Numerical and experimental study of pulse-jet cleaning in fabric filters - DTU Orbit
(10/12/2018)

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Pulse-jet cleaning and understanding of the complex physics are essential when designing fabric filters used for air pollution control. Today, low-pressure cleaning is of particular interest due to demand for reduced compressed air consumption. Pulse-jet cleaned fabric filters have been studied for many years by experimental investigation and to a limited extent by Computational Fluid Dynamics (CFD). The majority of the studies have focused on high-pressure cleaning systems, and the CFD models presented are so far two-dimensional (2D). In the work presented here, pulse-jet cleaning of low-pressure fabric filters (2 bar) is studied using a full three-dimensional (3D) CFD model. Experimental results obtained in a pilot-scale test filter with 28 bags, in length of 10 m and in general full-scale dimensions of the cleaning system are used to verify the reliability of the present CFD model. The validated CFD model reveals the strong compressible effects, a highly transient behaviour, the formation of compressible vortex rings and the shock cell phenomenon within the overexpanded supersonic jet. The cleaning nozzles and venturi design aid or oppose the pulse-pressure within the bags, and this plays an important role in the resulting efficiency of removing the dust layer from the bags. The CFD simulation shows that the traditional straight-bore nozzles provide substantial misalignment of the jet, and the add-on nozzle design offers only limited improvement. Further, the need for venturis in low-pressure filters and the importance of optimising the venturi design are demonstrated. The working principle of the venturi is to restrict backflow which is detrimental to the pressure rise in the bags. Reducing the venturi throat diameter is shown to reduce backflow and improve the pulse-pressure.

General information
State: Published
Organisations: Department of Mechanical Engineering, Fluid Mechanics, Coastal and Maritime Engineering, FLSmidth & Co. A/S
Contributors: O. Andersen, B., Nielsen, N. F., Walther, J. H.
Pages: 284-298
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Powder Technology
Volume: 291
ISSN (Print): 0032-5910
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.47 SJR 0.982 SNIP 1.669
Web of Science (2017): Impact factor 3.23
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.16 SJR 0.975 SNIP 1.497
Web of Science (2016): Impact factor 2.942
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.99 SJR 0.939 SNIP 1.588
Web of Science (2015): Impact factor 2.759
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.67 SJR 0.874 SNIP 1.614
Web of Science (2014): Impact factor 2.349
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.64 SJR 0.889 SNIP 1.855
Web of Science (2013): Impact factor 2.269
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.36 SJR 0.844 SNIP 1.805
Web of Science (2012): Impact factor 2.024