

Dehydration of water-in-bitumen emulsion using polyoxyalkylated DETA



Presenter: Johann Venter
In recognition of Jan Czarnecki,
A true mentor and friend!



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Outline

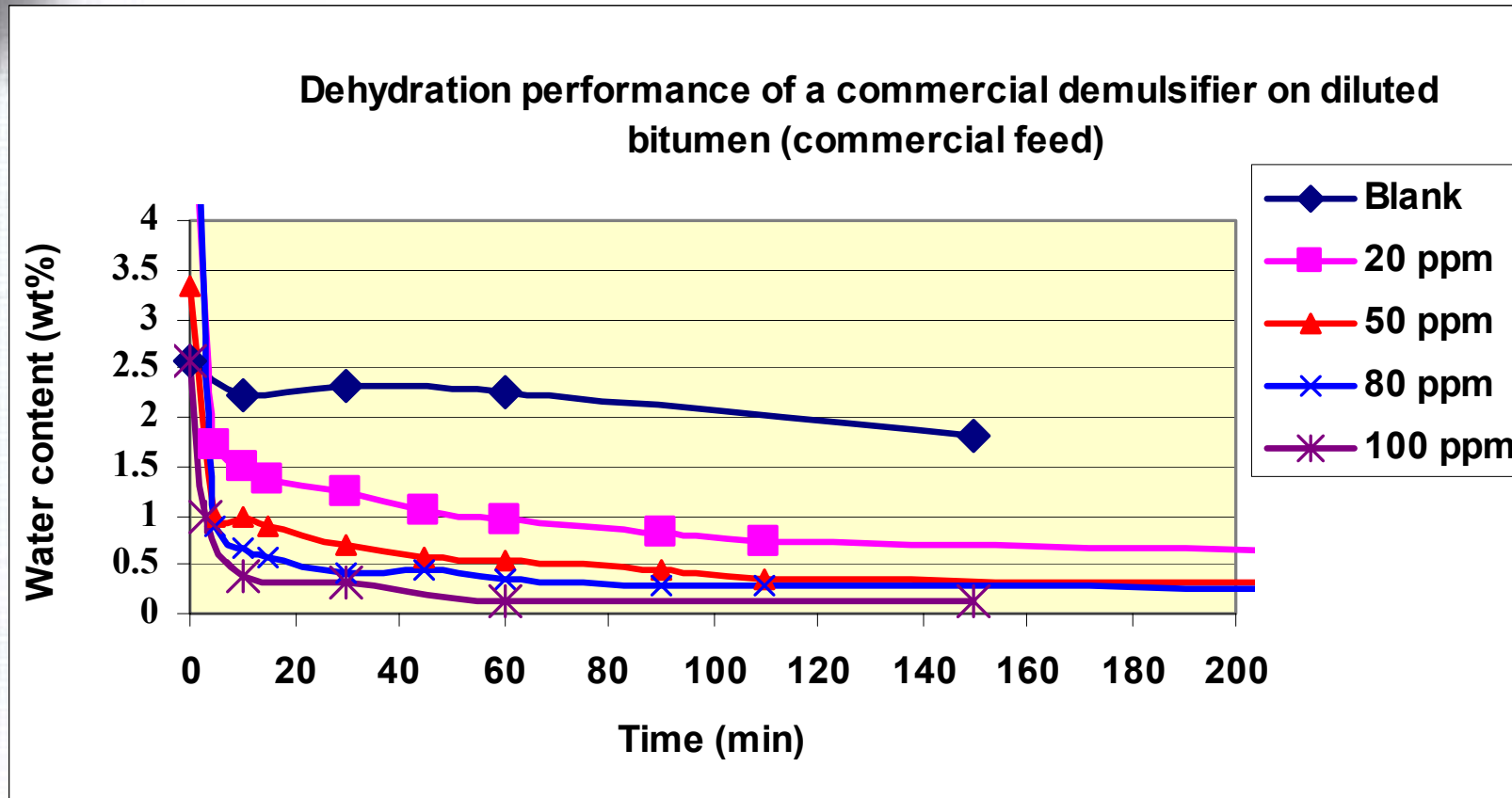
- **Introduction**
 - Oil sand process
 - Application of demulsifier
 - Commercial demulsifier performance
- **Experiments**
 - RSN determination
 - Settling test
 - Centrifugation test
- **Results and Discussions**
 - Correlation of RSN and PO/EO
 - Settling test results
 - Centrifugation test results
- **Summary**



Introduction

- **Oil sand processing generate stable water in oil emulsions**
- **Water in diluted bitumen detrimental to downstream processing**
 - **Promote corrosion**
 - **Promote mineral solid carry-over**
 - **May cause catalyst poisoning**
- **Addition of Specialty Oil Field Chemicals facilitate processing**
 - **A synergistic combinations of chemical and mechanical treatment ensures reliable operation.**
- **Demulsifiers have been in use in commercial Oil Sand plants since 1989 and has shown**
 - **Improved dehydration**
 - **Improved throughput**
 - **Improved mineral solid removal**

Introduction



- Champion Technologies, CANMET and Syncrude Canada cooperated in this study to investigate demulsifier performance as a function of –
 - Molecular architecture – Copolymer type, EO content, Co-monomer ratio
 - Relative solubility Number - HLB



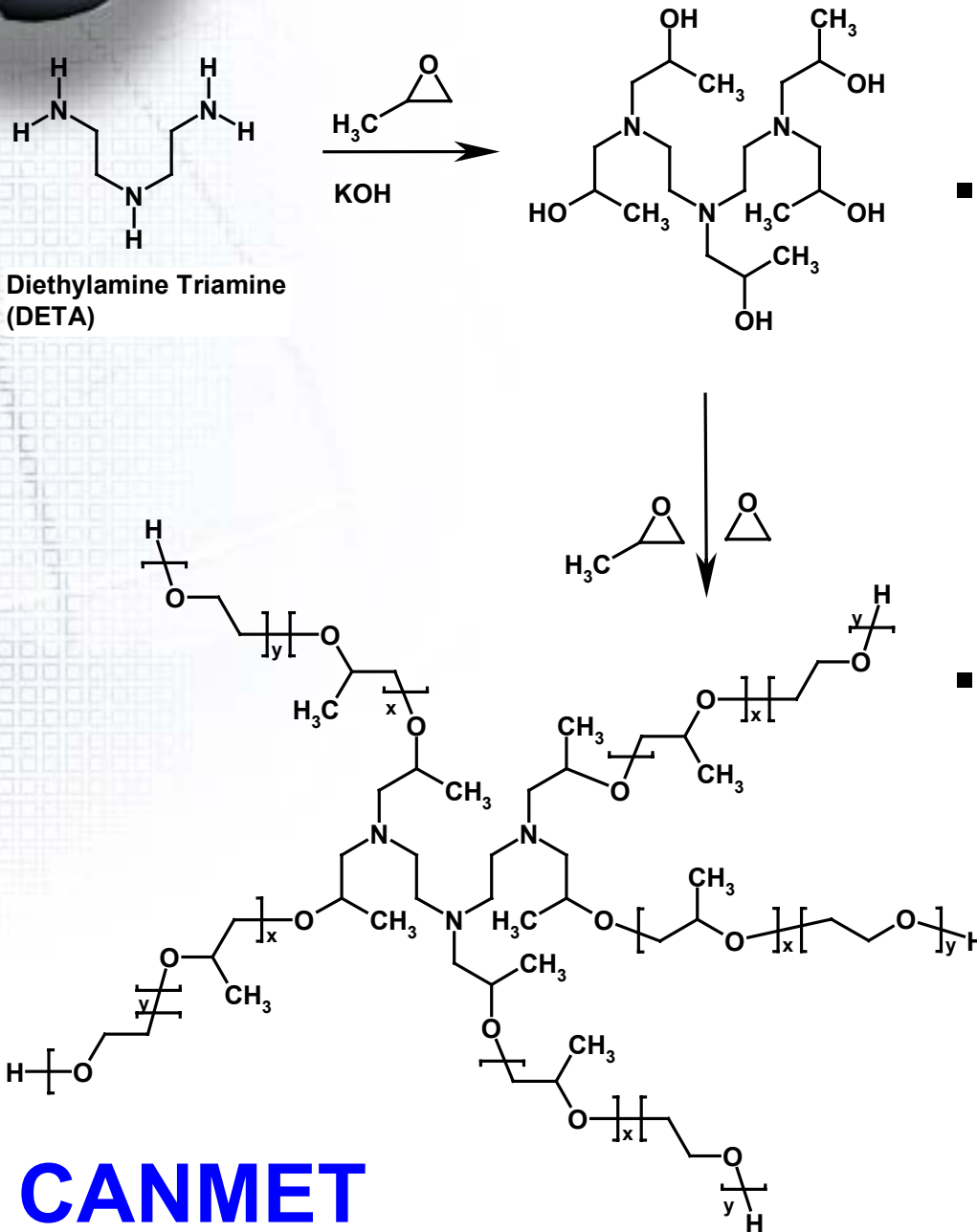
Efficient demulsifier design

- System specific
- Multi-component design aimed at
 - Promoting water drop
 - Dehydration to pipe-line specification
 - Interface control
 - Mineral solid control
 - Organic solid control
 - Asphaltenes
 - Wax
 - Metal-naphthenates
- This study report just on dehydration!





Experimental – Demulsifier Description



- **Non-ionic surfactants based on DETA EO/PO copolymers**

- block copolymer
- random copolymer
- Systematic variation of PO and EO percentages

- **RSN determination**

- Using new procedure developed by CANMET
- Presented by Tadeusz Dabros



Gravitational Settling Test Procedure

- **Evaluating demulsifier performance in IPS operation**
 - Traditional bottle test
 - Diluted froth (naphtha to bitumen ratio, 0.65) was allowed to settle at 80°C for three hours
 - At the end of settling, sample was taken at the middle of the oil phase
 - Water content was analyzed
- **Demulsifier performance was evaluated by water removal (1)**
- **Water removal (%) = $(C_o - C_t)/C_o * 100$ (1)**
 - C_o : water content of blank sample after settling
 - C_t : water content in oil phase with surfactant addition

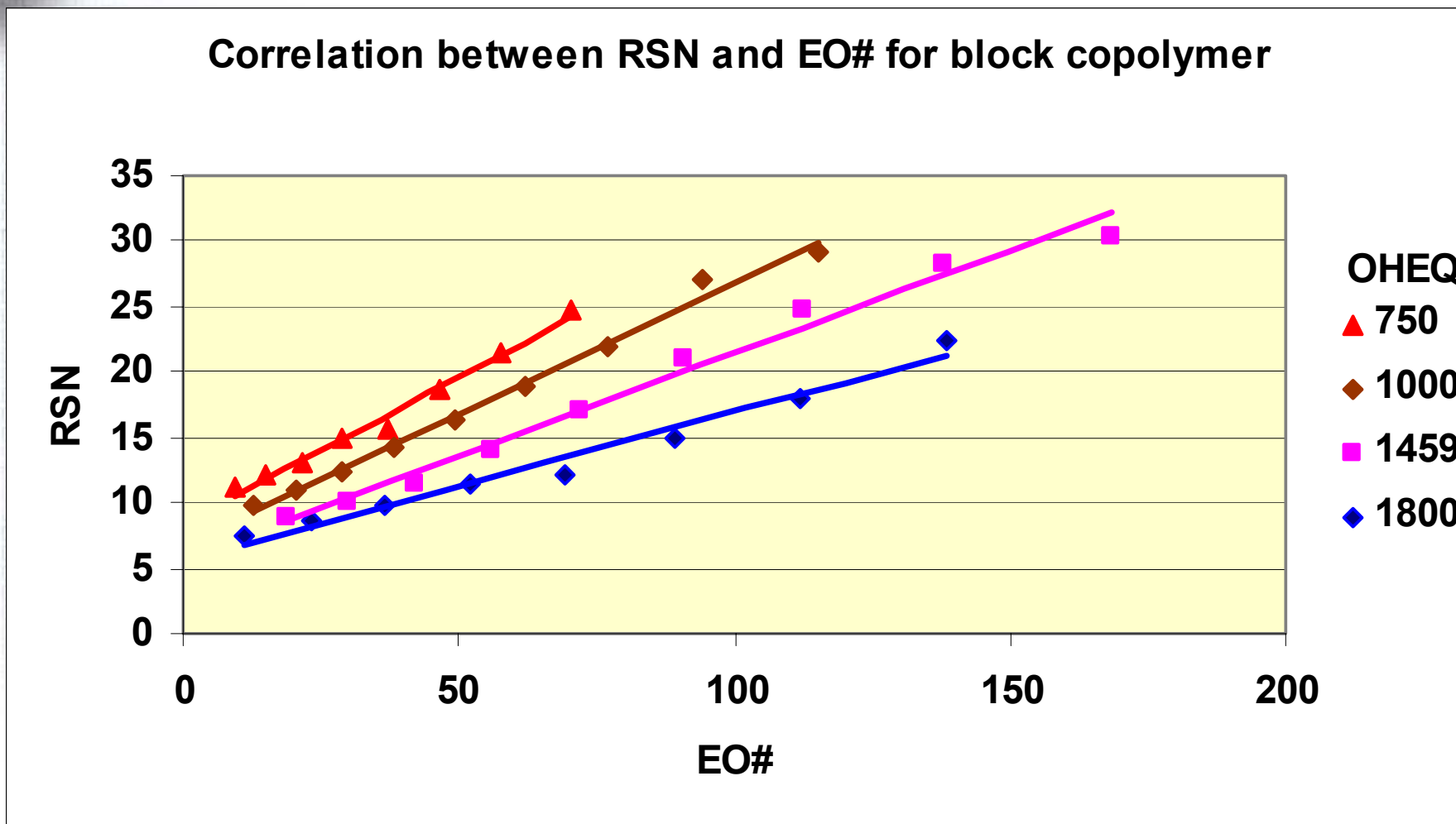


Centrifuge Test Procedure

- **Mimic the centrifuge plant in the oil sand operation**
 - Froth and naphtha (N/B 0.65) were mixed in a 32-oz jar;
 - Demulsifier was added and mixed for 2 min, sample was transferred to 12-mL centrifuge tube
 - Centrifuge the sample for 10 min at 1200 rpm
 - Water content was measured for mid oil phase
 - Water removal % was calculated using Equation 2
- **Water removal (%) = $(C_o - C_t)/C_o * 100$ (2)**
- **Where C_o : water content of blank sample after centrifugation**
 C_t : water content in oil phase with demulsifier addition

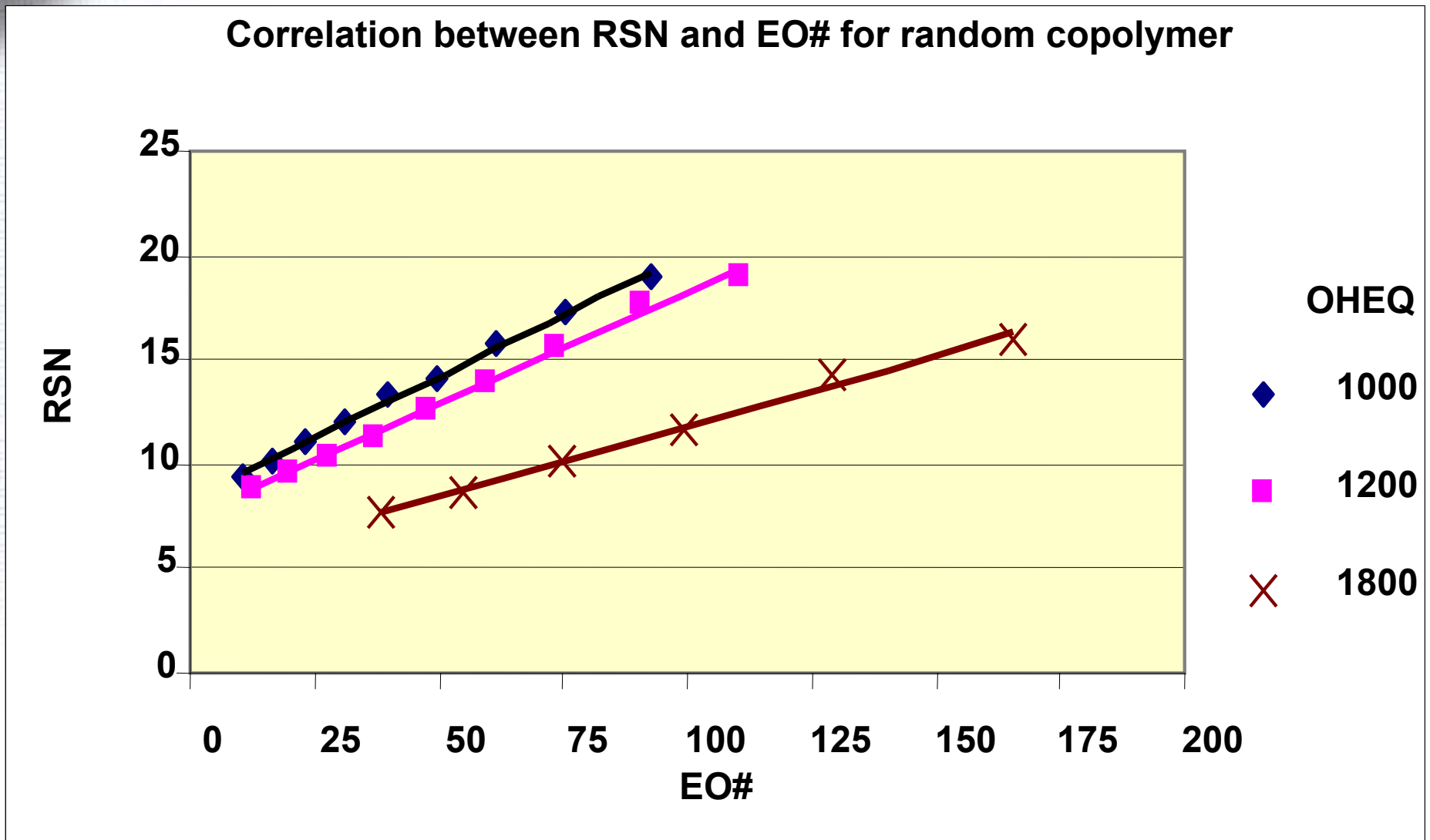


RSN of Block Copolymers





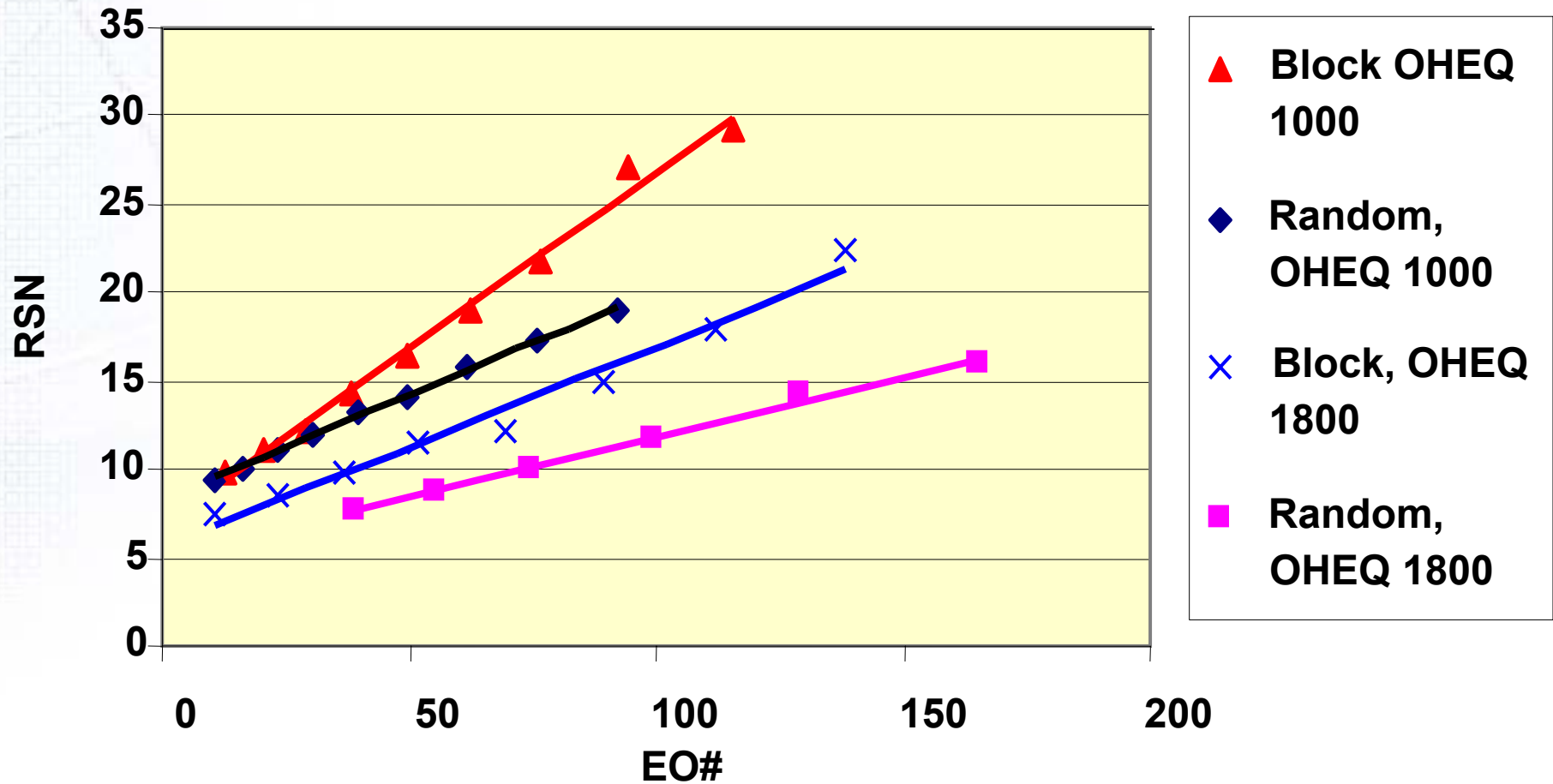
RSN of Random Copolymers





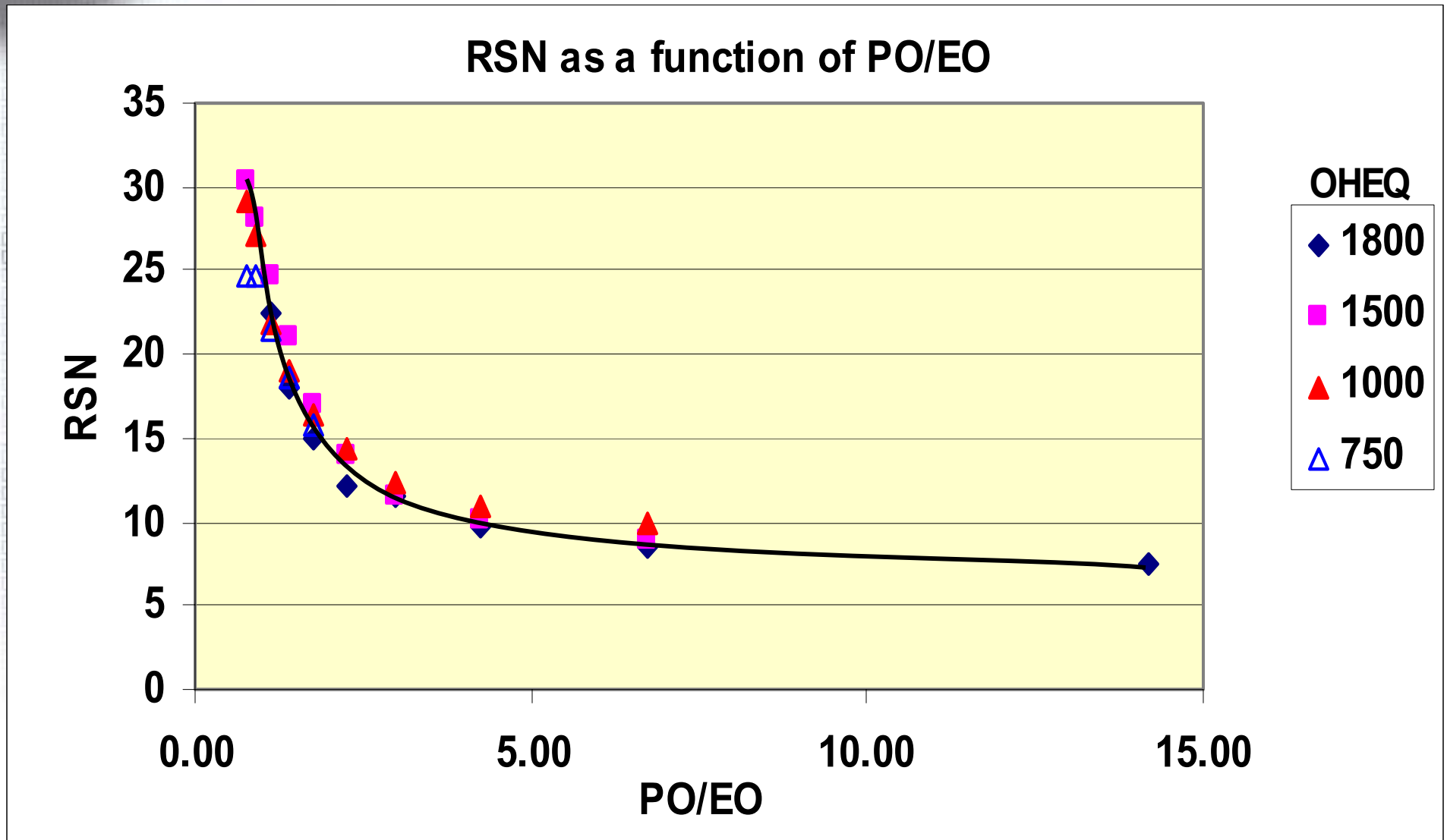
Block and Random Copolymers RSN

Comparison between block copolymer and random copolymer





RSN as a function of PO/EO Ratio





RSN Prediction for DETA-based Demulsifiers

- Regression of RSN number with EO number and PO number resulted in equations that can be used to predict the RSN number of block copolymers and random copolymers
- For block copolymers

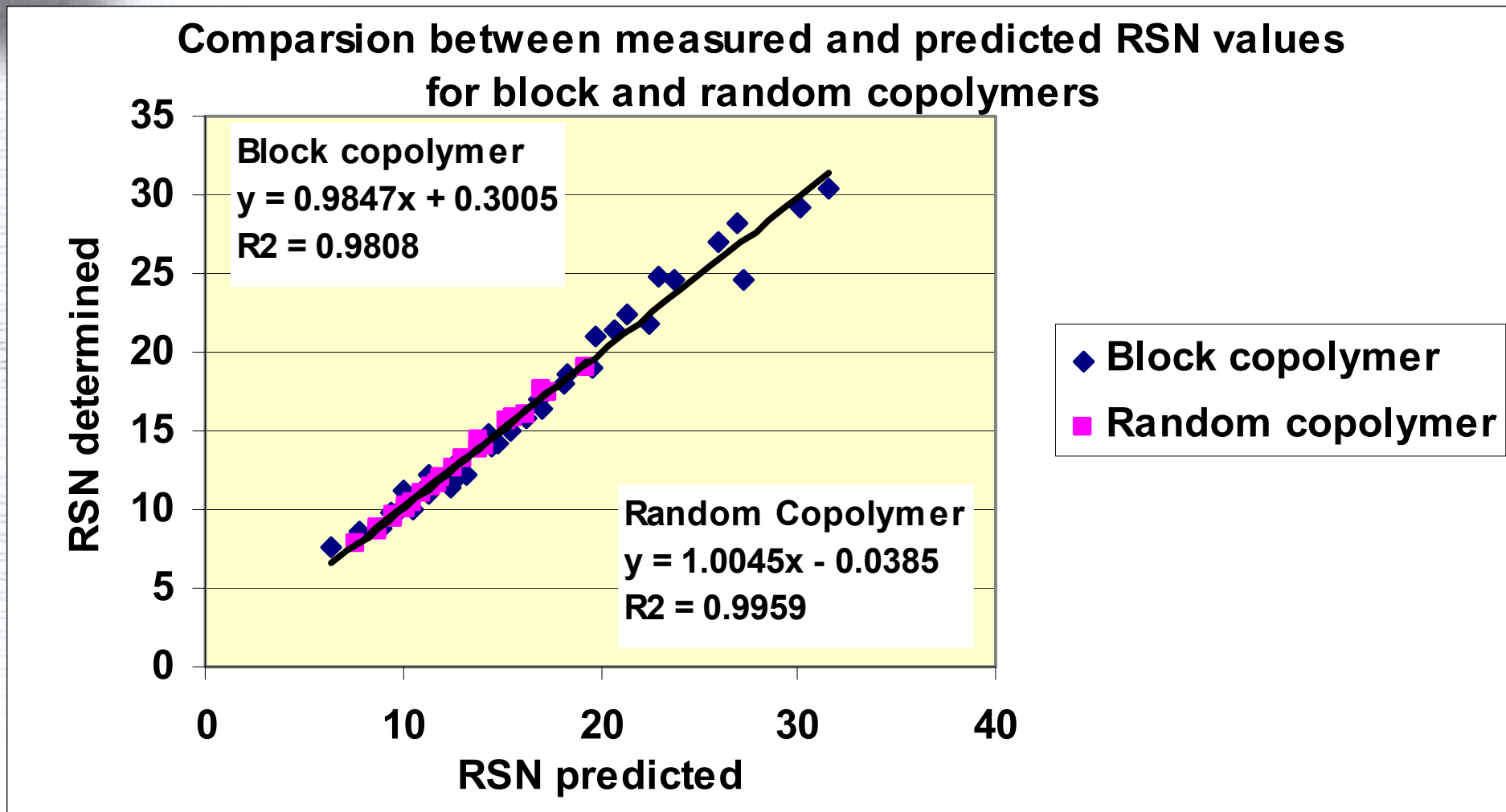
$$\text{RSN} = (-0.0012)(\text{PO}\#)(\text{EO}\#) - (0.0309)(\text{PO}\#) + (0.2988)(\text{EO}\#) + 9.9246$$

- For random copolymer

$$\text{RSN} = (-0.000744)(\text{PO}\#)(\text{EO}\#) + (0.1832)(\text{EO}\#) - (0.0467)(\text{PO}\#) + 12.334$$

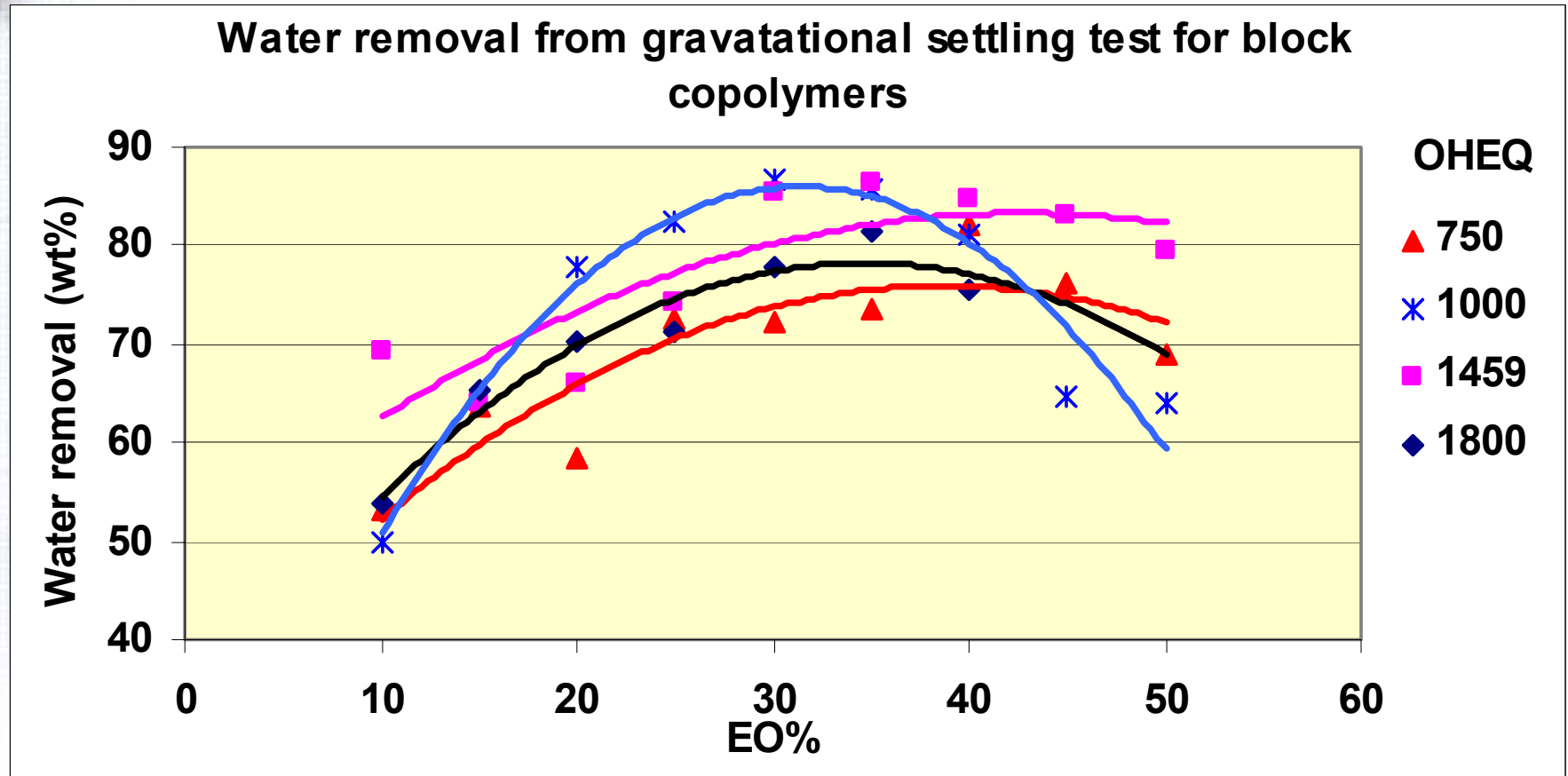


Comparison between measured and predicted Relative Solubility Numbers





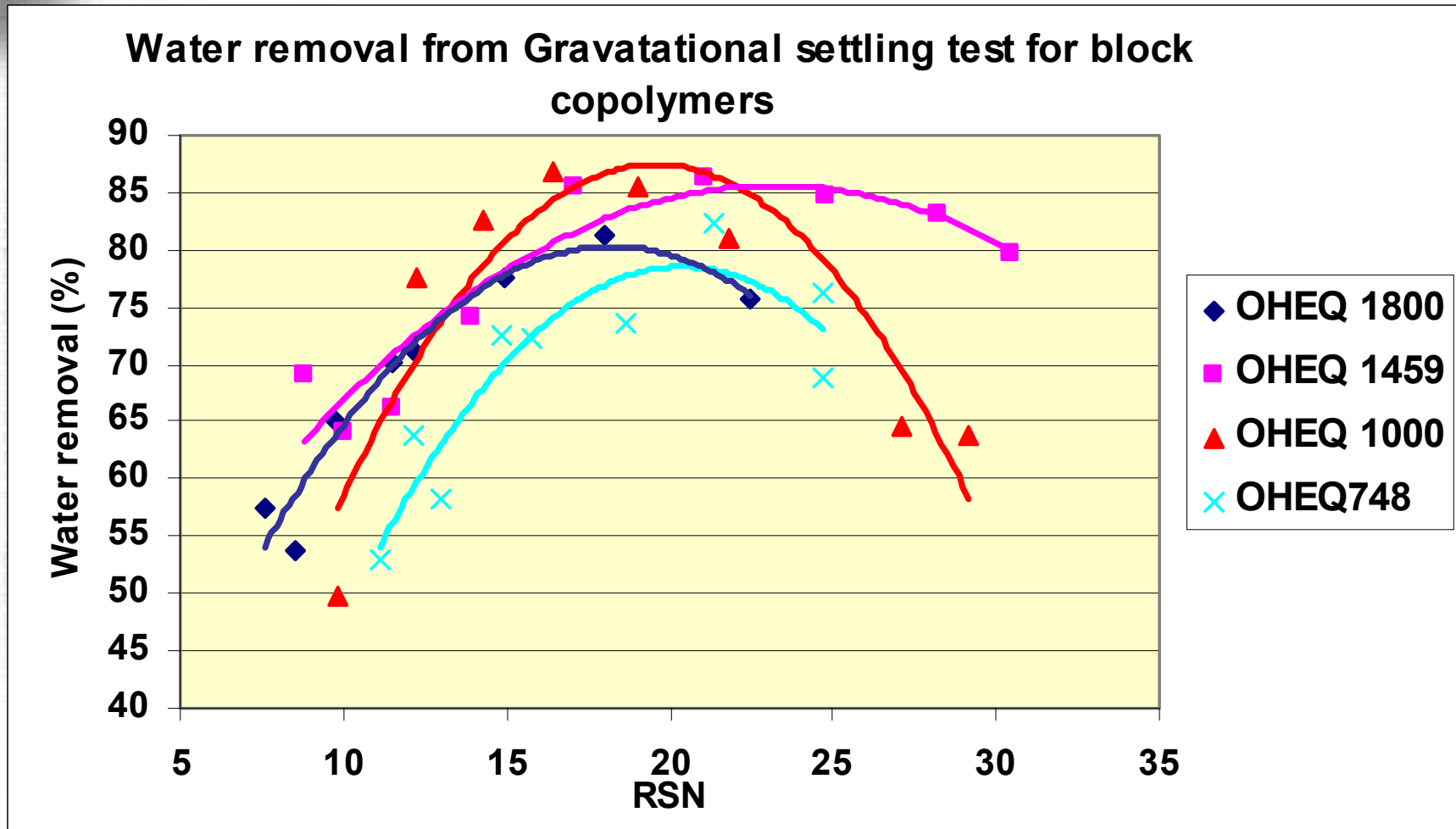
Gravitational Settling Test Results



- For each OHEQ series, an optimal EO% existed for dehydration performance
- The optimal EO% is dependent of the OHEQ or PO number



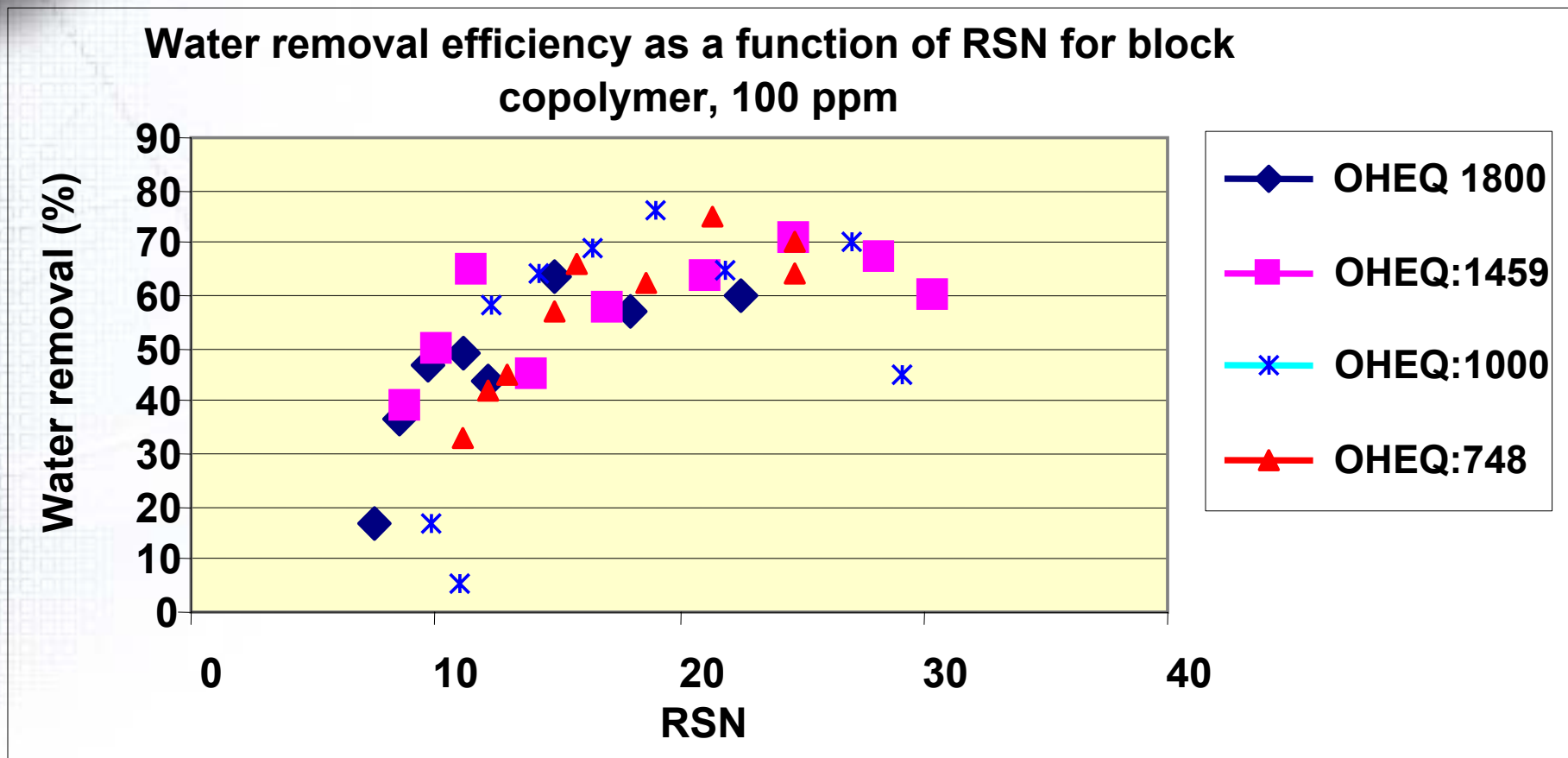
Dehydration as a function of RSN



- Dehydration performance showed an optimal RSN range of 18-22



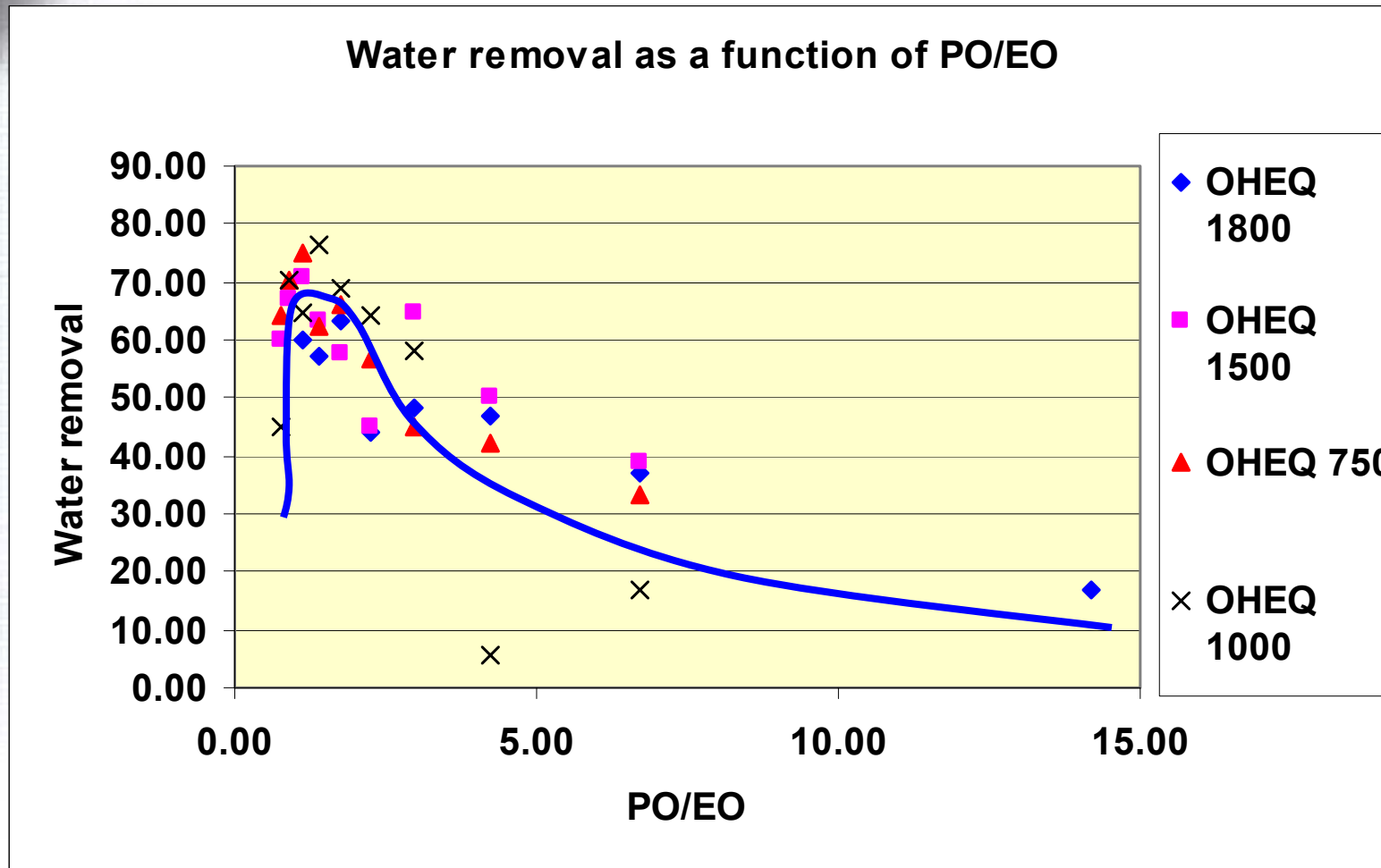
Centrifugation Test Results Block



- Dehydration performance increase with RSN until RSN reaches about 20
- Optimal RSN existed in the range of 18-22



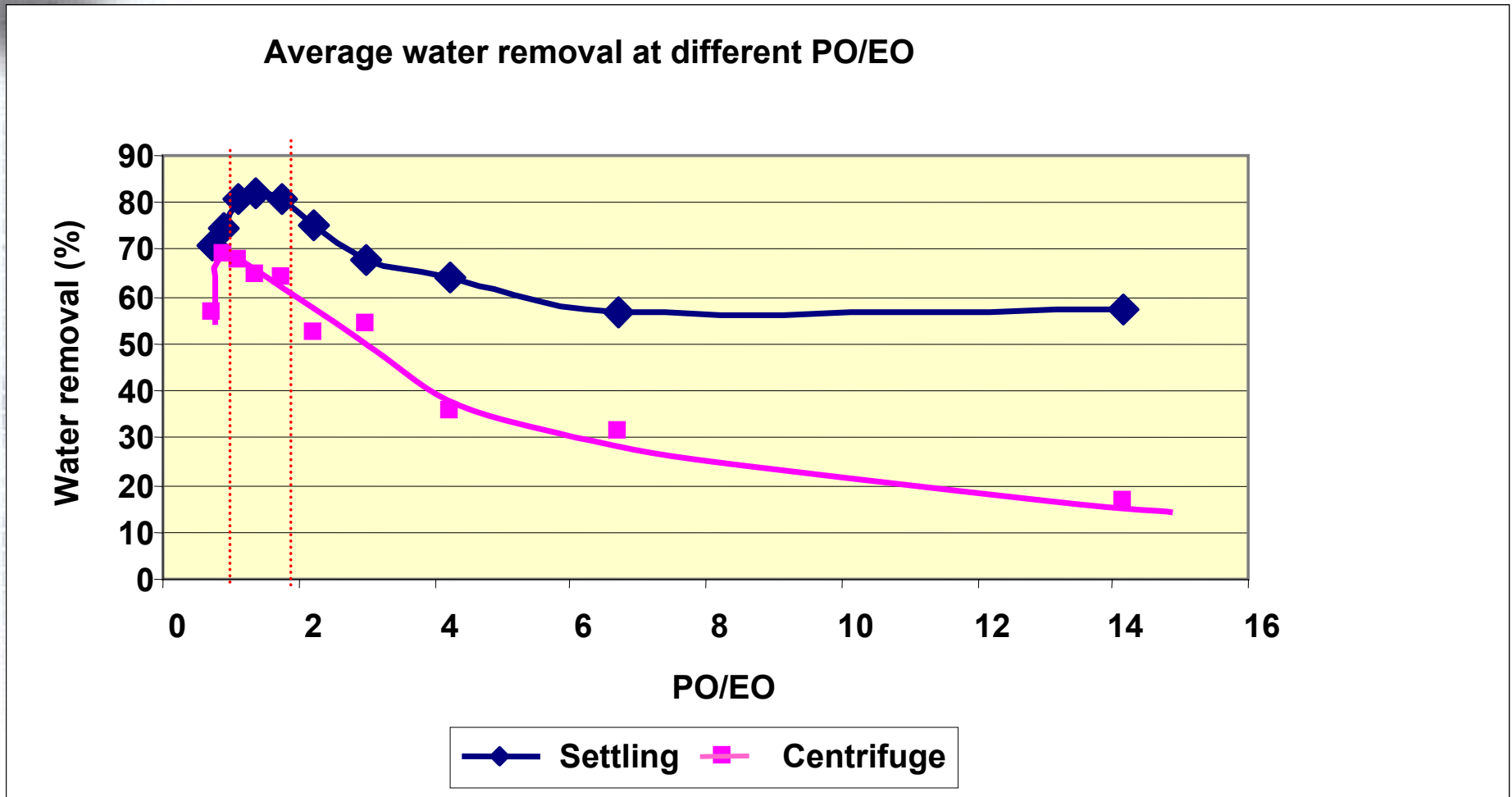
Dehydration as a function of PO/EO Ratio



- Dehydration performance is influenced by PO/EO ratio
- Optimal PO/EO in the range of 1-1.8



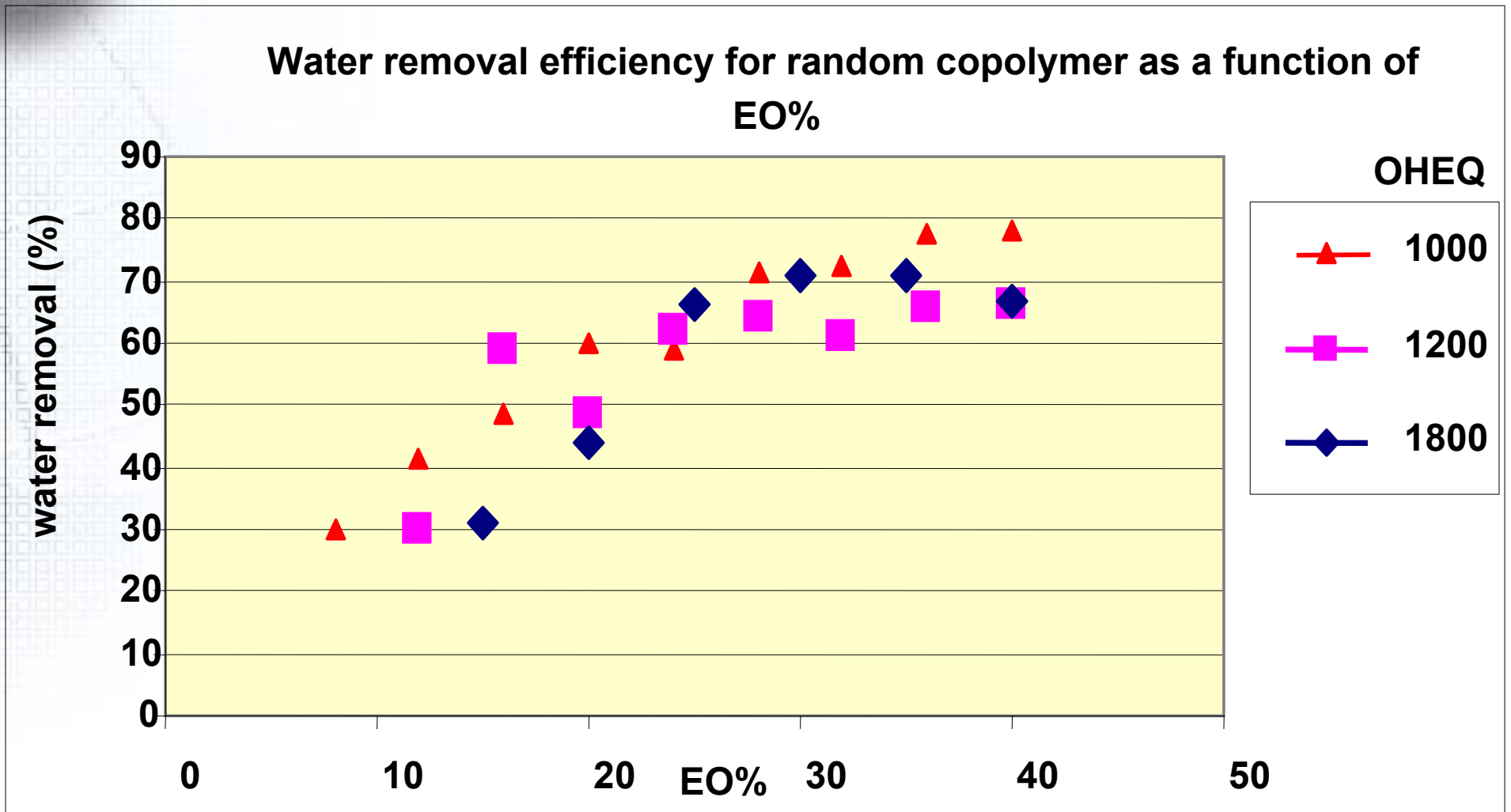
Water removal as a function of PO/EO ratio



- Optimum water removal at PO/EO ratio between 1 – 1.8



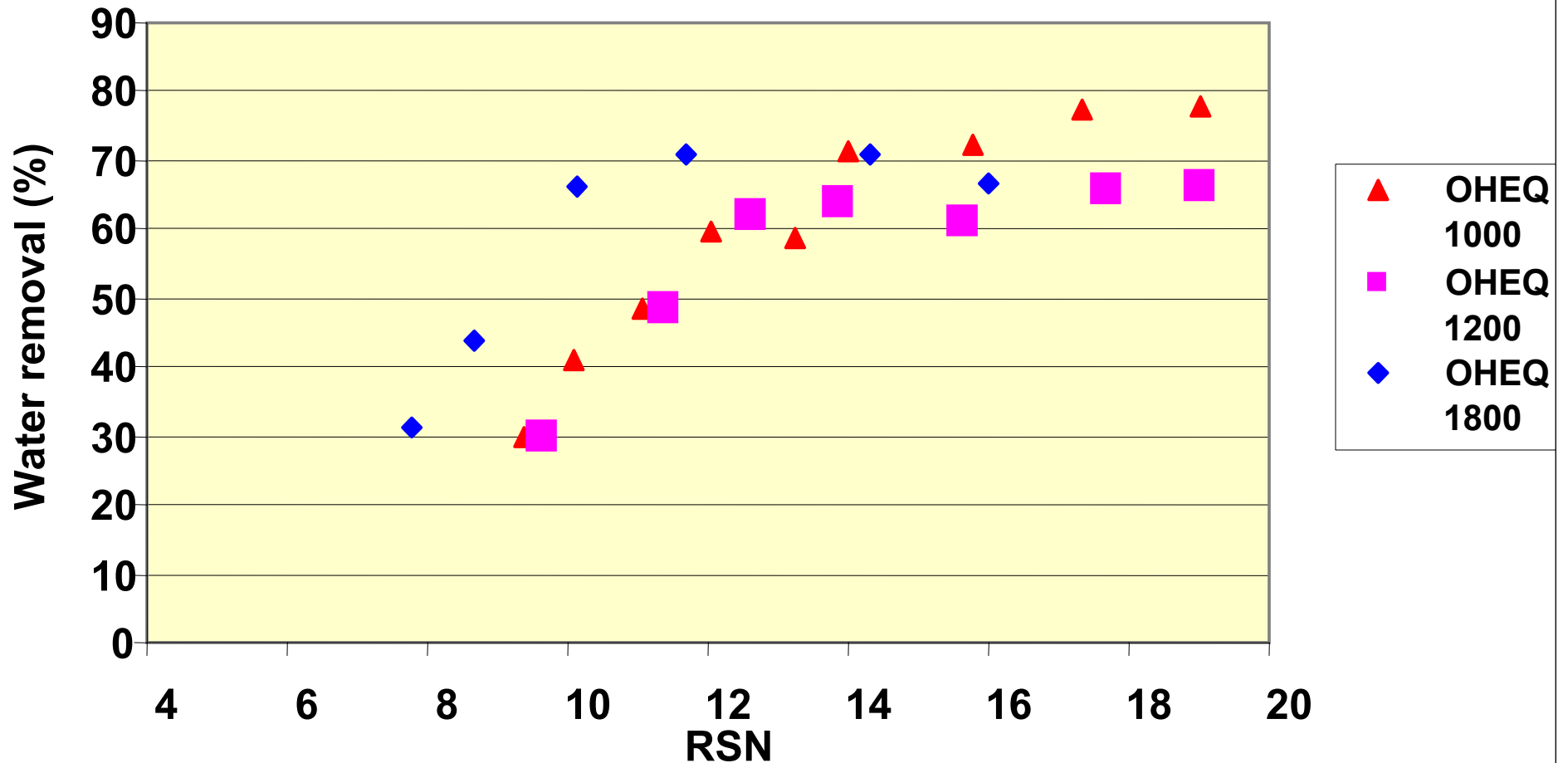
Centrifuge Test Results- Random copolymer





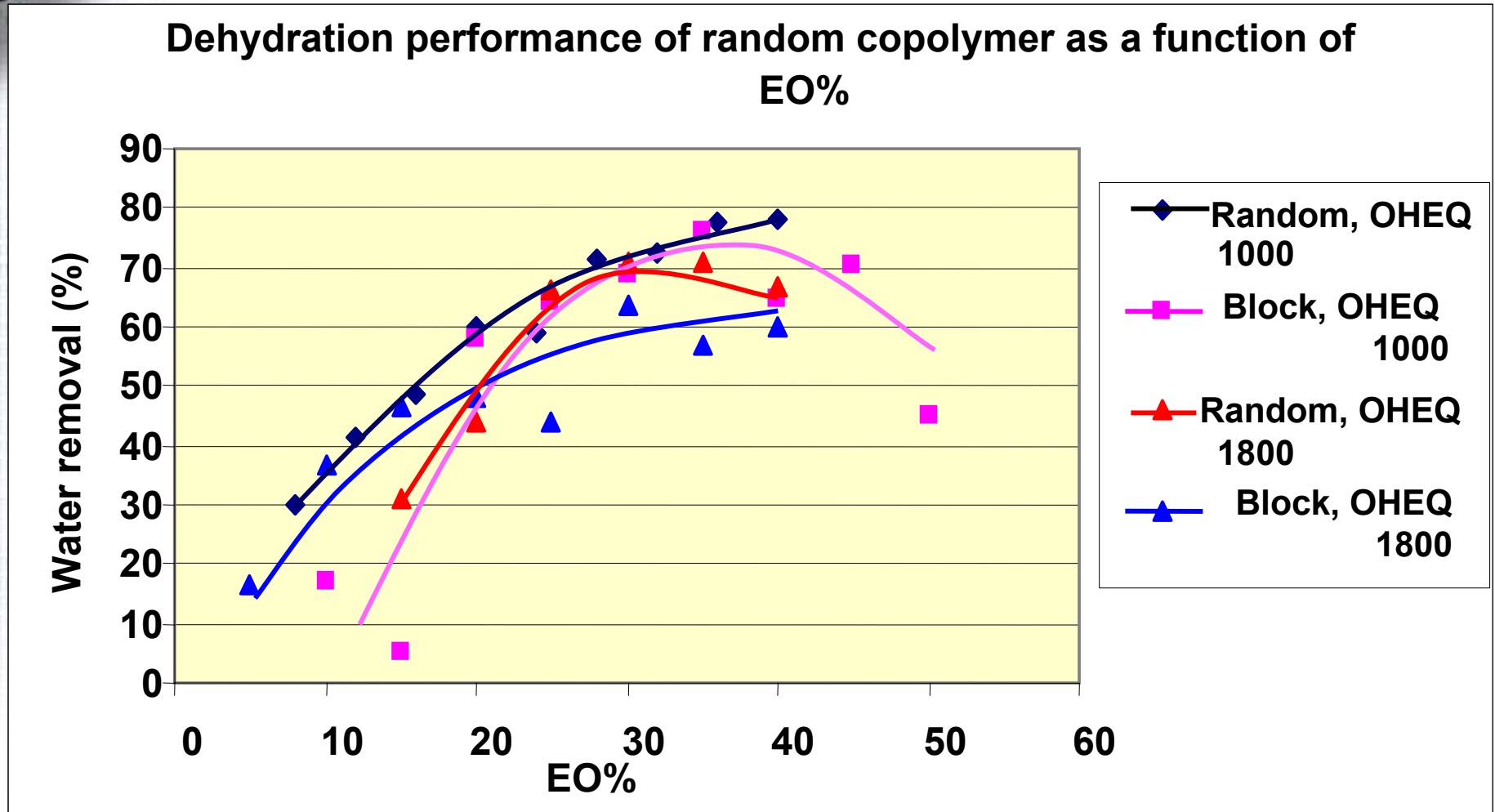
Random copolymer

Random copolymer water removal efficiency as a function of RSN





Comparative Dehydration performance





SUMMARY

- **Efficient demulsifier is very important in oil sand processing**
- **Experimental DETA-based demulsifiers were tested in diluted oil sand bitumen**
- **RSN values of the demulsifiers correlates well with EO# and PO/EO ratio**
- **Demulsifier dehydration performance are correlated to the EO content, and RSN value**
- **Optimal EO content or RSN number were observed**
- **Block copolymers and random copolymers do not show significant difference in terms of dehydration performance**



Thank you for your time!

Any questions?