EPJ E
www.epj.org
Soft Matter

Eur. Phys. J. E **28**, 479–480 (2009) DOI: 10.1140/epje/i2009-10445-3

Numerical modelling of foam Couette flows

I. Cheddadi, P. Saramito, C. Raufaste, P. Marmottant and F. Graner

EDP SCIENCES
Società Italiana Di Fisica
Springer

Eur. Phys. J. E **28**, 479–480 (2009)
DOI 10.1140/epje/i2009-10445-3

THE EUROPEAN PHYSICAL JOURNAL E

Erratum

Erratum

Numerical modelling of foam Couette flows

I. Cheddadi[1], P. Saramito[1,a], C. Raufaste[2,b], P. Marmottant[2], and F. Graner[2,c]

[1] Laboratoire Jean Kuntzmann, Université J. Fourier, CNRS and INRIA, 51, rue des Mathématiques, 38400 Saint-Martin d'Hères Cedex, France
[2] Laboratoire Spectrométrie Physique, UMR 5588, CNRS and Université J. Fourier, B.P. 87, 38402 Saint-Martin d'Hères Cedex, France

Original article: Eur. Phys. J. E **27**, 123 (2008) DOI: 10.1140/epje/i2008-10358-7

Received: 3 February 2009

Published online: 14 March 2009 –

We have found a technical error in Appendix A of [1] which induced errors in Appendix B and in the figures. However, the text of the paper, including all conclusions drawn, is completly unaffected by the changes. In [1], equations (A.1a), (A.1b), and (A.1c) should read

$$\lambda \frac{\partial \tau_{rr}}{\partial t} + \max\left(0, 1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d|}\right)\tau_{rr} = 0, \tag{A.1a}$$

$$\lambda\left(\frac{\partial \tau_{r\theta}}{\partial t} - 2\dot{\epsilon}_{r\theta}\tau_{rr}\right) + \max\left(0, 1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d|}\right)\tau_{r\theta} = 2\eta\dot{\epsilon}_{r\theta}, \tag{A.1b}$$

$$\lambda\left(\frac{\partial \tau_{\theta\theta}}{\partial t} - 4\dot{\epsilon}_{r\theta}\tau_{r\theta}\right) + \max\left(0, 1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d|}\right)\tau_{\theta\theta} = 0, \tag{A.1c}$$

with $\dot{\epsilon}_{r\theta} = 1/2\left(\frac{\partial v}{\partial r} - \frac{v}{r}\right)$. Consequently, Appendix B is modified but its conclusion remains the same: if the strain rate is discontinuous, we can predict the critical strain rate

$$\dot{\varepsilon}^c_{r\theta} = \frac{1}{2\eta}\left[1 - \frac{\tau_Y}{\sqrt{2}|\tau_{r\theta}(r_c)|}\frac{1}{\left(1 + \frac{\lambda^2}{\eta^2}\tau_{r\theta}(r_c)^2\right)^{1/2}}\right]\tau_{r\theta}(r_c).$$

All the presented computations have been made again, and most figures are unchanged, except Figures 7, 8(b), and 9(b), whose new versions are shown in the following page.

[a] e-mail: pierre.saramito@imag.fr
[b] *Present address*: Physics of Geological Processes, University of Oslo, Sem Selands vei 24, NO-0316 Oslo, Norway.
[c] *Present address*: CNRS UMR 3215, Institut Curie, 26 rue d'Ulm, 75248 Paris Cedex 05, France.

Modified Appendix B

[...] We write the constitutive equation with $\frac{\partial}{\partial t} = 0$. We have:

– When $r > r_c$: the plasticity term is zero, so (A.1c) leads to $2\lambda\dot{\epsilon}_{r\theta}\tau_{r\theta} = 0$, and $\dot{\epsilon}_{r\theta} = 0$ as $\tau_{r\theta} \neq 0$; in addition, we have $v = 0$ because of boundary conditions. However, (A.1a) and (A.1b) are then equivalent to $0 = 0$, and the normal stress components are not determined by the stationary equations only. In the transient problem, their values are determined by the initial conditions. Finally, as $v = 0$, (A.2b) yields $\tau_{r\theta} = C/r^2$, where C is a constant.

– When $r < r_c$: (A.1a, A.1b) lead to

$$\left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d|}\right)\tau_{rr} = 0,$$
$$-2\lambda\dot{\epsilon}_{r\theta}\tau_{rr} + \left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d|}\right)\tau_{r\theta} = 2\eta\dot{\epsilon}_{r\theta},$$
$$-4\lambda\dot{\epsilon}_{r\theta}\tau_{r\theta} + \left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d|}\right)\tau_{\theta\theta} = 0.$$

We denote with a^- (respectively, a^+) the quantities evaluated in $r = r_c^-$ (respectively in $r = r_c^+$); v and $\tau_{r\theta}$ are continuous, thus $v^- = v^+ = 0$, $\tau^-_{r\theta} = \tau^+_{r\theta} = \tau_{r\theta}(r_c)$ and we have

$$\left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d^-|}\right) \tau_{rr}^- = 0,$$
$$-2\lambda\dot{\epsilon}_{r\theta}^- \tau_{rr}^- + \left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d^-|}\right) \tau_{r\theta}(r_c) = 2\eta\dot{\epsilon}_{r\theta}^-,$$
$$-4\lambda\dot{\epsilon}_{r\theta}^- \tau_{r\theta}(r_c) + \left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d^-|}\right) \tau_{\theta\theta}^- = 0.$$

If $1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d^-|} = 0$, we find $\dot{\epsilon}_{r\theta}^- = 0 = \dot{\epsilon}_{r\theta}^+$: there is no discontinuity.

If $1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d^-|} \neq 0$, we find

$$\tau_{rr}^- = 0,$$
$$\tau_{\theta\theta}^- = 2\frac{\lambda}{\eta}\tau_{r\theta}(r_c)^2,$$
$$\dot{\epsilon}_{r\theta}^- = \frac{1}{2\eta}\left(1 - \frac{\tau_Y}{|\boldsymbol{\tau}_d^-|}\right) \tau_{r\theta}(r_c),$$

with now

$$|\boldsymbol{\tau}_d^-| = \left(2\tau_{r\theta}(r_c)^2 + 2\frac{\lambda^2}{\eta^2}\tau_{r\theta}(r_c)^4\right)^{1/2}.$$

As $\dot{\epsilon}_{r\theta}^- \neq \dot{\epsilon}_{r\theta}^+$, the strain rate is discontinuous at $r = r_c$ and we can define a critical strain rate

$$\dot{\varepsilon}_{r\theta}^c = \frac{1}{2\eta}\left[1 - \frac{\tau_Y}{\sqrt{2}|\tau_{r\theta}(r_c)|}\frac{1}{\left(1 + \frac{\lambda^2}{\eta^2}\tau_{r\theta}(r_c)^2\right)^{1/2}}\right]\tau_{r\theta}(r_c).$$

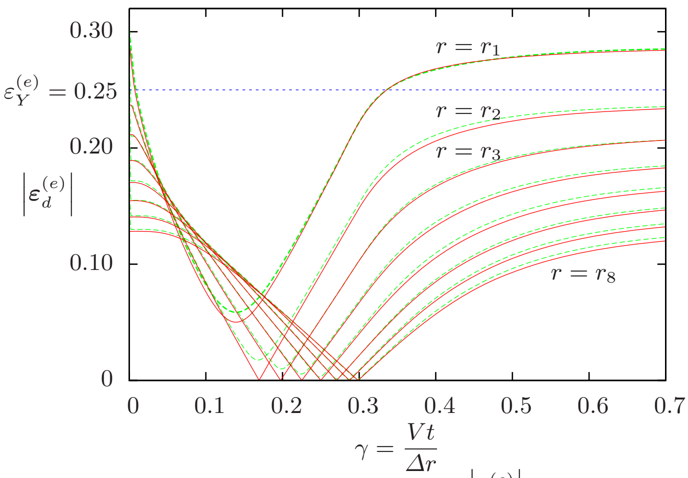

Fig. 7. (Colour online) Transient case: $\left|\boldsymbol{\varepsilon}_d^{(e)}\right|$ *versus* t for r from $r = r_1$ to r_8. Dashed green lines: former computations; solid red lines: present computations.

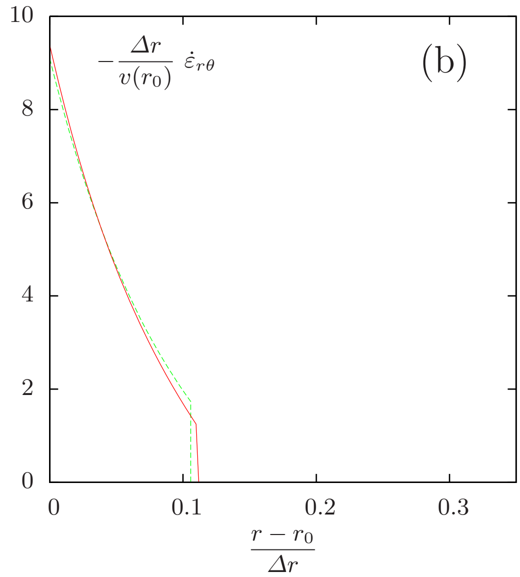

Fig. 8. (Colour online) Stationary case: (b) Shear strain rate $\dot{\varepsilon}_{r\theta}$ *versus* r. There is no experimental data available for the comparison. Dashed green lines: former computations; solid red lines: present computations.

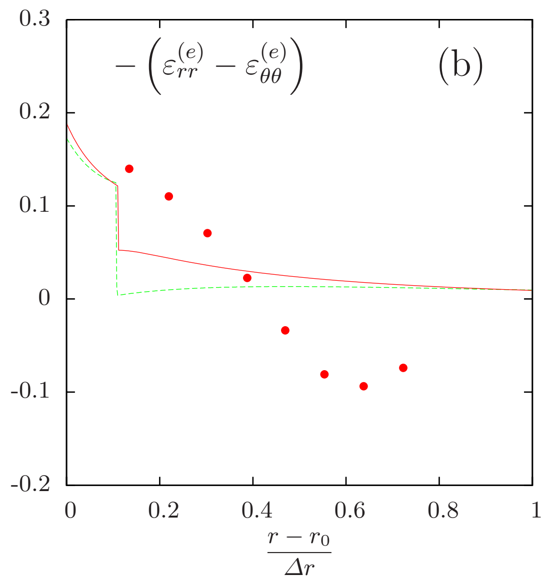

Fig. 9. (Colour online) Stationary case: (b) Difference of normal components. $-\left(\varepsilon_{rr}^{(e)} - \varepsilon_{\theta\theta}^{(e)}\right)$ *versus* r. Dashed green lines: former computations; solid red lines: present computations; •: experimental data.

References

1. I. Cheddadi, P. Saramito, C. Raufaste, P. Marmottant, F. Graner, Eur. Phys. J. E **27**, 123 (2008).