Estimation of the Gas Exhaust Rate Required on an Aluminium Reduction Cell During Start-up Using TASCflow3D

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Modeling potroom ventilation with CFD tools for almost 20 years

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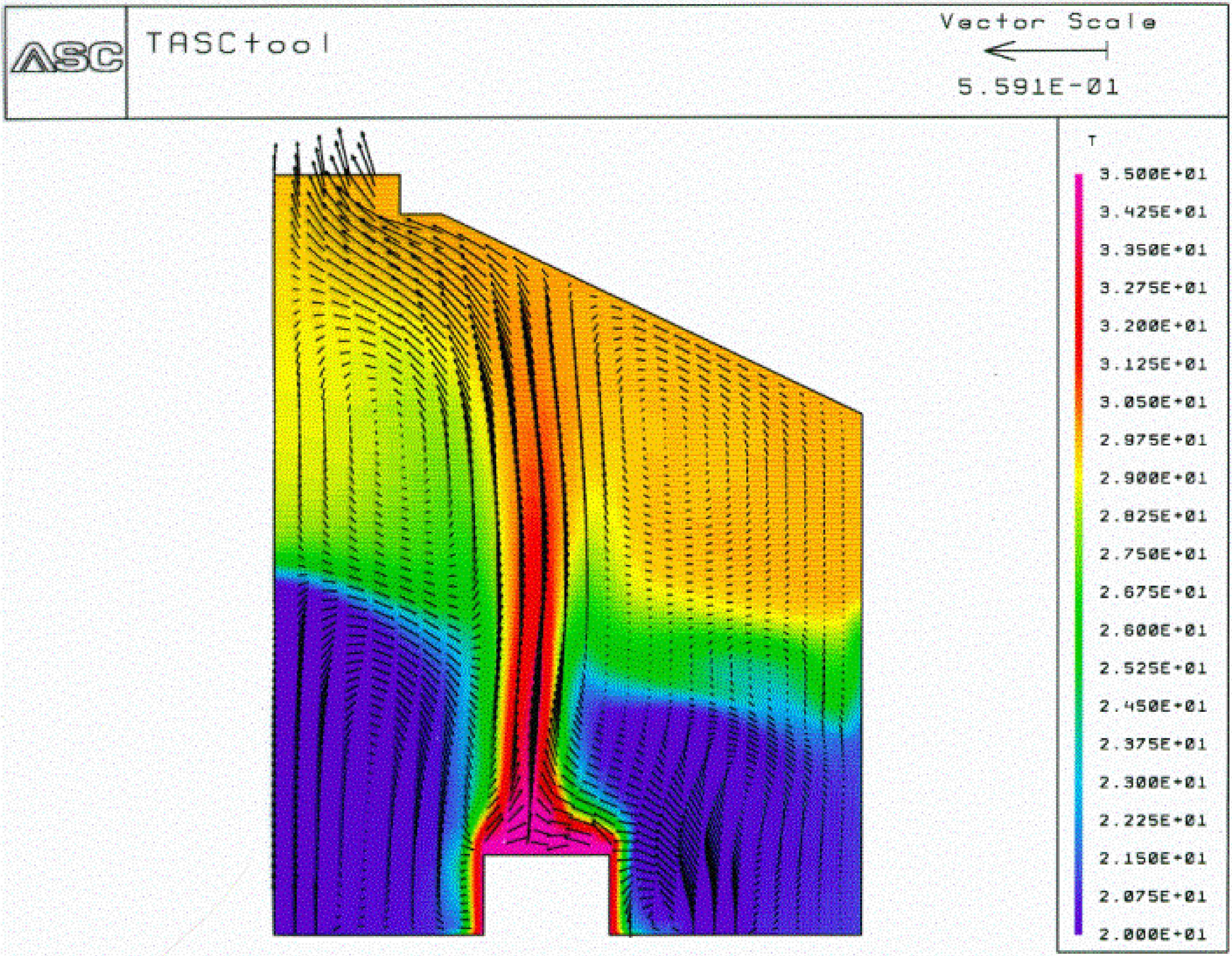

ASC
TASCtool
Vector Scale
5.591E-01
T
3.500E+01
3.425E+01
3.350E+01
3.275E+01
3.200E+01
3.125E+01
3.050E+01
2.975E+01
2.900E+01
2.825E+01
2.750E+01
2.675E+01
2.600E+01
2.525E+01
2.450E+01
2.375E+01
2.300E+01
2.225E+01
2.150E+01
2.075E+01
2.000E+01

New CFD modeling project for Reynolds at Baie-Comeau

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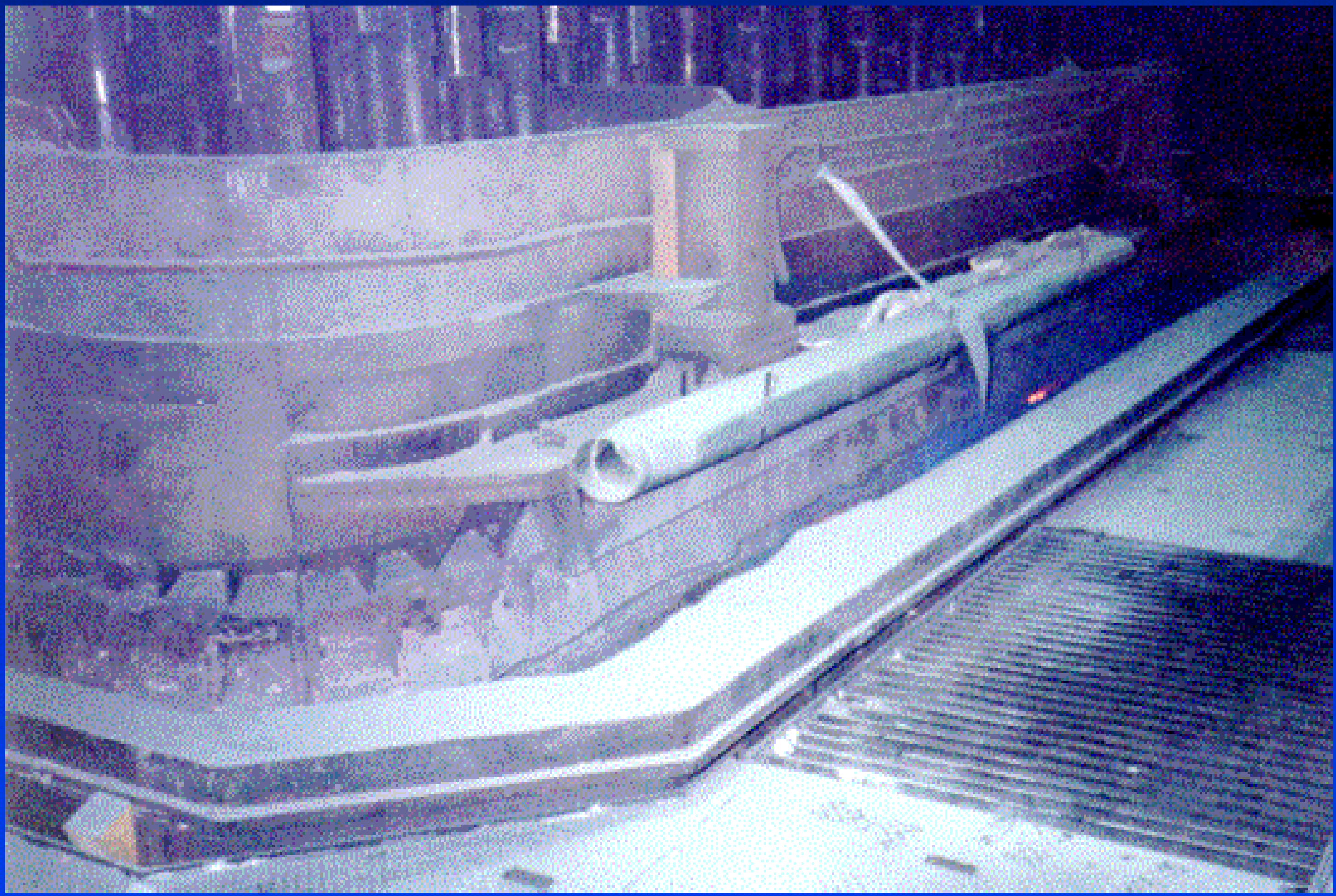
The mandate:
Estimate the gas exhaust rate required during start-up



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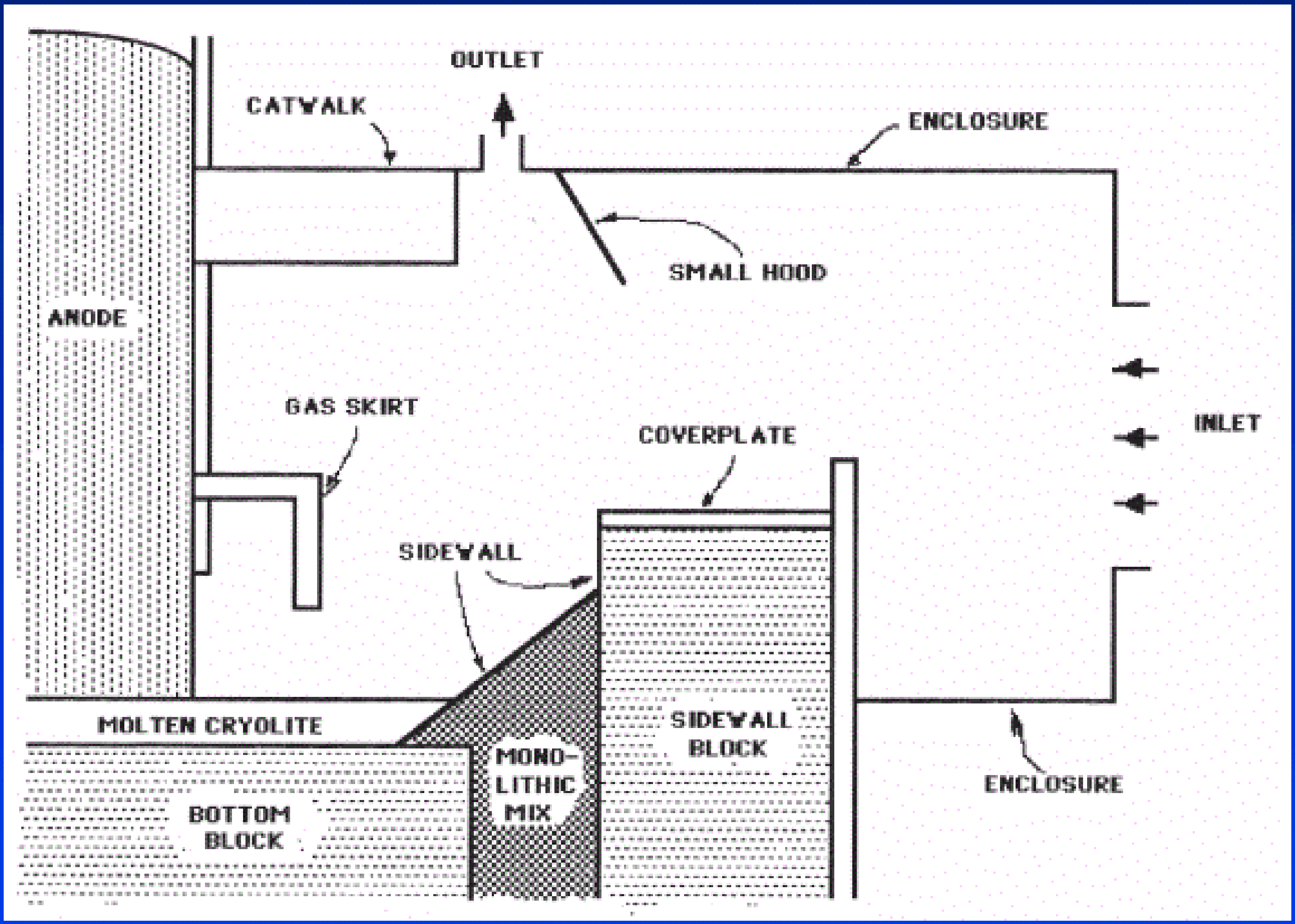
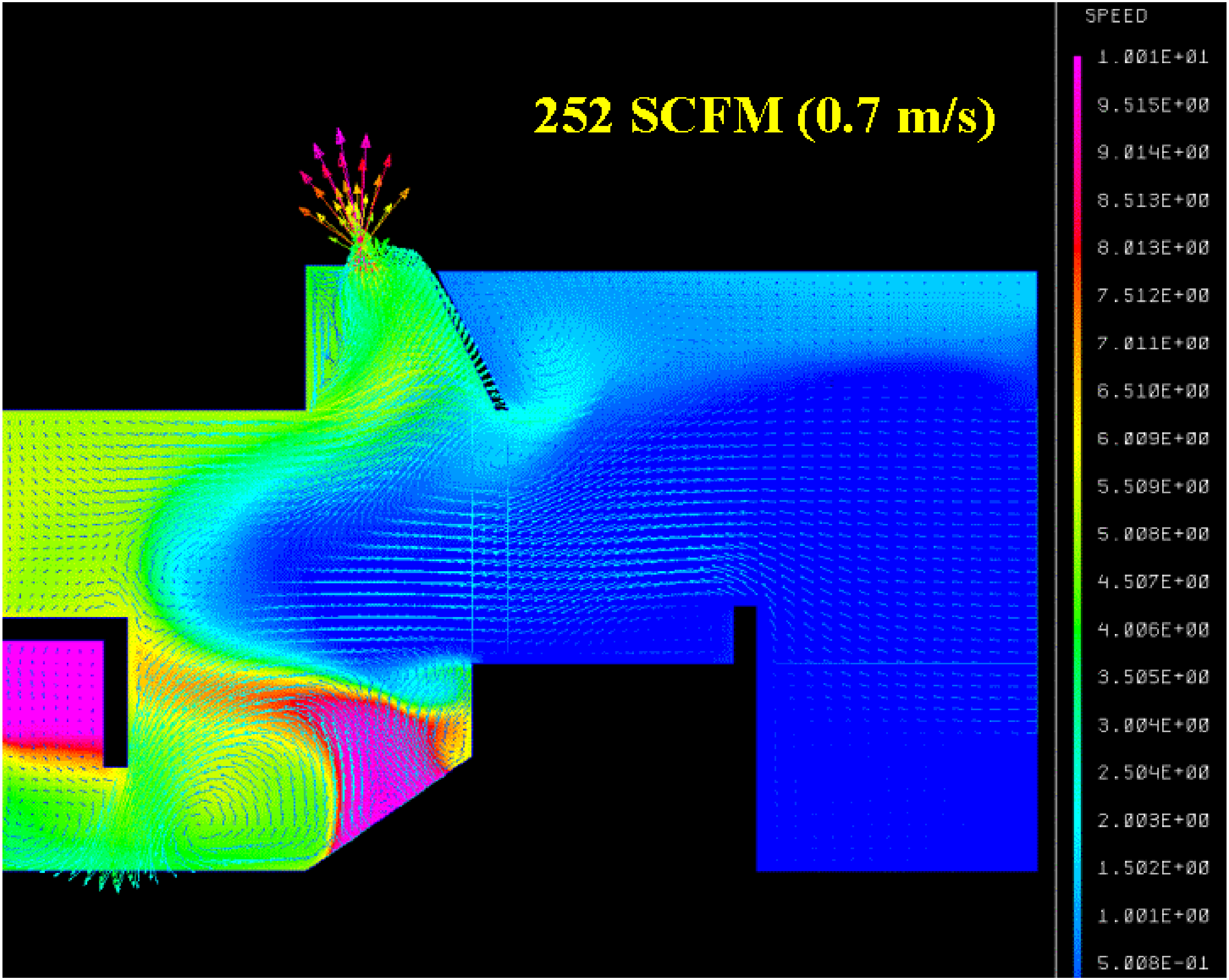
The modeled region:



Capture of hydrocarbon and fluoride fumes

- **TASCflow3D model setup:**
  - Pseudo-2D problem (2 cell layers, with 2 symmetry planes)
  - Mixed convection flow (buoyancy and energy equation)
  - Enhanced viscosity (20x) turbulence model (k-ε model was not adequate for this problem)
  - Open flow problem modelled as an enclose flow problem
- **Boundary conditions:**
  - constant cold air velocity at the inlet
  - constant pressure at the outlet
  - constant heat flux on the hot surfaces
  - secondary hot air inlet (combustion products) at constant velocity on the burning surface
- **Modelling strategy:**
  - increase the gas exhaust rate until no spill-over occurs



252 SCFM (0.7 m/s)
SPEED
1.001E+01
9.515E+00
9.014E+00
8.513E+00
8.013E+00
7.512E+00
7.011E+00
6.510E+00
6.009E+00
5.509E+00
5.008E+00
4.507E+00
4.006E+00
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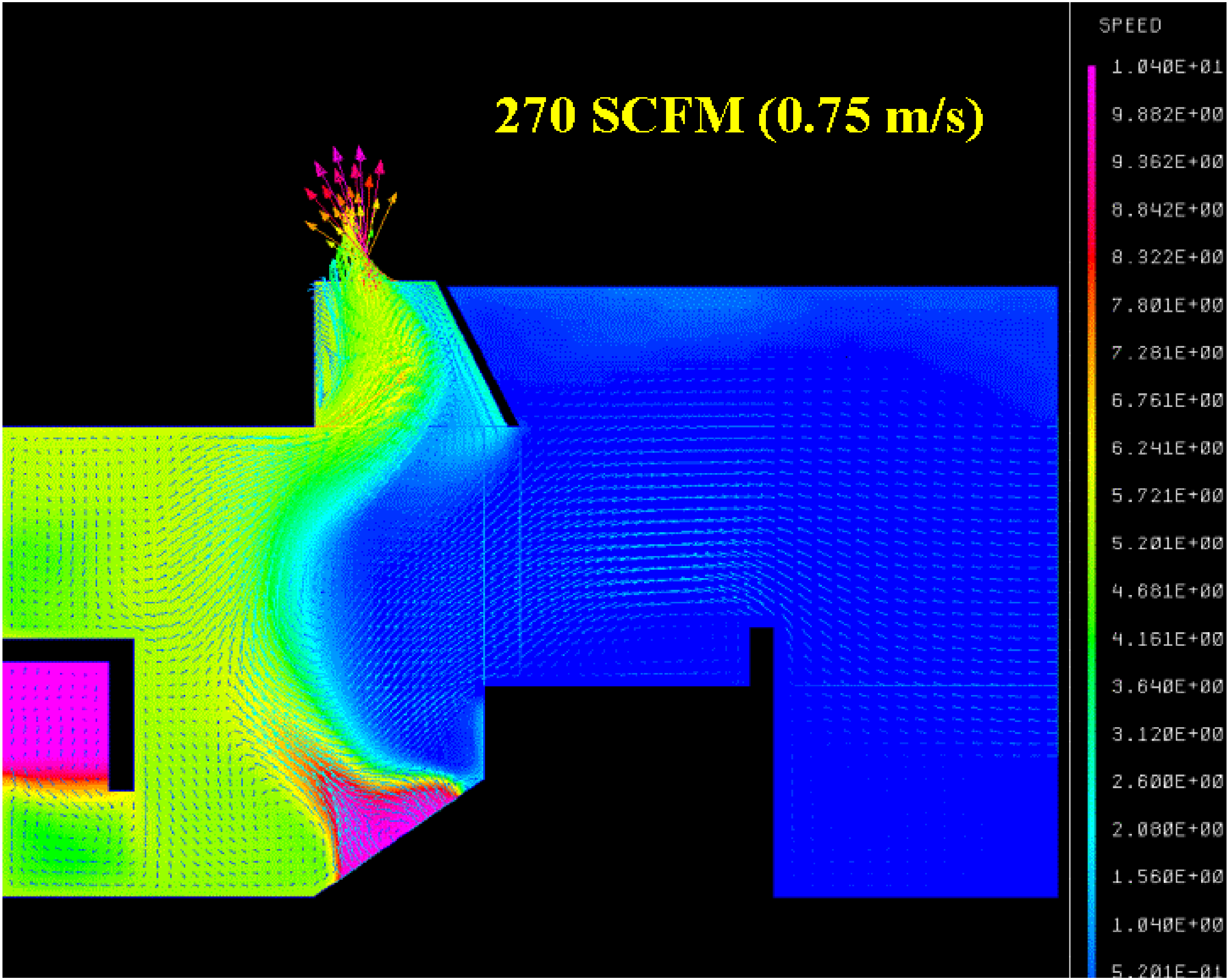
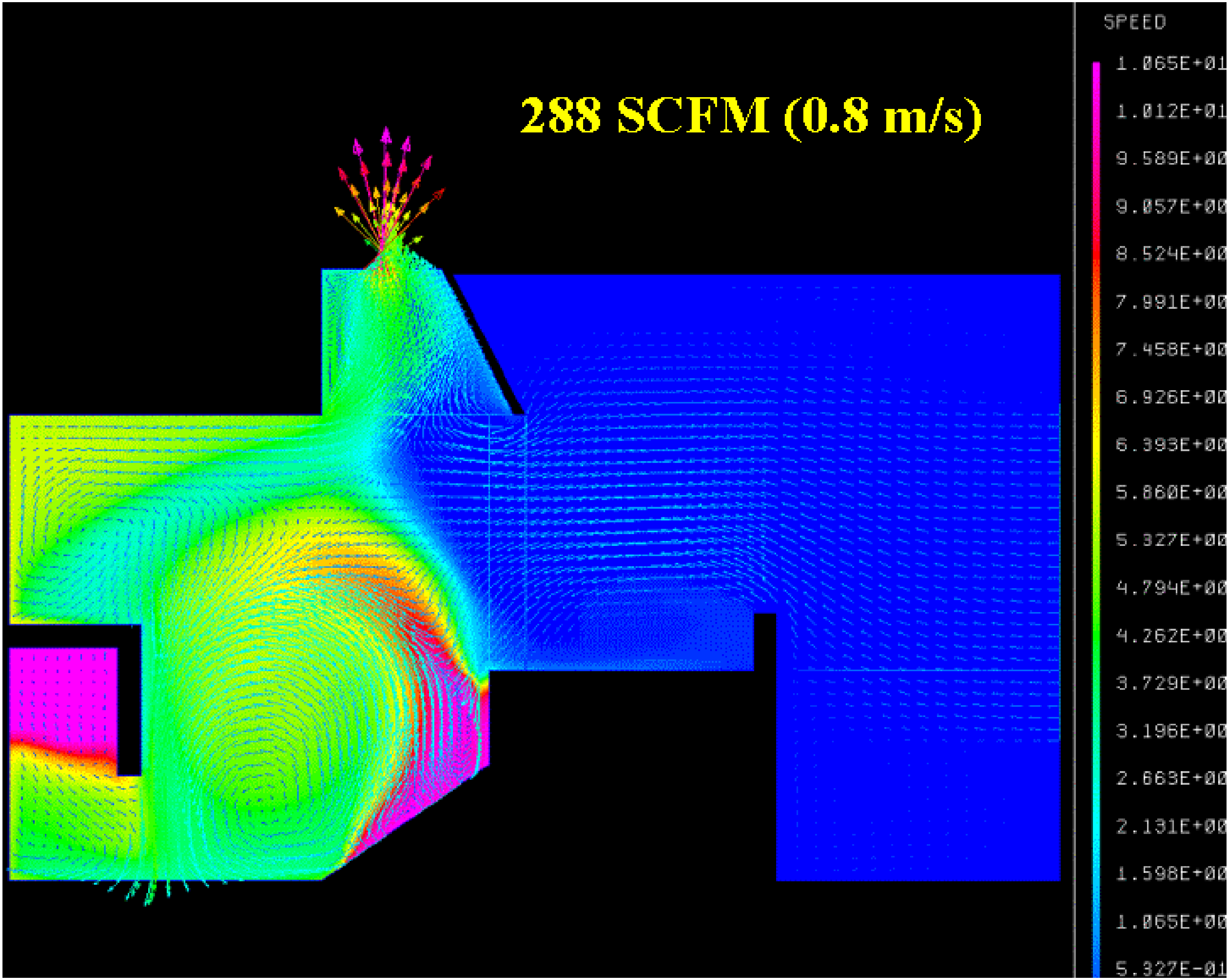
1.001E+00
5.008E-01


270 SCFM (0.75 m/s)
SPEED
1.040E+01
9.882E+00
9.362E+00
8.842E+00
8.322E+00
7.801E+00
7.281E+00
6.761E+00
6.241E+00
5.721E+00
5.201E+00
4.681E+00
4.161E+00
3.640E+00
3.120E+00
2.600E+00
2.080E+00
1.560E+00
1.040E+00
5.201E-01


288 SCFM (0.8 m/s)
SPEED
1.065E+01
1.012E+01
9.589E+00
9.057E+00
8.524E+00
7.991E+00
7.458E+00
6.926E+00
6.393E+00
5.860E+00
5.327E+00
4.794E+00
4.262E+00
3.729E+00
3.196E+00
2.663E+00
2.131E+00
1.598E+00
1.065E+00
5.327E-01

Capture of fluoride fumes

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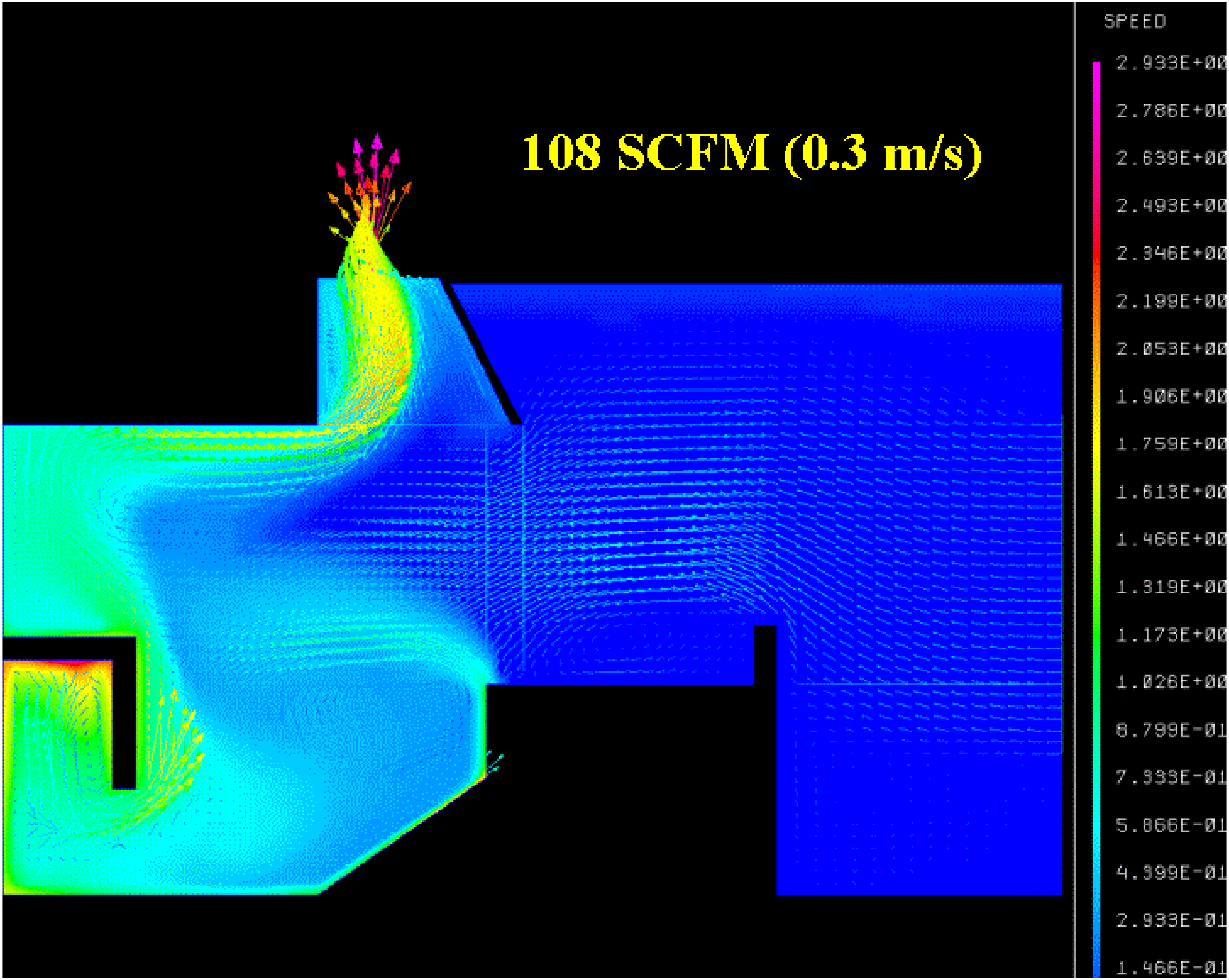
108 SCFM (0.3 m/s)
SPEED
2.933E+00
2.786E+00
2.639E+00
2.493E+00
2.346E+00
2.199E+00
2.053E+00
1.906E+00
1.759E+00
1.613E+00
1.466E+00
1.319E+00
1.173E+00
1.026E+00
8.799E-01
7.333E-01
5.866E-01
4.399E-01
2.933E-01
1.466E-01

Conclusions

- For the capture of all the fumes it was established that:
  - 18,000 SCFM per cell was required when the volatiles are burn
  - 7,000 SCFM per cell was required after the bake-out period
- The present study could lead to an under-estimation of the gas exhaust rate because of:
  - use of a 2D model
  - possible cross-drafts in the cell room

  A safety margin of 15% on the gas exhaust rate was made
- A more complete study should include:
  - a fully 3D geometry
  - a combustion model
  - a "Reynolds flux" turbulence model

  The workstation used in the present study (SGI 4D/35 with 32 meg of RAM) was not powerful enough for such a more complete study

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