STERG

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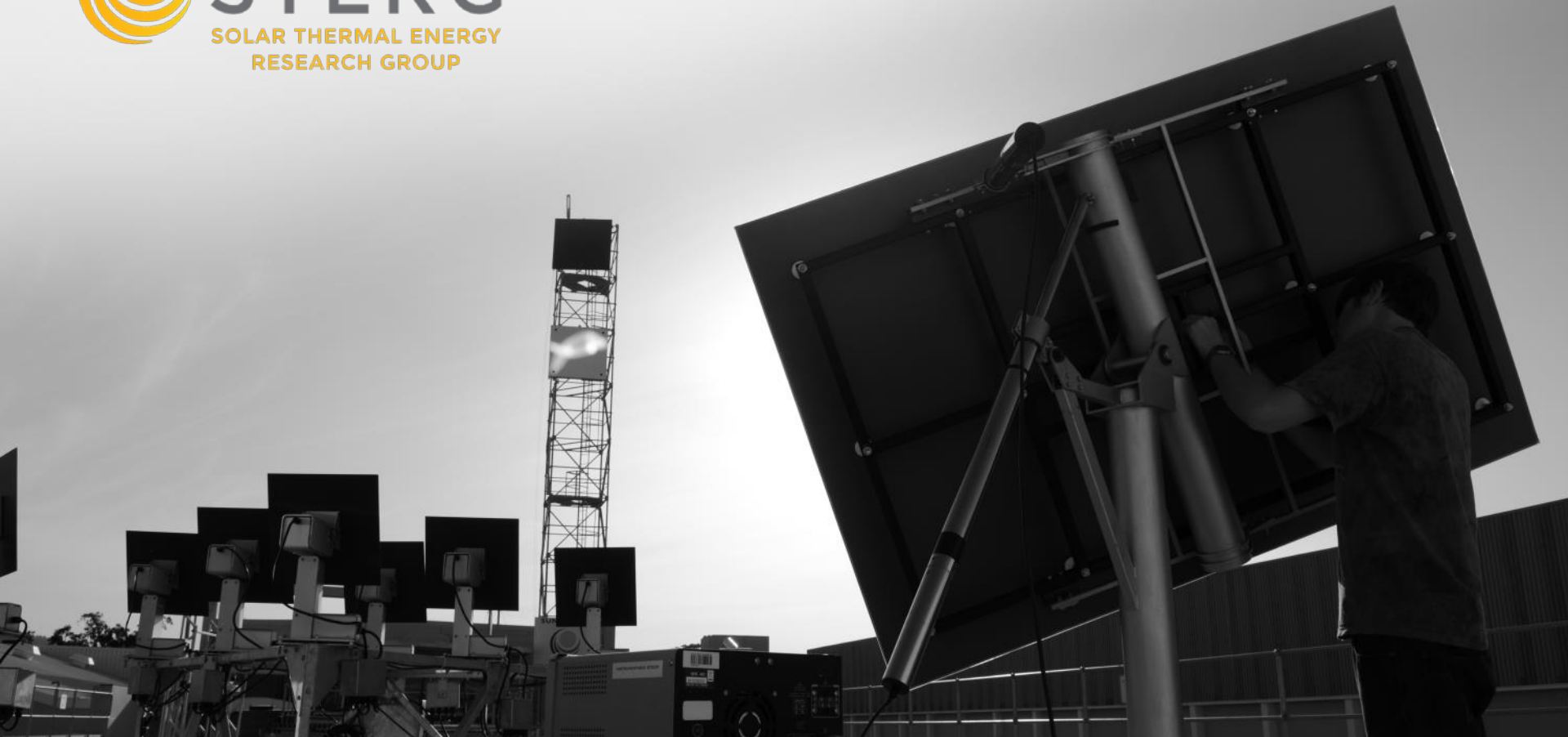

One-Dimensional Transient Cold Filling Simulation of a Molten Salt Central Receiver Pipe

Jean Swart, Jaap Hoffmann

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Molten Salt as a Heat Transfer Fluid

- Efficiency with central receivers
- High freezing temperatures
- Preheating costs
- Cold filling

Cold Filling

Cold filling is the filling of a receiver panel which is initially at a temperature below the molten salt freezing temperature

Previous Work

- Delameter & Bergan (1986)
- Pacheco et al. (1995)
- Pacheco & Dunkin (1996)
- Lu et al. (2010)
- Lu et al. (2013)
- Liao et al. (2014)
- Liao et al. (2015)
- Xu et al. (2016)

- Numerical model used to simulate cold filling a vertical pipe with a ternary salt
- Filling Modes

Previous Work

- Delameter & Bergan (1986)
- Pacheco et al. (1995)
- Pacheco & Dunkin (1996)
- Lu et al. (2010)
- Lu et al. (2013)
- Liao et al. (2014)
- Liao et al. (2015)
- Xu et al. (2016)

- Numerical model used to simulate cold filling a vertical pipe with Solar Salt
- Found the critical inlet velocities and temperatures for various initial tube temperatures

Modelling Framework and Methodology

- Numerical model used to simulate cold filling a vertical pipe with Solar Salt
- MATLAB
- One-Dimensional

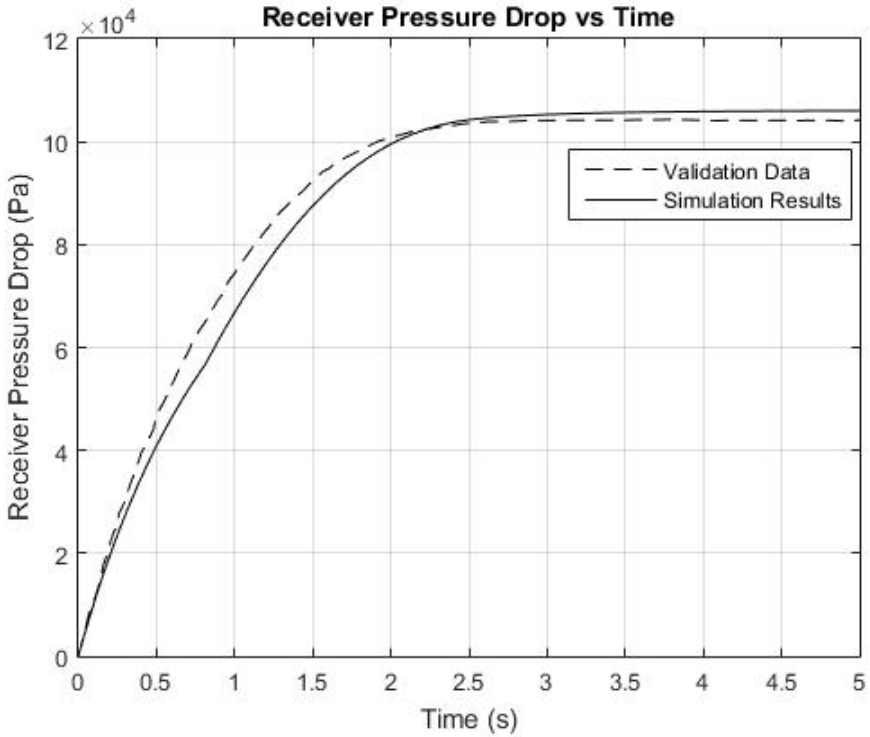
Numerical and Mathematical Modelling

- Property functions
- Coupled pressure and velocity
- Track three temperatures
    1) Molten salt
    2) Frozen salt
    3) Receiver tube

Validation

1) Liao et al. (2015)
2) Xu et al. (2016)

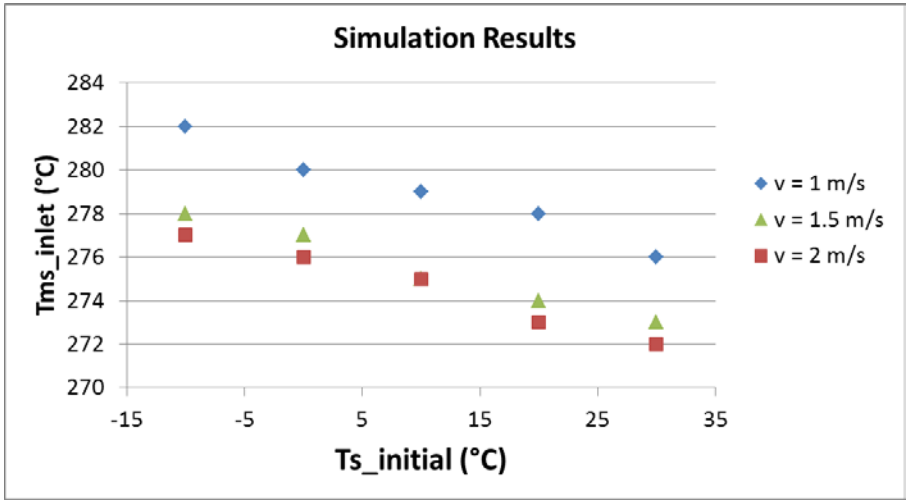
Validation

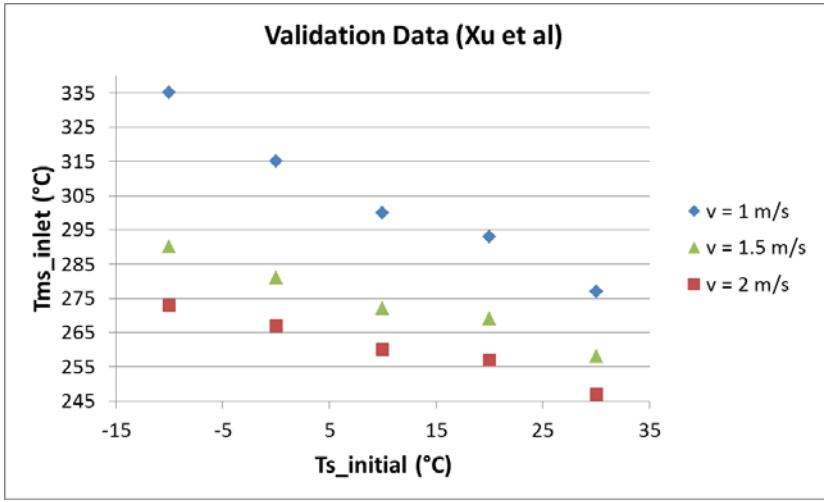


Inputs:

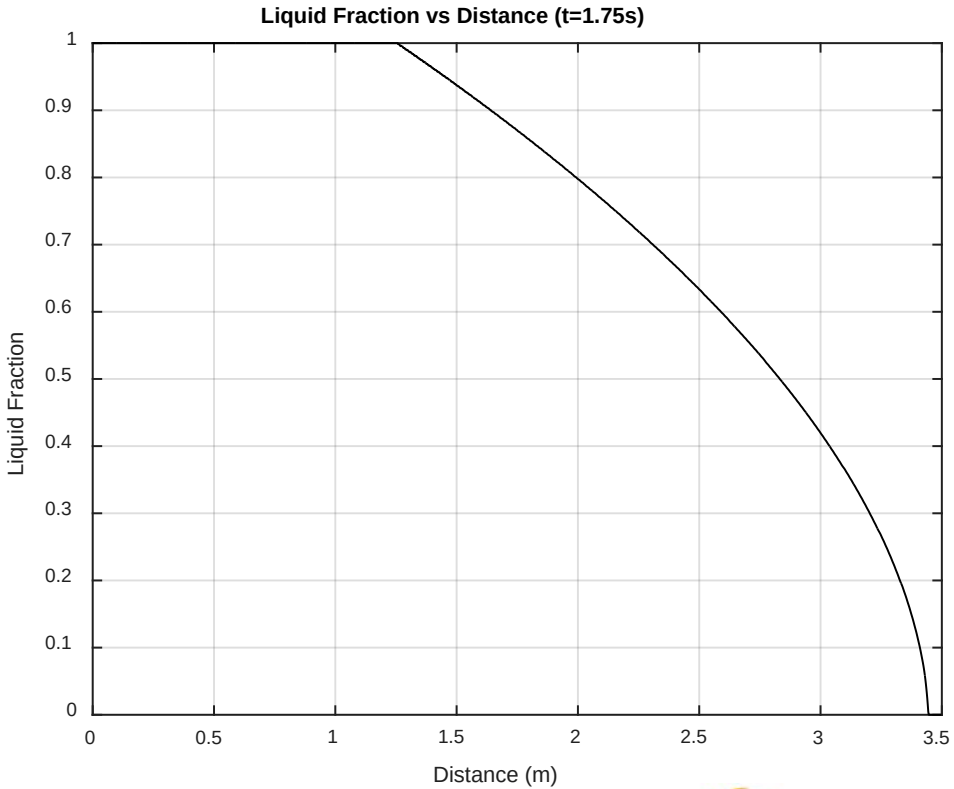
- Tms_inlet = 575 K
- Lr = 3.5 m
- Ts_initial = 345 K
- t_max = 5 s

Validation


Simulation Results
Tms_inlet (°C)
284
282
280
278
276
274
272
270
-15
-5
5
15
25
35
Ts_initial (°C)
v = 1 m/s
v = 1.5 m/s
v = 2 m/s


Validation Data (Xu et al)
Tms_inlet (°C)
335
325
315
305
295
285
275
265
255
245
-15
-5
5
15
25
35
Ts_initial (°C)
v = 1 m/s
v = 1.5 m/s
v = 2 m/s

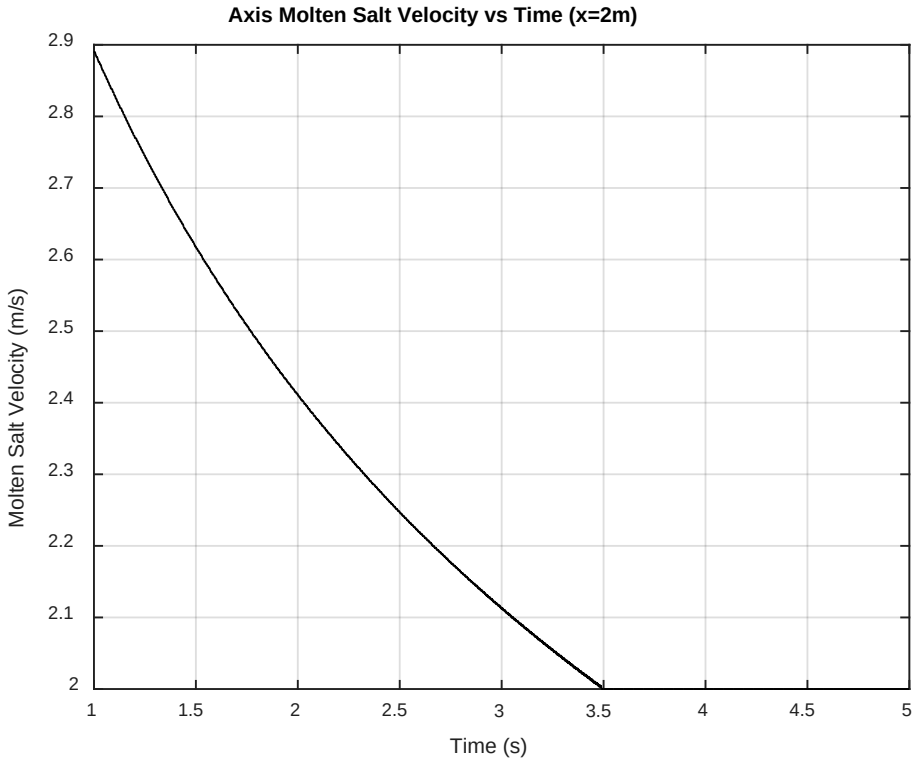
Preliminary Results



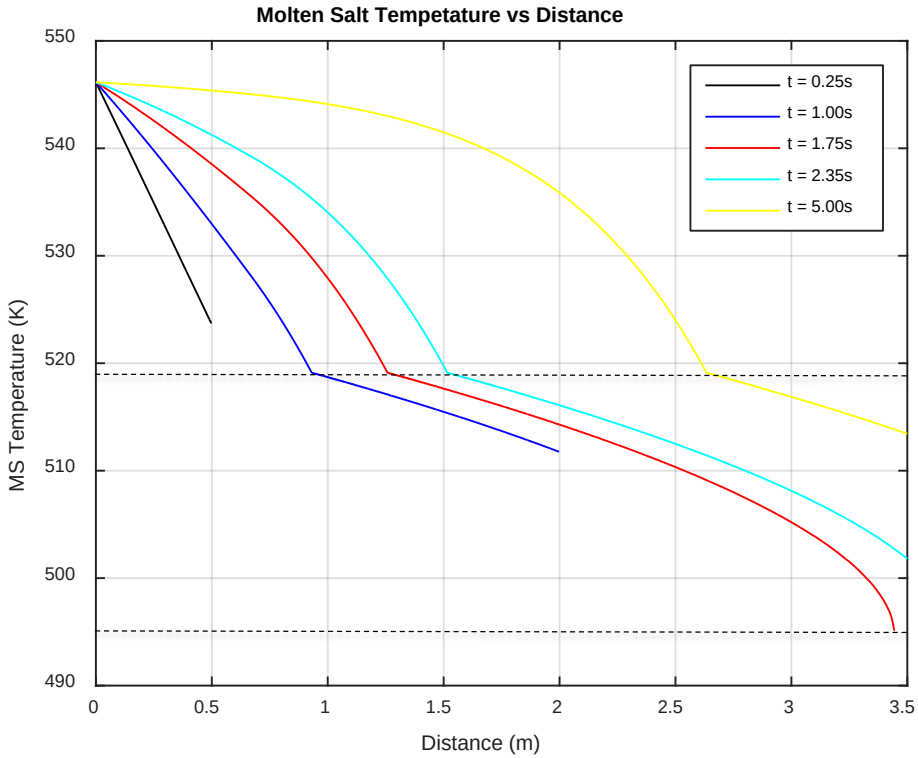
Inputs:

- Tms_inlet = 546 K
- Lr = 3.5 m
- Ts_initial = 295 K
- t_max = 5 s
- v_inlet = 2 m/s

Preliminary Results



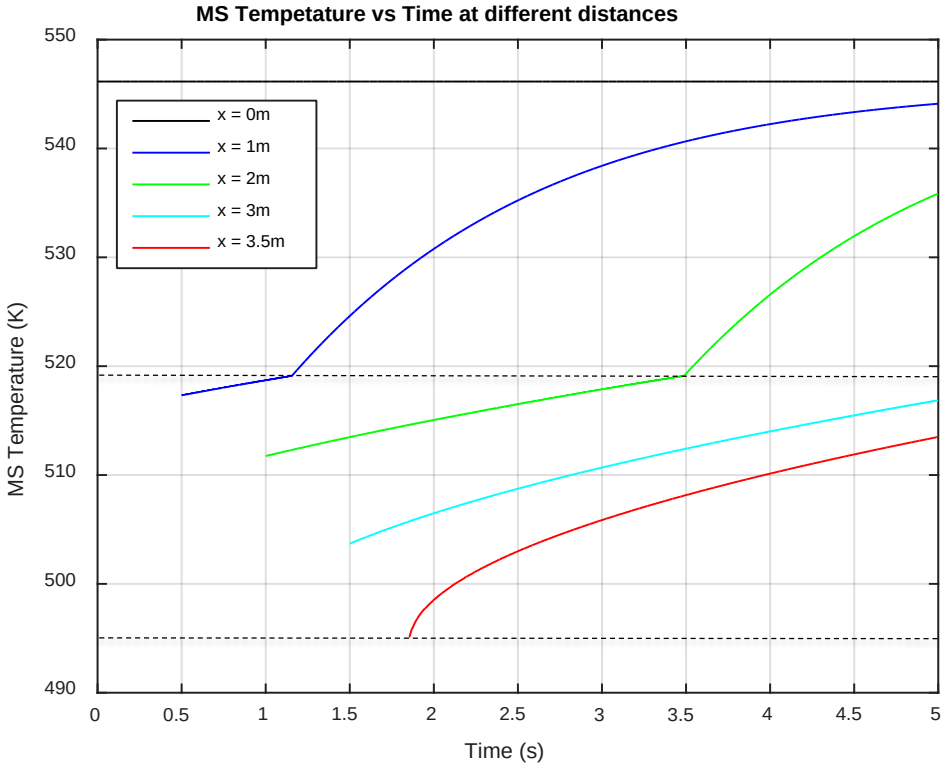
Preliminary Results



T_liquid

T_solid

Preliminary Results



T_liquid

T_solid

Conclusion

- The cold filling solution
- Promising research
- Working model
- Future work

THANK YOU!

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CONTACT DETAILS:

J Swart email: 17001536@sun.ac.za
Solar Thermal Energy Research Group (STERG)
Stellenbosch University
South Africa

visit us: concentrating.sun.ac.za