1 Comparison with analytic SOCA calculations

In Rädler & Stepanov (2006, referred to as RS06 in the following) the mean electromotive force has been calculated in the second–order correlation approximation for a generally inhomogeneous turbulence in a incompressible rotating fluid showing a position–dependent mean motion. In this context the second–order correlation approximation was understood as neglect of terms in the induction equation as well as in the momentum balance. Both the Coriolis force and the derivatives of the mean velocity were assumed to be small enough so that the mean electromotive force is linear in the angular velocity $\boldsymbol{\Omega}$ and the gradient tensor of $\overline{\boldsymbol{U}}$. Detailed results were obtained for a special correlation function for the background turbulence.

Let us apply the results to the situations considered in this paper. In the case of rotation without shear we obtain

$$\frac{\delta}{\eta_{\rm t}} = \frac{\sqrt{\pi}}{4\sqrt{2}} {\rm Co}\,{\rm Re}_M (\lambda_{\rm c} k_{\rm f})^2 \sqrt{q}\,\delta^o(q, {\rm Pr}_M) \tag{1}$$

with Co, Re_M and Pr_M as defined above, $q = \lambda_{\rm c}^2/\eta\tau_{\rm c}$, and λ_c and $\tau_{\rm c}$ being correlation length and time. When introducing the Strouhal number $\mathrm{St} = u_{\rm rms} k_{\rm f} \tau_{\rm c}$, we have $q = \mathrm{Re}_M/\mathrm{St}$. The function δ^o approaches unity if $\mathrm{Pr}_M = 1$ and $q \to 0$. It can be calculated according to

$$\delta^o(q, {\rm Pr}_M) = \frac{\delta^{o(\Omega)}(q, {\rm Pr}_M) + \kappa^{o(\Omega)}(q, {\rm Pr}_M)}{2\beta^{o(0)}(q)}\,, \tag{2}$$

from the functions $\delta^{o(\Omega)}$, $\kappa^{o(\Omega)}$ and $\beta^{o(0)}$ defined and plotted in RS06.

Proceeding to the case of shear without rotation we note first that due the above–mentioned assumption on the linearity in the mean–velocity gradient, that is in S, both κ_{11} and κ_{22} are equal to zero. Further we have

$$\frac{\eta_{12}}{\eta_{\rm t}} = -\frac{19}{20} {\rm Sh}\,{\rm Re}_M (\lambda_{\rm c} k_{\rm f})^2 \eta_{12}^o(q, {\rm Pr}_M)\,, \quad \frac{\eta_{21}}{\eta_{\rm t}} = -\frac{7}{20} {\rm Sh}\,{\rm Re}_M (\lambda_{\rm c} k_{\rm f})^2 \eta_{21}^o(q, {\rm Pr}_M) \tag{3}$$

with functions η_{12}^o and η_{21}^o which approach unity if $\mathrm{Pr}_M = 1$ and $q \to 0$. They are given by

$$\eta_{12}^o(q, {\rm Pr}_M) = \frac{13\kappa^{o(D)}(q, {\rm Pr}_M) + 5\delta^{o(W)}(q, {\rm Pr}_M) + \kappa^{o(W)}(q, {\rm Pr}_M)}{19\beta^{o(0)}(q)}\,, \tag{4}$$

$$\eta_{21}^o(q, {\rm Pr}_M) = \frac{13\kappa^{o(D)}(q, {\rm Pr}_M) - 5\delta^{o(W)}(q, {\rm Pr}_M) - \kappa^{o(W)}(q, {\rm Pr}_M)}{7\beta^{o(0)}(q)} \tag{5}$$

with the functions $\kappa^{o(D)}$, $\delta^{o(W)}$, $\kappa^{o(W)}$ and $\beta^{o(0)}$ of RS06.

[From (**??**) we conclude that $\ln(\delta/\eta_{\rm t}) = \ln \mathrm{Co} + const$ if all relevant parameters except Co are constant. The data with $\mathrm{Co} \leq 1.15$ given in Fig.1 correspond to $\ln(\delta/\eta_{\rm t}) \approx 0.86 \ln \mathrm{Co} + const$.
We further conclude that $\ln(\delta/\eta_{\rm t}) = \ln \mathrm{Re}_M + const$ if all relevant parameters

(including q) except Re_M are constant. The data of Fig.2 with $0.65 \leq \mathrm{Re}_M \leq 5.0$ lead to $\ln(\delta/\eta_\mathrm{t}) \approx 0.76 \ln \mathrm{Re}_M + const$.
It is hard to evaluate Fig.3 in that sense.
From (**??**) we conclude that $\ln(\eta_{12}/\eta_\mathrm{t}) = \ln \mathrm{Re}_M + const$ and $\ln(\eta_{21}/\eta_\mathrm{t}) = \ln \mathrm{Re}_M + const$ if all relevant parameters except Re_M are constant. From the data for $0.7 \leq \mathrm{Re}_M \leq 10$ in Fig.4 we conclude that $\ln(\eta_{12}/\eta_\mathrm{t}) \approx 0.87 \ln \mathrm{Re}_M + const$, from the data for $0.7 \leq \mathrm{Re}_M \leq 7$ there $\ln(\eta_{21}/\eta_\mathrm{t}) \approx 0.61 \ln \mathrm{Re}_M + const$.
All evaluations of the figures are very crude, maybe erroneous. Moreover I am not sure to which extent the assumptions on the constancy of the other parameters are justified.
These considerations say, of course, nothing about, e.g., the dependencies on $\lambda_\mathrm{c} k_\mathrm{f}$, q or Pr_M.]