Article citation info:
Kindler O, Królak S, Warguła Ł, Wieczorek B. Research on the design of a non-commercial impulse compressed air supply system for the turbocharger of a spark-ignition internal combustion engine. Combustion Engines. 2025;202(3):11-19. https://doi.org/10.19206/CE-205010

Oleg KINDLER
Szymon KRÓLAK
Łukasz WARGUŁA
Bartosz WIECZOREK

Combustion Engines
Polish Scientific Society of Combustion Engines

Research on the design of a non-commercial impulse compressed air supply system for the turbocharger of a spark-ignition internal combustion engine

ARTICLE INFO

Received: 29 April 2025
Revised: 8 May 2025
Accepted: 12 May 2025
Available online: 3 June 2025

A compressed air pulse directed to the turbocharger of an internal combustion engine can significantly improve the power and torque build-up characteristics. This article presents the design and testing of a universal compressed air delivery system for the turbine rotor on the exhaust side of a turbocharger, demonstrated using a Volvo V70 2.0 Turbo vehicle. The proposed solution offers a retrofit approach for older engine designs, inspired by the PowerPulse system, which was first introduced commercially by Volvo in 2016 in the S90 model. The non-commercial prototype tested in this study increased engine torque by up to 13% within a selected rotational speed range (1700 to 2400 rpm). Simultaneous changes were also observed in the manifold absolute pressure (MAP), lambda sensor readings, injection timing, and air mass flow in the intake manifold.

Key words: *Power Pulse system, reduction of turbo lag, improvement of torque and power characteristics, engine boosting with compressed air, enhancement of engine acceleration response*

1. Introduction

The phenomenon known as turbo lag refers to the delay between the demand for power and the actual increase in engine power output in turbocharged engines. This delay is primarily due to the time required for the turbocharger to spool up and provide the necessary boost pressure. Several key factors contribute to turbo lag. The design and efficiency of the turbocharger [19], including the turbine and compressor geometry, have a significant impact on transient response; for example, mixed flow turbines can improve efficiency at low velocity ratios [11], while variable geometry turbines (VGT) and variable diffuser vanes extend operating range and optimize torque delivery by adjusting flow conditions [9]. Turbochargers also operate under highly unsteady flow conditions due to the reciprocating nature of internal combustion engines, which affects overall performance [7, 13, 16]. The interaction between the turbocharger and the intake and exhaust systems [2], including pulsating flow dynamics, is critical to optimizing performance [13, 14]. Additionally, heat transfer within the turbocharger and aerodynamic aspects such as the shape of the turbine volute influence performance, especially under pulsating flow conditions [24], and deviations from expected behavior can occur at low engine loads due to heat transfer effects [17]. To address these challenges, advanced control strategies are employed, including computational fluid dynamics (CFD)-based optimization and genetic algorithms to improve design [10, 12, 15], as well as model-based control of fueling and valve timing to reduce cylinder-to-cylinder variation and improve performance [21, 25]. Mitigation techniques such as variable geometry turbochargers [9], turbo-discharging methods to recover exhaust energy [3], and the application of advanced materials and coatings to improve durability and efficiency under high-stress conditions are all helping to reduce turbo lag. While turbo lag remains a key challenge in turbocharged spark-ignition engines, ongoing advancements in turbocharger design, control systems, and materials continue to enhance engine response and overall performance.

One of the emerging solutions in the effort to improve engine response and reduce torque delay is the use of compressed air systems for turbochargers. Compressed air systems can help address this issue by providing an immediate supply of compressed air to the engine, thereby reducing the time required for the turbocharger to reach optimal performance levels [4]. Cieslar et al. in 2013 investigated two such systems: Air-Assist Systems and Exhaust Assist Systems. The Air-Assist System injects compressed air directly into the intake manifold, significantly enhancing the engine's transient response. This approach is relatively cost-effective compared to more complex technologies such as multi-stage turbocharging or electrically assisted turbochargers. However, its performance is often limited by the compressor surge margin. In contrast, the Exhaust Assist System represents a more innovative approach, where a compressed air reservoir, charged during braking, delivers air into the exhaust manifold. This technique helps overcome the surge limitation and substantially improves turbocharger acceleration, reducing the time required to generate torque by approximately 60% during gear shifts. Additionally, Song et al. in 2020 analyzed the Active Control Methodology (ACM), which involves extracting a portion of compressed air from the compressor outlet, heating it with fuel, and supplying it to the turbine inlet. This method aims to optimize turbocharger operating conditions by expanding the surge margin and enhancing instantaneous engine performance [18]. In 2008, Basu described hyperbar supercharging, also known as hyper-bar turbocharging, as a high-pressure turbocharging method primarily employed in applications demanding exceptionally high engine output. The technique utilizes turbochargers to dramatically increase intake air pressure, thereby boosting engine power density and overall performance [1]. In conclusion, compressed air-based systems present promising avenues for improving turbocharger dynamics and mitigating turbo lag. Each system offers distinct advantages and limitations, and further research is essential to refine these technologies for practical implementation in modern automotive engines.

The first commercially implemented compressed air system for turbocharger support was introduced by Volvo in 2016 in the D5 engine of the Volvo S90 under the name PowerPulse (Fig. 1). Developed in-house, this pneumatic system was designed to eliminate turbo lag and improve low-end engine response by injecting a pulse of compressed air directly into the exhaust manifold, accelerating the turbocharger turbine more rapidly. The system uses an electric compressor to pressurize a 2-liter air tank to 18 bar, releasing air through a solenoid valve when additional torque is requested, particularly enhancing responsiveness at engine speeds below 1500 rpm. Testing showed torque gains of up to 30% within one second of load application and improved acceleration in real-world driving conditions, such as stop-and-go traffic. Compared to competitors with larger diesel engines, the PowerPulse-equipped Volvo XC90 D5 delivered superior launch performance while maintaining fuel efficiency and low emissions [5, 6].

The aim of this article is to present the design of a universal compressed air pulse system for the turbocharger of a spark-ignition internal combustion engine, along with the results of experimental studies on its impact on torque, power output, manifold absolute pressure (MAP), intake air flow, injection duration, and lambda sensor readings. The research was conducted using a Volvo V70 2.0 Turbo as the test platform.

Fig. 1. Power-Pulse Volvo design [20]

2. Materials and methods

The concept involves designing a system that delivers compressed air to the turbine rotor on the exhaust side of the turbocharger, with the aim of increasing the air momentum. The primary actuator of the system is a pressure nozzle located in the exhaust manifold, aligned with the direction of exhaust gas flow (Fig. 2).

The subject of the study is a Volvo V70 2.0 Turbo equipped with a spark-ignition internal combustion engine designated as B5204T5. This 2004 engine is a five-cylinder unit with a displacement of 1984 cm³ (Table 1). It features Variable Valve Timing (VVT) on both camshafts and is fitted with 20 valves. According to the manufacturer's specifications, it delivers 180 HP and a maximum torque of 240 Nm. The compression ratio is 9.5:1, which is considered relatively low for modern turbocharged engines focused on reducing emissions. However, this ratio is relatively high in the context of modifications aimed at increasing boost pressure and engine output.

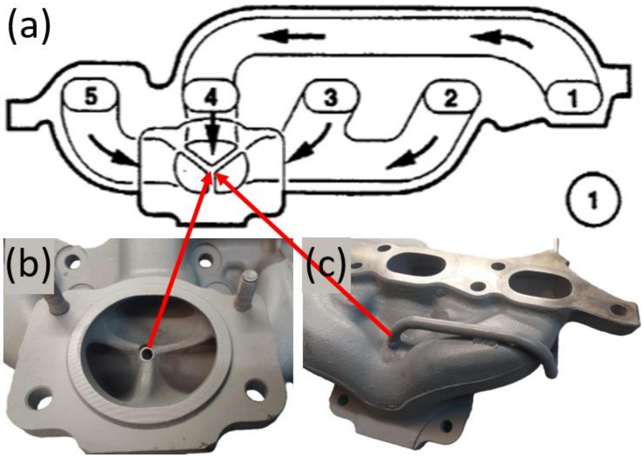

Fig. 2. Exhaust manifold of the Volvo V70 2.0 Turbo: (a) manufacturer's schematic, (b) additional channel for the compressed air impulse system (internal side), (c) additional channel for the compressed air impulse system (external side), where: 1–5 – cylinder numbers of the exhaust channels

Engine control is managed by the Bosch Motronic ME7 system, a series of control units developed by Bosch for spark-ignition engines with multi-point fuel injection. Fig. 3 illustrates the internal architecture of the controller, including the sensors and actuators it operates.

The engine's forced induction system features a Mitsubishi turbocharger from the TD04HL-20T family. On the intake side, it has a 47 mm inlet and a 58 mm outlet, while the exhaust side features a 52 mm inlet and a 45.6 mm outlet. This series of turbochargers is specifically designed for gasoline-powered engines. The rotor shaft is supported by journal bearings and is lubricated by oil supplied from the engine's main oil line. Additionally, the turbocharger core is cooled using a water jacket.

Table 1. Technical specifications of the B5204T5 engine

Parameter	Specifications
Type	Inline 5-cylinder
Displacement	1984 cm³
Power	180 hp (132 kW) at 5300 rpm
Torque	240 N·m (180 lb·ft) at 2000–5300 rpm
Bore	81 mm
Stroke	77 mm
Compression ratio	9.5:1
Type of supercharging	Turbocharged

To analyze the engine's operating parameters, the Volvo DICE diagnostic interface was used in combination with the Volvo VIDA software. Simulated engine load tests were conducted on a Dynomet ASP chassis dynamometer with active load control capabilities. The device is a load-type (brake) chassis dynamometer, capable of applying programmable resistance to simulate various driving conditions. The dynamometer allows for real-time measurement of wheel torque, engine output, and vehicle speed, with typical measurement accuracy of ±1% for power and torque, and ±0.2% for rotational speed. The system supports both steady-state and transient testing and can operate under automated load profiles for repeatable performance evaluations.

Measurements were carried out under three different scenarios involving the initiation of the compressed air impulse. In the first scenario, the system was activated at an engine speed of 1200 rpm; in the second, at 1700 rpm; and in the third, at 2000 rpm.

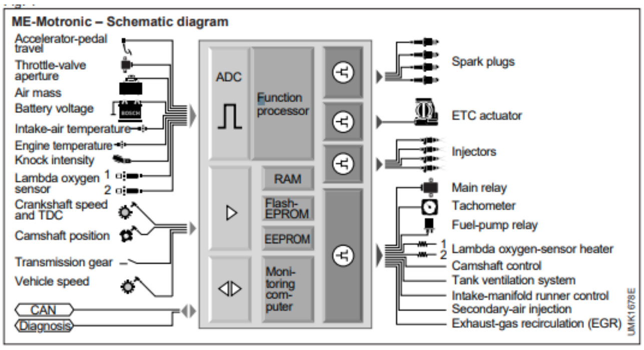

Fig. 3. Diagram of the BOSCH ME control unit with sensors and actuators [8]

3. Prototype design of the conceptual compressed air impulse delivery system

3.1. Concept of operating principle

The designed system is responsible for delivering a compressed air impulse to the turbocharger while maintaining full automation. This means that once installed and configured, the system operates autonomously, with all necessary actions managed and executed by the control unit.

The primary function of the system is to continuously monitor selected engine parameters that reflect the load on the power unit – specifically, the throttle opening degree, measured by the position sensor integrated into the original throttle body. At the same time, it monitors the pressure in the intake manifold, which, under high throttle opening, equals the pressure generated by the turbocharger. Another essential parameter for evaluating engine performance is engine speed.

Based on these inputs, the system compares real-time values with thresholds programmed by the installer. When specific conditions are met, the system decides to inject compressed air into the turbocharger. This injection is initiated by actuating a solenoid valve, and the supplied air accelerates the rotation of the turbocharger's rotors.

Due to the need for a constant supply of compressed air – something not typically available in passenger vehicles – the system includes a dedicated air preparation module. This module consists of a compressor and a storage tank. Its operation is supervised by the system's central control unit.

To allow both the user and the installer or technician to view system parameters and quickly deactivate the system if needed, a user interface panel is included. Designed for in-cabin installation via a single cable, the panel features an LCD display for real-time data and control buttons for manual input.

Ensuring system reliability and maintenance-free operation requires self-monitoring capabilities. For this purpose, the system includes additional temperature and pressure sensors. If any monitored parameter exceeds safe limits, the system automatically deactivates to prevent damage. Normal operation resumes automatically once the conditions return to a safe range.

3.2. Monitored parameters

Power demand assessment in gasoline engines is made possible by monitoring the Throttle Position Sensor (TPS). The standard output range for such built-in sensors is 0 to 5 V, which corresponds to an interpretable signal range for a microcontroller.

Intake manifold pressure in a turbocharged engine is a key parameter for the designed system, as it determines both the activation of the system and the correctness of its operation. This pressure is measured by a MAP sensor installed in the intake system. For optimal performance, the most suitable measurement location is in the intake manifold downstream of the throttle body, as this position includes vacuum values. In vehicles equipped with a MAF sensor, the MAP sensor is typically located in the intake before the throttle body. Therefore, in the new system, the MAP reading is taken from an auxiliary sensor, which may also be shared with an alternative fuel injection system (e.g., LPG or CNG). The pressure sensor used in the system must have a minimum operating range of –0.1 to 0.15 MPa.

Engine speed is a fundamental operating parameter of an internal combustion engine. It serves as the basis for functions that define other parameters. In the context of the designed system, it is essential for determining operational thresholds. The engine speed is determined in coordination with angular position detection, using a toothed ring rigidly connected to the crankshaft, in combination with an inductive or Hall-effect sensor.

Compressed air preparation would not be possible without monitoring the pressure inside the storage tank. It is necessary to maintain the desired pressure level via a compression unit, consisting of a compressor or a set of compressors controlled electronically by the system controller. For this reason, it is a critical parameter for overall system operation. The pressure is measured by a transducer mounted on and connected to the storage tank. The transducer's readings are processed by the control unit. The required sensor must have a measurement range of at least 0 to 0.8 MPa. However, considering that the system may require higher boost pressures for improved performance, a transducer with a wider operating range, such as up to 1.2 MPa, should be considered.

Temperature monitoring within the system is necessary due to the need for automation, self-diagnostics, and the challenging operating environment. The control unit is designed for installation in the engine bay and includes heat-generating components such as a step-down voltage converter supplying 5 V to digital circuits, power transistors for driving the solenoid valve, and a microcontroller. The controller is passively cooled without additional heat exchangers. A thermistor will be placed on its surface for temperature monitoring.

Another critical location requiring thermal management is the air compressor mounted in the vehicle's trunk. It is responsible for supplying significant volumes of compressed air. The electric motor generates considerable heat, and under the system's assumed working pressures, not all commercially available compressors support a 100% duty cycle. Additionally, the compression process itself generates heat that must be dissipated. As a result, the compressor is another potential overheating point and will also be equipped with a temperature sensor.

3.3. Actuators

The solenoid valve plays a crucial role in the designed system as the main actuator responsible for the precise delivery of compressed air. It operates by opening to allow airflow when the control unit detects the need for an air impulse, and closing to stop the flow when compressed air delivery is unnecessary or undesirable, such as in the case of system overheating. The valve's performance requirements include a fast response time to enable accurate activation and deactivation of the compressed air impulse, resistance to high pressure up to 0.8 MPa, and durability in harsh operating conditions such as elevated engine bay temperatures, moisture, and vibrations.

Equally important to the system's operation is the compressor, which is tasked with compressing air into a thin-walled storage tank essential for the system's functionality. In the proposed setup, the compressor is powered by a 12–14.4 V electric motor. It must meet several key requirements: it must generate compressed air at a target pressure of 0.8 MPa, have a compact design suitable for vehicle integration, and provide sufficient performance to pressurize the air tank efficiently in the shortest possible time. Additionally, the compressor must maintain power consumption at an acceptable level to ensure reliable and efficient operation within the vehicle's electrical system.

3.4. Control unit

The control unit serves as the central component of the system, responsible for analyzing sensor data, making real-time decisions to operate actuators, and ensuring communication with the vehicle driver through the user interface panel (Fig. 4). Its core functions include the analysis of input signals such as:

– MAP (Manifold Absolute Pressure): measuring intake manifold pressure in the internal combustion engine
– TPS (Throttle Position Sensor): detects the throttle opening angle
– TAP (Tank Air Pressure): monitoring the pressure of compressed air stored in the thin-walled tank
– RPM (Engine Speed): derived from the first fuel injector signal, allowing the system to determine the engine's crankshaft speed
– Compressor Temperature Sensor: monitoring the thermal condition of the compressor
– Control Unit Temperature Sensor: tracking the operating temperature of the control module itself
– Vehicle Electrical System Voltage: assessing power supply status
– User Panel Button States: detecting manual user inputs.

In terms of actuator control, the unit performs the following actions:

– Solenoid Valve Control: based on the analysis of selected engine parameters, the control unit determines when to open or close the valve
– Compressor Activation: it triggers the compressor when the pressure in the air tank drops below a preset threshold.

The user interface panel supports:

– Displaying system operating parameters
– Presenting predefined values for key variables
– Handling user input via buttons.

For safety and diagnostics, the control unit continuously monitors critical thresholds and deactivates the system if any parameter exceeds its safe limit. Once conditions return to normal, the system automatically resumes operation, ensuring reliability and minimizing the need for manual intervention.

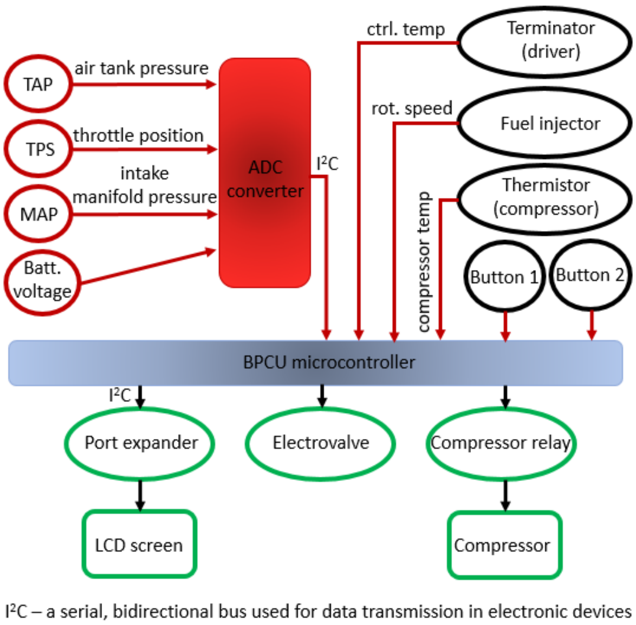

Fig. 4. Schematic diagram of the control system

3.5. User panel

The user panel serves as the interface that allows the driver to monitor and manage, in real time, the operation of the system responsible for delivering compressed air impulses to the turbocharger. It is equipped with a 20×4 LCD screen and two buttons for system control.

Each button on the user panel has a distinct function. The first button enables system deactivation. Pressing it immediately shuts down the system, including the compressor. The driver can reactivate the system at any time by pressing the same button again. The second button is used to switch between different display screens, allowing the user to browse current operating parameters.

The first screen displays real-time engine and system parameters.

Displayed engine parameters include:
- Engine speed [rpm]
- Intake manifold pressure (MAP) [bar]
- Battery voltage (U.BAT.) [V].

Displayed system parameters include:
- Compressor activation status
- Compressed air pressure in the storage tank
- Compressor temperature
- Control unit temperature.

The second screen provides access to the preset values that define the system's activation conditions. The following data is shown:
- Boost pressure range (MAP) in the intake manifold at which the system is triggered
- Minimum throttle opening angle required to indicate power demand
- Maximum impulse duration, i.e., the maximum time compressed air is delivered into the intake or exhaust system.

When the system is deactivated, the screen displays a welcome message containing the project name and the authors' credits.

The electrical and pneumatic system components are shown in Fig. 5 and 6, respectively.

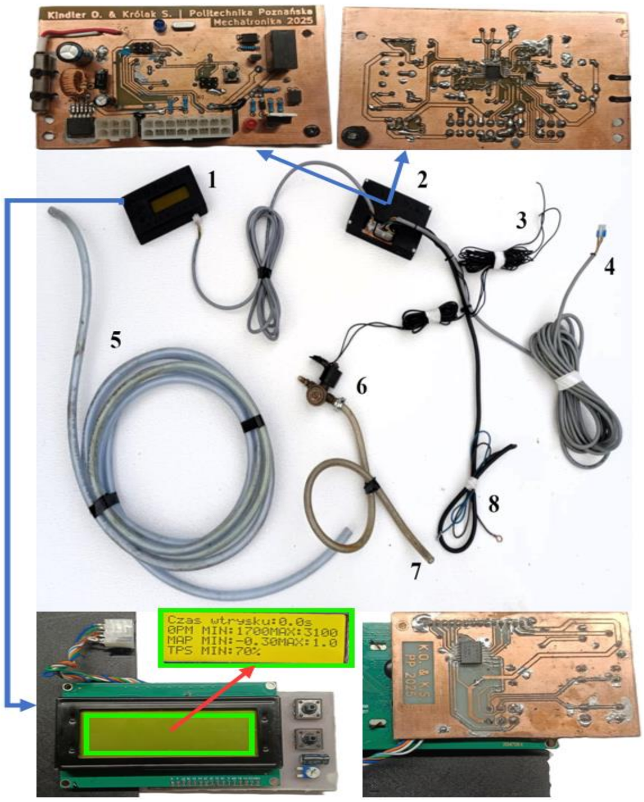

Fig. 5. Electrical system components, where: 1 – user panel, 2 – control unit, 3 – sensor signal inputs: MAP, TPS and rpm signal, 4 – air preparation module signal wire, 5 – air compressor wire, 6 – solenoid valve, 7 – air compressor output, 8 – power supply wires

4. Results and discussion

The tests conducted on the chassis dynamometer (Fig. 7) focus on the operating range of the designed system, which means the lower engine speed range—where, due to insufficient exhaust gas flow, the turbocharger cannot achieve the rotational speed necessary to generate the desired boost pressure. This type of testing enables a clear assessment of the system's effectiveness. The results for torque and power as a function of engine speed are presented for three tested activation ranges: starting from 1200 rpm (Fig. 8), 1700 rpm (Fig. 9), and 2000 rpm (Fig. 10).

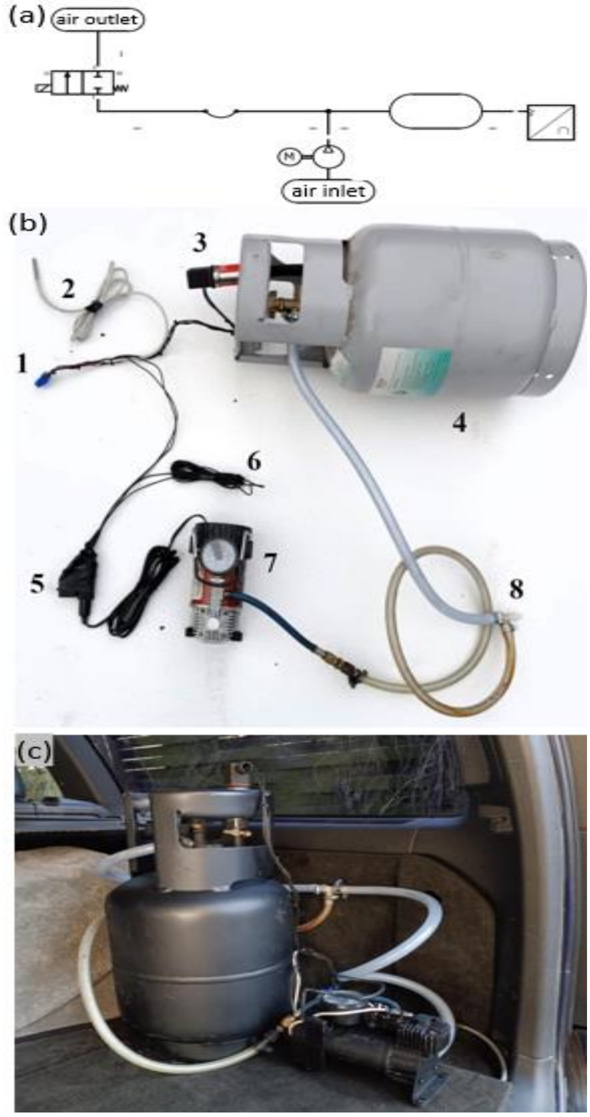

Fig. 6. Pneumatic system components (a) pneumatic diagram, (b) real parts, (c) air preparation system in the luggage compartment, where: 1 – air preparation module cable input, 2 – compressor temperature probe, 3 – tank pressure sensor (TAP), 4 – pressure tank, 5 – compressor relay, 6 – compressor power cables, 7 – electric compressor, 8 – air compressor output

The testing begins with a reference measurement across the full engine speed range to verify the proper functioning of the engine and control system. This reference serves as the baseline for evaluating the performance of the compressed air impulse system. By activating the system at different engine speeds, it becomes possible to determine the optimal timing for air injection in order to achieve the best performance gains. On the graphs, the operating range of the system is marked by two vertical lines indicating the beginning and end of the air impulse. The red curves on the graphs represent power output, while the green curves represent torque.

In the first test scenario, the system is activated at the lowest planned engine speed of 1200 rpm. Upon activation, a torque increase of approximately 6% is observed, lasting until the solenoid valve closes (Fig. 8).

The second test is carried out with a starting engine speed 500 rpm higher, at 1700 rpm – representing the mid-range of the tested speeds. Activating the compressed air impulse system at this point results in the performance shown in Fig. 9. A noticeable torque increase of approximately 25 Nm (around 9%) is recorded over a 400 rpm increase in engine speed. The engine responds immediately at the onset of the injection.

The third test is conducted with the system activation set at 2000 rpm. The results, shown in Fig. 10, reveal a significant torque increase of approximately 13%, equivalent to around 30 Nm. This improvement is substantial and would be clearly noticeable during real-world driving. However, it's important to note that the duration of the impulse is significantly shorter in this case. This is due to the control unit's programmed boost pressure limit of 0.06 MPa. Once this threshold is reached during injection, the system terminates the impulse after approximately 2 seconds. Increasing the activation speed any further would not yield additional benefits, as the MAP pressure limit would be exceeded, triggering the software's safety constraint and preventing further impulse generation.

Fig. 7. Vehicle tested on the chassis dynamometer

Testing on the chassis dynamometer confirms that the designed system is functional and has a measurable impact on engine power output. To objectively assess the influence on engine performance, additional parameters such as intake manifold pressure were also monitored (Fig. 11). In each scenario, an increase in boost pressure is observed during the system's operation. However, once the air injection ends, the pressure quickly returns to the baseline reference value. This indicates that the exhaust gas volume remains insufficient to drive the turbocharger effectively on its own in the low-speed range.

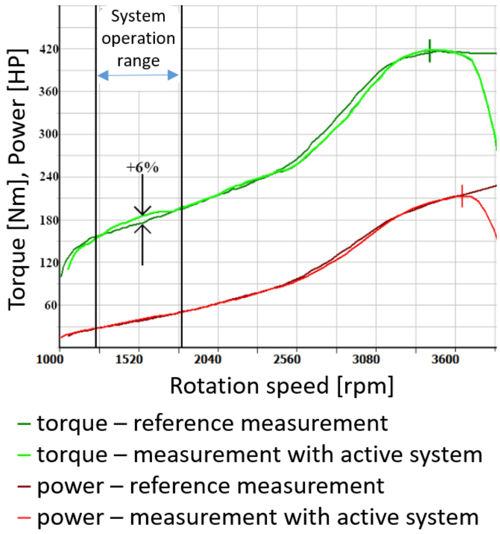

Fig. 8. Torque and power characteristics of the engine with the compressed air impulse system activated starting from 1200 rpm

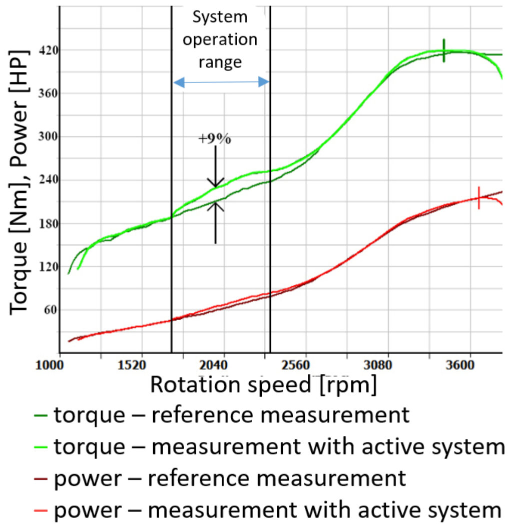

Fig. 9. Torque and power characteristics of the engine with the compressed air impulse system activated starting from 1700 rpm

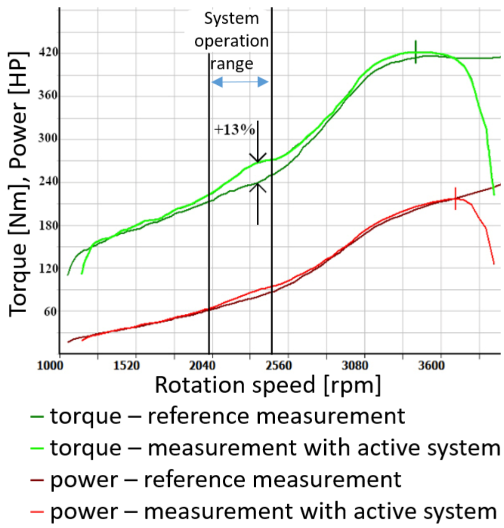

Fig. 10. Torque and power characteristics of the engine with the compressed air impulse system activated starting from 2000 rpm

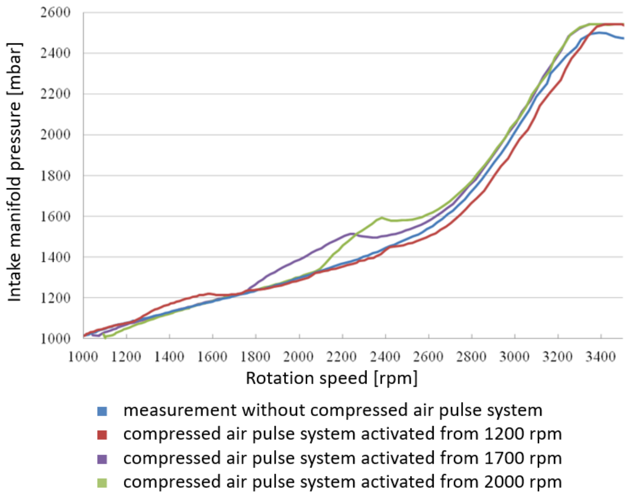

Fig. 11. Pressure in the intake manifold for different activation variants of the compressed air impulse system

The chart presents the Lambda sensor reading, which is directly influenced by the compressed air introduced into the system (Fig. 12). A Lambda value of 1 corresponds to a stoichiometric air-fuel mixture (14.7:1) [22, 23]. Values above 1 indicate an increased oxygen content in the exhaust gases, which the ECU interprets as a lean fuel mixture.

It is observed that, at the moment compressed air is delivered to the exhaust manifold, the Lambda value rises significantly. This prompts the ECU to apply a correction by increasing the fuel injection time in order to restore the proper mixture composition (Fig. 13). The extended injection duration is clearly visible in the chart (Fig. 13).

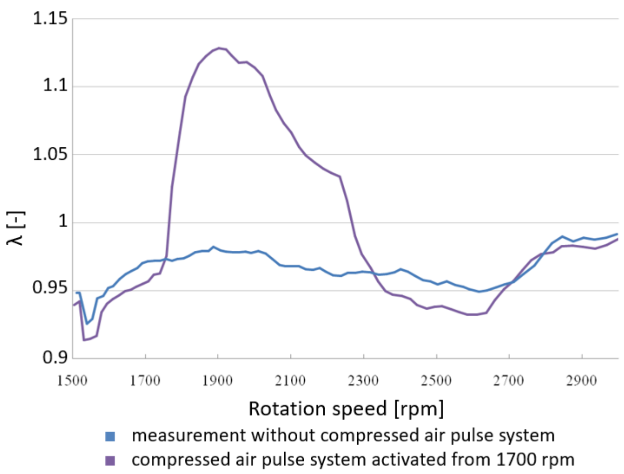

Fig. 12. Lambda value of the rotational speed function for with and without compressed air pulse system for exemplary system operating conditions, i.e. activation from 1700 rpm

The system's shutdown, i.e., the point when the air supply to the exhaust manifold is cut off, is marked by a sharp drop in the Lambda value (Fig. 12). This drop results from a sudden change in the oxygen content of the exhaust gases. At this moment, the Lambda value falls below that of the reference run, which is caused by a slight delay in the ECU's adjustment of the injection time.

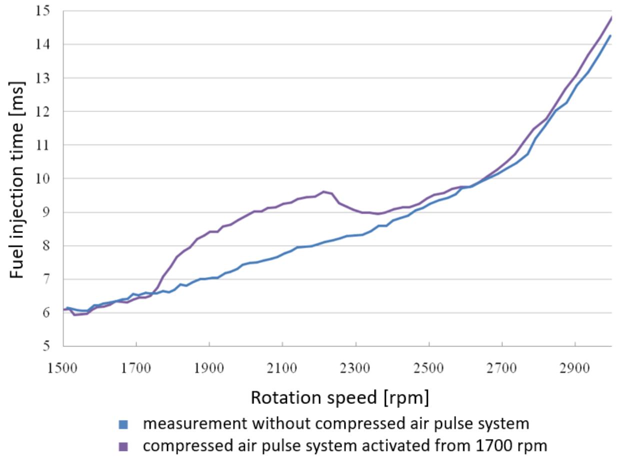

Fig. 13. Fuel injection time as a function of rotational speed for the system with and without compressed air pulse for exemplary system operating conditions, i.e. switching on from 1700 rpm

Figure 14 shows an increase in the mass of air delivered to the engine, indicating that the system has positively influenced turbocharger performance and reduced turbo lag – ultimately affecting the shape of the torque curve. Additionally, the enriched mixture, triggered by the Lambda sensor's initial misreading, may also enhance turbocharger function. A larger amount of fuel entering the combustion chamber leads to a higher exhaust gas volume, which helps drive the turbine rotor more effectively.

Despite the noticeable impact on the engine control system, the compressed air impulse system does not trigger any safety or protection algorithms built into the ECU. This confirms that the system is safe for engine operation and does not contribute to accelerated wear. Even if certain temporary deviations from ideal parameters may seem undesirable, their brief duration within the engine's full operating cycle is negligible.

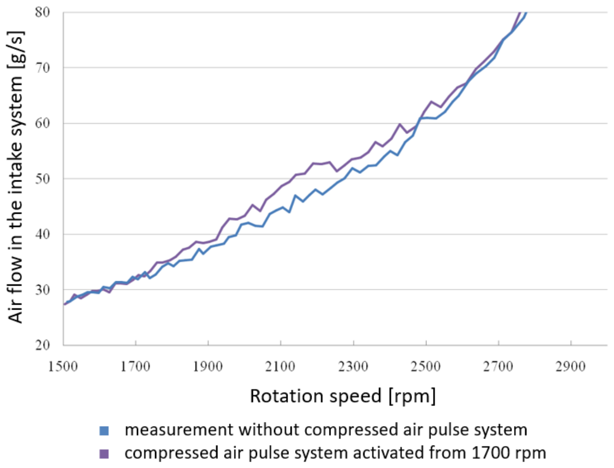

Fig. 14. Air flow in the intake system as a function of rotational speed for the system with and without compressed air pulse for exemplary system operating conditions, i.e., switching on from 1700 rpm

While commercial systems like Volvo's PowerPulse are tightly integrated into the vehicle's design and benefit from optimized software and hardware interactions, the presented prototype offers a modular and retrofittable alternative.

This makes it particularly relevant for aftermarket applications or for enhancing the performance of existing fleets without requiring significant modifications to the engine's core architecture.

One of the key insights from the testing phase is the system's immediate influence on engine control parameters, such as air-fuel mixture, fuel injection timing, and MAP readings. The observed increase in Lambda values at the onset of air injection, followed by rapid ECU correction through increased injection duration, demonstrates that the system operates within the expected logic of a spark-ignition control strategy. Importantly, no diagnostic faults or safety interventions were triggered, indicating that the system integrates safely with existing ECU routines.

The system also proved to have a positive effect on turbocharger performance by improving intake airflow and enhancing the transient response of the engine. Although brief fluctuations in mixture composition and MAP pressure were observed, their duration was minimal and did not lead to excessive deviations from reference operating conditions. These findings support the view that compressed air impulse systems – despite their simplicity – can provide substantial benefits in transient performance without compromising engine durability or efficiency.

However, certain limitations were also identified. For instance, the pressure threshold set within the control software constrained the duration of the impulse at higher engine speeds, reducing the effectiveness of the system as boost naturally increases. Future development should therefore consider dynamic boost thresholds or adaptive strategies to extend the usable operating window of the system.

Conclusion

The research presented in this study highlights the potential of non-commercial compressed air impulse systems as an effective solution to reduce turbo lag in spark-ignition engines, particularly in older vehicle platforms without modern turbocharger support technologies. The most important achievements of the study can be summarized as follows:

- Demonstrated up to 13% torque increase within a narrow engine speed range through the use of a compressed air impulse system
- Validated the concept of pneumatic turbo support as a viable retrofit solution for improving engine response
- Confirmed improvements in boost pressure characteristics and torque buildup at low engine speeds, where conventional turbochargers typically underperform
- Proved safe integration with the existing ECU without triggering diagnostic errors or protection algorithms
- Offered a cost-effective and modular alternative to factory-integrated systems like Volvo's PowerPulse, suitable for retrofitting
- Identified directions for further development, such as adaptive boost control and improved lambda signal interpretation under transient air injection conditions.

These results indicate that non-commercial compressed air impulse systems offer a promising approach for enhancing the performance and drivability of turbocharged spark-ignition engines, especially under low-speed, high-load conditions. Further development could extend their application in both performance tuning and emissions reduction for existing vehicle platforms.

Acknowledgements

The work on the prototype was financed from private funds of students of Mechatronics at the Faculty of Mechanical Engineering, Poznan University of Technology, Szymon Królak and Oleg Kindler. The tests on the chassis dynamometer at WSTR in Poznan were paid for by the Institute of Machine Design at Poznan University of Technology. Funding for publication of the article was provided by the subvention of the Ministry of Science and Higher Education.

Nomenclature

ACM	active control methodology
CFD	computational fluid dynamics
CNG	compressed natural gas
DICE	diagnostic communication equipment (Volvo)
ECU	engine control unit
LCD	liquid crystal display
LPG	liquefied petroleum gas
MAP	manifold absolute pressure
SI	spark ignition
TAP	tank air pressure
TPS	throttle position sensor
VIDA	vehicle information and diagnostics for aftersales
VGT	variable geometry turbines
VVT	variable valve timing

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Oleg Kindler, MEng. – Faculty of Mechanical Engineering, Poznan University of Technology, Poland.

e-mail: *oleg.kindler@student.put.poznan.pl*

Łukasz Warguła, DSc., DEng., Prof. PUT – Faculty of Mechanical Engineering, Poznan University of Technology, Poland.

e-mail: *lukasz.wargula@put.poznan.pl*

Szymon Królak, MEng. – Faculty of Mechanical Engineering, Poznan University of Technology, Poland.

e-mail: *szymon.krolak@student.put.poznan.pl*

Bartosz Wieczorek, DSc., DEng., Prof. PUT – Faculty of Mechanical Engineering, Poznan University of Technology, Poland.

e-mail: *bartosz.wieczorek@put.poznan.pl*