Robust simulations of viscoelastic flows at high Weissenberg numbers with the streamfunction/log-conformation formulation - DTU Orbit (01/01/2019)

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A new streamfunction/log-conformation formulation of incompressible viscoelastic flows is presented. The log-conformation representation guarantees the positive-definiteness of the conformation tensor and obviates the high Weissenberg number problem. The streamfunction is defined as a vector potential of the velocity field, and provides a pressureless formulation of the conservation laws, which automatically enforces the incompressibility. The resulting numerical method is free from velocity-pressure decoupling errors, and can achieve stable calculations for large Courant numbers, which improve the robustness and the efficiency of the solver. The two-dimensional flow of an Oldroyd-B fluid inside the lid-driven cavity is simulated for a large range of Weissenberg numbers. The numerical results demonstrate the second-order accuracy of our scheme, and our solutions are in good agreement with the available data from the literature for Weissenberg number 3 and below. Finally, the simulations at higher Weissenberg numbers 5 and 10 reveal a structural mechanism that sustains quasi-periodic elastic instabilities arising at the upstream corner of the moving lid.

General information
State: Published
Organisations: Department of Mechanical Engineering, Manufacturing Engineering
Contributors: Comminal, R., Spangenberg, J., Hattel, J. H.
Number of pages: 25
Pages: 37-61
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Journal of Non-Newtonian Fluid Mechanics
Volume: 223
ISSN (Print): 0377-0257
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.44 SJR 1.14 SNIP 1.509
Web of Science (2017): Impact factor 2.293
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.43 SJR 1.145 SNIP 1.604
Web of Science (2016): Impact factor 2.536
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.23 SJR 1.155 SNIP 1.505
Web of Science (2015): Impact factor 2.172
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 1.96 SJR 0.988 SNIP 1.324
Web of Science (2014): Impact factor 1.821
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.09 SJR 1.024 SNIP 1.606
Web of Science (2013): Impact factor 1.944
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 1.93 SJR 1.101 SNIP 1.532
Web of Science (2012): Impact factor 1.567
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 1.93 SJR 1.09 SNIP 1.408
Web of Science (2011): Impact factor 1.675
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.232 SNIP 1.743
Web of Science (2010): Impact factor 1.572
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.534 SNIP 1.504
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.519 SNIP 1.917
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.342 SNIP 1.477
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.439 SNIP 1.456
Scopus rating (2005): SJR 1.573 SNIP 1.52
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.288 SNIP 1.82
Scopus rating (2003): SJR 1.326 SNIP 1.312
Scopus rating (2002): SJR 1.755 SNIP 1.679
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 2.293 SNIP 1.155
Scopus rating (2000): SJR 1.354 SNIP 1.479
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.505 SNIP 1.629
Original language: English
Keywords: Elastic instability, High weissenberg number, Incompressible viscoelastic flow, Lid-driven cavity, Log-conformation representation, Streamfunction formulation, Velocity, Viscoelasticity, Elastic instabilities, Lid-driven cavities, Log conformation, Viscoelastic flows, Weissenberg number, Numerical methods
DOIs: 10.1016/j.jnnfm.2015.05.003
Source: FindIt
Source-ID: 275241366
Research output: Research - peer-review › Journal article – Annual report year: 2015