

# Processing of red blood cells for preservation and storage using spray drying

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## OVERVIEW

**Objective:** To evaluate the feasibility of spray drying red blood cells (RBCs) for long-term preservation and storage.

### Methods:

- RBCs were exposed to several temperatures. RBC hemolysis was measured using a spectrophotometer
- RBCs were dried in humidity-controlled containers. Water content was measured using thermo-gravimetric analysis (TGA)

**Results:** RBCs can withstand 50 °C for 10 seconds while maintaining  $\geq 80\%$  viability. RBCs dried under 20% relative humidity (RH) should result in 5 wt% water content.

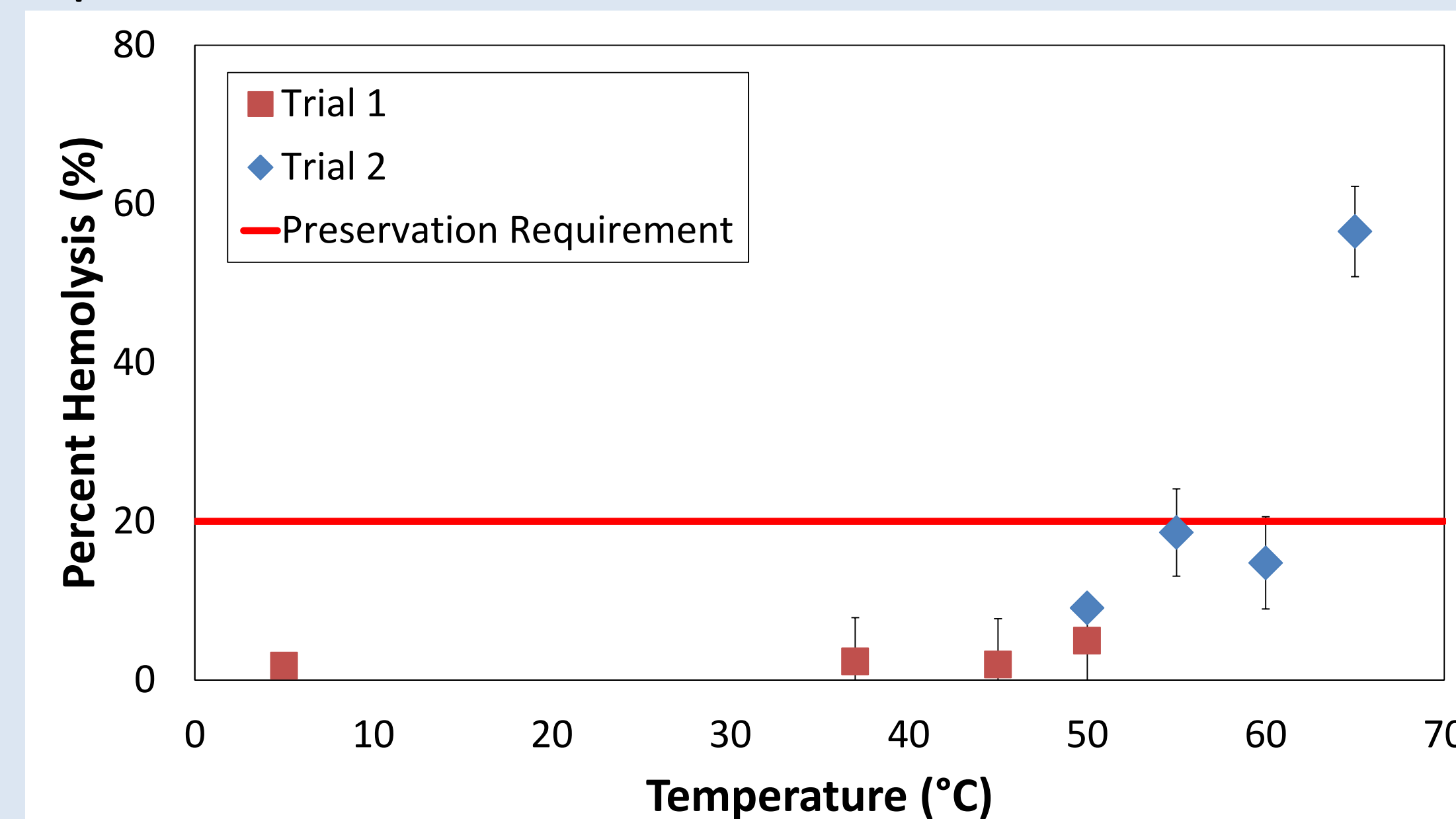
## EXPERIMENT 1: Determining $T_{in}$

**Objective:** To determine the maximum solution temperature RBCs can withstand while maintaining 80% viability.

### Methods:

- RBC solutions at 5 °C brought to 37-65 °C for 10 seconds and returned to 5 °C
- Percent hemolysis measured using spectrophotometer

**Results:** Hemolysis was minimal until exposure temperatures exceeded 50 °C. The highest temperature which met the preservation requirement of  $\geq 80\%$  viability was 50 °C to 95% confidence. The spray dryer should be designed so that this is the highest temperature that the RBCs experience.

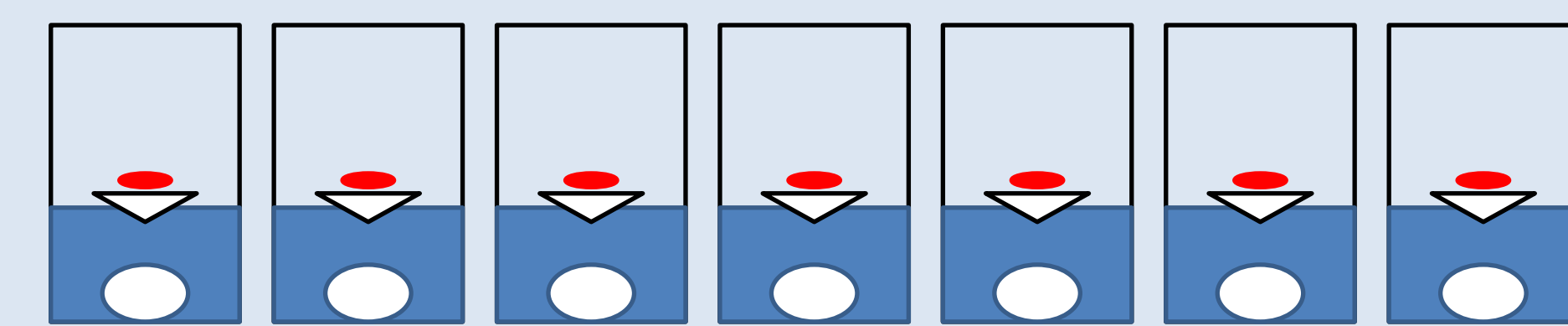


## EXPERIMENT 2: Determining %RH

**Objective:** Obtain 5 wt% water in dried RBCs

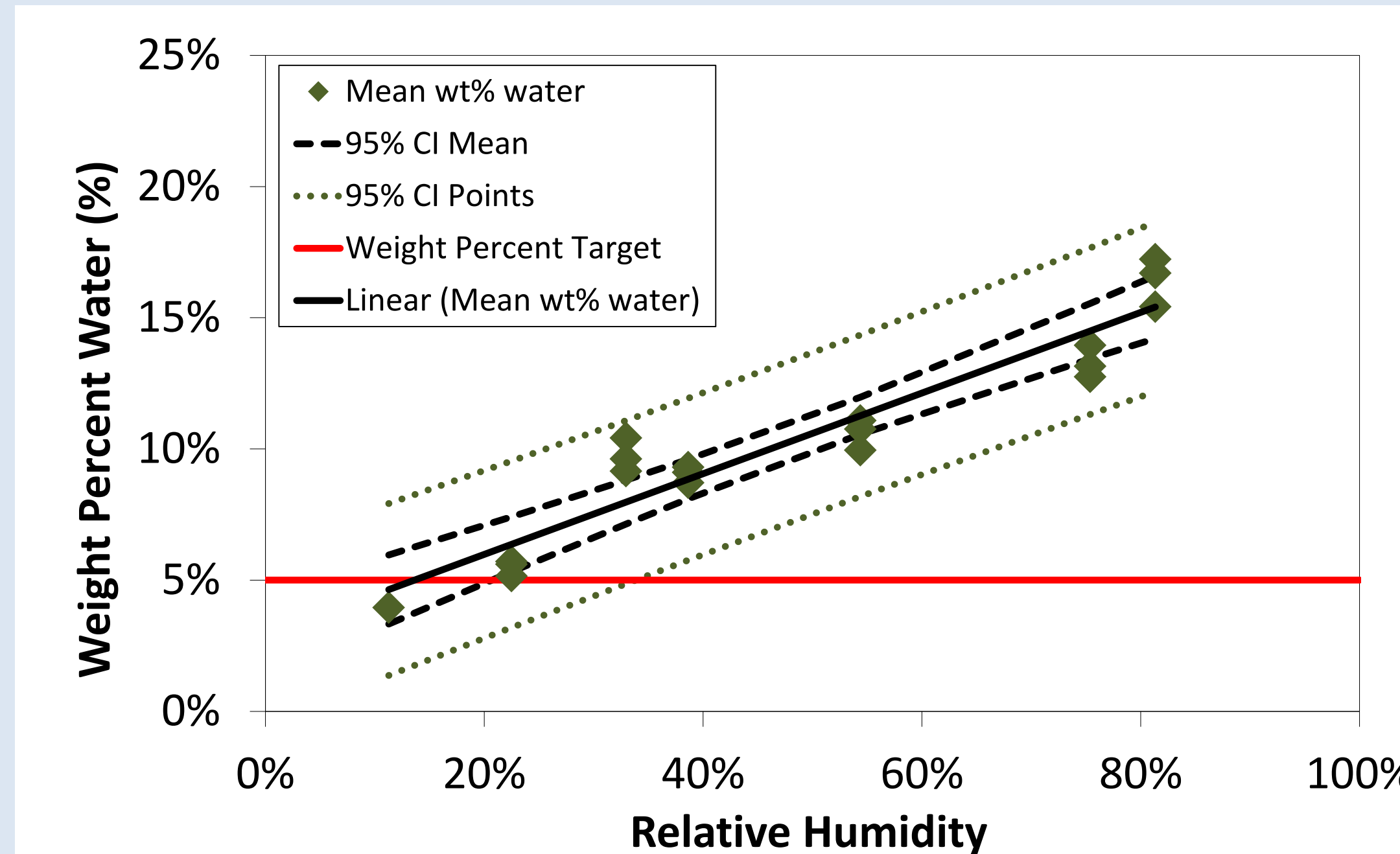
**Methods:** RBC sealed in saturated salt solutions experiencing a range of RH

- Salt solutions were prepared in triplicate
- Drying completed after two weeks
- RBC moisture content was measured using TGA



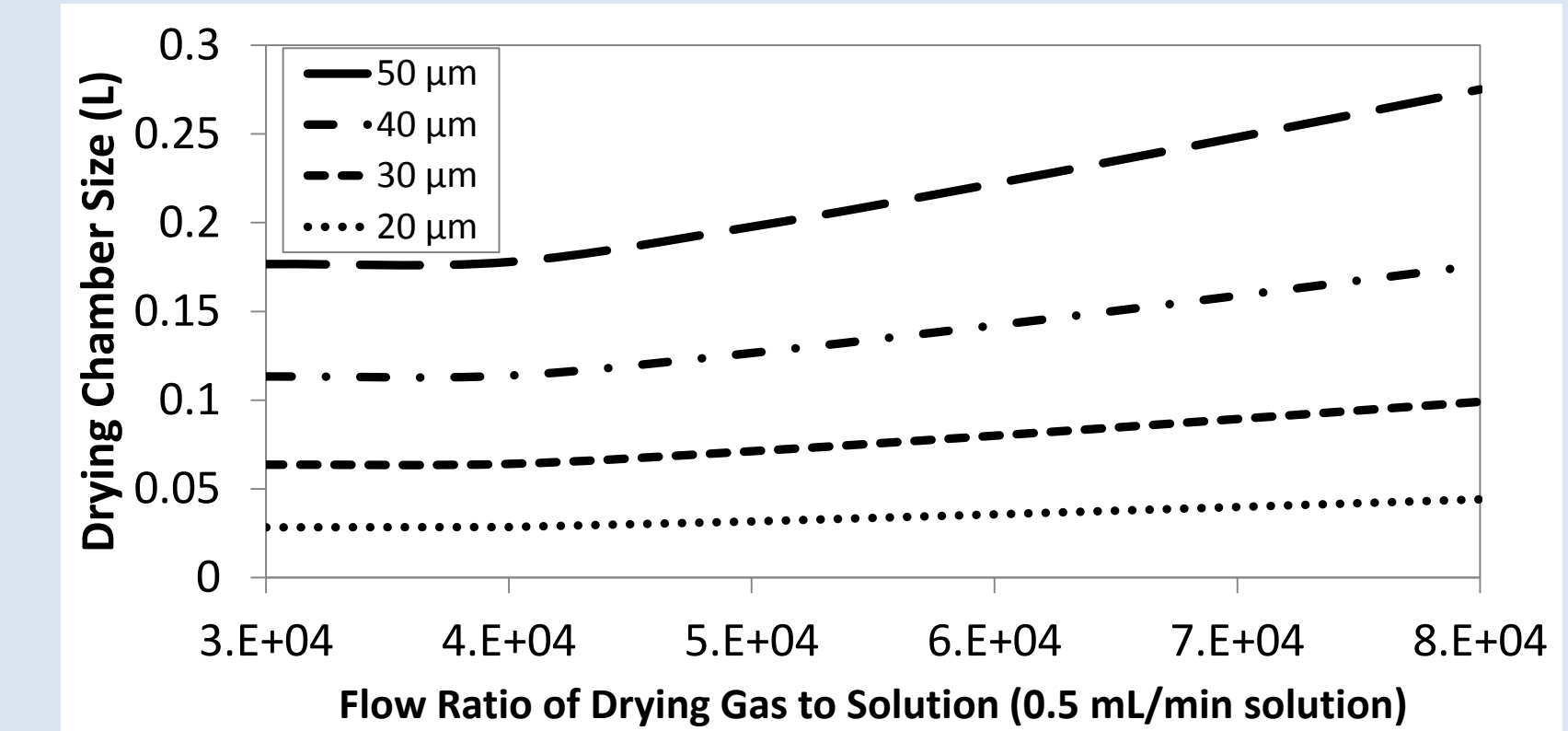
LiCl: 11% RH    CH<sub>3</sub>CO<sub>2</sub>K: 22% RH    MgCl<sub>2</sub>: 33% RH    K<sub>2</sub>CO<sub>3</sub>: 43% RH    Mg(NO<sub>3</sub>)<sub>2</sub>: 54% RH    NaCl: 75% RH    (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>: 81% RH

**Results:** 5 wt% water content target may be achieved when spray dryer outlet RH is 20%.

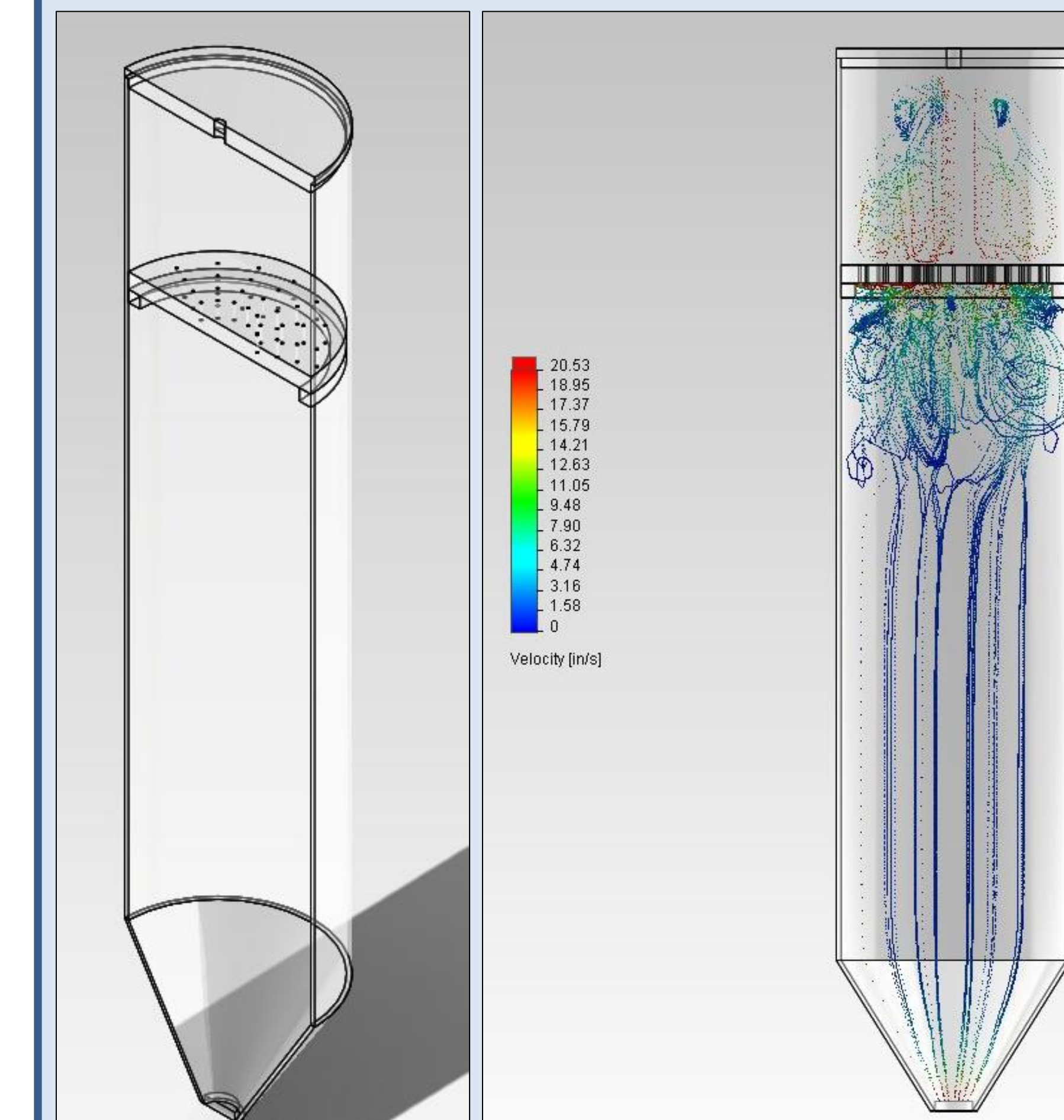


\*data and regression analysis is conducted for bound water regime

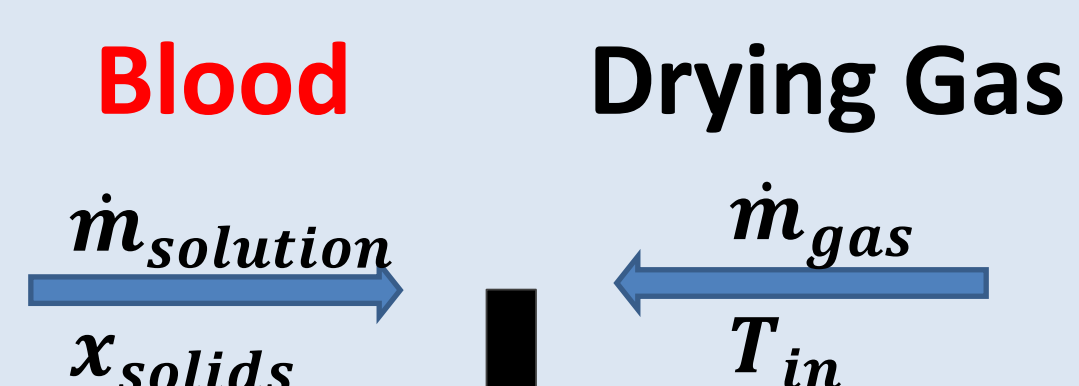
## SIZING DRYING UNIT: Kinetics



## DRYING CHAMBER DESIGN

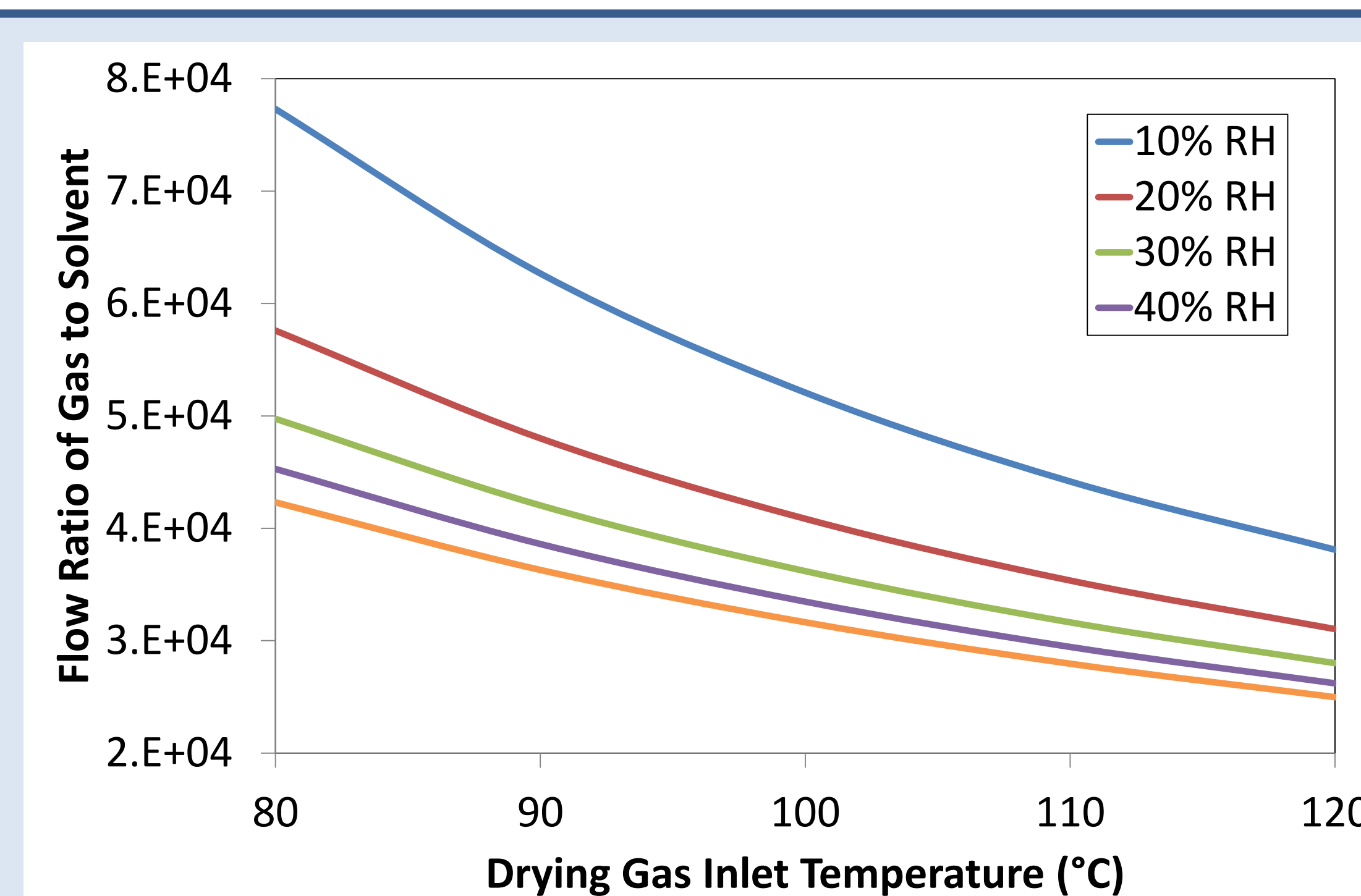


## SPRAY DRYING



### Degrees of Freedom Analysis

- 8 variables (+8)
- 3 M&E balances (-3)
- 3 fixed parameters:
  - $\dot{m}_{solution}$  (-1)
  - $x_{solids}$  (-1)
  - $x_{water}$  (-1)
- +2 degrees of freedom



**CONCLUSIONS:** Spray drying is a potentially viable operation for drying RBCs for long term storage and preservation.

### FUTURE WORK:

- Construct sealed drying chamber
- Evaluate flow pattern through different diffuser plate designs; optimize design for plug flow
- Conduct drying operation with parameters defined by experiments:  $T_{in} = 115^\circ\text{C}$  and flow ratio of gas to solution of 33,000
- Evaluate morphology of RBCs after drying

### ACKNOWLEDGEMENTS:

- Bend Research for spray nozzle
- Spray Systems Co. for providing nozzle documentation
- Nicolas Kraaz and Dr. Rochefort for use of TGA
- Dr. Kelly for use of spectrophotometer
- Dr. Philip Harding for project guidance
- Graduate students Ratih Lusianti and Allyson Fry for assistance with lab operations