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Laboratory Experimentation and Modeling of Installation Slope Impacts on Drain Water Heat Recovery Effectiveness

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Outline

- Introduction
- Research Goals
- Methods
- Results
- Conclusions

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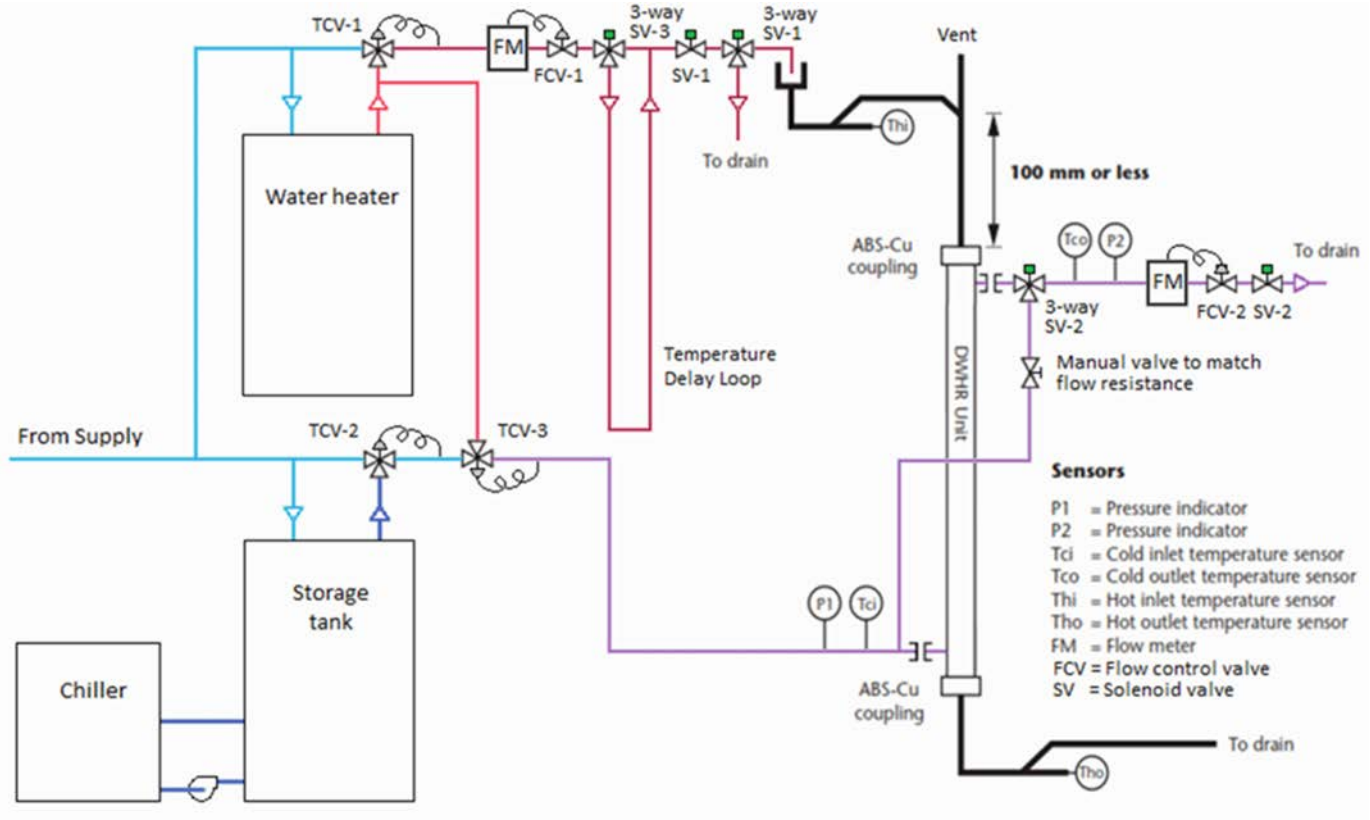
Introduction

- Drain water heat recovery (DWHR) now in Title 24, Part 6
  - Based on Canadian Standards Association (CSA) B55.1
    - Only applies to vertical DWHR devices
- Later…
  - International Association of Plumbing and Mechanical Officials (IAPMO) released IGC 346-2017
    - Applies to sloped DWHR devices
    - Test device at known angle, report angle on ratings sheet
- Now have ratings data for sloped DWHR devices
- What if installed at angle different from rating test?

Research Goals

- Test 2 sloped DWHR devices at 7 different angles
- Develop regressions => $\varepsilon = f(\theta)$
- Develop a generic regression

Methods - Testing



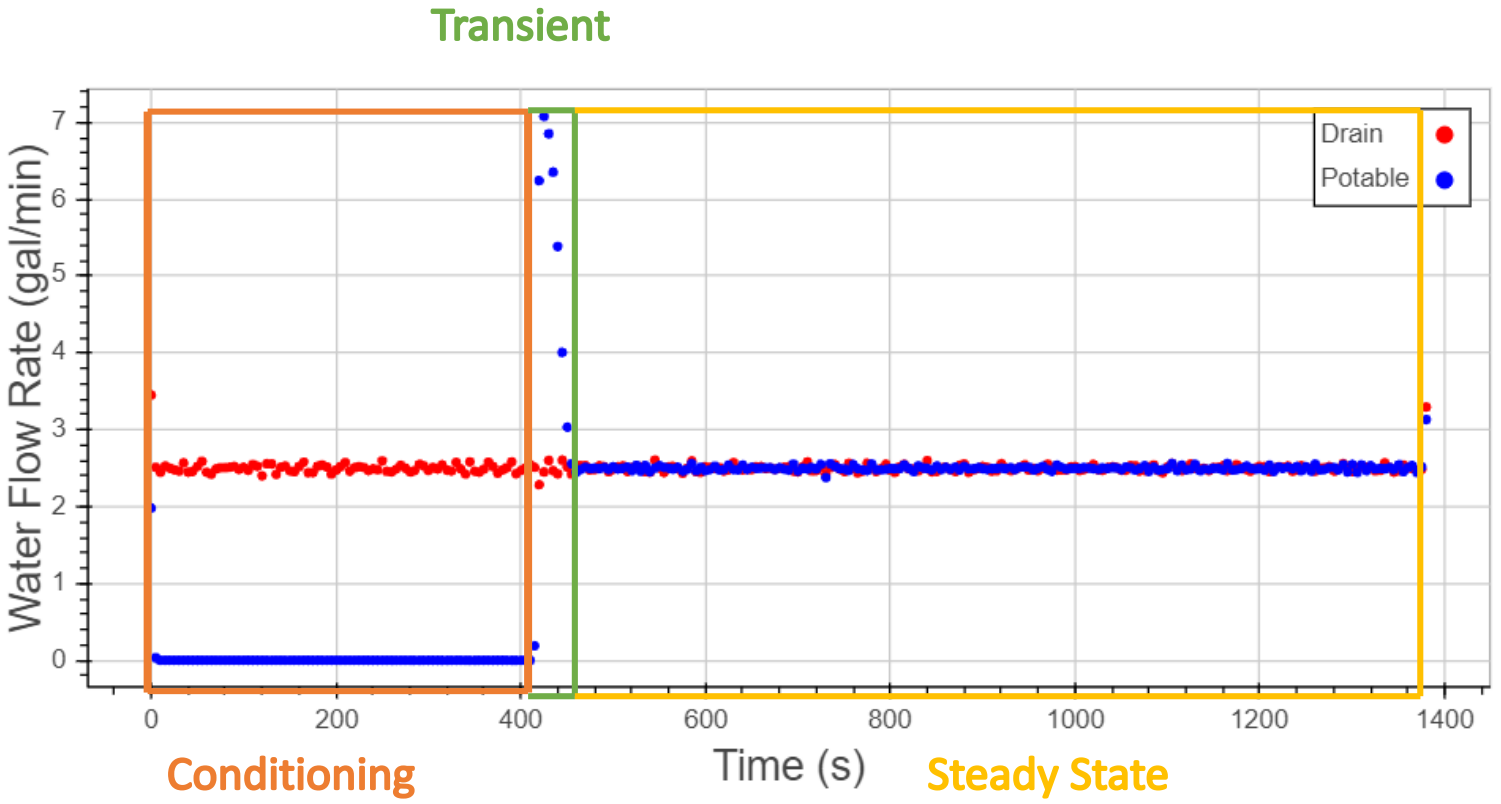
Unit	Length (in)	Width (in)
H-DWHR 1	56	4.57
H-DWHR 2	66	4.57

Methods - Testing

Methods - Testing

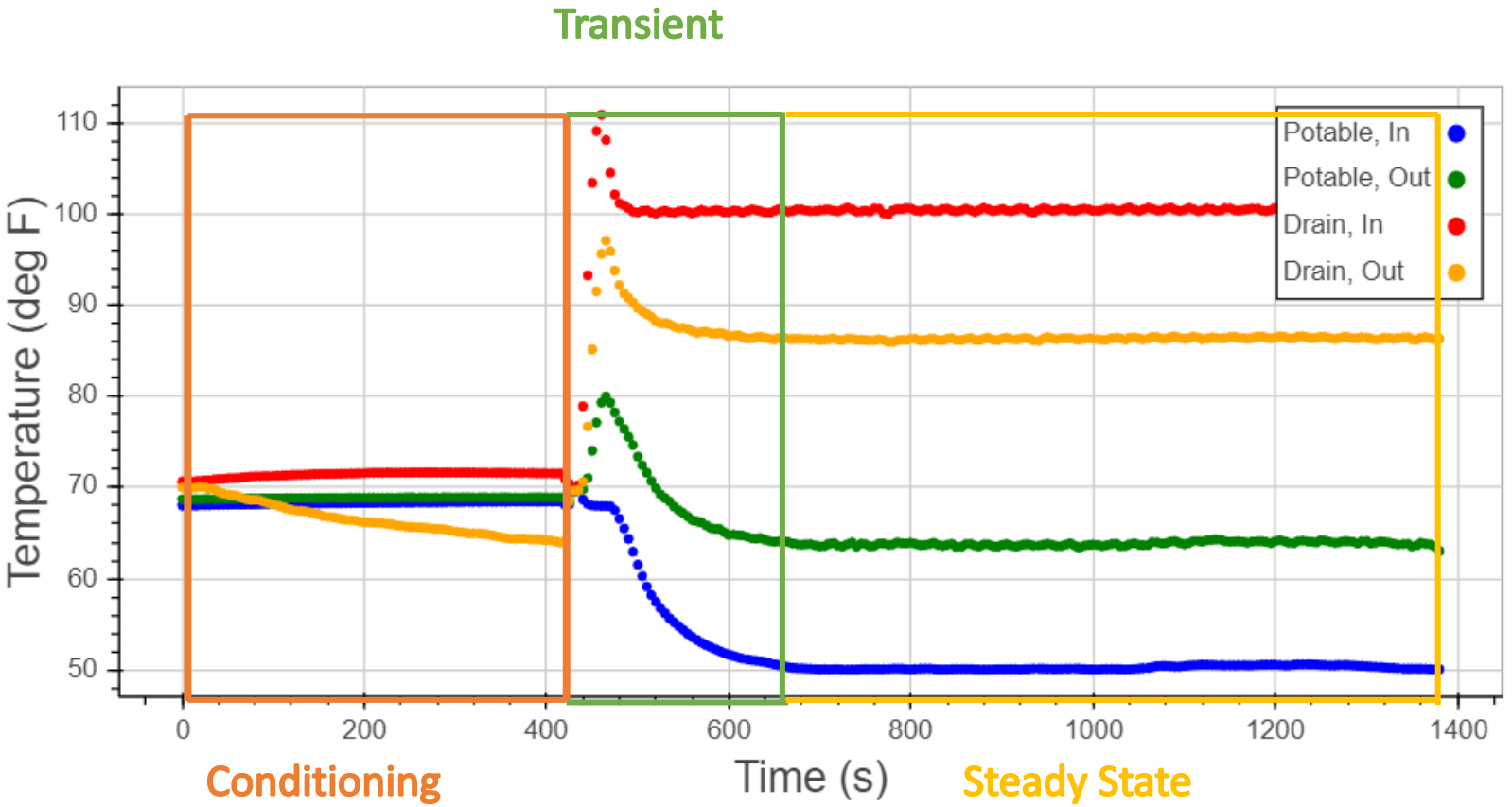
DWHR Unit	Slope (deg)	Drain-Side Inlet Temperature (°F)	Cold-Side Inlet Temperature (°F)	Flow Rate, Both Sides (gal/min)
55"	**3**	100.4	50	2.5
55"	**6**	100.4	50	2.5
55"	**10**	100.4	50	2.5
55"	**14**	100.4	50	2.5
55"	**18**	100.4	50	2.5
55"	**22**	100.4	50	2.5
55"	**26**	100.4	50	2.5
55"	**30**	100.4	50	2.5
66"	**3**	100.4	50	2.5
66"	**6**	100.4	50	2.5
66"	**10**	100.4	50	2.5
66"	**14**	100.4	50	2.5
66"	**18**	100.4	50	2.5
66"	**22**	100.4	50	2.5
66"	**26**	100.4	50	2.5
66"	**30**	100.4	50	2.5

Methods - Analysis

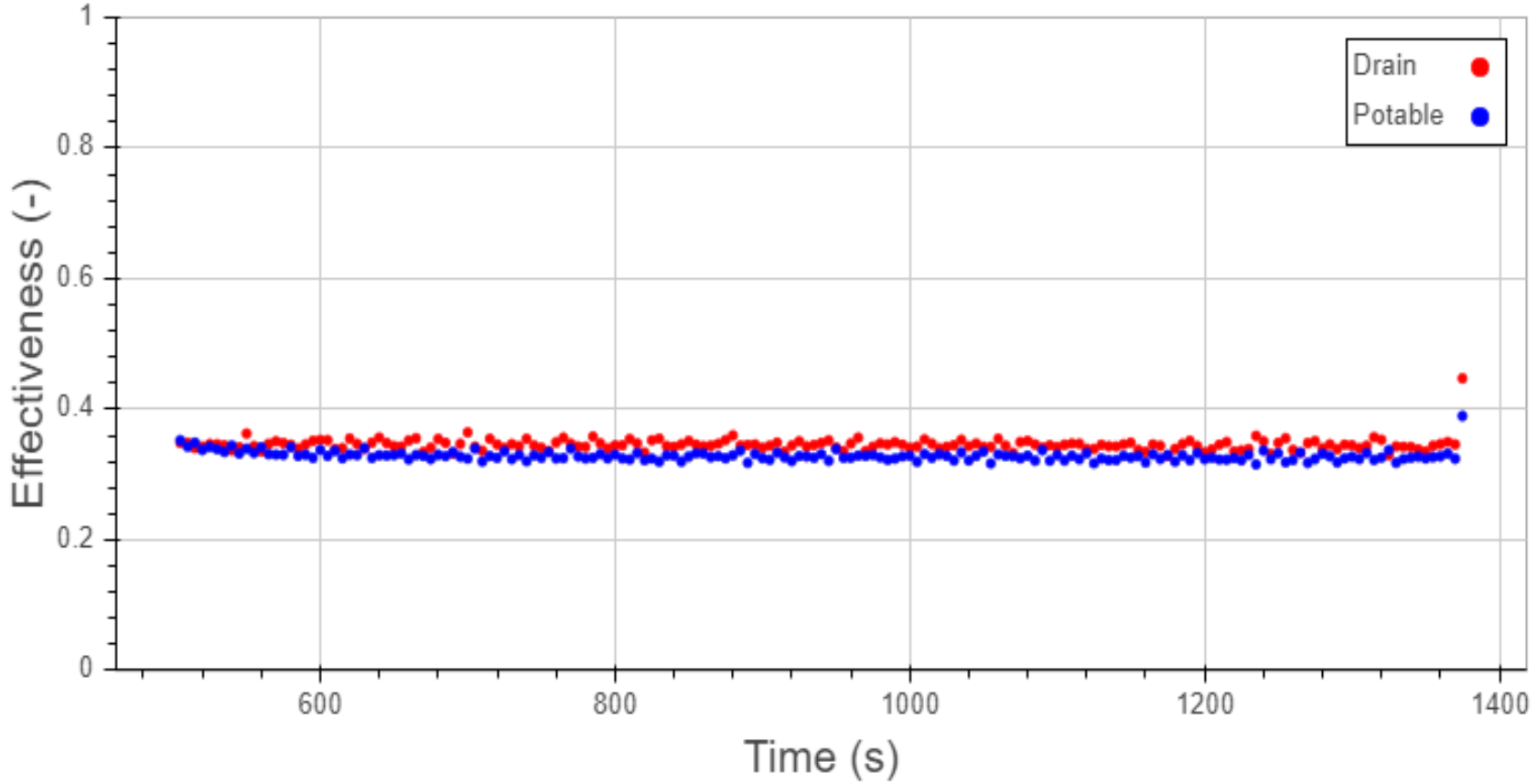


- System adjust until maintains flow & temp conditions
- Flow through DWHR unit
- Not yet at steady state
- Flow through DWHR device
- At steady state operation
- Use to identify effectiveness

Methods - Analysis



Methods - Analysis



Filtered to show only Steady State

Methods – Single Unit Effectiveness

- Developed regressions predicting effectiveness
  - 1 dimension (Slope)
  - 2nd order
  - One for each unit
  - Validated against measured data

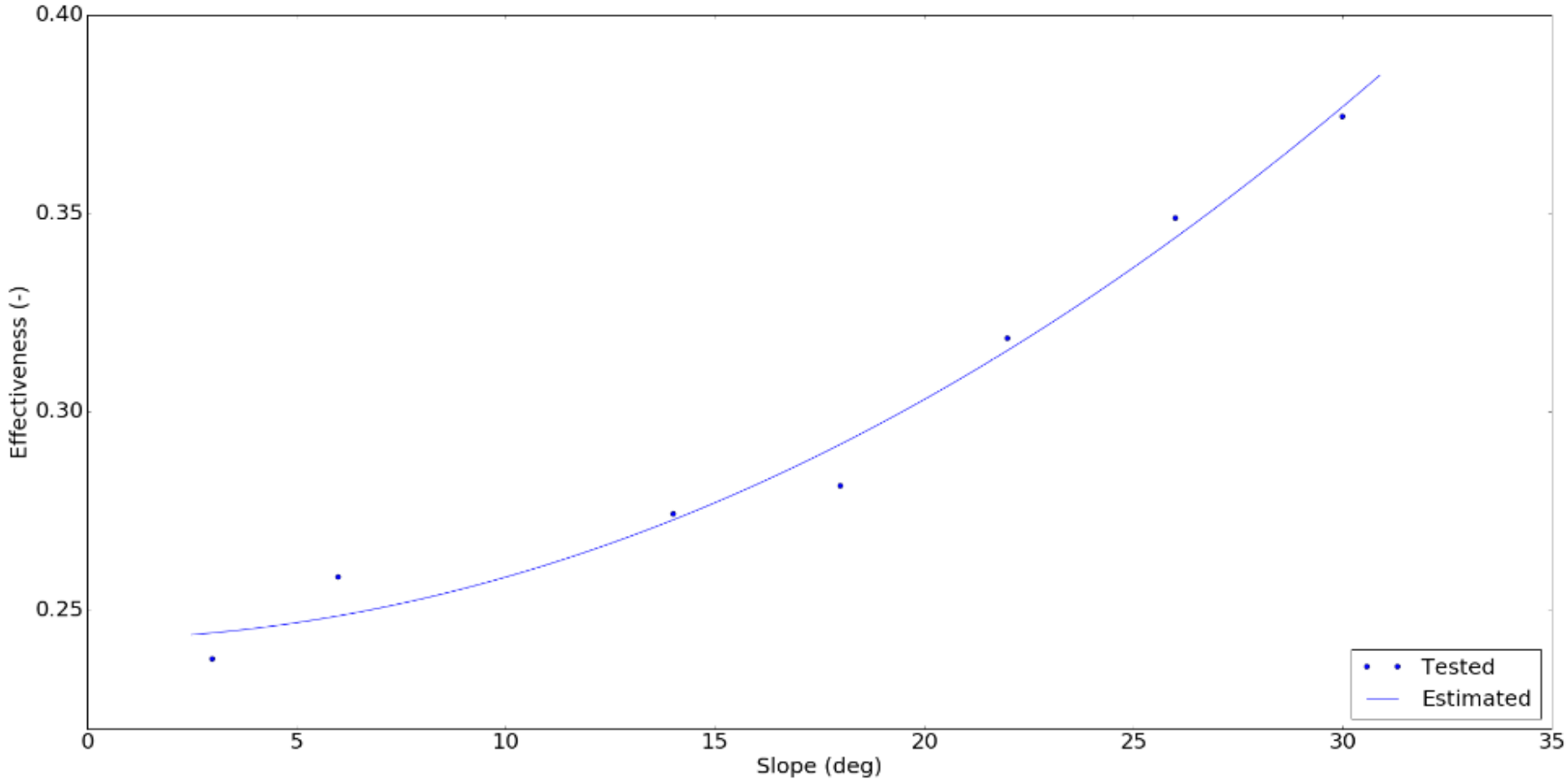
Methods – Generic Algorithm

- Developed generic algorithm from single unit models
  - Divided effectiveness by rating to create correction factors
    - This step must be replicated using angle on IAPMO ratings sheet
  - Averaged correction factors
  - Regress => $\text{Correction Factor} = \text{f}(\gamma)$
  - Now…

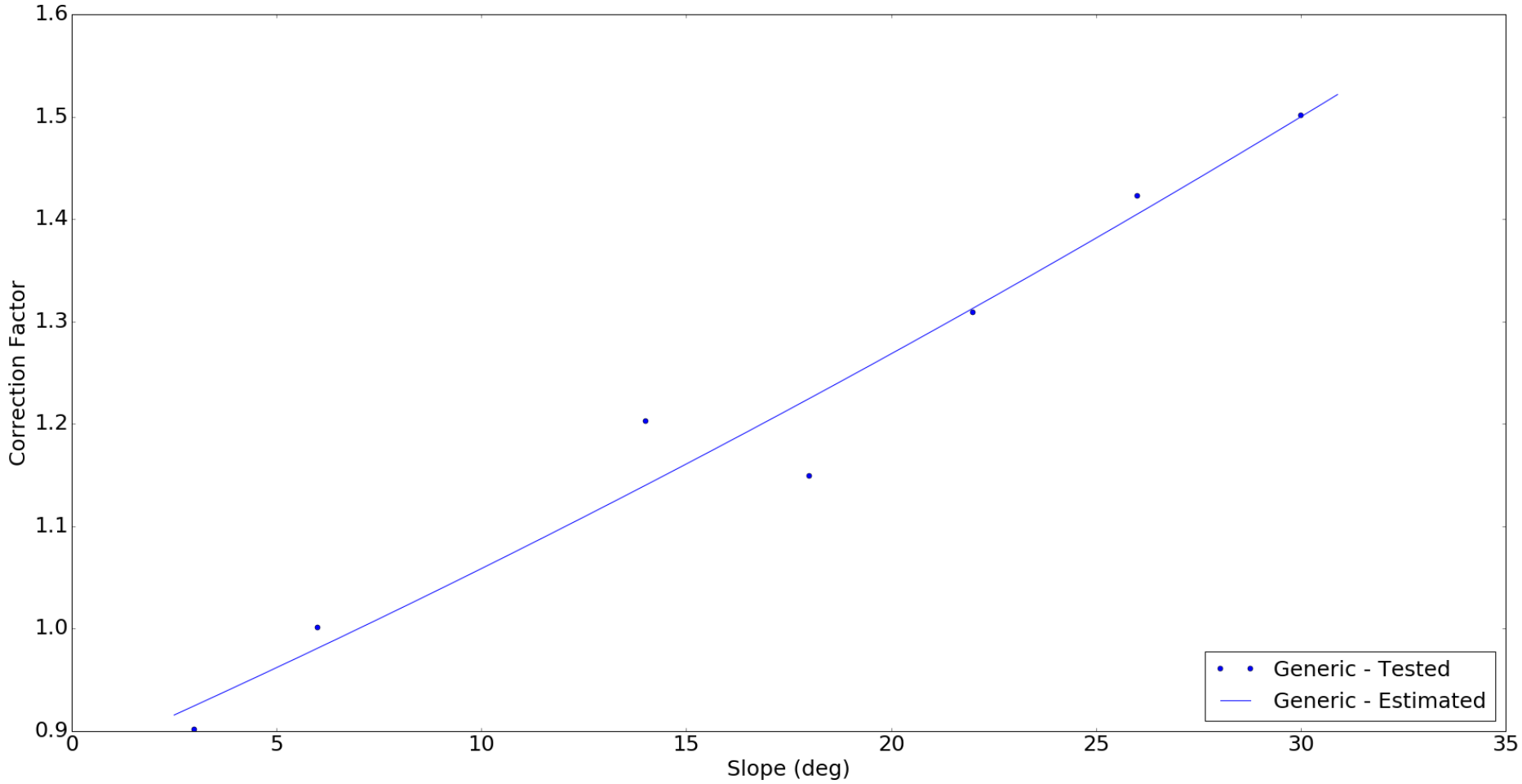
$$\varepsilon_\theta = Rating_{IAPMO} * Regression(\gamma)$$

  - where:
    - Θ = Angle in your installation
    - $Rating_{IAPMO}$ = Rated effectiveness from IAPMO spec sheet
    - γ = Angle specified on IAPMO spec sheet

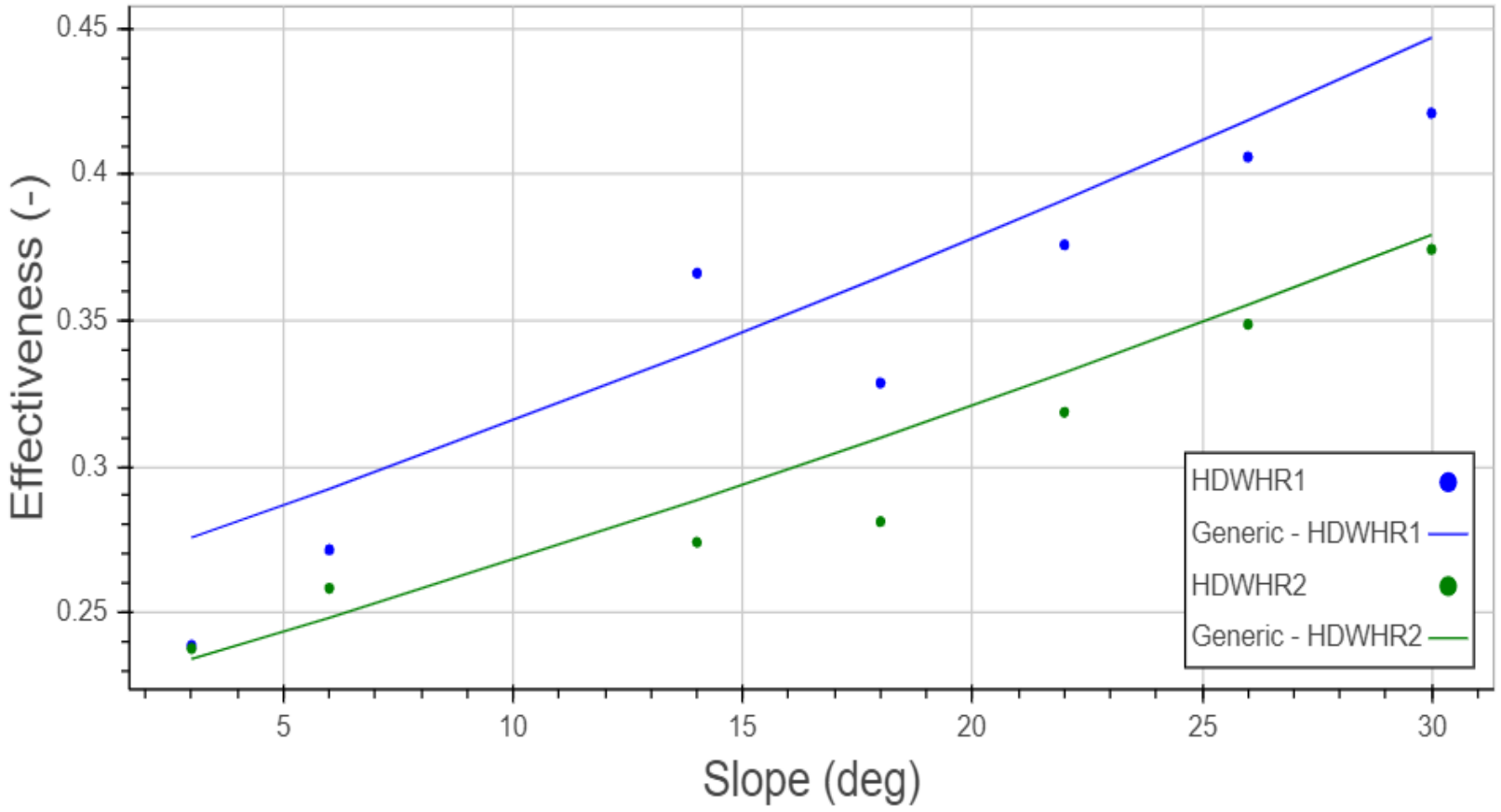
Results – Single Unit Effectiveness



Results – Generic Model Correction Factors



Results – Generic Algorithm



Conclusions

- Responding to IAPMO IGC 346-2017 test protocol for sloped DWHR devices
- Performed testing on 2 sloped DWHR units
  - Identified effectiveness as a function of installed slope
- Created generic regression
  - Predicts effectiveness when installed slope differs from slope used in ratings test
  - Less than 5% error in most cases
- Regression is available for use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