
Reijer Idema
**Convergence of inexact Newton methods in the number of
linear iterations**

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In our research on iterative methods for the power flow problem in large power systems, we have been using inexact Newton methods with preconditioned GMRES for the linear solves. We observed that the Newton convergence was often approximately linear in the total number of GMRES iterations, independent of the number of GMRES iterations used in each Newton iteration. This inspired us to further research the theoretical convergence of the inexact Newton method.

We present a convergence theorem that relates the reduction in the Newton error to the reduction in the residual error in the GMRES iterations. Using this theorem we show that under certain circumstances Newton convergence is indeed linear in the total number of GMRES iterations, and independent of the number of GMRES iterations used in each Newton iteration. Experiments illustrate the practical use of the convergence theorem, and visualize how GMRES convergence influences the Newton convergence.