# Polymer-Based Materials Investigation

## An unusual threat to flight safety – A Case Study.

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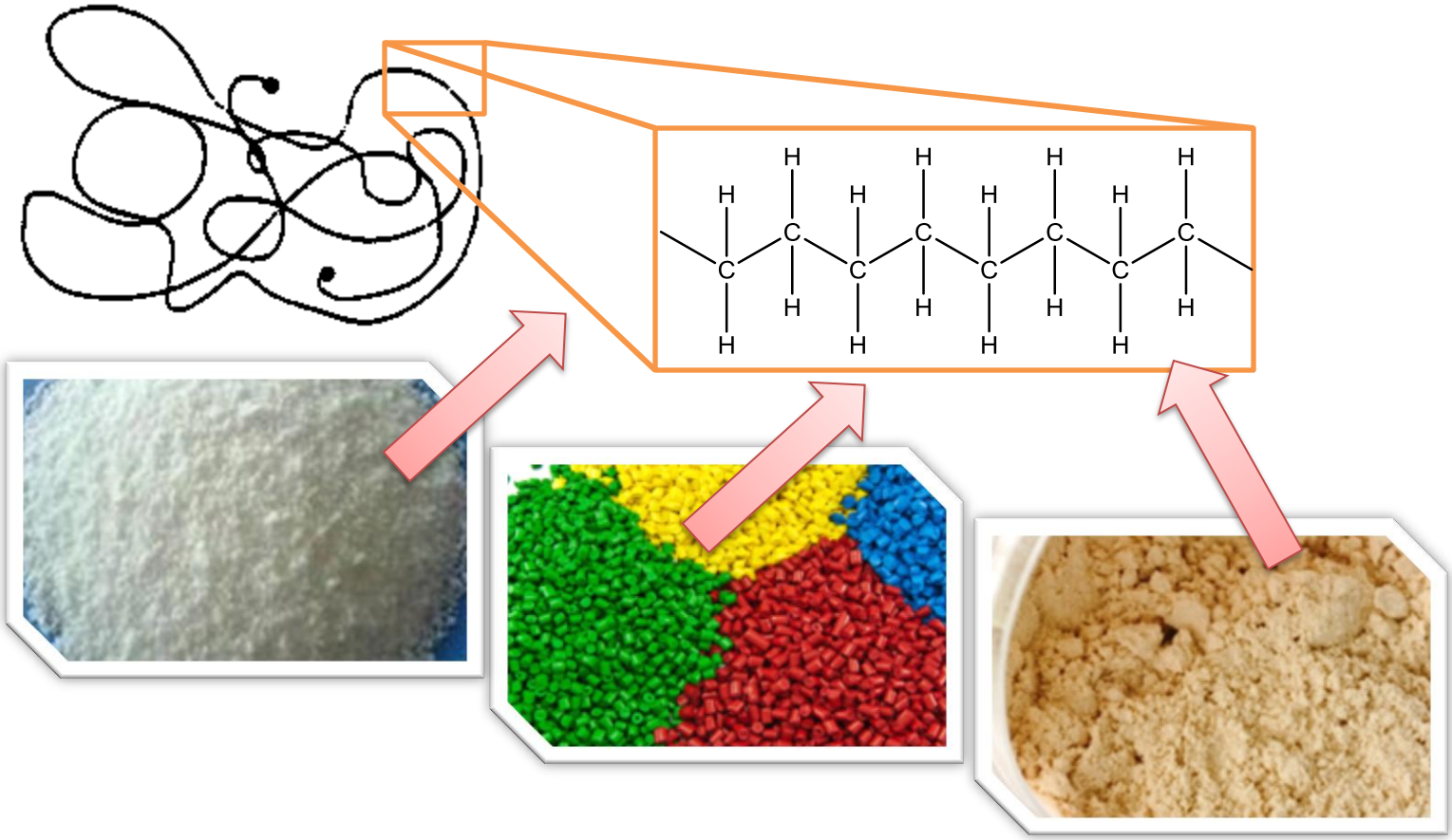
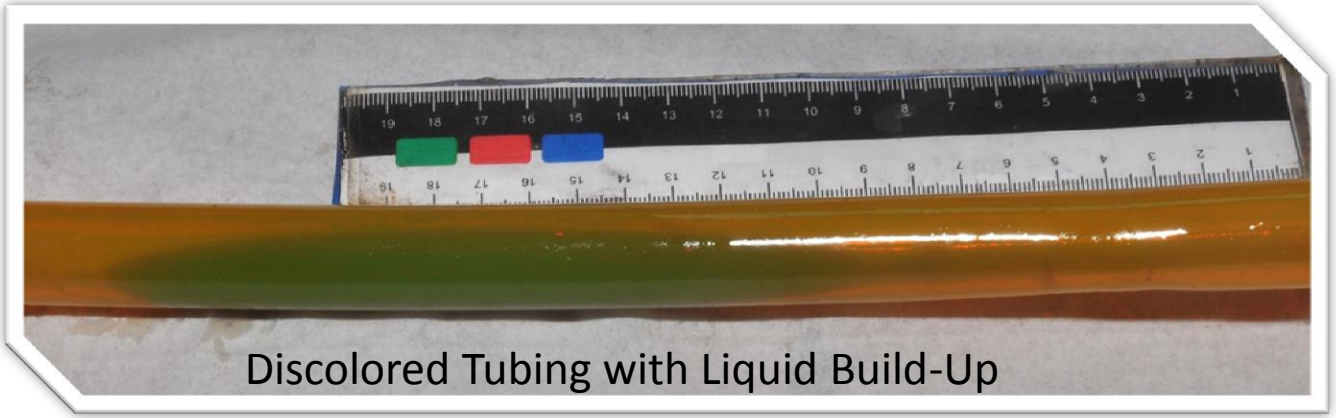
# What is a Polymer?

- Molecular scale long chains.
- Made of a lot of different components.



# Background

- What we saw:



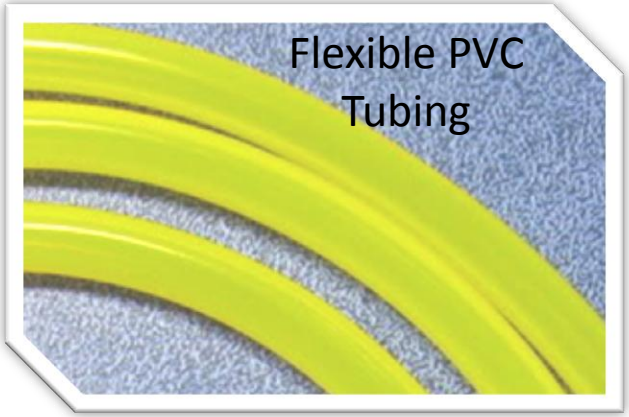
Discolored Tubing with Liquid Build-Up

Tubing for Comparison

"Honey"

# Background

- What we put in:





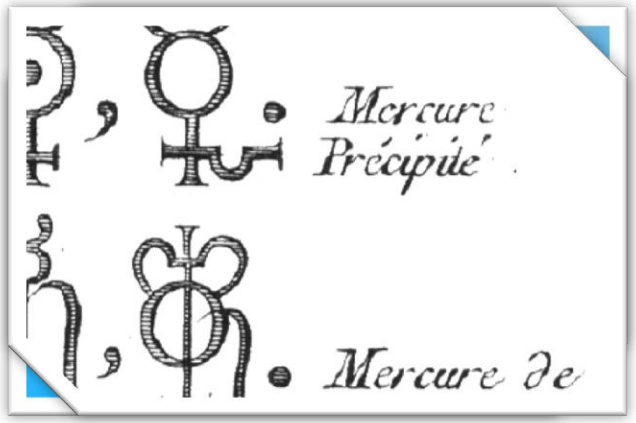
- What probably didn't happen:
  - Faulty Manufacture.
  - Natural ageing phenomenon.

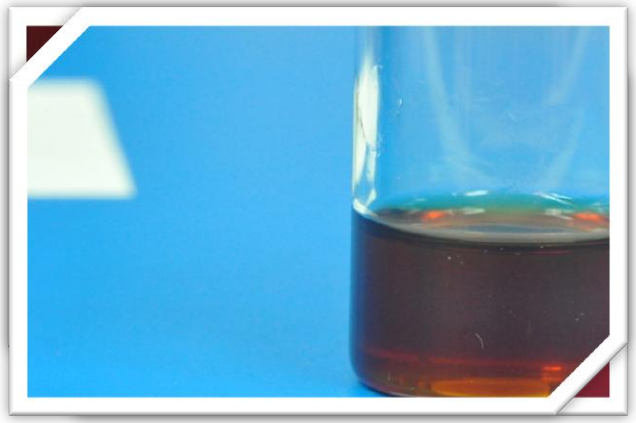
# Hypothesis

- An external substance caused the system to become contaminated;

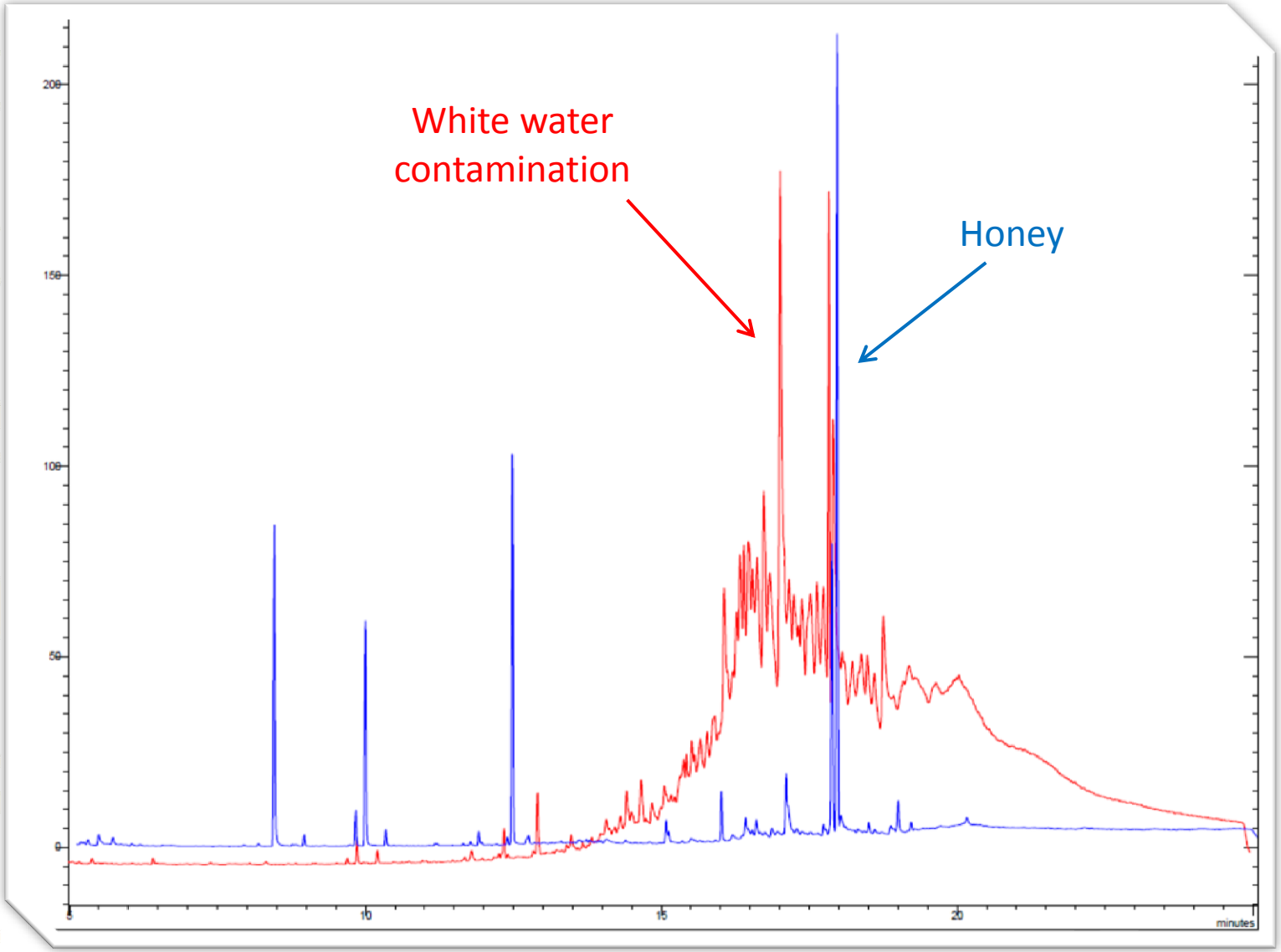
OR

- The oil had undergone some process or reaction, changing into “honey”.



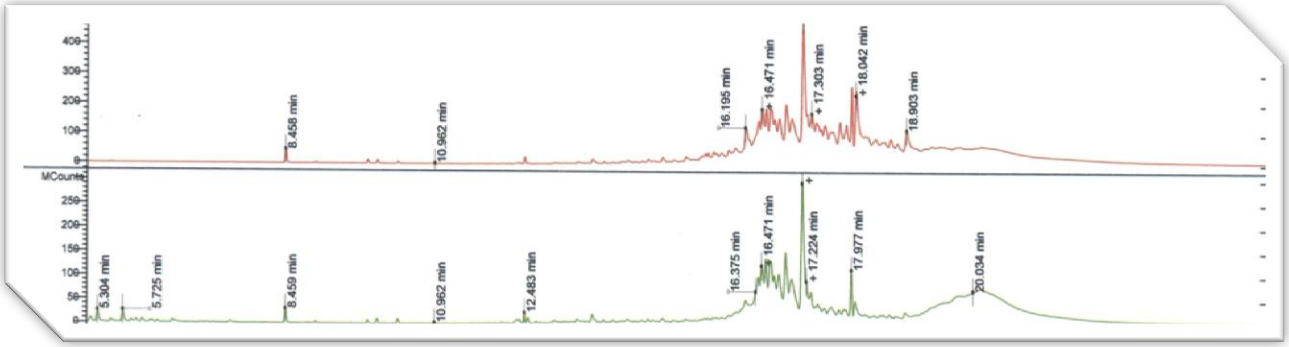



# Contamination?



# Contamination?

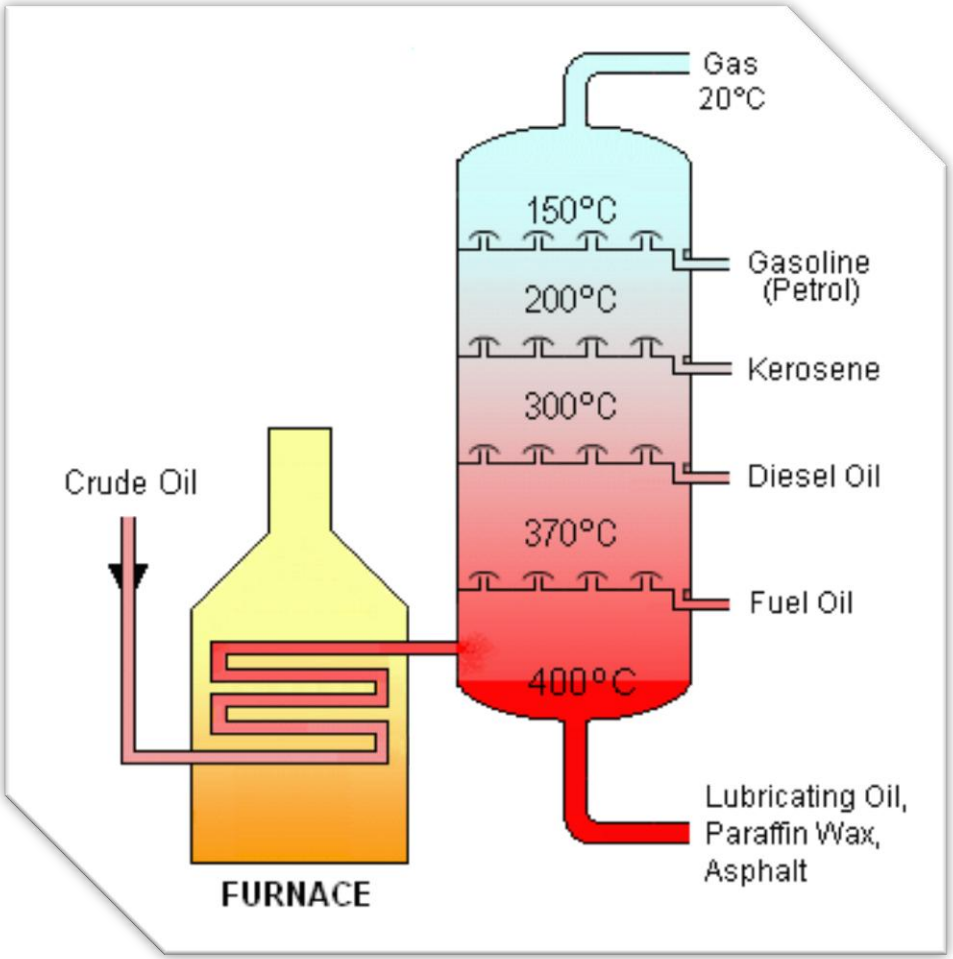
- Other contaminants?




- Similar spectra, but no such phenomenon arose.

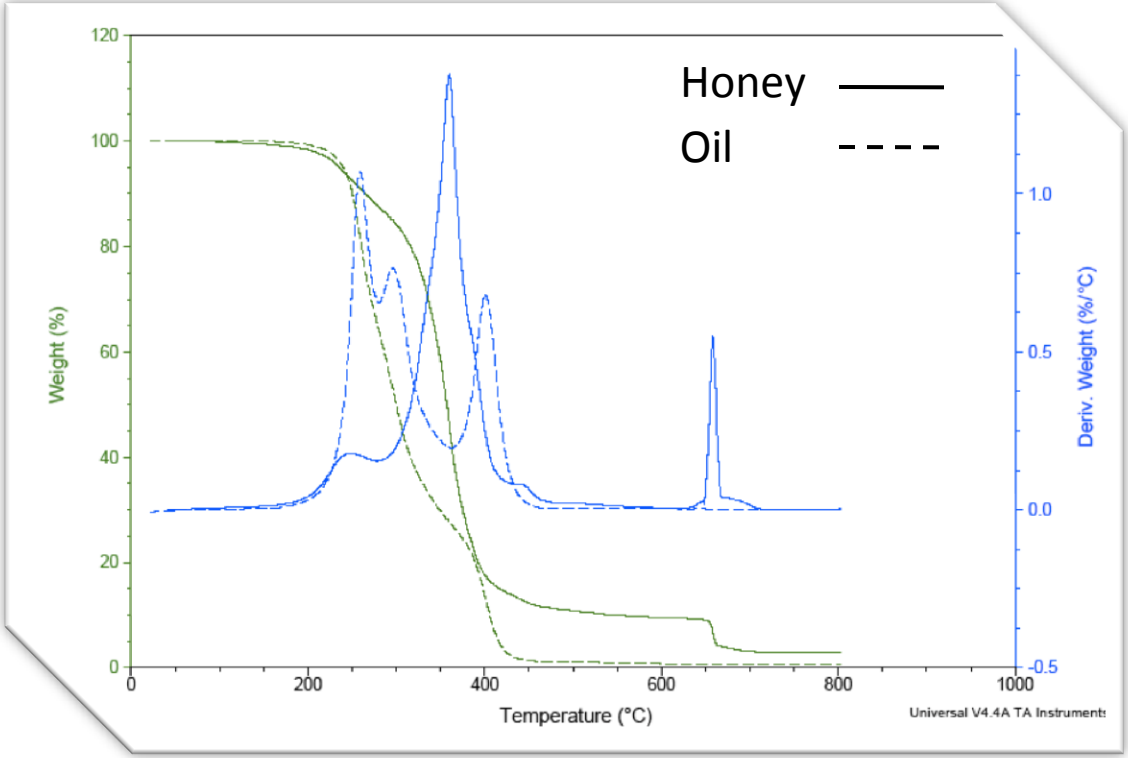
# What is Oil?

- A mixture.
- Has fractions.



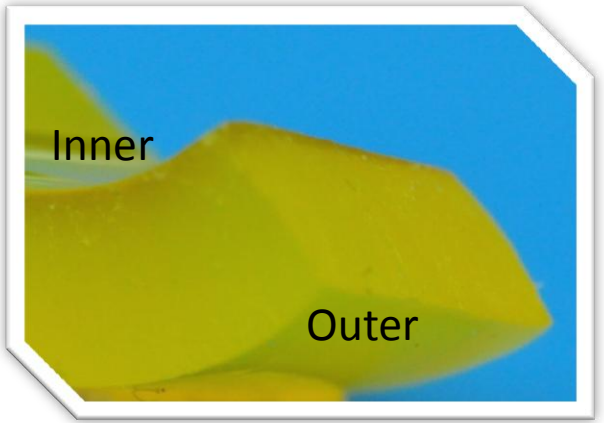
# Process?

- Separation of fractions?
- Heavier fractions grouped together to form the “honey”?



# Intermediate Conclusions

- Inner and outer surfaces of the affected tubing are different from each other.
  - Inner surface shares characteristics with “honey”.
  - Outer surface is similar to an unaffected tubing.



# Intermediate Conclusions

- "Honey" has both similarities and differences regarding the fresh oil.
- It is also similar to an affected pipe.
- No oil had been found in the affected pipe.

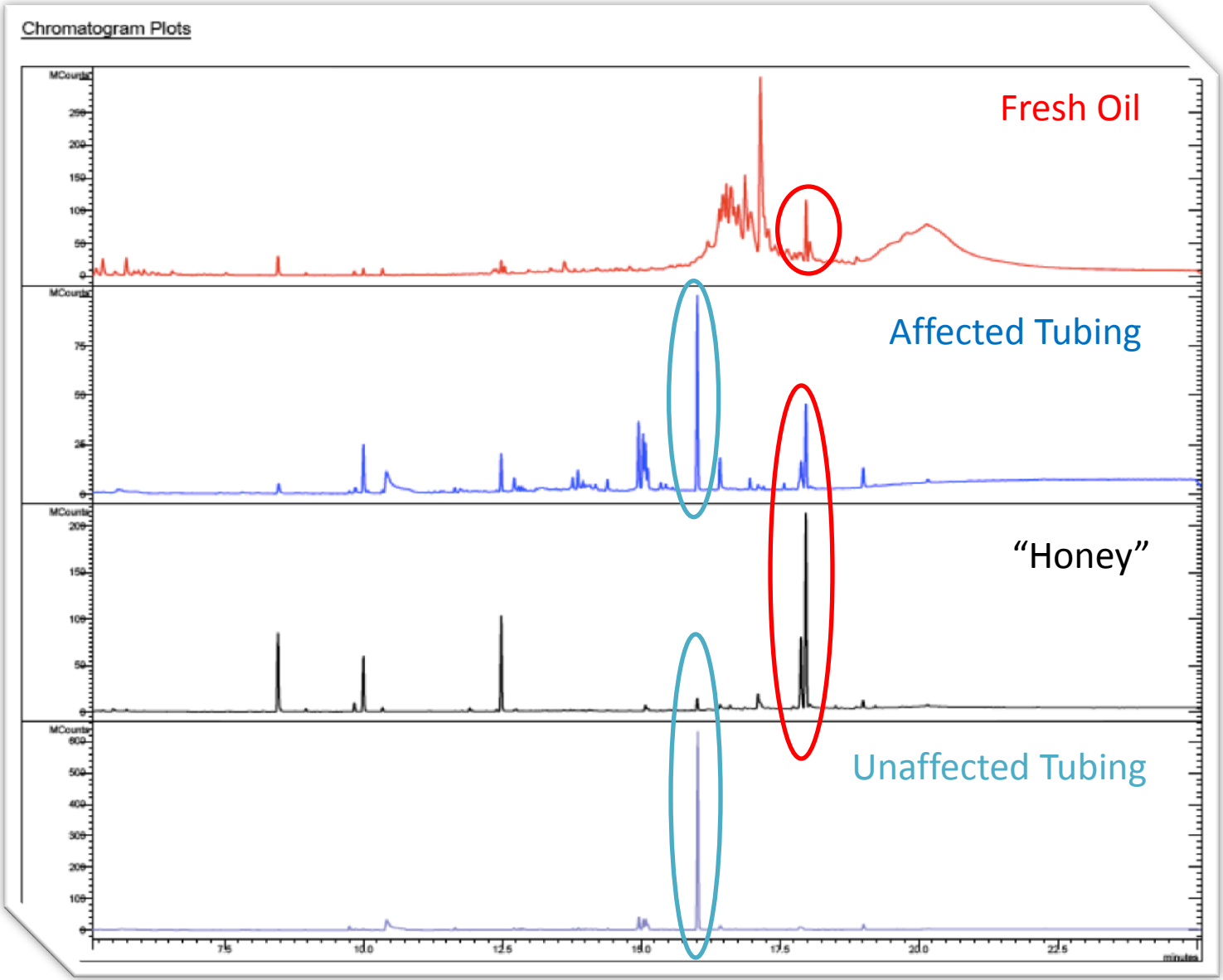
# Intermediate Conclusions

- There are components from both the oil as well as the tubing in the “honey”!

# Further Analyses

- The “honey” was found to contain **components** of both fresh oil and the tubing, but neither substance was found in its entirety in it: Every molecule could be attributed either to the oil or to the tubing.
- The same thing could be said about the affected, discolored tubing.

# Further Analyses

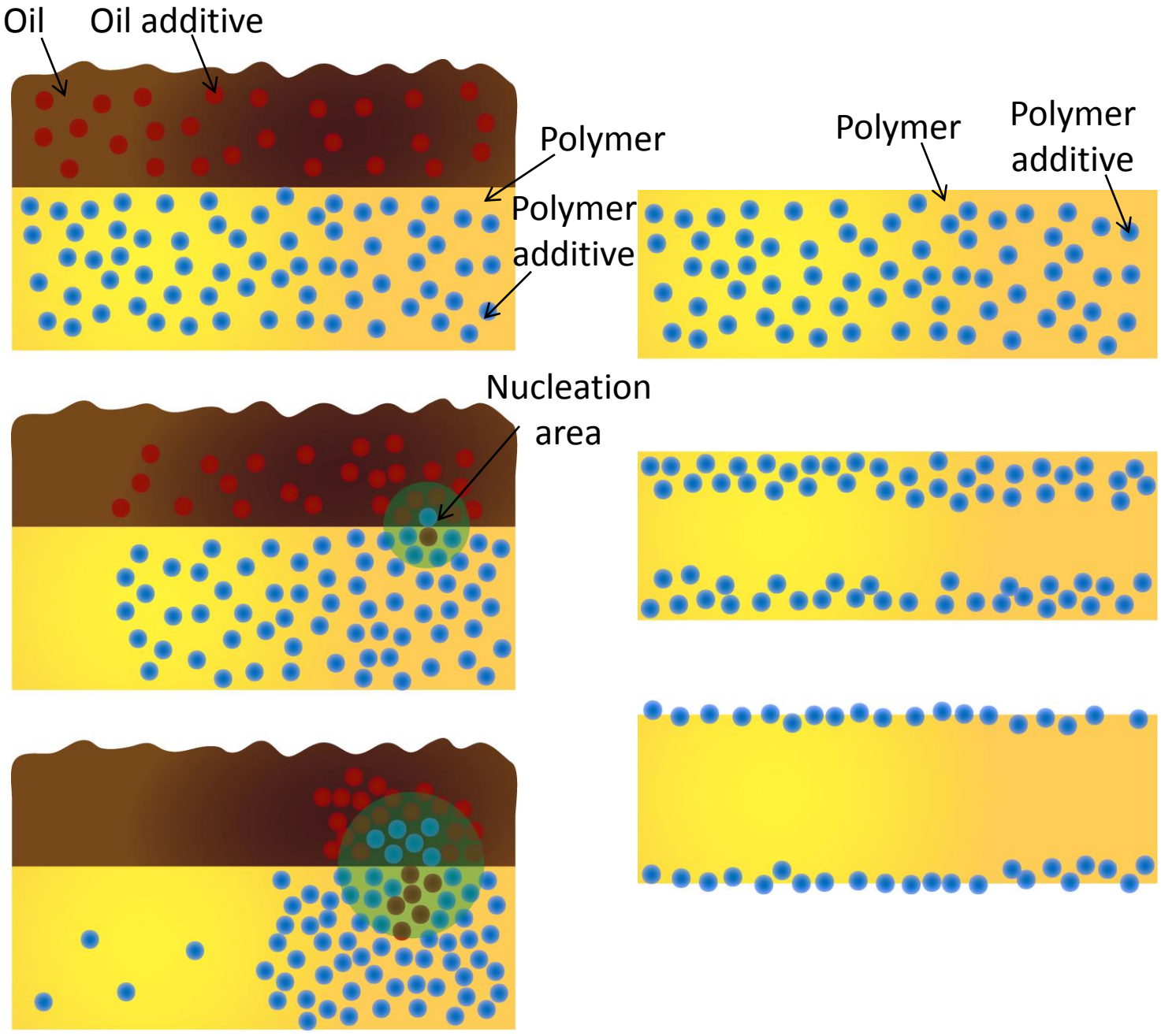


# Conclusion

- Diffusion!
- Components in the oil and in the tubing with similar chemical properties attract each other.
- Their diffusion towards each other began an accumulation.
- This accumulation manifested as “honey” in the macro scale.

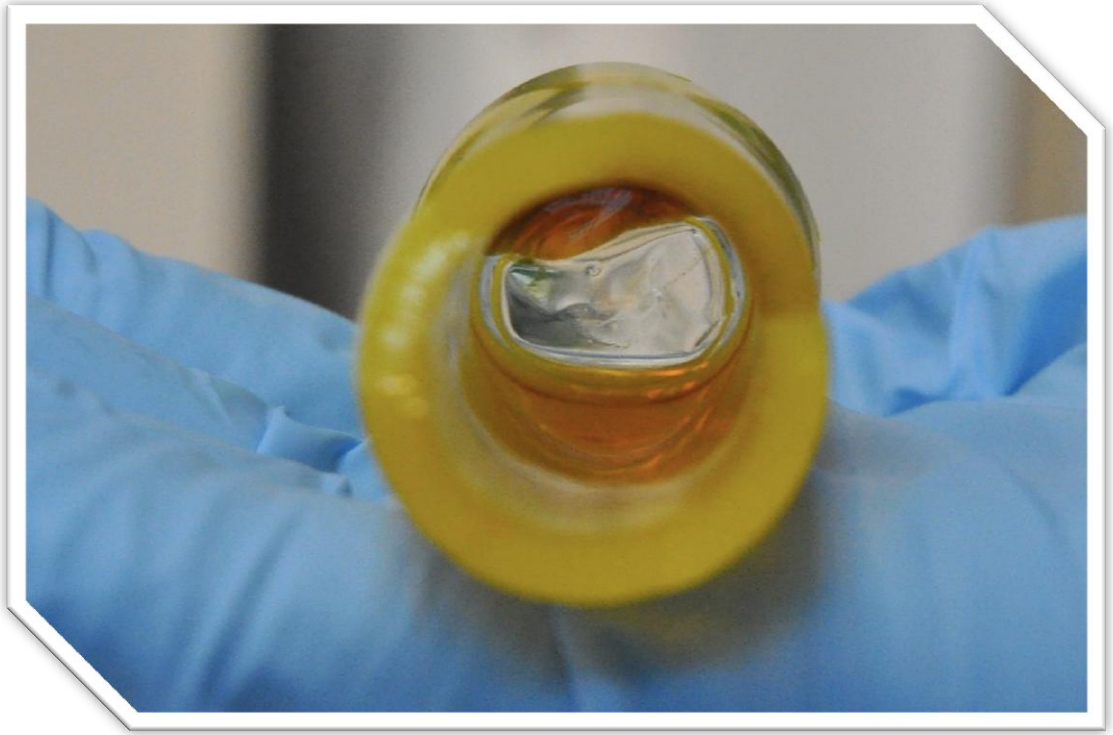
# But Wait!

- Isn't this blooming?
- No, because:
  - Much faster than blooming.
  - Non-uniform.
- Why is this an "unusual threat to flight safety"?


Oil
Oil additive
Polymer
Polymer additive
Nucleation area
Polymer
Polymer additive
Accumulation Process
Blooming Process

# Conclusion

- This conclusion was proved by our laboratory by synthesizing the “honey” using the same materials.



# Thank You!