# MĚŘICÍ SYSTÉM PRO KONTROLU ZATĚŽOVACÍ SÍLY PRACOVNÍHO VÁLCE TLUMIČE

# MEASUREMENT SYSTEM FOR LOAD FORCE CHECK-UP ON OPERATING CYLINDER OF A DAMPER

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***Abstrakt***

Při výrobě automobilových tlumičů je třeba kontrolovat správnost seřízení zavalovacího stroje. Tato kontrola se provádí změřením síly, kterou je stlačen vnitřní válec tlumiče po operaci zavalení. Pro tyto účely je do tlumiče místo normálního pracovního válce osazen speciální měrný válec s nalepenými tenzometry. Protože se vyrábí celá škála typů tlumičů, bylo potřeba navrhnout systém, který umožní realizovat celý proces měření přímo na výrobní lince, s požadavkem na maximální jednoduchost a vyloučení možných chyb obsluhy. Příspěvek popisuje konstrukci kompletního měřicího systému pro automatizaci tohoto procesu přímo v průmyslové praxi.

**Klíčová slova:** tlumič, tenzometr, měření síly.

***Abstract***

During production process of car dampers it is required to check proper adjustment of a machine for spinning operation. The check-up is based on evaluation of force to which the inner operating cylinder of the damper is exposed after the spinning operation. In order to get the force information, a special cylinder with strain gages is used. Since a vast range of the dampers is produced, it was required to develop a system which can be used directly in the production line, ensuring ease of use and minimizing possible failures caused by personnel. The paper describes structure of a complete measurement system automating the process in the industry.

**Keywords:** damper, strain gage, force measurement.

## INTRODUCTION

The check-up process of the spinning machine for dampers is performed before production of a set of dampers start. It is based on a verification assembly of a test damper where the inner cylinder is replaced by a special one with strain gages applied. This allows measurement of the inner cylinder deformation. Since the complete damper is spinning while the outer tube edge is being wrapped over the inner tube, it would be difficult to measure the deformation during this operation. The deformation can only be evaluated as a difference between recorded pre- and post-operation values. The measuring cylinder is calibrated prior to application in the assembly, i.e. values of deformation are correlated to a force applied to the cylinder. Thus the check-up result is value of force load applied to the cylinder after the spinning operation. The force value has to fit criteria given by technological standard. After the verification assembly, the test damper is disassembled and the measuring cylinder removed. It can be used several times before recalibration is required. Recently the process of calibration and measurement demanded great participation of staff. As the produced dampers range increased, a chance of error caused by

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improper calculation or measurements without recalibration rised. A complete automation of the process was required in order to eliminate errors caused by personnel and to log results of the check-ups. Figure 1 shows the spinning operation principle.

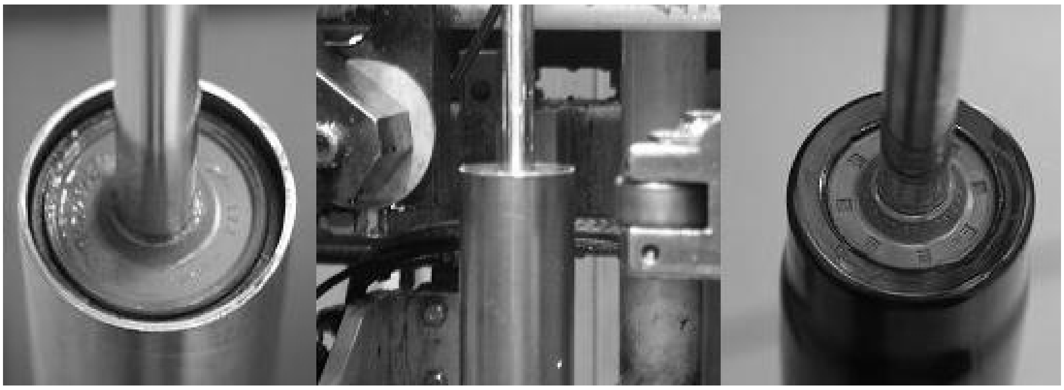

Fig.1 The spinning operation

## MEASUREMENT SYSTEM

The dampers producer required properties of the measurement system as follows: Each of the measuring cylinders will carry an electronic identification (TEDS) in addition to the strain gages. Connected cylinder will be automatically identified and the calibration status checked. The measurement result will be immediate information "passed / failed" including record of the results to a log file at the same time. The system will also enable calibration of the cylinders using a force test stand and its connection to a computer will be possible without its power-off providing use of the system on multiple computers.

Resulting from the above, we designed a three-component measurement system: a set of measuring cylinders with strain gages and TEDS, electronic unit processing data from the cylinder and software installed in a PC. The electronic unit is connected via USB interface to any PC where the software is running as a user interface for the complete measurement system.

1) MEASURING CYLINDERS

A new set of measuring cylinders which carry a complete strain gages bridge made by two pairs of temperature-compensated foil strain gages HBM was prepared. There is a small memory chip inside of each cylinder that contains non-volatile cylinder type identification and is used to record status of the cylinder, i.e. calibration constant, calibration date, number of performed measurements, etc. This way is all the important information integrated in the cylinder and it can be used by multiple computers with no need of data transfer between the workstations. The cylinder connection is made by cover-adapted MINI DIN connector which fits the diameter limitation and has needed number of pins. Fig. 2 shows the measuring cylinder with strain gages applied and connector prepared, just before covering it by a protection layer. Mechanical protection is necessary when the cylinder is put into the test damper assembly.

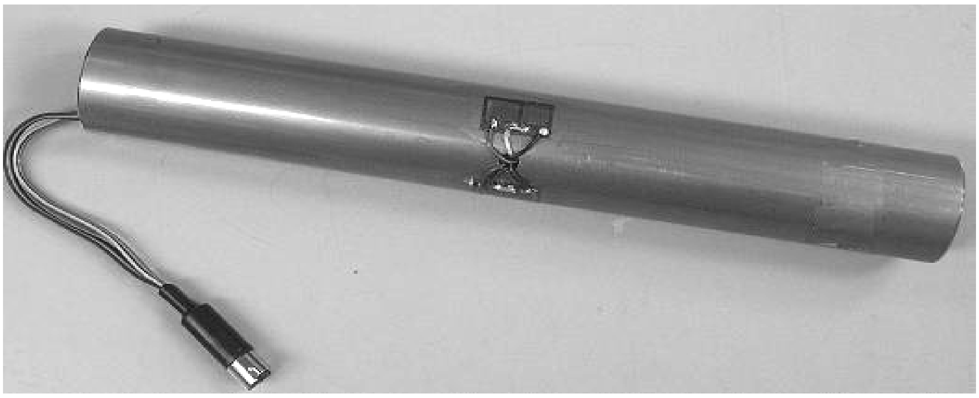

Fig.2 Measuring cylinder with strain gages and connector

2) ELECTRONIC UNIT

The unit is based on multifunctional measurement device equipped by an USB interface for communication with PC. The device consists of analog inputs and outputs with 12-bit A/D and D/A converters and set of logical lines. It also provides a 5V power supply that is adapted by a DC/DC converter to levels required for other circuits. Thus the complete unit is powered only via the USB connection and no other power supply is needed. The analog input has connected a differential pre-amplifier which adapts the strain gages bridge signal to a level suitable for the analog input of the device. Since many measuring cylinders with different strain gages bridge unbalances can be connected to the unit, the pre-amplifier has software-controlled offset adjustment capability. The logical lines are used to control indication LEDs on the front panel of the electronic unit. Basic configuration of the unit is shown on Fig.3.

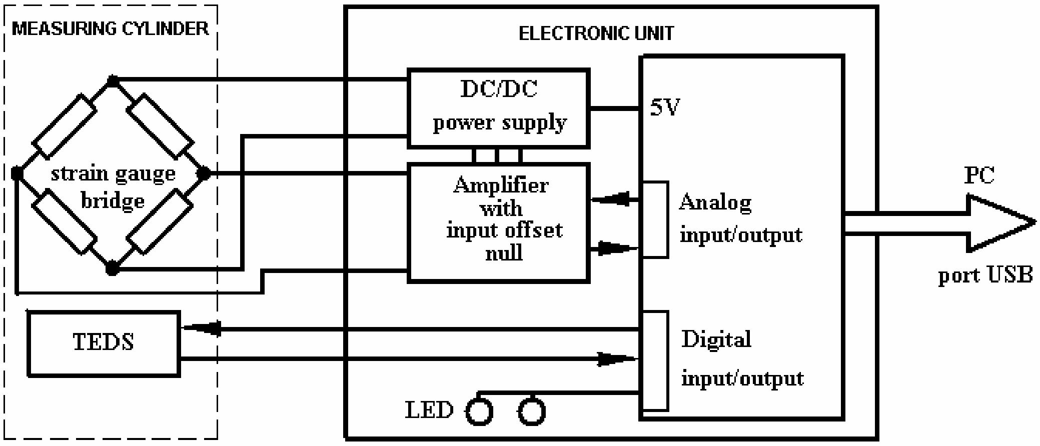


Fig.3 Electronic unit configuration scheme

3) CONTROL SOFTWARE

The software provides communication with the multifunctional measurement device inside the electronic unit via the USB port and controls all of its functions. It is designed with respect to maximal simplicity in terms of its use. The user is guided by instruction window and the software automatically offers operation required as the next step. Since the check-up process can be interrupted by production line demands in terms of the single steps continuity, each step pass and its result is stored in the memory of the cylinder. Therefore the software can be installed on multiple computers and after the measuring cylinder is connected to any of them, the check-up process status is recognized and can continue just right from the last point. The software enables all measurement operations, i.e. the measuring cylinder calibration on a test stand and force measurement prior and after the spinning operation including immediate result display, its record to a log file for later recall and data export into a general format. A sample screenshot of the software is on Fig.4.

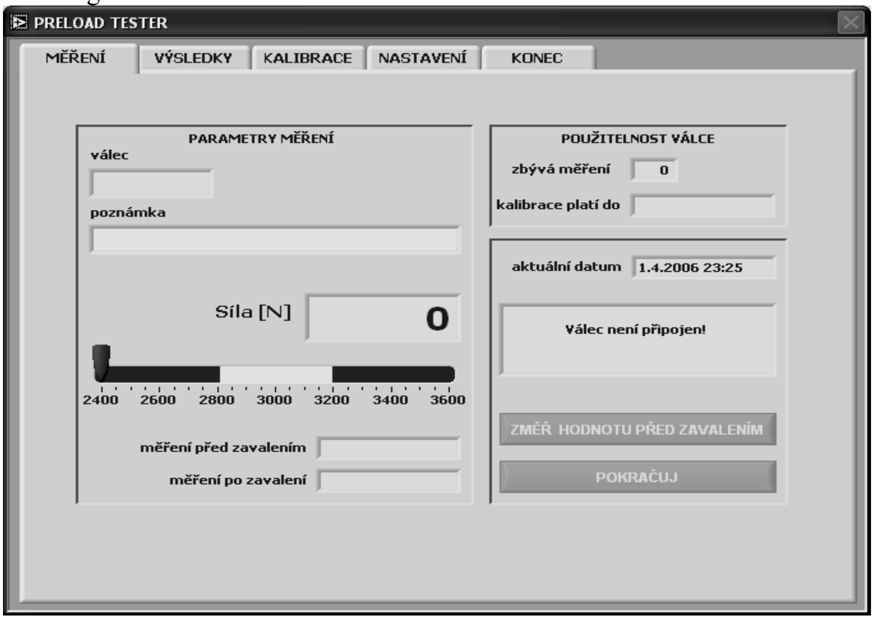


Fig.4 Control software window example

## CONCLUSION

The developed measurement system increased the check-up process for spinning operation effectiveness and thanks to complete automation with minimum staff influence the precision increased along with remarkable reduction of possibility of error caused by personnel.

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