distinguishing characteristic of the vacuum operated control valve (ARV) is the low pressure loss. To actuate this valve vacuum from the intake manifold is supplied by a solenoid valve. In most cases the ARV is carried out with an integral check valve function to prevent return flow.

Cost was the driver to develop a pump pressure operated valve. This secondary air valve (SLV) – shown in fig.4 – is opened by pressure generated from the air pump. The SLV reduces system complexity greatly, since there is no need for electric actuation or any vacuum lines. The SLV type of valve can be equipped with an integrated check valve too. **The secondary air valve can also be selected with an enlarged membrane diameter to boost the actuating force.**

One of our latest developments is an electric secondary air valve (ESV) – shown in fig. 5 – that combines the advantages of the pressure operated valve and the vacuum operated valve. The ESV works independent of pump pressure and intake vacuum levels. Actuated by a solenoid the valve‘s response time is faster than the equivalent ARV or SLV response time. A split armature and the resulting plate magnet effect guarantees high opening forces that ensure full function even at ambient temperatures below freezing. The ESV has a maximum opening force of approx. 110 N in the important first 0.5 mm of travel.

The ESV can also have an integrated pressure sensor to allow for secondary air system diagnosis as required by OBD II, EOBD. All three types of valves can have a pressure sensor integrated in the inlet flange as an option.

Based on existing components Pierburg is continuously developing further secondary air technology to ensure that the challenges for future applications can be met.

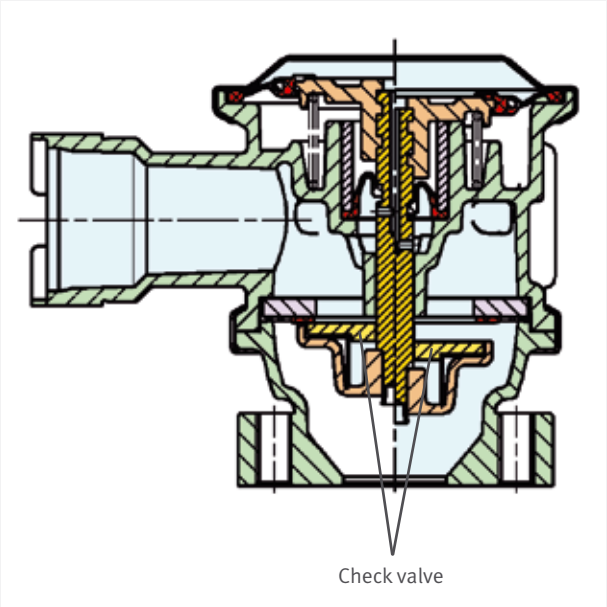


Fig. 4: Secondary air valve

Fig. 5: ESV

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