

CFD study of flow in a natural rubber sheet smoking-cooperative

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CFD study of flow in a natural rubber sheet smoking-cooperative

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1. Introduction

Thailand is the largest natural rubber producer in the world. One of the main products is the smoked sheet (RSS) rubber. There are totally about 300 rubber sheet smoking cooperatives (RSSC) under going RSS production business in Thailand.



Smoking of wood results in a large quantity of smoke particles. RSS production results in thick smoke cloud containing fire around in the work place. Improvement of air flow is then necessary to reduce the risk to workers' health by exposing to these smoke particles. Particle trajectory of the smoke, velocity distribution and temperature distribution inside of the RSSC are investigated.

2. Methodology

Study velocity distribution, temperature distribution and smoke particle trajectory using FLUENT along with GAMBIT. Measurements at boundaries were performed to obtain boundary conditions. Measurements at several positions were performed and these data were used for validation. Measurement positions are shown in Fig. 2 Rubber smoke room.

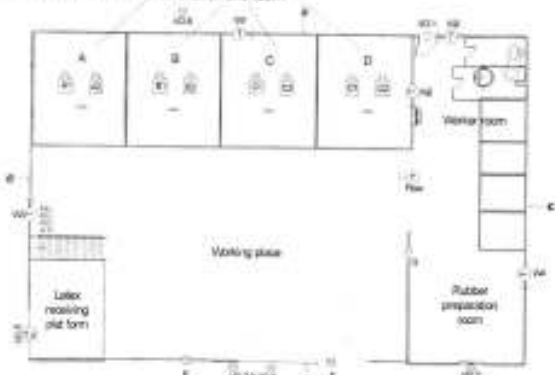


Fig. 2 Diagram of Measurement positions (Top view)

It is consider a better air flow is needed cooperation on natural data. Use certain combination of ratio between Greenwell weather and Recycled weather was performed.

The realistic smoking in the primary was performed by using GAMBIT. Results is shown in Table 2.

Element	TriTetrahed
Face	3164
Size	41.000
Mesh Volume Coarsened	41.000

3. Results

Value of velocity near the walls is less than 0.01 m/s or zero.

$$\frac{d^2 T}{dt^2} = \frac{h_c A_c (T_{amb} - T) + h_r A_r (T_{amb} - T)}{m C_p} \rightarrow \text{fire or natural gas combustion and}$$

$$\mu = \frac{1.45 \times 10^{-4}}{1 + 0.000145 T} \rightarrow \text{air viscosity and } \mu = 1.78 \times 10^{-4} \text{ Pa}\cdot\text{s} \rightarrow \text{flow is turbulent}$$

ANSI convergence were converged with respect to the convergence criteria by default of FLUENT (shown in Fig.3).

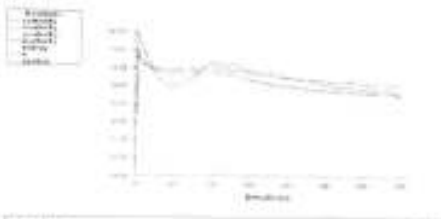


Fig. 3 Residuals. 100 iterations reach (within 0.1% convergence) (10^-3 continuity, maximum residual: 3.74e-05)

Velocity distribution inside of the RSSC is shown in Fig. 4. The highest velocity is located at the ventilating side.

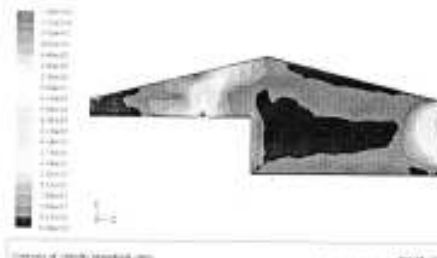


Fig. 4 Contour of velocity (m/s) from direction 4 at plane B1

Temperature distribution inside of the RSSC is shown in Fig. 5. The highest temperature takes place at the surface of the plane B1 and plane B2. These plane surfaces area are the outlets of hot-airflow to the RSSC.

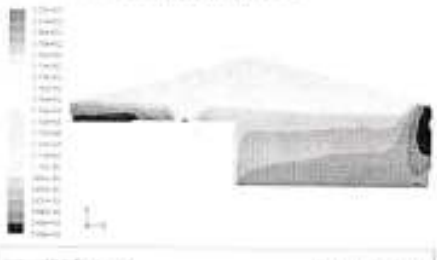


Fig. 5 Contour of Temperature (K) from direction 4 at plane B1

Smoke particle trajectory is shown in Fig. 6.



Fig. 6 Smoke particle trajectory (with follow flow B1 and B2) (view 200 m)

Table 1 Comparison between measurement and simulation results

Parameters	Velocity (m/s)		Temperature (K)	
	Min	Max	Min	Max
U	0.00	0.01 (0.01)	30.00	30.00
V	0.00	0.00 (0.01)	30.00	30.00
W	0.00	0.00 (0.00)	30.00	30.00
Ux	0.00	0.00 (0.00)	30.00	30.00
Uy	0.00	0.00 (0.00)	30.00	30.00
Uz	0.00	0.00 (0.00)	30.00	30.00
T	29.00	32.00 (32.00)	30.00	30.00
Tx	29.00	32.00 (32.00)	30.00	30.00
Ty	29.00	32.00 (32.00)	30.00	30.00
Tz	29.00	32.00 (32.00)	30.00	30.00

4. Discussion and Conclusion

It flow air (smoke, smoke particles) from the smoking place mainly flow ventilating side to the ventilating side.
 The Gaussian Plume Model of FLUENT can apply to show the response of the particles.
 Conclusions from measurement and simulation:
 - Results between CFD Simulate and Measurement are in good agreement.
 - Location of the highest temperature measurement and simulation is at the ventilating side.
 - Location of the highest temperature measurement and simulation is at the ventilating side.
 - Higher velocity is needed.

References

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 M. Farnach, P. Takawati, "CFD study of flow in natural rubber smoking-room: 1 Validation with the present smoking-room", *Applied Thermal Engineering*, vol. 26, pp. 2113-2121

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