

Abstract

Flour-based paints are eco-friendlier options than traditional paints, but they can experience cracking as water evaporates. Our study proposed that with addition of propylene glycol, water loss could be minimized. This study tested the effect of propylene glycol concentration on moisture retention and mass loss in flour-based mixtures. We mixed flour (50g), water (25g), and propylene glycol by w/w from 0.5% to 20% and they were observed over a 5-day period. Mass and moisture content loss was measured daily. Overall, higher propylene glycol concentrations led to lower mass loss, and on day 5, 0.5% propylene glycol exhibited highest mass loss while 20% propylene glycol exhibited the lowest mass loss. On day 5, 0.5% propylene glycol concentration demonstrated the greatest negative change in moisture content, while 20% demonstrated the lowest negative change in moisture content, with around 41.6% moisture content remaining in the mixture. These results suggest that higher concentrations of propylene glycol may overall improve water retention and mass preservation, potentially due to the interactions between propylene glycol and water.

Introduction

Acrylic and traditional paints contain hazardous materials that can cause environmental problems.¹ An alternative to such synthetic paints is flour-based paints, created with a mixture of flour, water, and dye. However, they are prone to cracking and destabilizing due to poor moisture retention. Propylene glycol (PG), a transparent, odorless humectant, is used in products where moisture retention is crucial.² Its OH group interacts with water through hydrogen bonding, suggesting that propylene glycol may retain moisture in flour-based mixtures and reduce cracking.³ **We hypothesize that an optimal concentration of propylene glycol exists, which maximizes moisture retention and minimizes mass loss.**

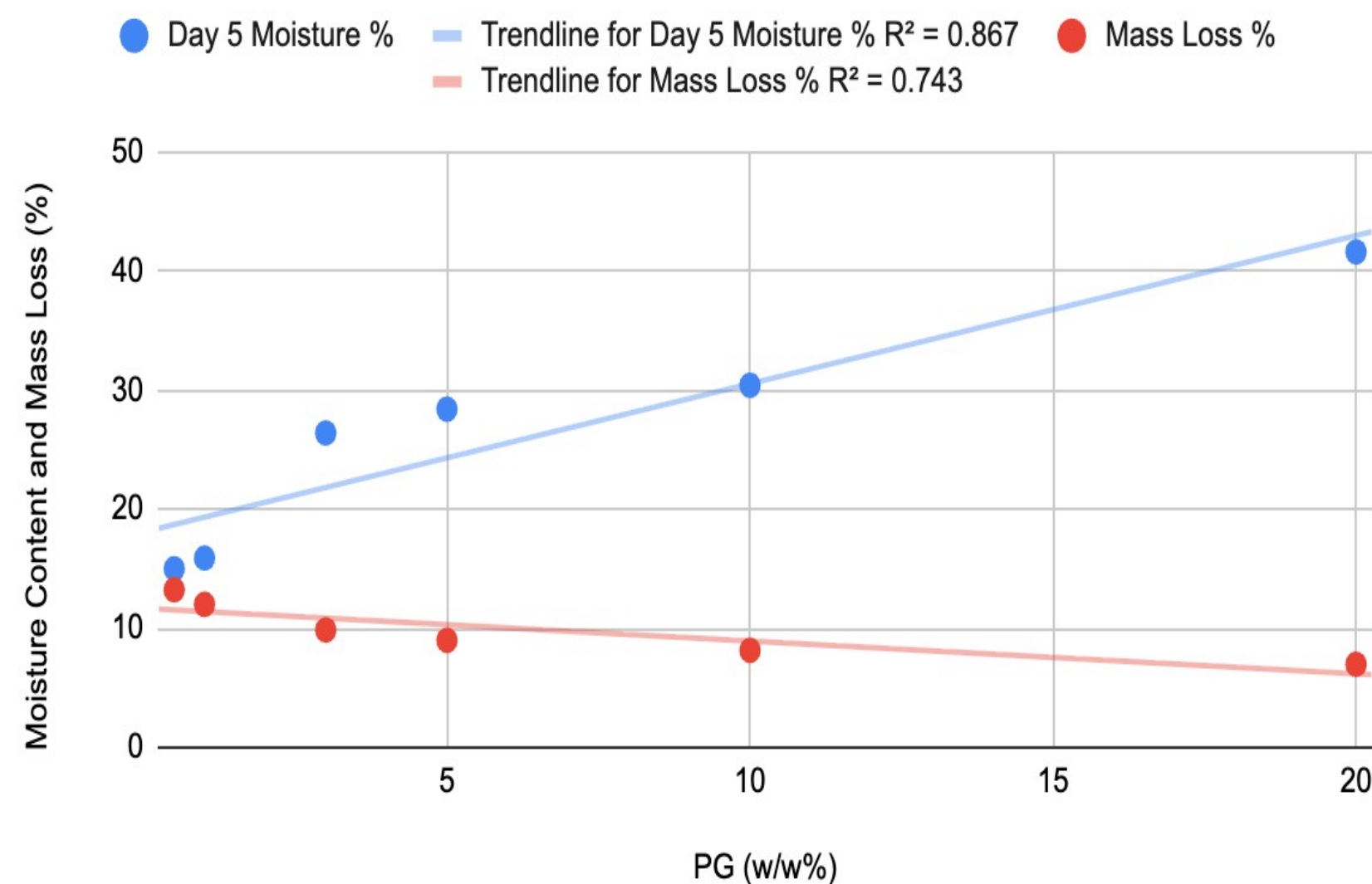
Methods

Procedure:
1: Dissolve the different concentrations of PG in 25 grams of water, each in its own separate container.
2: Mix 50 grams of flour into each container.
3: Weigh the initial weight of each container.
4: Leave the samples untouched and expose them to room temperature
5: Weigh the samples every 24 hours for the next 5 days with the digital scale and moisture meter; this will test evaporation and loss of moisture.

	Day 1	Day 2	Day 3	Day 4	Day 5
1%					
3%					
5%					
10%					
20%					

Moisture %	Day 1	Day 2	Day 3	Day 4	Day 5
PG 0.5% w/w	55.3%	37.7%	24.5%	17.2%	15.0%
PG 1% w/w	53.0%	41.3%	26.1%	21.8%	15.9%
PG 3% w/w	58.0%<	51.8%	35.6%	30.8%	26.4%
PG 5 % w/w	58.0%<	54.9%	39.6%	33.3%	28.4%
PG 10 % w/w	58.0%<	55.2%	41.8%	36.4%	30.4%
PG 20% w/w	58.0%<	55.5%	53.7%	47.9%	41.6%

Moisture Content and Mass Loss of PG Samples



Results

- 20% PG exhibited the lowest mass loss and retained the most moisture (41.6%) by Day 5.
- 0.5% PG exhibited the highest mass loss and retained the least moisture (15%) by Day 5.
- Visual cracks were inversely proportional to PG concentration; higher PG mixtures formed smaller and fewer cracks

Mass	Day 1	Day 2	Day 3	Day 4	Day 5
PG 0.5% w/w	75.25g	72.27g	69.65g	67.38g	65.29g
PG 1% w/w	75.5g	72.91g	70.39g	68.28g	66.43g
PG 3% w/w	76.5g	74.05g	72.2g	70.56g	68.96g
PG 5 % w/w	77.5g	75.09g	73.29g	71.79g	70.53g
PG 10 % w/w	80.00g	77.70g	76.00g	74.62g	73.48g
PG 20% w/w	85.00g	82.83g	81.31g	80.07g	79.07g

Conclusion

Our experiments supports our hypothesis that propylene glycol improves moisture retention and lowers cracking in flour-based mixtures as concentration increases. However, our experiment did not support that it was OH bonds that caused the trend. Also, 20% w/w propylene glycol may not have been optimal, as our testing could only go up to 20% w/w propylene glycol. Future research should test whether the number of available hydrogen bonds caused the moisture retention and increased propylene glycol concentrations beyond 20%.

Discussion

Our initial range of propylene glycol mixture concentrations was insufficient to determine the ideal concentration at which water retention is maximized. Our linear regressions for moisture content percentages across different propylene glycol concentrations on day 5 were $1.36x + 16.82$, which leads us to believe that water retention should grow as we continue to increase its concentration. The linear regression for mass loss percentages across different propylene glycol concentrations on day 5 was $-0.27x + 11.89$, which suggests that mass loss should continue to decrease as the concentration of propylene glycol is increased.

Over time, mixtures showed notable visible changes at the surface. Generally, all mixtures formed more visible cracks on the top of their surfaces over time. The size and number of cracks were inversely proportional to the w/w percentage of the mixture, meaning mixtures with higher propylene glycol concentration formed smaller and fewer cracks.

References

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Crupi, V., Longo, F., Majolino, D., & Venuti, V. (2006). The hydrogen-bond network in propylene-glycol studied by Raman spectroscopy. *Journal of Molecular Structure*, 790(1), 141–146. <https://doi.org/10.1016/j.molstruc.2005.10.052>