NUMERICAL ANALYSIS OF A MULTI-PHYSICS MODEL FOR TRACE GAS SENSORS

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Abstract. Trace gas sensors are currently used in many applications from leak detection to national security and may some day help with disease diagnosis. These sensors are modelled by a coupled system of complex elliptic partial differential equations for pressure and temperature. Solutions are approximated using the finite element method which we will show admits a continuous and coercive problem with optimal H^1 and L^2 error estimates. Numerically, the finite element discretization yields a skew-Hermitian dominant matrix for which classical algebraic preconditioners quickly degrade. We develop a block preconditioner that requires scalar Helmholtz solutions to apply but gives a very low outer iteration count. We also present analysis showing eigenvalues of the preconditioned system are mesh-dependent but with a small coefficient. Numerical experiments confirm our theoretical discussion.

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