Acoustic Emission Applications at Pneumatic System

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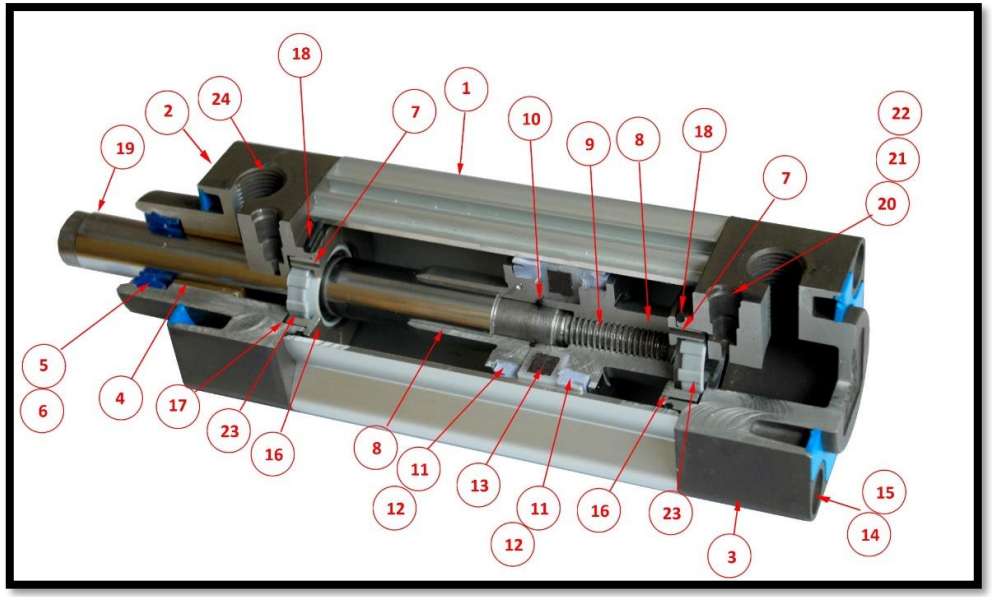
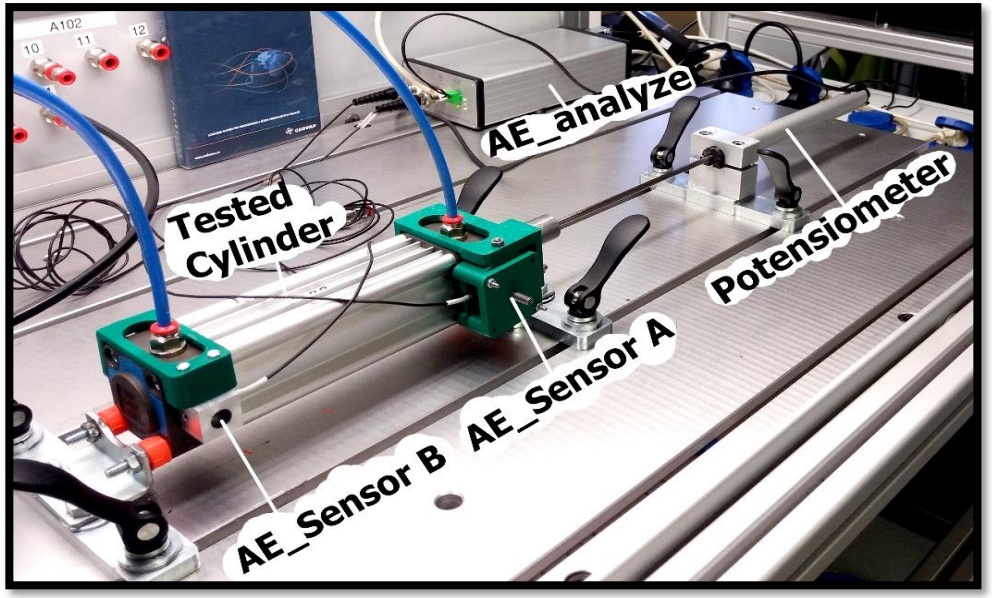
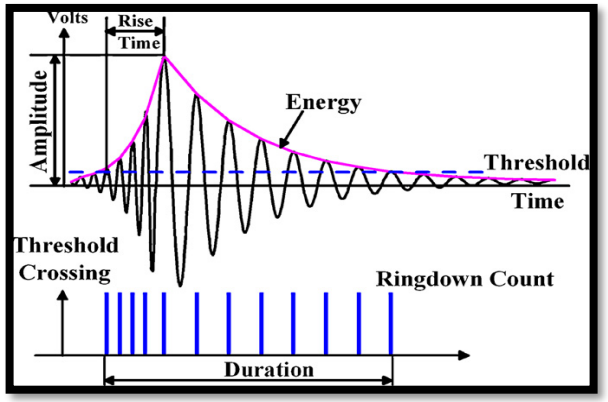
Specification of pneumatic cylinders



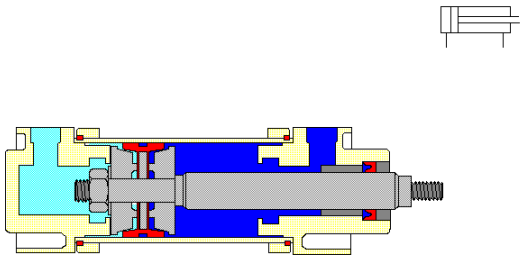
Types of defects in cylinder

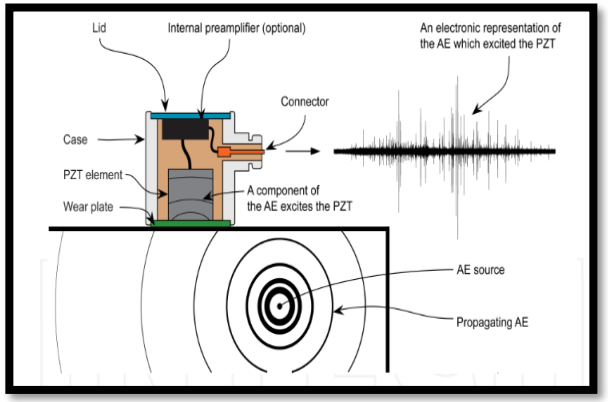


Assembly of experimental equipment



Method AE parameters [2]



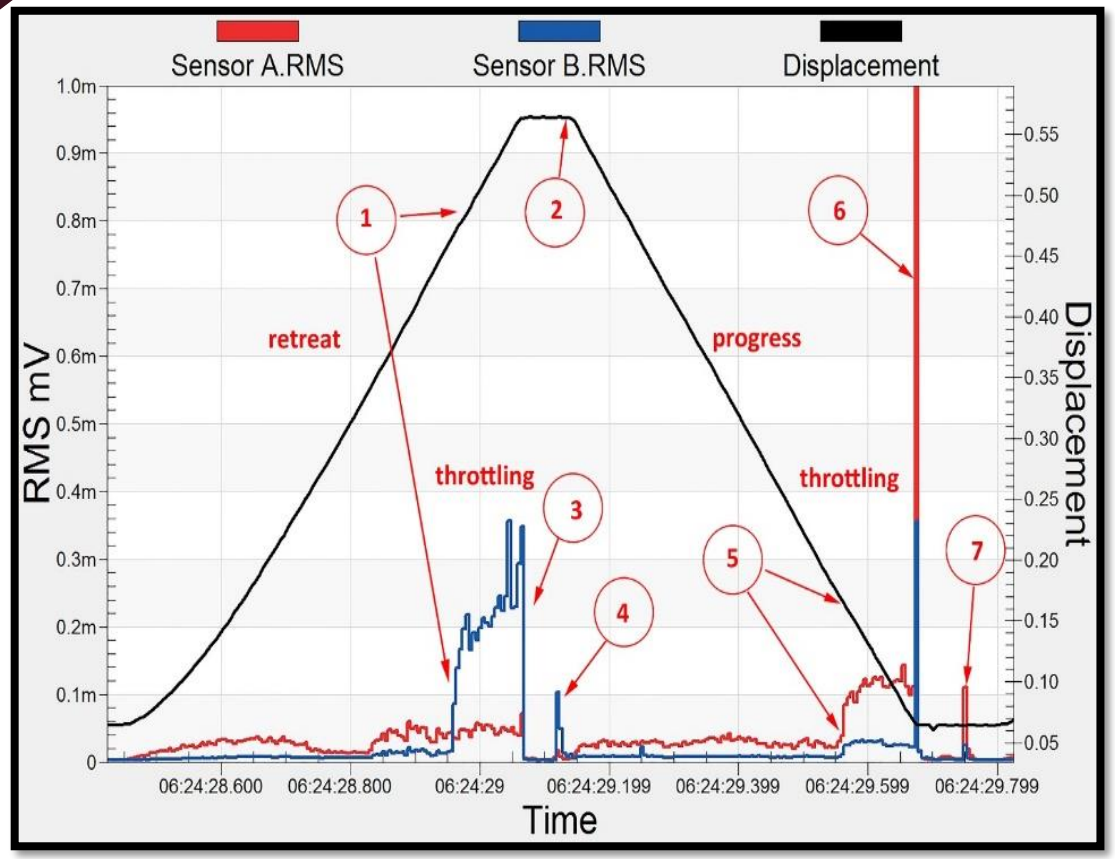


AE transducer and how an AE is converted into an electric representation[1]

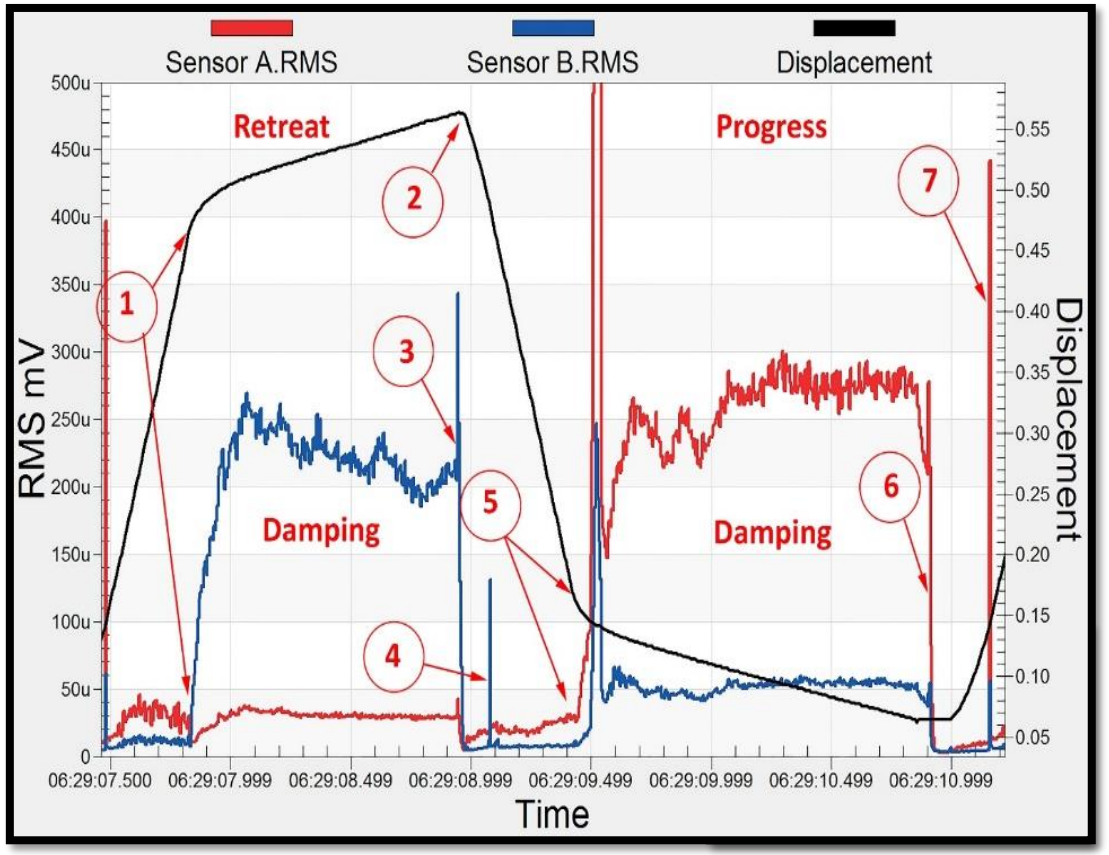
Beattie A.G., Acoustic Emission: Principles and Instrumentation. Journal of Acoustic Emission, Vol. 2, 1983.

Rúnar Unnþórsson. Hit Detection and Determination in AE Bursts. 2013 Unnþórsson; licensee InTech

Analysis and evaluation and Previous studies

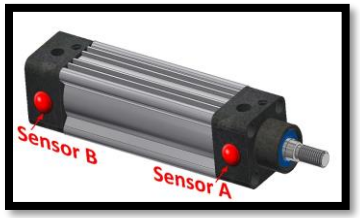


Undamaged cylinder No.2 after 101500 cycles without damping

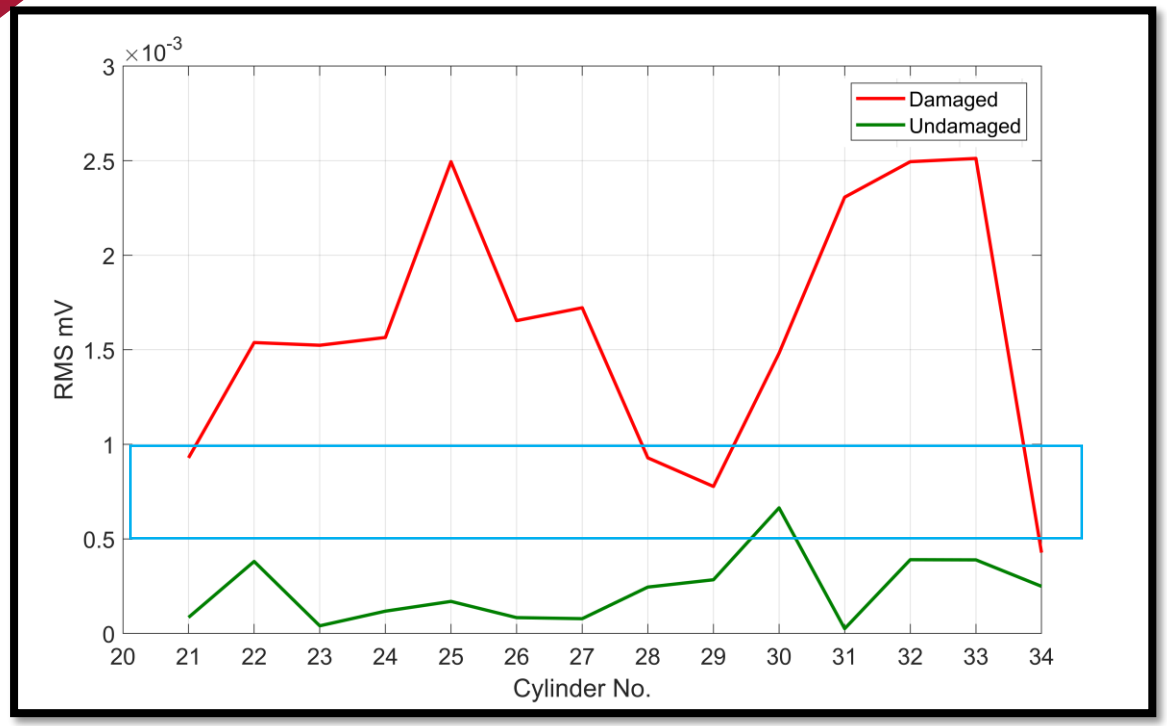


Undamaged cylinder No.2 after 101500 cycles with damping

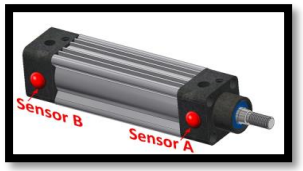
(1). Initiation of progress stroke, (2). When the piston leaves the throttling zone in progress stroke, (3). Initiation of throttling (damping) in progress stroke, (4). End of throttling in progress stroke, (5). Initiation of retreat stroke, (6). When the piston leaves the throttling zone in retreat stroke, (7). End of throttling in retreat stroke.



Result and Discussion

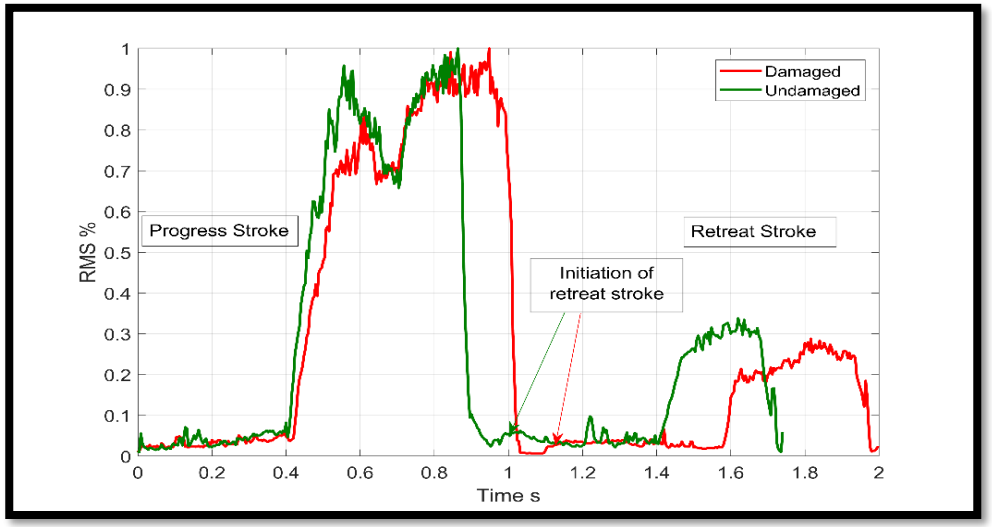


Comparing between damaged and undamaged cylinders
NP08, PP03, NP07

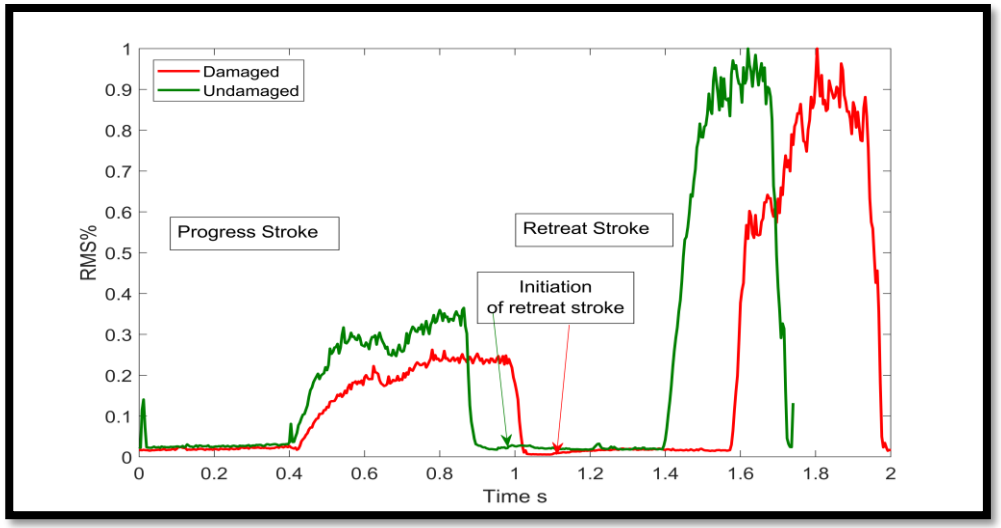


$$RMS = \sqrt{\sum(U[i]^2)/N}$$

Comparing between damaged and undamaged cylinders

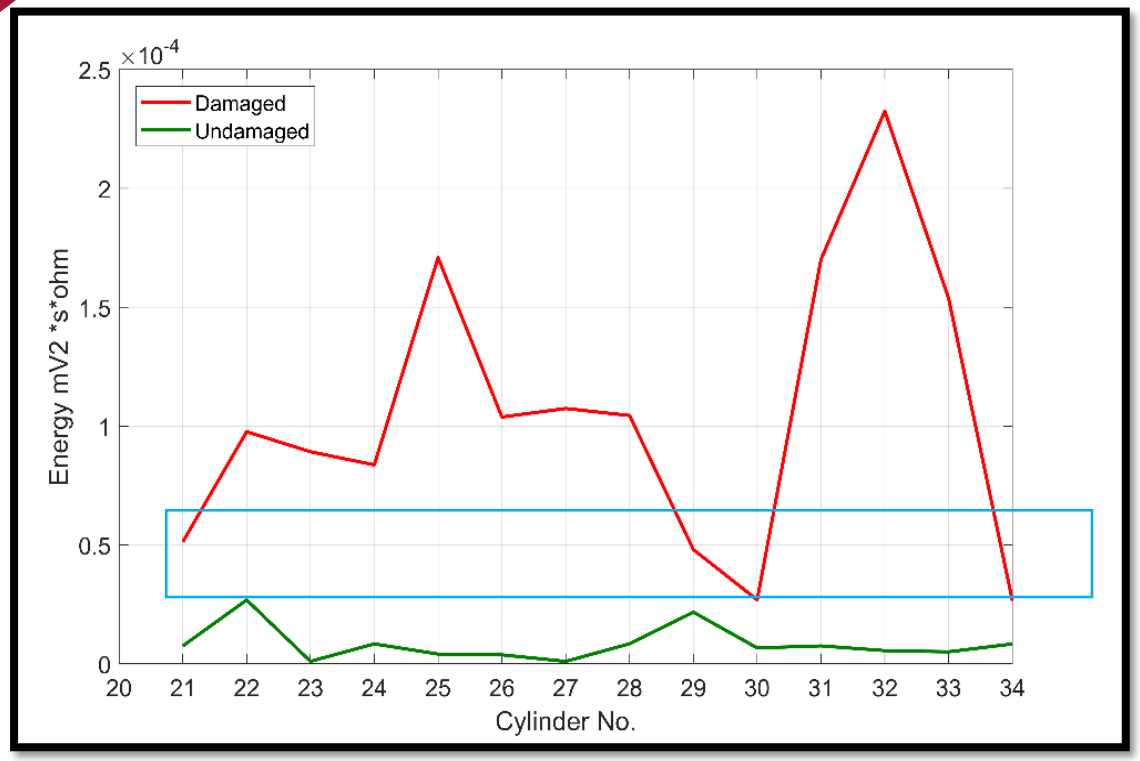


No. 21, NP08, PP03 derived from the sensor A

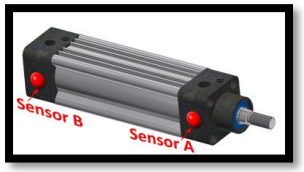


No. 21, NP08, PP03 derived from the sensor B

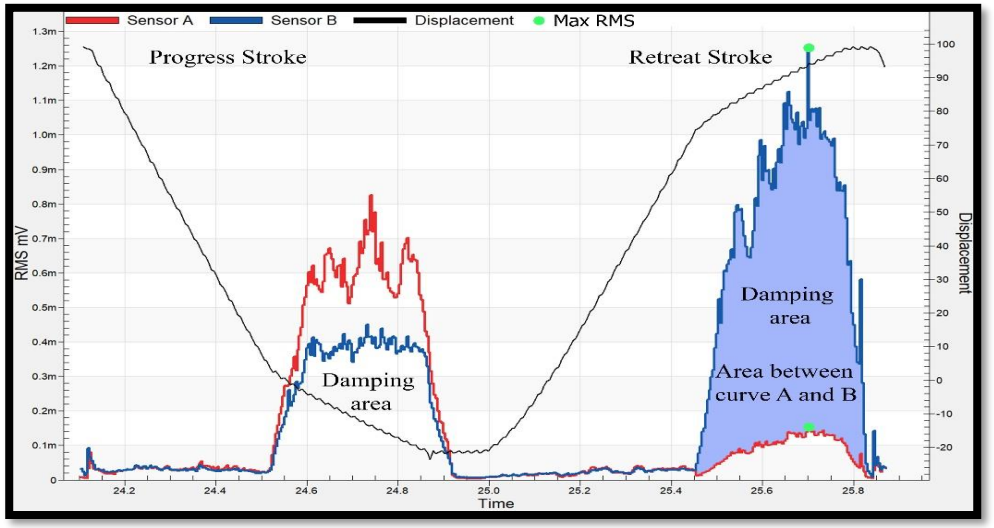
Result and Discussion



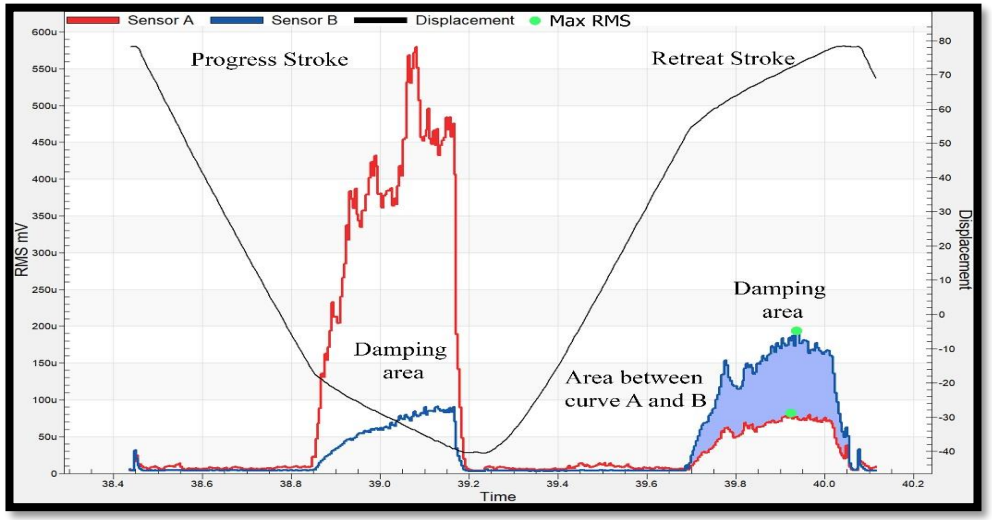
Comparing between damaged and undamaged cylinders



$$E = \sum U_{retreat\ A}[i]^2 * \mathrm{dT} - \sum U_{retreat\ B}[i]^2 * \mathrm{dT}$$

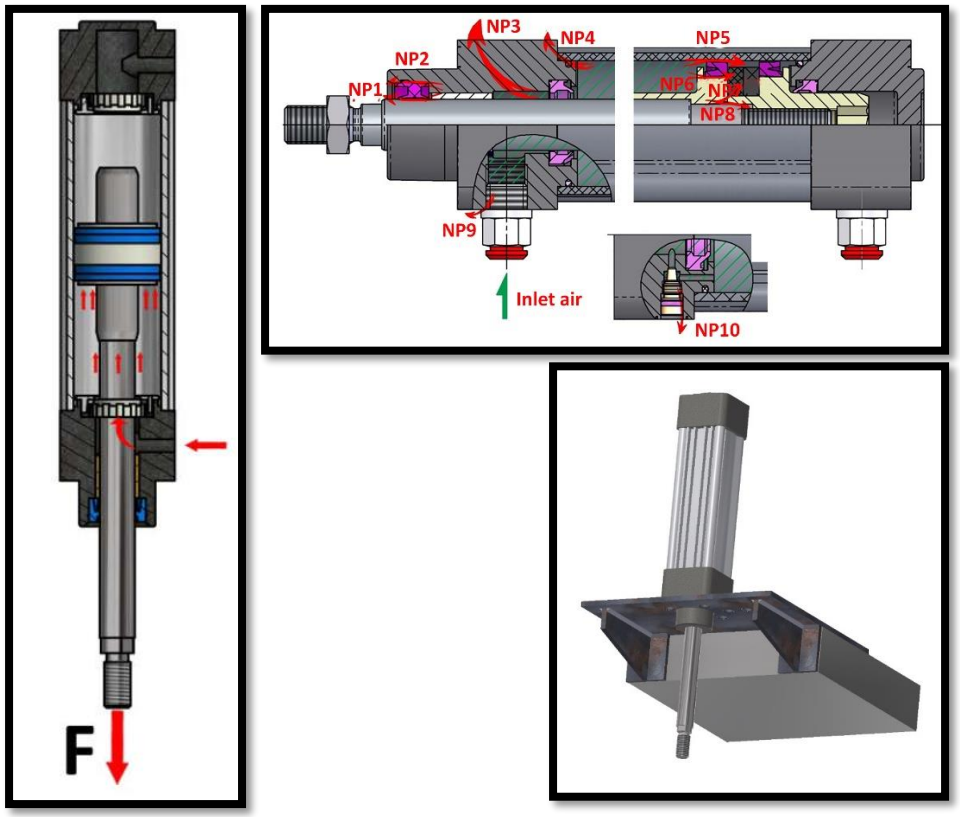


Damaged cylinder No.32 with damping

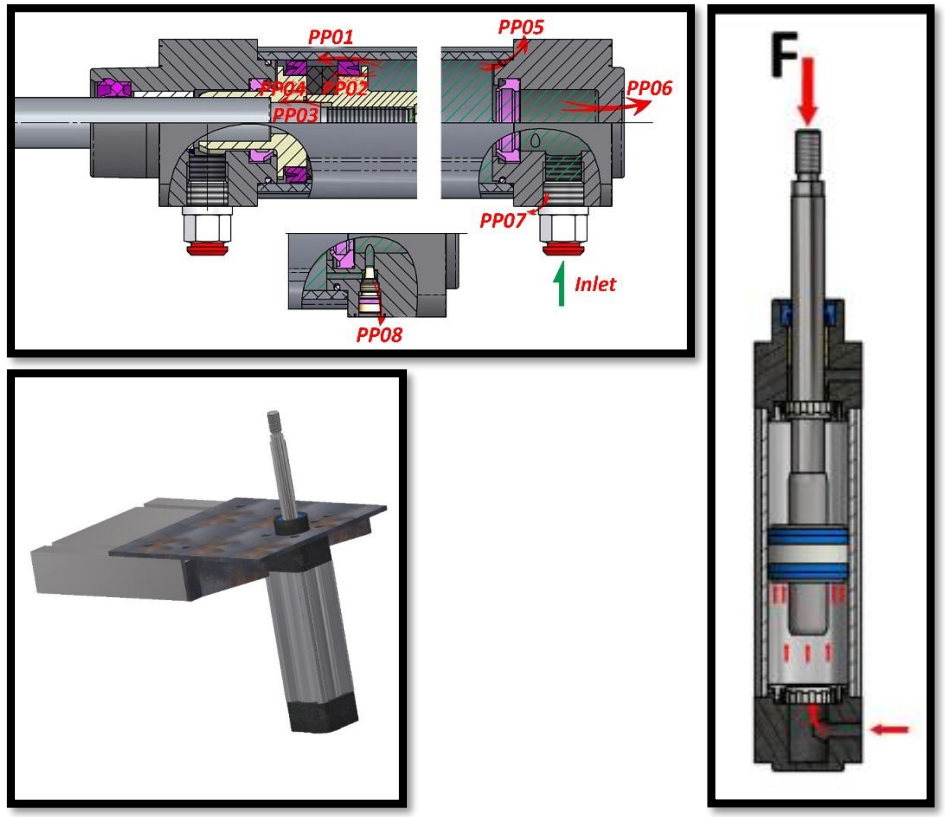


Undamaged cylinder No.32 with damping

Loading



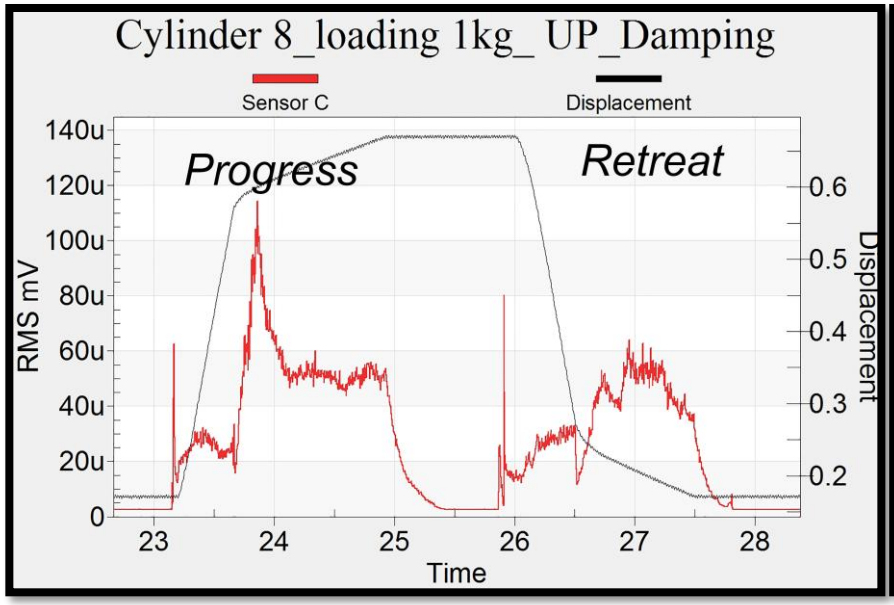
Leaks above the piston during retreat stroke



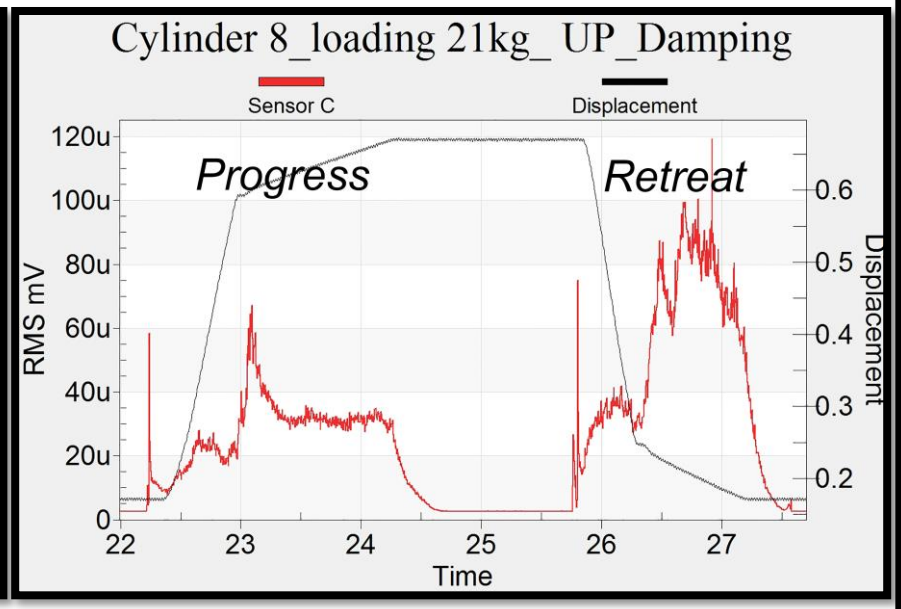
Leaks below the piston during progress stroke

Result and Discussion

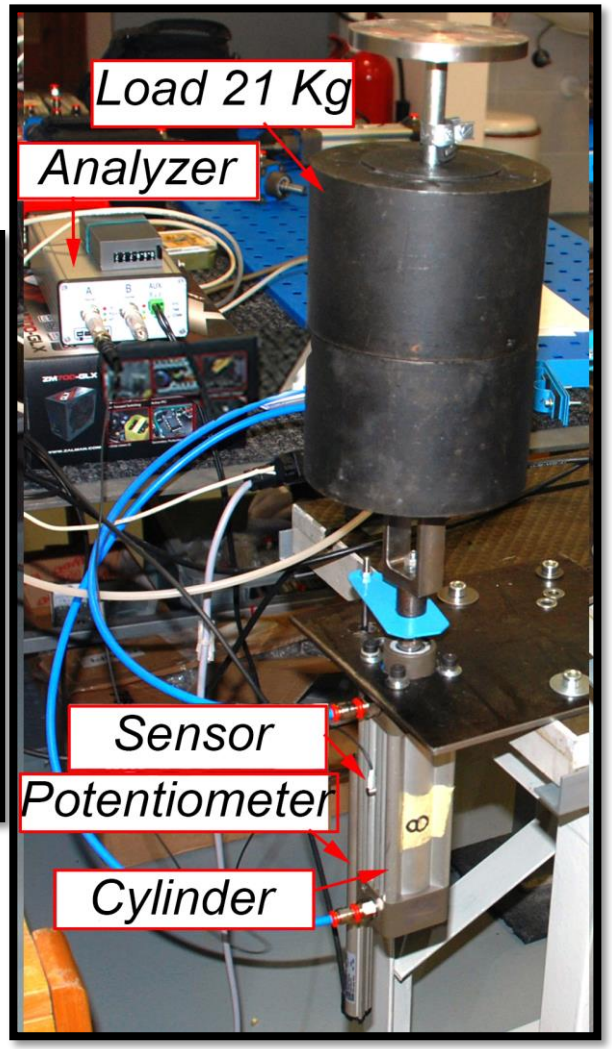
Comparing between RMS of AE during one cycle according to the applied load



Load 1 kg was applied above Cylinder



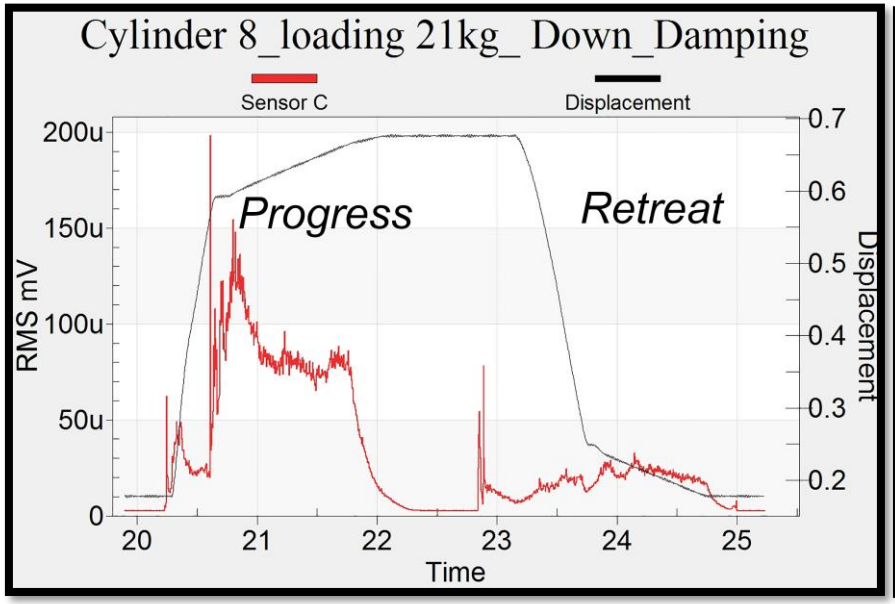
Load 21 kg was applied above Cylinder



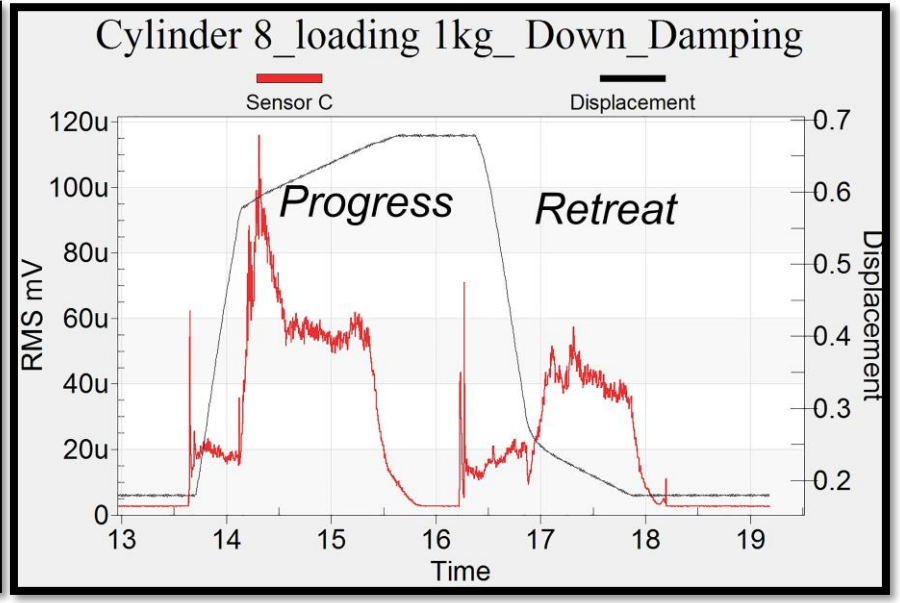
b) Loading above the rod of cylinder

Result and Discussion

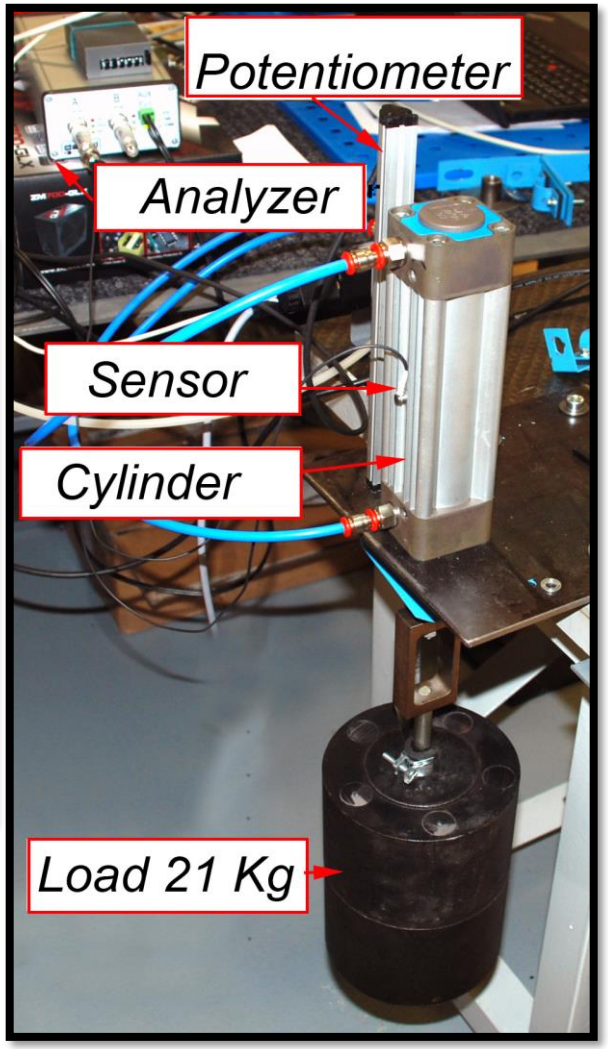
Comparing between RMS of AE during one cycle according to the applied load



Load 1 kg was applied below Cylinder



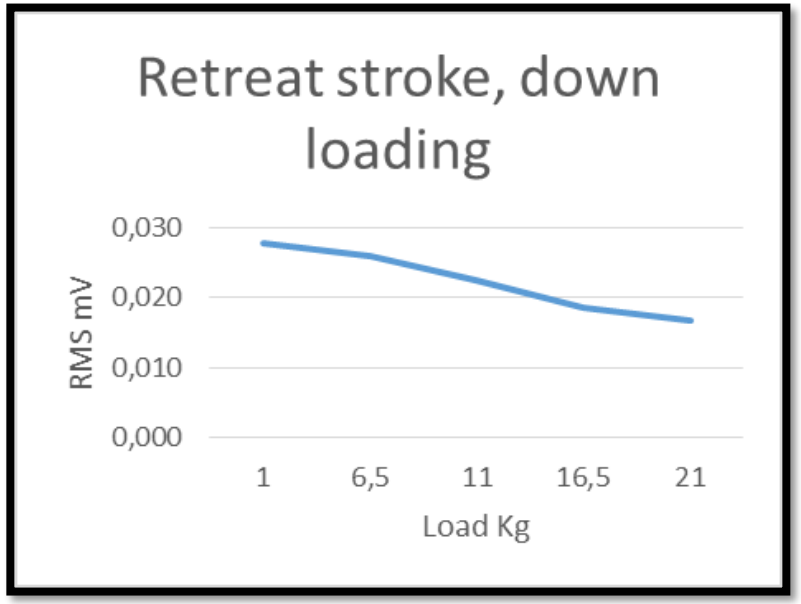
Load 21 kg was applied below Cylinder

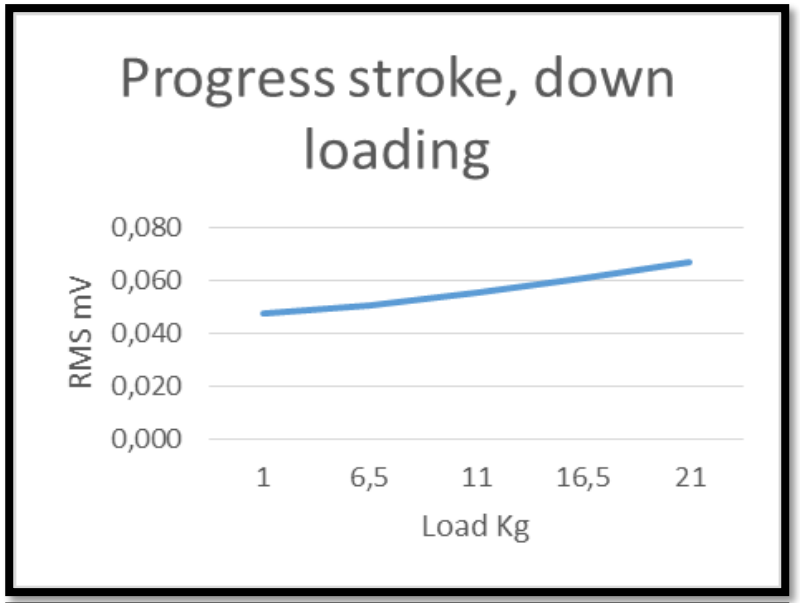


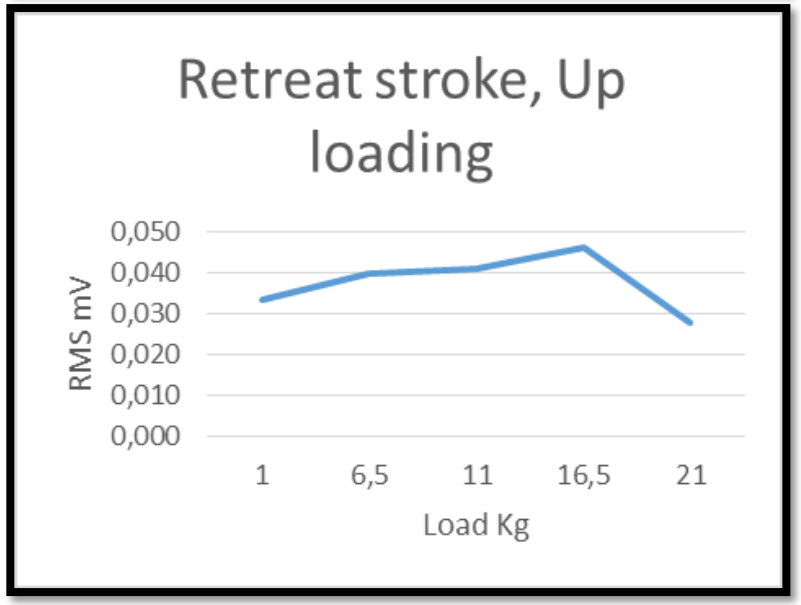
Loading below the rod of cylinder

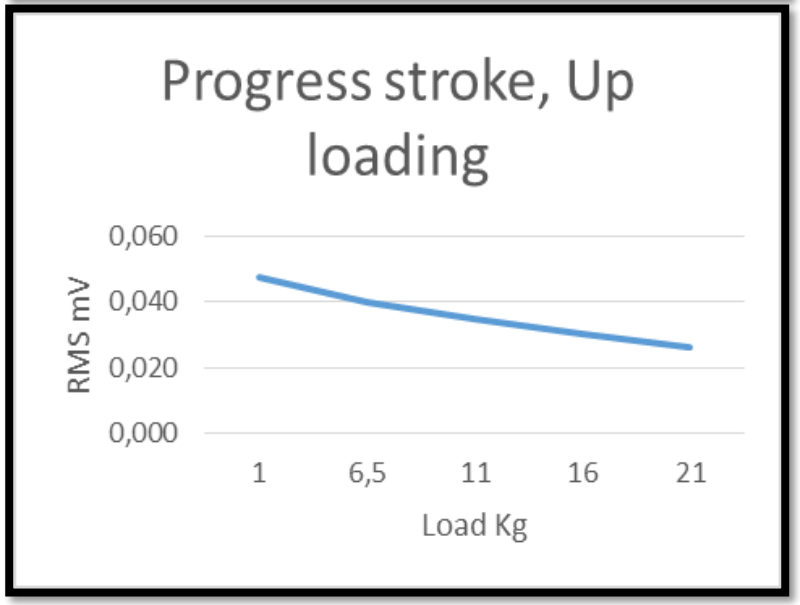
Result and Discussion

Relationship between RMS and loading during one cycle



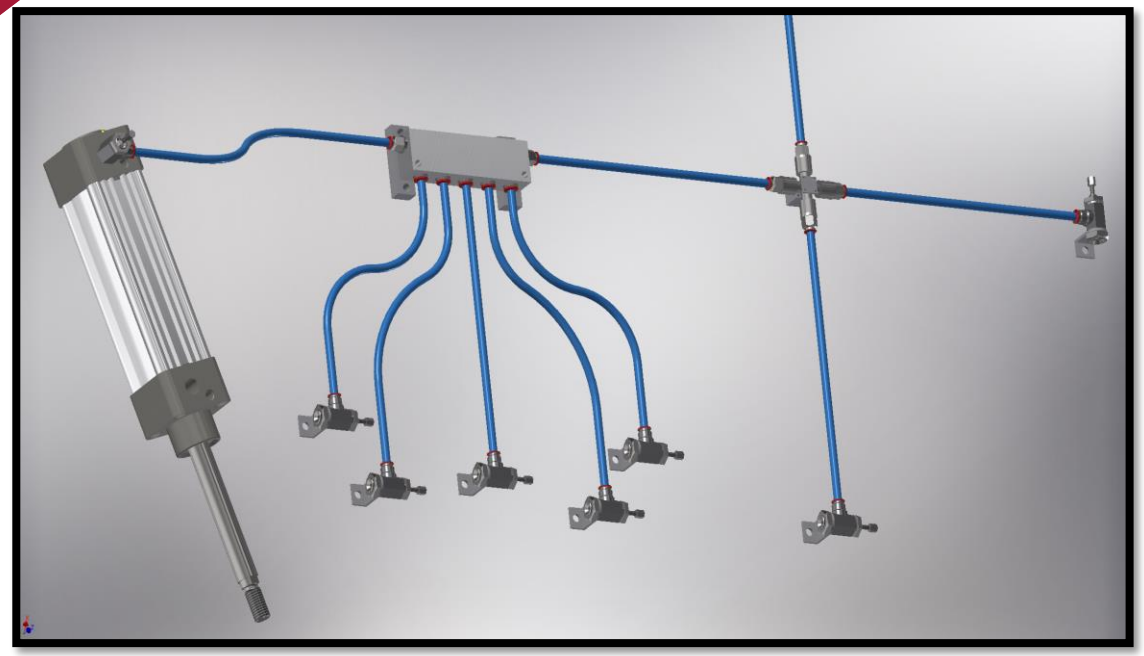


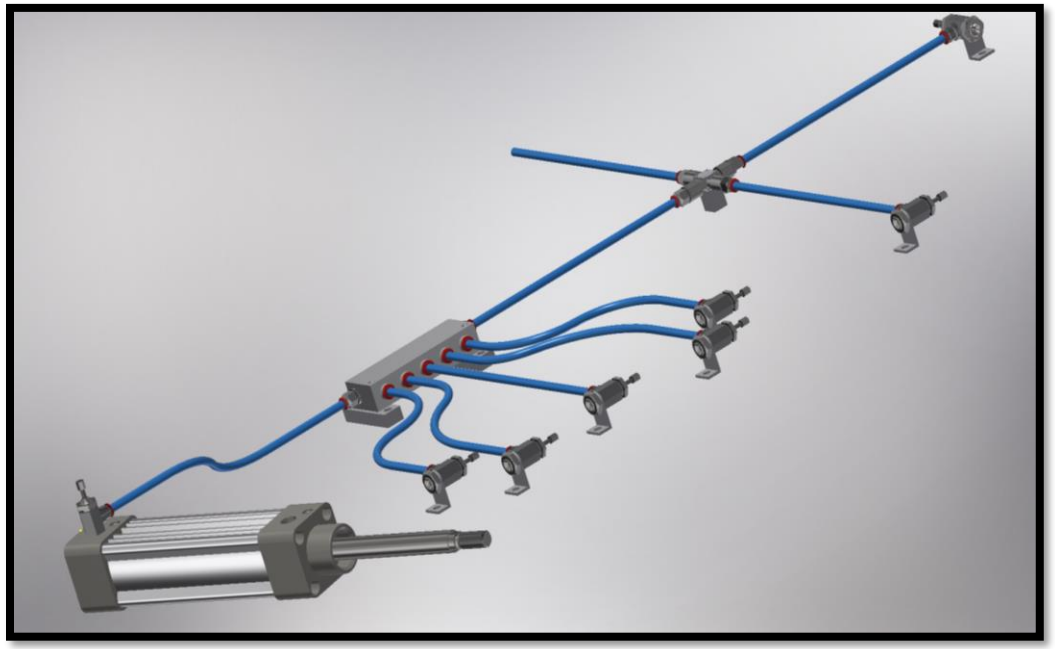


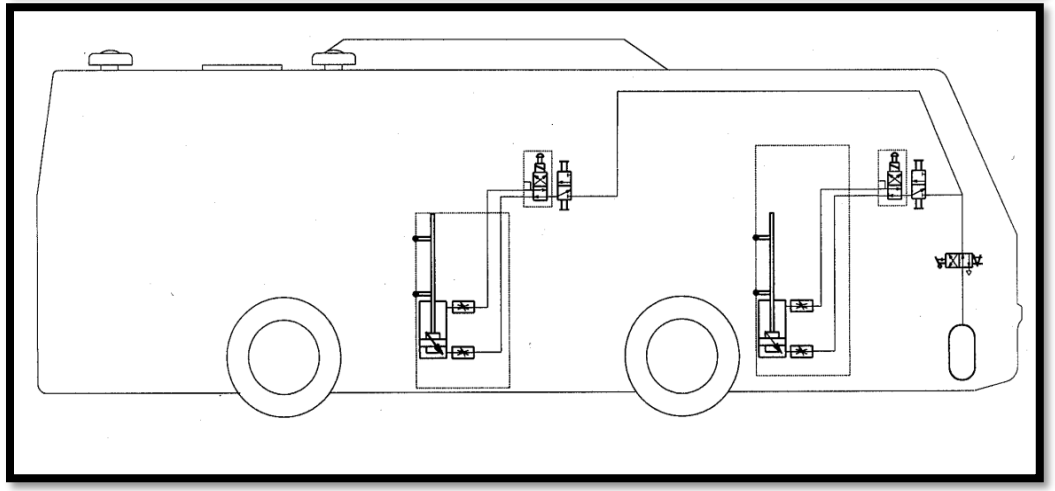


Future work

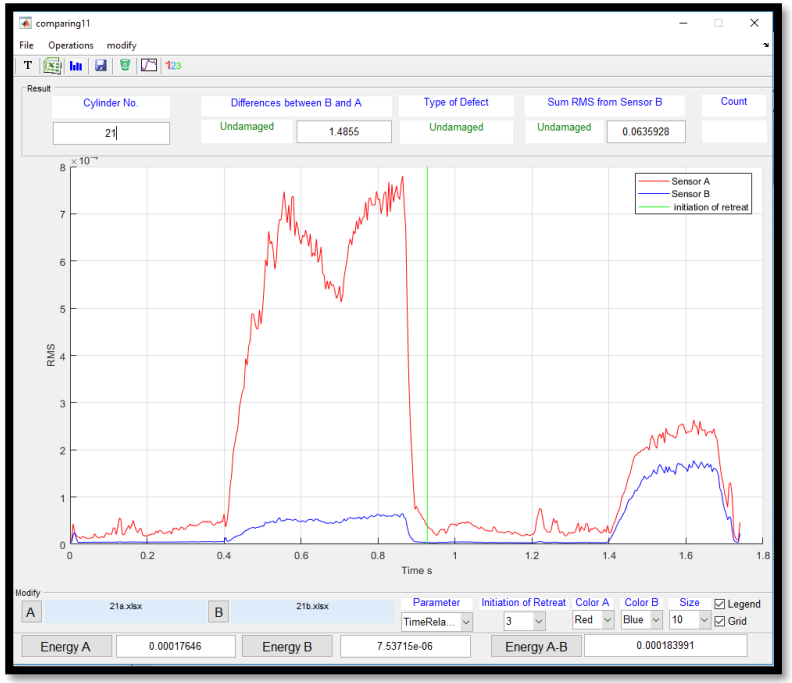
The simulation of simple circuit of bus's door



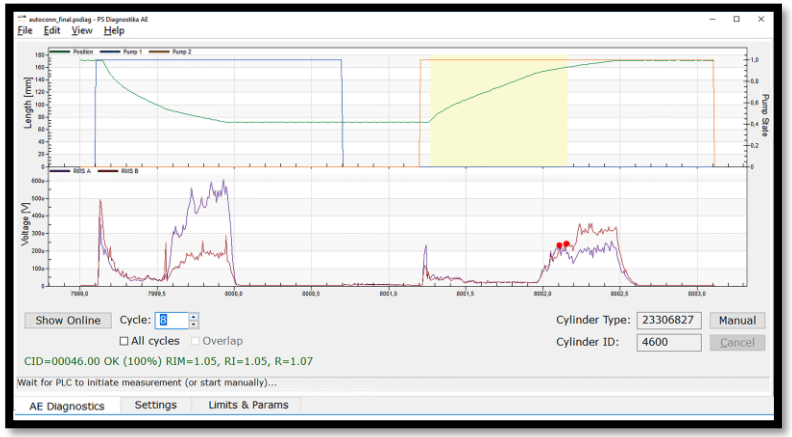




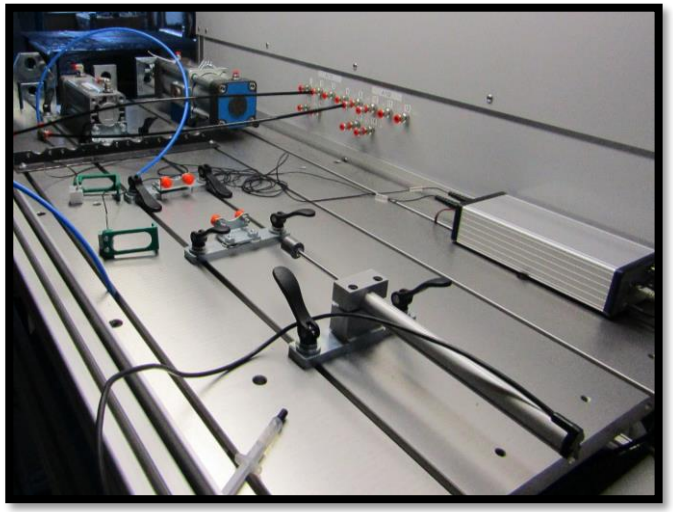
Activities

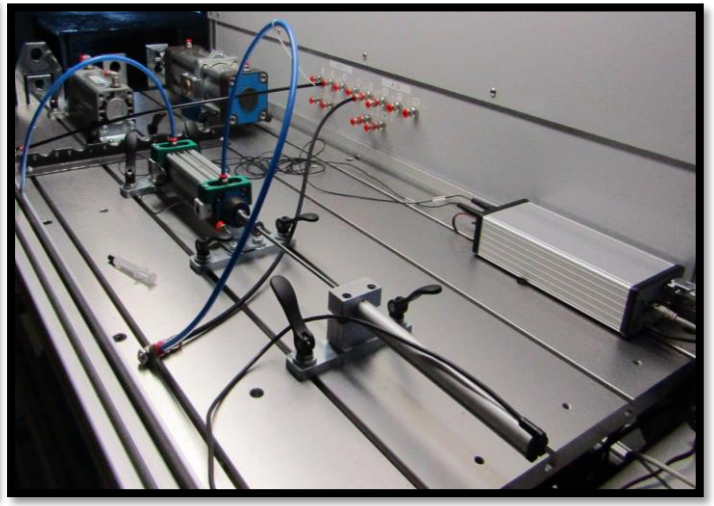


Evaluation program using MATLAB gui



Online evaluation program by Dakel Company





Assembly the cylinder in Policka company

Certificate of methodology

TÜV NORD Czech

CERTIFIKÁT

o uznání přezkoušené metodiky
evidenční číslo: 002/17

Zákazník:	**Vysoké učení technické v Brně** **Fakulta strojního inženýrství, Ústav konstruování** **Technická 2896/2, 616 69 Brno** **Česká republika**
IČO:	**00216305**
Metoda:	**Hodnocení provozního stavu přímočarých pneumotorů pomocí metody akustické emise**
Autoři metodiky:	**Ing. František Vlašic, Ph.D.** **doc. Ing. Pavel Mazal, CSc.** **Ing. Houssam Mahmoud** **Ing. Vladimír Bukáček**
Označení:	**TA04011374**
Interní informační označení metodiky:	**Testy pneuválců akustickou emisí**
Místo uložení metodiky:	**Poličské strojírny a.s.,** **Bořiny 1145, Horní Předměstí, 572 01 Polička**

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Certifikační a inspekční společnost TÜV NORD Czech 10 TÜV NORD Czech, s.r.o.

Praha, 07.12.2017
Místo a datum

Ing. Daniel Jarchovský
ředitel Divize posuzování shody
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Conclusion

- The RMS parameter can be used as an important criterion for the evaluation of pneumatic cylinders, particularly in combination with other monitoring parameters.

- The damping area should have the same time in all cylinders, but the defect in the damaged cylinder causes a delay in the signal time which causes an extension in damping area. This delay distinguishes between undamaged and damaged cylinders.

- The smaller the value of RMS, the better the quality of cylinder. When $\sum RMS < 0.0005$ mV, the cylinder is undamaged, otherwise it is damaged.

- When the ratio of the difference of maximum RMS is bigger than 2.5, the cylinder is damaged otherwise the cylinder is undamaged.

- The quality of the cylinder is related to the value of energy.
- When the energy is less than 3*10^8 ($\boldsymbol{V^2 * s * ohm}$) the cylinder better quality.

- The relationship between RMS of AE and the loading could be linear. The loading on the cylinder makes the defect clearer to detect. The relation between the RMS and displacement explained all the positions of the cylinder during the work.

Author or co-author of publications

1. Pavel MAZAL, Houssam MAHMOUD, Miroslav JÁNA, Vladimír BUKÁČEK, František VLAŠIC: Use of Acoustic Emission Method to Identify Damage of Pneumatic Cylinders, In NDE for Safety / Defektoskopie 2015, Brno 2015, p 81 - 90, ISBN978-80-214-5280-0.
2. Pavel MAZAL, Frantisek VLASIC, Houssam MAHMOUD, Miroslav JANA: The Use of Acoustic Emission Method for Diagnosis of Damage of Pneumatic Valves, In XIXth World Conference on NDT, Munchen, Germany 2016, ISBN 978-3-940283-78-8, USB edition, 10 pages.
3. Pavel MAZAL, František VLAŠIC, Houssam MAHMOUD Možnosti hodnocení pneumatických prvků metodou akustické emise, Defektoskopia 2016, Vysoké Tatry, Slovakia, 26.-28.4.2016, prezentace.
4. Houssam MAHMOUD, Frantisek VLASIC, Pavel MAZAL: Simulation of Operational Loading of Pressure Equipment by Means of Non-Destructive Testing. In Metal 2015, Brno 2015.
5. Houssam MAHMOUD, Pavel MAZAL, Miroslav JANA, Frantisek VLASIC: Damage Identification of Pneumatic Components by Acoustic Emission. In European Conference on AE Testing (EWGAE 2016), Prague, Sept. 2016.
6. Pavel MAZAL[1], Houssam MAHMOUD[1], Petr DOSTAL[2], Michal CERNÝ[2], Michal SUSTR[2], Jaroslav ZACAL[2]: Cooperation Of Mendel University And Brno University Of Technology In The Field Of Biological Applications Of Ae Method. . In European Conference on AE Testing (EWGAE 2016), Prague, Sept. 2016.
7. **Houssam MAHMOUD[1], Frantisek VLASIC[2], Pavel MAZAL[1], Miroslav JANA[3]: Leakage Analysis of Pneumatic Cylinders Using Acoustic Emission. Insight journal.**
8. Houssam MAHMOUD, Frantisek VLASIC, Pavel MAZAL, Miroslav JANA: Application of Acoustic Emission Method to Diagnose Damage in Pneumatic Cylinders. Conference in London WCCM17, It will be published
9. Houssam Mahmoud, Pavel Mazal, Frantisek Vlasic, Miroslav Jana : Condition Monitoring Of Pneumatic Cylinders By Acoustic Emission. ICNDT2017 in Slovenia.

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